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Environmental regulation tools and economic growth

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Subject. Negative external environmental effects caused by the rapidly increasing global consumption of coal and oil aimed at ensuring economic growth have a detrimental effect on the environment and human society. Countries adopt different approaches to the problem of pollution and the threat of global climate change, which is explained by the specifics of their economies. This article focuses on the environmental regulation tools which stimulate governments and companies to reduce emissions and introduce technologies neutralising negative external factors.
Purpose. To determine the most effective environmental policy tool and identify the nature of the correlation between this tool and economic growth.
Methodology. In our study, we used general scientific methods for the analysis of economic phenomena, logical analysis, economic analysis, statistical analysis, and the method of empirical observations based on the analysis of statistical data.
Results. The study determined that environmental taxes allow for the best internalisation of the consequences of negative external environmental effects. The dependence between this tool and economic growth was determined, and the specific features of this dependence for the Russian economy were identified.
Discussion. The obtained results were compared to the conclusions made by experts in external environmental effects and economic growth. Some explanations for the observed dependence between environmental taxes and economic growth were suggested.
Conclusions. The results of the study allowed us to determine the advantages and disadvantages of various environmental policy tools. We can conclude that the stimulating effect of environmental taxes as an optimal environmental policy tool on economic growth depends on the initial characteristics of the studied economic system (the initial level of GDP per capita).

Key words: economic growth, external effects, environmental taxes.

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Introduction

The relevance of the study presented in this article stems from the fact that carbon dioxide emissions, i. e. negative external environment factors, contribute to severe air pollution within the country and accumulation of carbon dioxide in the atmosphere, which is the main cause of global warming. It is reasonable to believe that environmental and economic consequences of global warming vary depending on the country. Some countries believe that the danger is so distant and probably so insignificant that technical progress and alternative renewable energy sources can easily substitute for strict measures to combat emissions in the near future. It is obvious that if dramatic climate change happens, it will have a direct impact on state budgets, terms of trade, economic growth rates and the well-being of the world's population. The task of the economic science is to search for methods and tools that could stimulate governments and companies to reduce emissions and introduce technologies reducing negative external factors.

There are a large number of studies focusing on external environmental effects. Thus, Cole & Grossman (2018) focus on the efficiency of command-and-control and economic measures in environmental policies. Baumol & Oates (1988), Atkinson et al. (1997) consider the application of various economic tools. Economic tools, and environmental taxes in particular, were analysed by Ewringmann & Schafhausen (1985). The introduction of environmental taxes was substantiated by Ekins & Speck (2011), Baumol & Oates (1971). Ligthart & van der Ploeg (1994), Bovenberg & De Mooij (1997), Abdullah & Morley (2014) studied the effect of environmental taxes on economic growth.

Despite a large number of studies considering the choice of environmental policy tools and their effect on economic growth, there are still a considerable number of controversies regarding the matter. The purpose of our study was to determine the dependence between economic growth and environmental taxes. It is important to study the dependence between environmental taxes and economic growth because it will help to determine the nature of this dependence and the factors affecting it.

The study was structured as follows. To determine the most optimal environmental policy tools, we analysed the advantages and disadvantages of each of them. Next, we determined the value of the best tools for the state. Then, we analysed the nature of the dependence between environmental taxes and economic growth. The nature of this dependence for developed countries was then compared to the results obtained for developing countries and Russia.

Methods and data sources

The theoretical and methodological basis of the study is scientific literature on environmental and economic regulation, environmental protection, and public sector economics. In our study, we used general scientific methods for the analysis of economic phenomena and methods of statistical analysis.

The database included statistical data published by authorities and organisations in the Russian Federation and the European Union, as well as the reports by the Organisation for Economic Co-operation and Development for 2005–2020. There is little data regarding environmental taxes, because the Federal Service for National Statistics and the OECD only publish information about the revenue obtained from taxes associated with environmental protection, rather than about the tax rates. The revenue is used as an indicator of environmental taxes, so in our study we focused on this parameter.

We also considered developed countries as opposed to developing ones with regard to their approach to environmental taxes as a tool for managing negative external factors, because their approaches have a different impact on the economic growth. These differences stem from the structure of the economic system in these countries, both industrial and technological.

