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Development of Methods for Assessing the Impact of Environmental Regulation on Competitiveness

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Abstract. Discussions about whether the improvement of environmental indicators of companies has a positive or negative impact on their competitiveness (i.e., based on their economic indicators) have been conducted for a long time: environmentalists and the public insist on stricter environmental standards, and politicians, economists, and the business community are looking for a compromise between the costs of environmental protection and economic efficiency. Understanding this relationship is important for all disputing parties since two goals are simultaneously pursued: ensuring high quality of the environment, which requires unproductive costs, and obtaining good economic results. This is also important for separating environmental, economic, and political goals: is the policy of "greening" business implemented in developed countries a real fight against climate change and bad ecology, or is it used as a tool for mobilizing the electorate and hidden protectionism? Despite a large number of studies conducted in this area, the question remains open about the direction of the causal relationship: whether environmental investments lead to higher profits or simply act as indicators of firms with high financial results. This article presents a comparative analysis of methods and models for forming relationships between the environmental and economic characteristics of firms in the context of the activation of the international environmental agenda as one of the promising areas for the development of economic analysis. The authors show that the relationship between environmental regulation and competitiveness is not the same and depends on the market structure of the industry, while important problems of analysis are the presence of different approaches to defining the concepts of "competitiveness," "economic efficiency," "environmental efficiency," and "regulatory rigor," as well as the use of various indicators for their measurement, the complexity of selecting indirect indicators of environmental regulation and competitiveness, and the availability and quality of data. Furthermore,the possibilities and problems of the empirical analysis of the relationship between environmental and economic efficiency according to Russian companies and domestic statistics are studied.

Keywords: Competitiveness; Economic efficiency; Environmental costs; Environmental efficiency; Methods and models of environmental regulation

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1. Introduction

Today, the problem of the decarbonization of the economy in the context of climate change forms one of the central topics in the economic and political agendas of developed countries. Leading economic scientists are actively involved in substantiating solutions to this problem. In connection with the EU's plans to introduce a border carbon tax, environmental policy issues have also come to the fore in Russia: a new goal has been announced within the framework of the Paris Climate Agreement, and the adoption of a low-carbon development strategy and a law on carbon regulation is expected (Davydova, 2021). Thus, the issue of the impact of environmental costs on competitiveness is important for Russian companies today: their competitiveness on the international market and the risks to Russia's economic development can be closely related to the costs of monitoring greenhouse gas emissions and organizing appropriate accounting and reporting and the introduction of environmental standards and practices that are as close as possible to the best international ones.

The degree of strictness of environmental legislation as a way to reduce the anthropogenic burden on the environment, as well as the tools and mechanisms of environmental regulation, varies from country to country and depends on the level of development of national economies and social institutions. Stricter environmental standards mean for firms a larger amount of environmental costs, consisting of the costs of compliance with environmental standards and the fee for their violation. On the one hand, the inevitable consequence of environmental regulation is that it withdraws part of the capital of firms from production, leads to higher prices, reduces profits, and therefore worsens the competitiveness of both individual firms and the national economy as a whole (Ambec et al., 2010). On the other hand, since environmental pollution is a consequence of inefficient use of resources, stricter environmental regulations will encourage firms to innovate, resulting in saving resources and compensating for environmental protection costs, which will eventually increase their competitiveness (Porter and van der Linde, 1995). One way or another, it is obvious that "environmental safety issues are becoming more and more relevant in regions with a high quality of life and high population density, which leads to the necessity of implementation of various kinds of innovative solutions in this area" (Tatiana andMikhail, 2020).

The peculiarity and novelty of this study consists in the development of a methodology for assessing the direction and closeness of the relationship between environmental costs and the economic results of companies that determine their competitiveness.

Therefore, this study aims to develop methodological approaches to establishing the relationship between environmental regulation and competitiveness through the characteristics of indicators used to measure them, as well as the adaptation of these approaches to use in the Russian economy based on the study, systematization, and comparative analysis of economic models and methods proposed by scientists in the study area.