Economies of developing countries are largely based on the industry and agriculture, which employ energy sources with high level of CO_2 emissions. This is the tax base of environmental taxes in such countries. As a result, tax charges are rather high, which significantly hiders the economic growth. A common feature of such economies is a low GDP per capita. Conversely, developed economies demonstrate a large GDP per capita and a greater share of services and human resources in the overall GDP. Therefore, the hypothesis of our study was that the level of economic development of a country, measured based on the initial level of GDP per capita, can affect the dependence between taxes aimed at the internalisation of external environmental factors and the economic growth.

Results

Both theory and practice suggest four basic types of economic tools for the internalisation of external effects associated with harmful emissions: taxes and fees, emissions trading, subsidies, and deposit-refund systems. These tools are used to introduce changes in the economic policy and by doing so alter the behaviour of economic agents so that they would take into account expected costs and benefits of alternative approaches available to them.

There are three types of taxes and fees: emission fees calculated based on the amount of harmful emissions; consumer fees (i.e. fees for using public sewage systems or natural deposits), and product taxes, including taxes on products, whose production or consumption results in pollution.

Subsidies include grants, preferential loans, and tax exemptions which facilitate the development of environmentally friendly technologies or help polluters to bear the cost of combating pollution in the short term.

Emissions trading means that permits that allow a discharge of a specific quantity of greenhouse gases are allocated between polluters or sold on the market. Polluters are required to hold permits in amount equal to their emissions.

Deposit-refund systems include additional charges for potential pollutants, which are then refunded, if the economic agent manages to prevent pollution by means of treatment of these substances.

Table 1 presents the advantages and disadvantages of the above listed environmental policy tools.

With regard to the climate change, the most attention is paid to taxes on carbon dioxide emissions and emission permits due to their relative advantages.

The first advantage of these economic tools is that they help to achieve environmental goals at the lowest cost (Baumol & Oates, 1971). Another advantage is the potential for increasing public revenues. This is quite clear with regard to taxes on carbon emissions. The same is true for emissions trading, if the authorities offer emission permits for sale at an auction and set a price for them. However, the net present value of tax revenues can be different from the auctioning revenues.

In theory, the optimal environmental tax rate is determined by the marginal social damage caused by emissions. However, in practice it is not easy to determine the marginal damage. An alternative approach is to determine a certain standard of environmental quality and set the tax rate that would be high enough to attain this standard. Nevertheless, it is still necessary to gather empirically confirmed data regarding the dependence between taxes and the reduction of emissions by economic agents.

At the same time, using the emissions trading system, a community (national or international) agrees on a target environmental quality (the ideal situation is when the marginal social damage equals the marginal cost of reduction of emissions) and therefore the amount of permitted emissions. The community then allocates permits (within a country or between countries) and allows economic agents to trade these permits (within a country or internationally). Obviously, the main difficulty is to distribute permits in a way that everyone would consider fair.

Table 1

Advantages and disadvantages of environmental policy tools

Environmental policy tools	Advantages	Disadvantages
Taxes and fees	– Environmental taxes can facilitate fiscal consolidation or reduction of other taxes; – eliminate market failures by adding environmental expenses to the final cost; – provide consumers and companies with complete freedom of choice with regard to their behaviour and activities aimed at reducing pollution; – increase the competitiveness of alternative approaches with lower emission rates; – stimulate innovative activities; – well-planned taxes are highly transparent	– It is difficult to design effective tax processes; – taxes do not provide a solution on their own and should be combined with other environmental policy tools to manage specific problems; – a well-developed communication line is required; – it is necessary to thoroughly analyse the effect of taxes on competitiveness, as well as the measures aimed at facilitating the transition to new environmental policies; – a potential source of the distribution problem
Emissions trading	– Provides opportunities for effective exchange, when polluters can buy permits from each other with the overall pollution rate remaining the same; – environmental organisations can buy emission permits without using them in order to reduce air pollution (in this case, emissions trading results in a significant positive external effect for the society, because environmental organisations use their own resources to reduce pollution created by others); – effective use of pollutants without the need to assess the social costs of pollution; – authorities can obtain a large income by selling extra permits to companies that want to increase their emissions (this income can be invested into environmentally friendly activities); – stimulates investments by companies; – environmentally friendly companies can obtain additional income, which gives them a competitive advantage	– The number of permits issued by the authorities may be too small, which reduces the competitiveness of companies and significantly increases production costs; – high production costs can result in higher consumer prices; – large companies can afford to buy more additional permits and thus pollute the environment on a greater scale
Subsidies	– Increase the investment efficiency of companies; – have a positive effect on the financing of companies; – stimulate technological innovations and development of new energy sources	– Decrease the investment efficiency of companies; – have a negative effect on the financing of companies; – create a suppression effect, which demonstrates that environmental subsidies have a limited effect on corporate innovations or even hinder the innovation process
Deposit-refund system	– helps to prevent midnight dumping; – does not require complex monitoring; – reduced risk of deposit violation	– Does not provide for the required level of waste disposal; – presents a form of covert fiscal expansion with the environmental and economic benefits of waste treatment being outweighed by the cost of reassigning the budget to waste treatment instead of using it more efficiently