2. Literature Review

In the foreign scientific literature, the growth in the number of publications on the relationship between environmental regulation and economic results began in the 1970s with the expansion of the environmental movement that started in the late 1960s and with the activation of environmental regulation in the United States and European countries· At this time, for the first time, economists systematically investigated the efficient and optimal use of resources at the macro level, introducing natural resources into neoclassical models of economic growth. The main attention was paid to the analysis of the trade-off between economic growth and ecology and the relationship between the degree of strictness of environmental regulation and its possible consequences. Based on theoretical models for optimizing economic growth and environmental quality, it was shown that improving the quality of the environment, which requires spending on pollution control, can only occur at the expense of other components of national income-production investment and consumption, and with cross-border mobility of factors of production and differentiation of regulation between countries, the regulated industry will be completely displaced from a more regulated economy to a less regulated one. At the microeconomic level, an important issue was the analysis of the impact of state regulation on the firm's decision-making regarding pollution control costs, employment, and investment. According to neoclassical theory, environmental regulation is an additional burden for firms and the national economy as a whole.

Contrary to traditional views, Porter and van der Linde (1995) argued that environmental pollution is a sign of economic inefficiency and represents an unproductive use of resources. Strict environmental standards and properly developed environmental regulation tools "can initiate innovations that can partially or more than fully compensate for the costs of their compliance" (Porter and van der Linde, 1995). At the same time, firms of those countries whose environmental standards will be more stringent will gain the advantage of pioneers in international markets, introducing innovations earlier than foreign competitors to ensure environmentally friendly production. The main criticism of Porter's hypothesis boils down to the following objections. First, it rejects the assumption of profit maximization by firms. Second, scientists did not agree with the statement that, since firms systematically do not use profitable opportunities, environmental regulation can help firms identify inefficient use of resources.

The authors of theoretical studies (ex ante), using formal models, sought to formulate conditions under which there was a positive relationship between environmental regulation and competitiveness.

Lankoski (2000) showed that the relationship between environmental regulation and competitiveness is not the same and depends on the market structure of the industry. Osang and Nandy (2003), using the Cournot duopoly with polluting firms, found that in the absence of state intervention, both firms choose an outdated, highly polluting technology, even if the introduction of a new technology with a low level of pollution gives higher profits for both firms (the prisoner's dilemma). State control of emissions, provided that the restrictions are sufficiently strict, eliminates the prisoner's dilemma and encourages both firms to use modern technologies with a low level of pollution (OsangandNandy, 2003). Qiu et al. (2018) focused on the fact that firms have different innovative potential. The authors used a model of monopolistic competition with linear demand and a pollution tax and concluded that Porter's hypothesis is valid for firms with higher potential, and firms with low potential will be forced out of the industry (Qiu et al., 2018). Reviews of the development of theoretical studies of the relationship between environmental and economic indicators in the context of Porter's hypothesis are presented in Wagner (2003) and Ambec et al. (2010).

The main issue of empirical research (ex post) was the discovery of a systematic link between environmental regulation and competitiveness. For example, Afanasieva et al. (2018) argued that for the effective management of competitiveness, an assessment of potential should be provided depending on the company's ability to use resources efficiently. At the same time, it is worth paying attention to the fact that "achieving environmental safety is a special activity sphere that has all the conditions and opportunities for reconciling the interests of stakeholders" (Gutman andTeslya, 2018).

Jaffe and Palmer (1997) identified three different hypotheses for which research can be conducted. The "narrow" version is that certain types of environmental regulation stimulate innovation. The "weak" version is that regulation will stimulate innovation. The "strong" version rejects the profit maximization paradigm. Rubashkina et al. (2015) found evidence in favor of confirming the "weak" version but did not find evidence in favor of the "strong" version.

The importance of having a regulatory framework is raised in Koroleva et al. (2020), where the results show that sustainable development policies can be implemented even in the absence of a strong regulatory framework.

Ramanathan et al. (2017) studied the mechanisms by which a firm's environmental behavior contributes to an increase in its private benefits: firms that apply a proactive approach to managing their environmental indicators are usually better able to extract private benefits. Hassan and Romilly (2018) found that the reduction of greenhouse gas emissions is largely associated with an improvement in economic indicators.

Russian scientists have also addressed the analysis of this topic. For example, Klochkov and Ratner (2013) concluded that Porter's hypothesis is not fulfilled; i.e., increasing the environmental friendliness of technology worsens economic indicators. Also earlier, the issue of developing an approach that allows for assessing the relative effectiveness of regional innovation systems in Russia was raised Rodionov and Rudskaya (2017), and competition issues were highlighted in Selentyeva et al. (2018) and Goncharova et al. (2017).