Source: based on: (Atkinson et al., 1997; Baumol & Oates, 1971, 1988; Cole & Grossman, 2018; Ewringmann & Schafhausen, 1985).

There is another issue associated with emissions trading. Initial permits can be either put up for auction or distributed for free. The advantage of the first approach is that it brings revenue. However, in the case of international emissions trading, it is not quite clear who will put the permits up for auction, as well as who will obtain and spend the revenues.

What is then better for controlling the global climate change: to introduce taxes on carbon dioxide emissions globally or to resort to international emissions trading?

Baumol & Oates (1988) developed to assumptions that help to understand the role of each tool. First, the steeper the curve of the marginal control cost, the greater the distortion caused by emissions trading and the smaller the distortion caused by carbon emission taxes. Second, emission taxes appear to be a better solution if the marginal control curve is steeper than the marginal benefit curve. If the opposite is true, emissions trading is more preferable. Therefore, the choice between the two economic tools should not depend on anybody's assessment of the costs and benefits of emissions reduction. However, from the point of view of the regulatory bodies monitoring the implementation of agreements on global warming, there are greater differences between the two approaches. A comparative analysis of the use of emission taxes and emissions trading is presented in Table 2.

Table 2

A comparative analysis of the use of emission taxes and emissions trading

Parameter	Taxes	Emissions trading
Reduction of uncertainty	– The regulatory body has to make decisions based on unmeasurable expectations of economic agents + Emission taxes can be levied by means of fossil energy taxes	+ The regulatory body sets the goal and issues a required number of permits sufficient to achieve this goal
Inflation risk	– A high inflation rate reduces the actual tax revenue + This can be dealt with by changing the tax rate more often	+ Automatically adjusts to inflation
Financial burden	– A significant financial burden, if there is little opportunity to change the type of fuel + Can be used to increase the financing of environmental and other state programmes, reduction of budget deficit and inflation, and reduction of the existing distortionary taxes (redistribution of income)	+ No burden, if the permits are granted for free – A burden occurs if the permits are initially put out for auction to increase revenues or when companies want to obtain additional permits
Damage compensation	+ The tool employs the "polluter pays" principle, according to which polluters have to compensate for the social damage and the tax revenues are used for environmental protection or other socially beneficial activities	– Companies can purchase permits from each other and thus pollute the environment even more without compensating the society

Source: based on: (Atkinson et al., 1997; Baumol & Oates, 1971, 1988; Cole & Grossman, 2018; Ekins & Speck, 2011).

The arguments in favour of emission taxes are the following: carbon emission taxes make consumers of fossil fuels internalise the external factors caused by the emission of greenhouse gases. As we mentioned before, the structure of the carbon emission tax depends on the objectives. The optimal tax rate is set so that the marginal social damage generated by pollution would be equal to the marginal cost of emissions reduction.

Therefore, emissions taxes are a reasonable policy aimed at reducing emissions. They also bring significant revenues.

Fig. 1 demonstrates the share of environmental taxes in the total amount of tax revenues in the Russian Federation.

The average share of environmental taxes in the total tax revenues over the considered period was 15.2 %, which indicates their significant contribution to public revenues and stresses the advantages of this tool of internalisation of external environmental effects for the country. A comparative analysis of the share of environmental tax revenues in Russia and in the European Union demonstrated that environmental taxes play a greater role in the environmental policy of Russia. A similar conclusion was drawn by A. G. Zeldner (2018), A. I. Serkova (2020), and L. P. Koroleva (2020).

However, national governments fear that taxes might hinder economic growth.

The effect of environmental taxes on economic growth is still a matter of scientific debate. The existing studies on the topic present several models used to solve the problem. Thus Bovenberg & Heijdra (2002), Wang et al. (2015) used the overlapping generations model to determine a negative dependence between environmental taxes and economic growth. Conversely, Bovenberg & Smulders (1995), Bovenberg & De Mooij (1997) demonstrated that environmental taxes can stimulate economic growth. At the same time, some studies (Ono, 2003) demonstrate a contradictory effect of environmental taxes on economic growth in OECD countries.

To analyse the dependence between environmental tax revenues and economic growth rate, we developed an empirical model

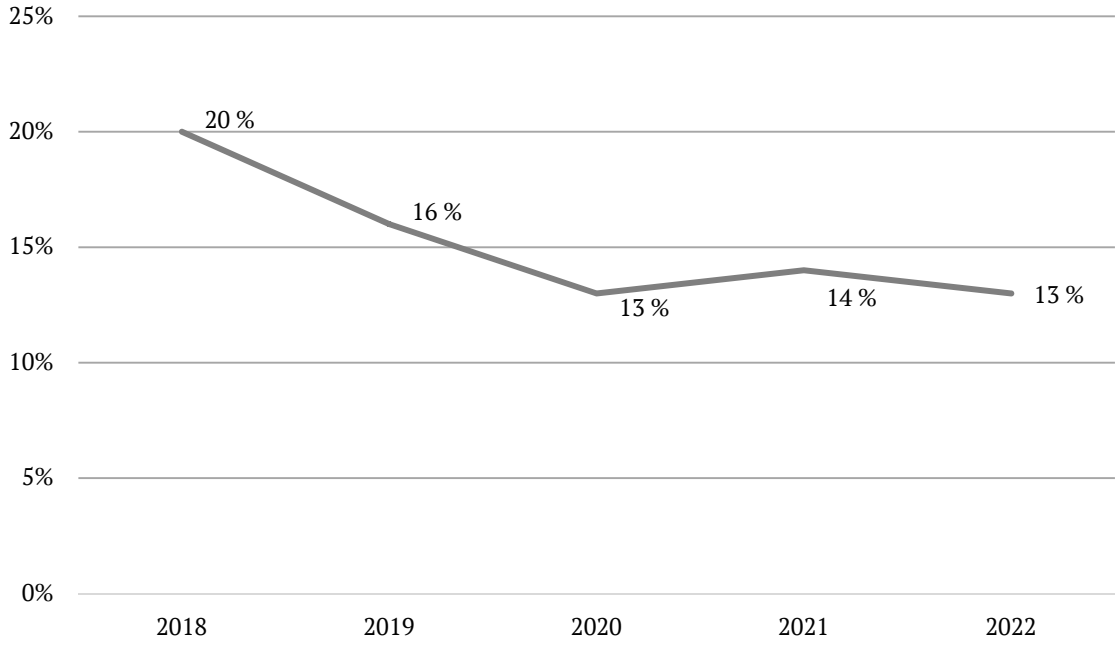

Fig. 1. Dynamics of the share of environmental taxes in total tax revenue in the Russian Federation, 2018–2022 [based on: Environmental taxes and fees account. Federal State Statistics Service of the Russian Federation. URL: https://rosstat.gov.ru/folder/11194]