3. Methods

In the management of environmental regulation, the following basic concepts are used: "competitiveness," "economic efficiency," "environmental efficiency," and "strictness of regulation," and various indicators are used to measure them. To assess the international competitiveness of countries, the studies used the real value of the exchange rate, the rate of productivity growth, changes in unit labor costs, changes in the share of world exports of goods and services, and indicators of foreign direct investment. At the firm level, competitiveness is linked to economic efficiency, which is measured by a variety of indicators. Some of them characterize commercial success (growth, market share), while others are indicators of financial success. The prevailing methods of measuring the financial performance of firms are the use of a single index and index systems. Index systems combine a number of indices for a comprehensive assessment of financial results; however, their application leads to heterogeneous results due to the subjectivity of the choice of weights assigned to the indices involved in the calculations (He et al., 2020). The main single indices in empirical studies are the market value indicator Tobin's Q and indicators of financial profitability—the return on assets (ROA) ratio and the return on equity (ROE) ratio. The ROA and ROE indicators are based on accounting data and reflect past results. Tobin's Q measures the market value of a firm and, like other stock market indicators, reflects both current financial performance and expectations for future results. The use of composite structures similar to competitiveness ratings is considered unacceptable since the indicators included in the ratings and their weights are chosen by experts and are subjective (Lankoski, 2000). Also, the question of what should be measured—results or factors determining competitive advantages—has not been resolved. Such measures as capital expenditures on pollution control technology, the volume of pollutant emissions, the number of environmental accidents or lawsuits for environmental violations, the introduction of environmental management standards, and ratings of the best environmental companies are used as environmental characteristics. Thus, the choice of indicators is determined by the design and purpose of the study, and its results may depend on the chosen approach since competitiveness and environmental characteristics are not uniquely determined. An interesting and important question is whether we can find any system—a logical link between environmental regulation and competitiveness.

The study of the methods and results of empirical studies published in peer-reviewed journals (Lankoski, 2000; Ambec and Barla, 2006; Ambec et al., 2010; KoźlukandZipperer, 2014) allows us to form a methodology for a comprehensive empirical analysis of the relationships between the environmental and economic efficiency of firms. The content of each stage of the analysis is presented in Table 1.

Table 1 Methodology of complex analysis of interrelations between ecological and economic efficiency

Dependent Variables	Independent Variables	Methodology
	Stage 1. Analysis of the relationship between environmental regulation and innovation	
- Investing in innovation	- Environmental costs - Investment in innovation in the year t – 1 - Individual (industry-specific) effect - Annual effects - Added value in the industry	Multiple linear with fixed unobservable effects (industry, year)
	Stage 2. The relationship between emission reduction and the efficiency of firms	
- ROS (return on sales) - ROA (return on assets) - ROE (return on equity)	- Emission reduction rate - R&D intensity - Capital intensity - Financial leverage - Dummy industries	Multiple linear regressions with lags of 1, 2, and 3 years
	Stage 3. The relationship between environmental indicators and stock market indicators	
- Tobin's Q	- Costs for reducing CO_2 emissions or discharging pollutants in wastewater - Relative and industry-specific emissions - Company size - Capital intensity - Sales growth rate - R&D intensity	Models with fixed and random effects
	Stage 4. The relationship between the disclosure of environmental information, environmental pollution, and economic indicators	
- CO_2 emissions per year t	- R&D expenses - The size of the company (revenue) - Asset utilization efficiency (capital expenditures) Public disclosure of data on R&D expenditure on pollution abatement and energy efficiency (dummy) - Availability of an environmental policy (dummy) - Availability of an energy-efficiency policy (dummy) - Attitude toward the industry with high pollution (dummy) - CO_2 emissions per year t – 1	Linear multiple regression

As shown in Table 1, data on the environmental and economic characteristics of a sufficiently large sample of firms are needed to conduct a comprehensive analysis. However, in modern conditions, their availability and quality are particular problems since only a limited number of domestic companies present them publicly.

4. Results and Discussion

The study of the possibility of analyzing the causal relationship between environmental costs and economic efficiency according to Russian firms and domestic statistics allowed us to obtain the following results.

1. There has been no tightening of environmental standards and an increase in the corresponding costs in the domestic economy over the past 15 years (see Figures 1–3).