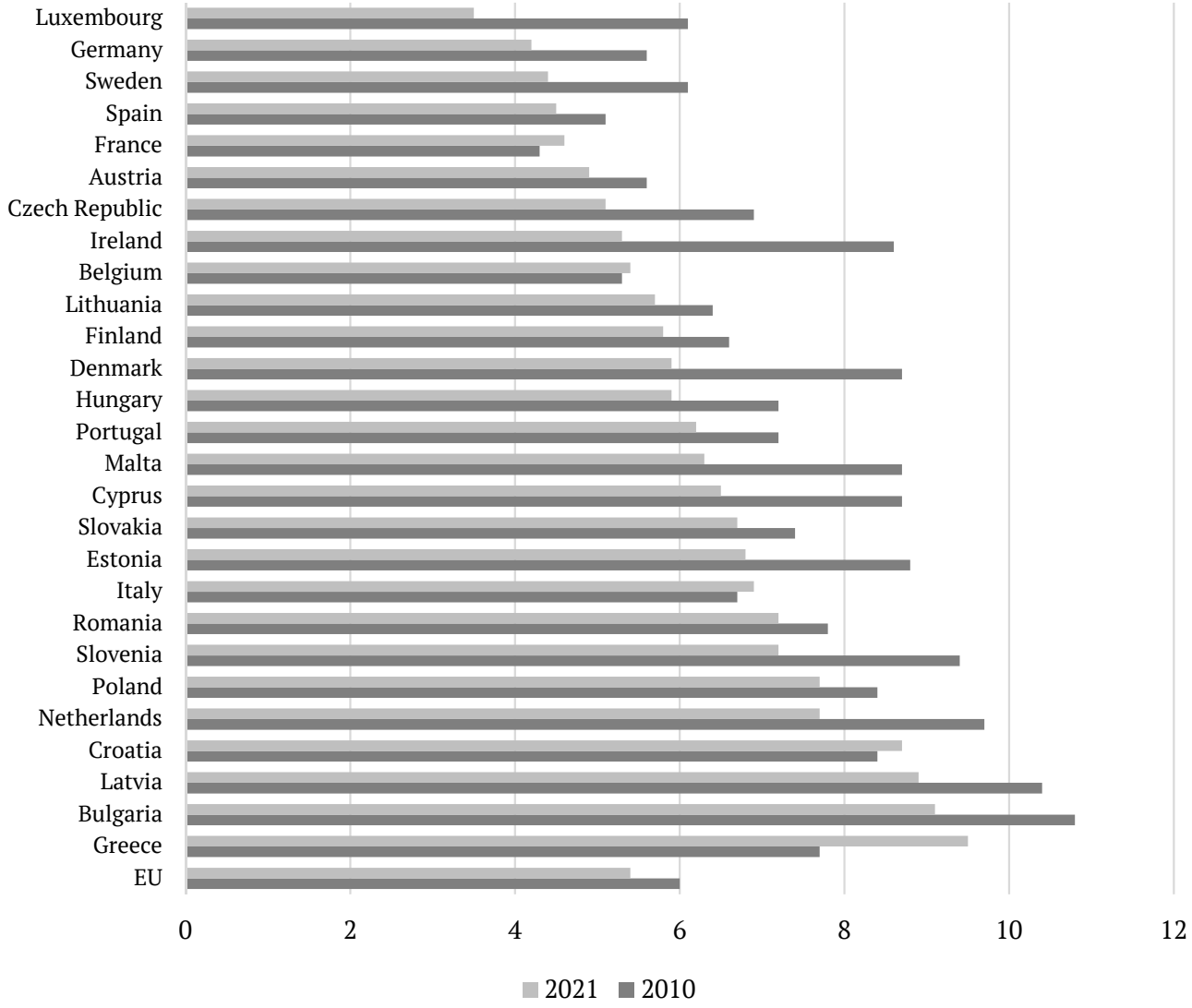

Fig. 2. Share of environmental taxes in total tax revenues in 2010–2021, %
[based on: Share of environmental taxes in total tax revenues. European environment agency. URL: https://www.eea.europa.eu/en/analysis/indicators/share-of-environmental-taxes-in]

of economic growth based on the factors suggested in (Abdullah & Morley, 2014; Bovenberg & De Mooij, 1997; Bovenberg & Heijdra, 2002; Bovenberg & Smulders, 1995; Wang et al., 2015).

The dependent variable was the economic growth rate measured as an annual increase in GDP per capita. The environmental tax revenue (as a percentage of GDP) was the control variable.

The explanatory variables were the following:

– ln y_0 – the initial level of the real GDP per capita measured using the natural logarithm of GDP per capita for each country;

– *TLF* – the overall rate of workforce growth;

– *K* – gross fixed capital formation as a percentage of GDP;

– *Ht* – human capital measured using the human development index;

– *CGD* – loans (+) or net borrowings (–) of public administration bodies.

To build the models, we used statistical data regarding 31 country for 2005–2020, including 25 developed countries (Greece, Slovenia, the Netherlands, Latvia, Denmark, Italy, Estonia, Finland, France, Portugal, the Czech Republic, Austria, Sweden, the UK, Belgium, Norway, Lithuania, Slovakia, Iceland, Spain, Germany, Switzerland, Japan, the USA, and Australia)

and 6 developing countries (Turkey, Hungary, Poland, Mexico, Chile, and Columbia). The data was derived from the OECD reports and a human development report.