Figure 1 The amount of environmental protection costs as a percentage of the GDP of the Russian Federation (according to Rosstat)

As shown in Figure 1, until 2012, there was a negative dynamics in the ratio of the total amount of expenditures of the state, enterprises, and organizations for environmental protection and gross domestic product, and then the value of this indicator stabilized at the level of 0.7% of GDP.

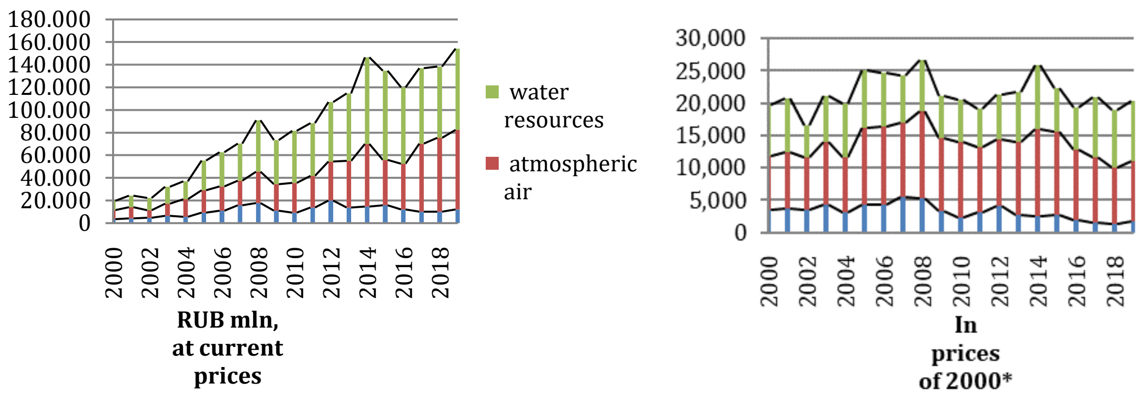

Figure 2 Investments in fixed assets aimed at environmental protection and rational use of natural resources in the Russian Federation (in million rubles)
*Calculations of the authors according to Rosstat data

As can be seen from Figure 2, the growth of environmental investments in fixed assets, expressed in actual prices, does not reflect the real state of affairs, and there is no positive dynamics when taking into account changes in the overall price level in the economy.

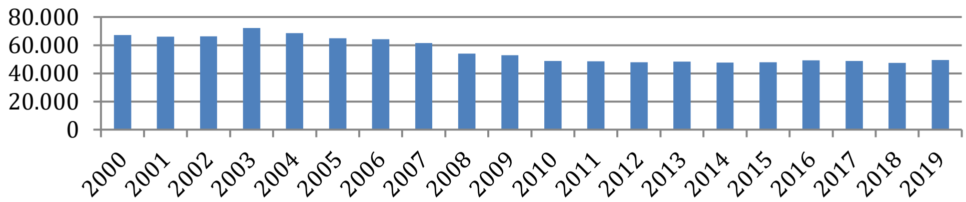

Figure 3 Current environmental protection costs in the Russian Federation in prices of 2000 (in million rubles)
*Calculations of the authors according to Rosstat data

As shown in Figure 3, after adjusting for changes in the general price level in the economy, the current (operational) costs for environmental protection in the period under review, as well as investments in fixed assets, did not show an increase in environmental protection activities.

Thus, Porter's hypothesis is currently inapplicable to manufacturing enterprises in Russia, which is explained by the inefficiency of environmental regulation. Similar conclusions were obtained by authors from China (He et al., 2020; Fua et al., 2020).

2. The sample should be based on businesses in the commercial sector, as they account for the largest share of environmental costs. It should be noted that almost all the empirical studies we studied used data from private commercial firms. These are mainly metallurgical enterprises, oil and gas producing companies, and water supply and sanitation enterprises (see Table 2).

Table 2 Environmental protection costs in the Russian Federation* (in % of the total)

	2014	2015	2016	2017
Total	100.0	100.0	100.0	100.0
Commercial sector	75.5	75.1	70.8	68.9
Sector of specialized environmental service providers	12.0	12.5	15.0	13.4
State sector	12.5	12.3	14.2	16.9

*Calculations of the authors according to Rosstat data.

As can be seen in Table 2, the main share of environmental protection measures is carried out by the commercial sector. Thus, there is no activation of environmental protection activities in the domestic economy in the period under review, and the study of the impact of tightening environmental standards on competitiveness, similar to foreign ones, does not make sense for Russian enterprises operating in the domestic market. We also note the lack of open data on the environmental costsand pollution of individual enterprises.