In order to determine the effect of environmental taxes, the initial level of GDP per capita and other explanatory variables on the economic growth in the developed countries, we assessed the parameters of model 1 (Table 3). To determine the dynamics of this dependence, when the developing countries were considered, we used model 2. Both equations allowed us to make the following conclusion: the higher the initial level of GDP per capita, the lower the economic growth rate, i. e. the more developed the country is, the slower the economic growth. There is also a negative dependence between environmental taxes and economic growth. The most important variables for the two cases were the initial level of GDP per capita and the overall environmental tax revenue as a percentage of GDP.

It is also reasonable to consider the dependence between the economic growth rate and the overall environmental tax revenue as a percentage of GDP and the initial level of GDP per capita. Model 3 describes this dependence for the developed countries and model 4 for the developing countries (Table 3). The obtained equations indicate a negative dependence between the economic growth and the total environmental tax revenue. The dependence is stronger in the developing countries. There is also a negative dependence between the economic growth and the initial level of GDP per capita in the developed countries and a positive dependence in the developing countries.

We also analysed the correlation between the environmental tax rate and the initial level of GDP per capita in the developed and developing countries. The analysis demonstrated that there is a greater dependence between environmental taxes and the initial level of GDP per capita in the developing countries than in the developed ones. Furthermore, the developed countries demonstrated a negative dependence between the initial level of GDP per capita and the total environmental tax revenue, while for the developing countries this dependence was positive. This is confirmed by the corresponding correlation coefficients: 0.85 and –0.24 respectively.

Model 5 (Table 3) describes the dependence observed for the Russian economy in 2005–2020.

Table 3

The results of the parametric identification of the factor models of economic growth for groups of countries

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
ETRT	–0.110 [–2.854]	–0.146 [–2.854]	–0.126 [–2.748]	0.233 [–1.513]	0.183 [0.226]
$\ln y_0$	–0.306 [–1.897]	–0.151 [–1.897]	0.204 [–2.540]	0.559 [1.616]	0.277 [0.036]
TLF	0.802 [1.436]	–0.722 [–1.436]	–	–	2.698 [0.032]
K	0.011 [0.834]	0.009 [0.834]	–	–	0.039 [0.009]
Ht	–0.419 [–1.150]	1.291 [1.150]	–	–	5.280 [0.386]
CGD	0.011 [0.742]	0.010 [0.742]	–	–	–0.010 –0.624]
(Intercept)	3.481 [1.433]	0.823 [1.433]	2.413 [2.747]	4.769 [–1.602]	11.463 [6.126]
R2	0.67	0.68	0.58	0.68	0.89
Number of observations	25	31	25	6	15

In this equation, all factors have a significant impact on the economic growth rate. There is a positive dependence between environmental taxes and the economic growth and a positive dependence between the economic growth and the initial level of GDP per capita. The obtained result can indicate that the sensitivity of the economic growth to environmental taxes for the analysed period of time in Russia is greater than in the developed countries and lower than in the developing ones.

Discussion

The results obtained in the study allowed us to determine a negative dependence between economic growth and environmental taxes. This can be explained by the fact that higher environmental taxes result in a reduced use of fossil fuels used by various industries. As a result, the production output decreases. The nature of the dependence can change, when the marginal requirement for the replacement of fossil fuel with renewable energy sources is close to 1. However, this requires significant investment into the development of renewable energy sources.

Our conclusions regarding the dependence between economic growth and environmental taxes agree with those made by Bovenberg & Heijdra (2002), Hassan et al. (2020), Fang et al. (2022), and Tao et al. (2023). They found that future generations would benefit from increased environmental taxes, because that would mean more natural resources. However, the economic growth rate would decrease in the long-term due to a small physical capital. Similar ideas were presented by Wang et al. (2015), Zhang et al. (2023): environmental taxes can reduce the pollution rate but will distort the rates of return and thus hinder the economic growth.

Ono (2003) demonstrated that environmental taxes have two opposing effects on economic growth in the long-term. When the tax rate is high, companies produce a smaller amount of pollutants, which results in a better environmental quality for the future generations, i. e. the effect of the tax revenue is positive. Then the next generation can save (and invest) most of its resources rather than spend them on combating pollution, which stimulates the accumulation of the production capital and the economic growth. On the other hand, higher tax rates mean a greater financial burden for companies. This leads to the reduction in savings and investment and slows down the economic growth. Conversely, these effects are not observed, when the tax rates are low.

Russian economy demonstrated a positive dependence between the economic growth and the environmental tax revenue. Theoretical explanations can be found in a number of studies (Bovenberg & De Mooij, 1997; Bovenberg & Smulders, 1995). Greater environmental tax revenues can stimulate economic growth because environmental taxes result in a better environmental quality, which in turn increases the productivity of resources and the total factor productivity.

The positive dependence between the level of GDP per capita and the economic growth with regard to environmental taxes can also be explained by the following correlations: environmental taxes stimulate the growth of prices; in countries with a large GDP per capita, individuals have a large discretionary income (the amount of an individual's income that is left after taxes and necessities are paid) and are thus able to pay more in exchange for better life standards, including the environmental quality. On the other hand, economies of countries with a large GDP per capita are based on services (as a result of economic growth) rather than on industry and agriculture, which also improves the environmental quality, because this sector of economy produces the smallest amount of emissions.

Therefore, the results obtained in the study demonstrate a controversial dependence between environmental taxes and economic growth: the introduction of environmental taxes on emissions does not necessarily reduce the GDP growth rate. This depends rather on the characteristics of the economic system. We should also note that GDP is not the only indicator of well-being of the population.

A reduction in the GDP growth rate can be accompanied by a growth in well-being.

Conclusions

The results of the study allowed us to determine the advantages and disadvantages of economic tools of environmental policy identified by Russian and international scholars. A comparative analysis of these tools led us to the conclusion that currently the most preferable tool is environmental taxation. However, environmental taxes have a controversial effect on economic growth.

Achieving the purpose of our study, we made the following conclusions:

– economies of developed and developing countries demonstrate a negative dependence between economic growth and environmental taxes;

– the Russian economy demonstrates a positive dependence between economic growth and environmental taxes;

– the dependence between economic growth and environmental taxes is stronger in developing countries;

– the dependence between the initial level of GDP per capita and environmental taxes is positive in developing countries and negative in developed countries;

– when the dependence between the initial level of GDP per capita and economic growth is positive, environmental taxes can stimulate economic growth.

These conclusions demonstrate that the effect of environmental taxes on economic growth depends on the characteristics of the economy. However, when the dependence between the initial level of GDP per capita and economic growth and the dependence between environmental taxes and the initial level of GDP per capita are positive, environmental taxes stimulate economic growth.

Conflict of Interest

The authors declare that there are no obvious and potential conflicts of interest related to the publication of this article.

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Инструменты экологического регулирования и экономический рост

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Предмет. Отрицательные экологические внешние эффекты, вызванные широким и быстро увеличивающимся использованием угля, нефти для обеспечения экономического роста, имеют разрушительные последствия для окружающей среды и для общества. Отношение стран к проблеме ухудшения качества окружающей среды и к угрозе глобального изменения климата неоднородно, что во многом определяется особенностями их экономических систем. Предмет данной статьи – инструменты экологического регулирования, стимулирующие государства и фирмы к сокращению выбросов и использованию технологий, сокращающих отрицательные внешние эффекты.
Цель. Выявление наиболее эффективного инструмента экологической политики и определение связи между экономическим ростом и этим инструментом и характера этой связи.
Методология. Для достижения цели исследования в работе использовались общенаучные методы изучения экономических явлений, методы системного, логического, экономического и статистического анализа, метод эмпирического наблюдения на основе сбора и анализа статистической информации.
Результаты. Определен инструмент экологической политики – экологические налоги, обладающий набором свойств, позволяющих наилучшим образом интернализовать последствия отрицательных экологических внешних эффектов. Установлено наличие связи между экономическим ростом и данным инструментом экологической политики, определен характер взаимосвязи, определена российская специфика.
Обсуждение результатов. Полученные в ходе исследования результаты сопоставлены с выводами специалистов в области экологических внешних эффектов и экономического роста. Рассмотрены причины установленной взаимосвязи между экономическим ростом и экологическими налогами как инструментом экологической политики.
Выводы. Полученные в ходе исследования результаты позволили определить преимущества и недостатки различных инструментов экологической политики, а также утверждать, что стимулирующее влияние экологических налогов как оптимального инструмента экологической политики на экономический рост зависит от особенностей стартовых условий исследуемой экономической системы (первоначального уровня ВВП на душу населения).

Ключевые слова: экономический рост, внешние эффекты, экологические налоги.

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Конфликт интересов

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