3. The study of nonfinancial reporting of Russian companies in the industrial sector showed the same problems that foreign scientists pointed out (Lankoski, 2000;Rubashkina et al., 2015). Despite the efforts of international organizations in regulating such reporting, companies are free to choose a set of indicators and the appearance of the report, which is more like an advertising booklet. For this reason, it is almost impossible to form a sample to study the relationship between environmental pollution data and economic indicators of firms.

For large domestic companies operating on the international market (see Table 3), it is important to create an image of an environmentally responsible organization through the voluntary implementation of environmental measures.

Table 3 Indicators of the largest Russian companies for 2019, billion rubles

Company	Revenue	Operating Expenses	Net Profit for the Year	Environmental Protection Expenses and Investments
Rosneft	8 676.0	944.0	805.0	64.0
Lukoil	7 841.2	933.7	642.2	36.0
Gasprom	4 758.7	1 471.9	651.1	53.2
Inter RAO UES	1 032.1	946.0	81.9	1.3
NorNikel	877.7	87.3	488.5	39.5
Severstal	527.8	57.5	114.4	3.8
RusHidro	406.6	336.6	0.6	1.9
Rostelekom	337.4	303.6	16.5	0.2
FosAgro	248.1	54.6	49.4	9.1

For the aggregate of companies from Table 3, there is a direct correlation between the amount of expenses and investments for environmental protection and the amount of net profit (see Figure 4). The relationship of environmental costs with other financial characteristics of the companies' activities is insignificant.

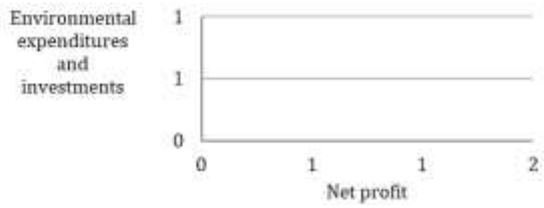

Figure 4 The relationship between the environmental and economic indicators of companies from Table 3

As shown in Figure 4, the results obtained may indicate that the companies under consideration, when assessing the environmental component of costs, are guided by the expected profit.

The study revealed the need to develop methods for a comprehensive assessment of the technologies used (Isa et al., 2018; Hassan et al., 2018;Yusuf et al., 2018) concerning environmental and cost characteristics. Also, special attention should be paid to the choice and justification of a generalizing indicator of a comprehensive assessment of performance.

5. Conclusions

In the context of climate change and rising resource prices, increasing attention is being paid to finding a compromise between the costs of environmental protection and economic efficiency, which has contributed to the introduction of indicators of the use of natural resources into a large number of neoclassical models of economic growth.

A comparative analysis of the proposed models revealed the following results. The relationship between environmental regulation and competitiveness varies, depending on the market structure of the industry. Improving the environmental performance of the exporting company in conditions of perfect competition clearly leads to a reduction in the manufacturer's surplus. The levels of environmental efficiency chosen by firms may not be optimal from the point of view of society, which entails the need for the intervention of regulatory authorities. State control over emissions, provided that the restrictions are sufficiently strict, encourages firms to use modern technologies with low levels of pollution, ensuring higher profits and lower pollution levels.

The following basic concepts are used in the management of environmental regulation: "competitiveness," "economic efficiency," "environmental efficiency," and "strictness of regulation," and various indicators are used to measure them. Important problems of empirical analysis are the selection of indirect indicators of environmental regulation and competitiveness, as well as the availability and quality of data.

The analysis of the data from domestic statistics showed that the problem is to obtain the environmental characteristics of firms. Data on the emissions of specific enterprises are their commercial secrets and are not publicly available. The analysis of the nonfinancial statements of the largest Russian companies in the industrial sector showed the difficulties indicated by foreign researchers: the lack of strict regulation significantly complicates the formation of a sample for analysis. At the same time, most Russian polluting enterprises do not form such reports. Thus, the possibility of collecting data from Russian companies for an empirical study of the relationship between environmental and economic efficiency is limited today.

The development of environmental regulation and the growth of competitiveness are based on the use of modern technologies. A comprehensive assessment of these three components is a new area of research requiring the selection and justification of the applied instruments. As a prospect for further research, it seems interesting to adapt the method of functional cost analysis to the study of this interaction effectiveness.

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