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Optimal Design of Transport Tax on the Way to National Security: Balancing Environmental Footprint, Energy Efficiency and Economic Growth

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Abstract: To ensure the progress of sustainable development and overcome threats to national security, the development of tools for balancing ecological, economic and energy aspects of economic activity acquires special importance. This study is related to the influence of choosing different functional elements of transport taxes on their effectiveness in ensuring national security. For calculations, panel regression modelling with panel-adjusted standard errors based on the use of the Durbin–Watson test using dummy variables was chosen. The assessment involves the selection of the main factor variable (tax revenues from transport taxes, as well as an additional dummy variable) and compliance with a country's transport taxation system, with a certain criterion for its application. The resulting criterion was chosen as an integral indicator of national security, which summarizes the parameters of environmental footprints, economic growth, energy efficiency and security. Calculations were made for nine countries (i.e., the Czech Republic, Finland, France, Ireland, Israel, Portugal, Romania, Slovakia and Turkey) for the period 1996–2019. The calculations proved that the establishment of transport taxes, depending on the type and weight of the car, increases their effectiveness on ensuring national security or, depending on the cost and age of the car, weakens such effectiveness. The use of emissions generated by the car, its capacity and its type of fuel requires additional research; the obtained results did not allow for unambiguously determining their impact on the effectiveness of transport taxes. The conducted research forms the basis for choosing the optimal design of transport taxes to ensure the maximization of their regulatory effectiveness. The developed approach can be extended to evaluate the effectiveness of other environmental taxes.

Keywords: transport tax; national security; sustainable growth; environmental pollution; energy efficiency; green consumption; modelling; tax elements

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1. Introduction

The aggravation of global environmental problems make relevant the issue of preserving the natural environment and reducing harmful anthropogenic impacts. This leads to the constant diversification and improvement of environmental policy instruments at the national and international levels. Nowadays, the environmental context accompanies the making of political decisions in any sphere and should be considered in the process of strategic planning for state and interstate development [1].

Modern contexts of scientific research testify that the issue of sustainable development is closely related to energy security and renewable energy [2]. At the same time, ensuring energy efficiency becomes important, which leads not only to economic but also to environmental benefits [3]. Energy efficiency is a complex process that is characterized not only by the features of energy production but also by the volume and structure of its consumption [4]. The implementation of high tech in the infrastructure network also makes an important contribution to increasing resource efficiency [5]. Thus, the integration of smart networks into economic activity has a positive effect on economic results, creates additional comfort benefits and reduces the irrational use of resources [6]. Recent events in the world have proven that energy security is among the most important guarantees of economic security. That is why the formation of a national policy in the field of energy and environmental protection should consider the priorities of energy security [7].

In modern conditions, ensuring sustainable development is carried out not only by producers but also by consumers. Thus, the development of a circular and sharing economy determines a reduction in the volume of product consumption, the generation of waste and a reduction in ecological footprints [8]. At the same time, the change in the level of consumers' environmental consciousness is correspondingly reflected in the structure of production and the implementation of environmentally safe technologies, the production of environmentally safe products, etc. At the same time, the role of civil society organizations and the unification of the initiatives of various groups of economic agents are growing. It has been proven that collective actions can ensure the maximum progress of sustainable development [9].

The psychology of the behaviour of economic agents is characterized by the influence of many factors that collectively determine changes and the peculiarities of decision-making [10]. It was determined that social interaction is an important factor in the development and implementation of business strategies [11]. This determines the need to find the most effective regulatory initiatives that will stimulate economic entities to increase environmental responsibility. Particularly, one of the modern manifestations of the implementation of the concept of corporate social responsibility is reducing the level of environmental pollution [12]. In this case, the additional benefit of the company is the formation of brand value, as well as gaining the trust of consumers with a high level of environmental awareness.

Studies of national and supranational policies to ensure the progress of sustainable development show that at the current stage, their effectiveness remains heterogeneous. So even in the countries of the European Union, there are quite significant gaps in the progress of implementing a circular economy [13]. This indicates the importance of finding the most effective regulatory initiatives that can become the basis for their comprehensive implementation. At the same time, the initial historical and cultural features of the country's development require the development of measures that factor in national specifics; only in this way will they be most effective [14].

Analysing promising ways to ensure the progress of sustainable development, we note that at the moment, it is important to take into account not only the complexity of the achieved effects but also their positive synergy. This requires a study of the interrelationships between the various components of sustainable development to determine the key points of ensuring synergistic effects. Thus, the close connection between energy consumption and economic growth [15], which cannot be ignored in the process of energy efficiency policy planning, has been repeatedly confirmed. At the same time, ecological and economic relations are usually reversed, such as trade in quotas for environmental pollution [16,17].

On the other hand, modern tools for ensuring economic development are increasingly becoming ecologically oriented. So green investments, which are becoming more and more popular, have positive consequences for both ecology and energy [18]. At the same time, innovative development provides not only economic competitiveness but also energy efficiency for industrial enterprises [19]. The energy-efficient transformation of the economy

in the long run ensures not only economic but also social progress. Thus, reducing the level of environmental pollution in the process of energy production and consumption and reducing the number of human-caused disasters ultimately have positive effects on the health of populations [20,21].

Even though the priority of sustainable development tasks is certainly recognized by the international community, one of the main obstacles to their achievement is the potential reduction of economic benefits. Thus, the shortage of economic resources and their high cost restrain the development of renewable energy [22,23]. At the same time, it has been proven that the strategic technical re-equipment of enterprises with resource-saving technologies provides long-term economic benefits [24–26].

All this proves that modern regulatory tools can simultaneously provide an impact on reducing environmental pollution, on increasing energy efficiency and safety and on increasing long-term economic growth. In this context, the significance of environmental taxes is growing, which, on the one hand, have regulatory effectiveness and, on the other hand, ensure the redistribution of financial resources. At the same time, as practice shows, environmental taxes are not as important for generating budget revenues as, for example, labour is or corporate income taxes are. That is why the assessment of the effectiveness of environmental taxes should be based on their regulatory function. Thus, environmental taxes can be aimed at reducing the level of environmental pollution and at increasing the level of rational use of natural resources. These taxes also play an important role in the energy sector, creating incentives for both the production and use of green energy. In the direction of economic development, environmental taxes create additional incentives for transforming the structure of production. The generalization of the main directions of influence on environmental taxes allowed for integrating them into a single vector for ensuring national security, which is measured by three components: environmental, economic and energy security.

The results of previous studies [27,28] have proved that the total income from environmental taxes as a parameter of the intensity of their use has a stable effect on ensuring national security. However, the indicator of revenues from environmental taxes does not fully reflect their regulatory effectiveness, given that the definition of the tax base for environmental taxes affects the decisions of the payers of these taxes to abandon environmentally harmful or energy-inefficient activities or to change the materials, technological processes or entities that are the reason for paying environmental taxes. That is why it is of great interest to determine the most effective modifications for environmental taxes that increase the intensity of their impact on the specified goals.

Transport taxes were chosen as the object of the study because the practice of their establishment proves that the combination of different criteria affect various aspects of environmental, economic and energy security. In particular, measuring the impact of cars on the environment uses such parameters as the level of emissions, engine volume and age of the car. The practice of establishing transport tax differentiation by the type of fuel aimed at the increase of their impact on energy security, as it determines the propensity to purchase cars that use green fuel. The use of transport taxes based on the principle of a car's value is a classic example of fiscal environmental taxes.

The main purpose of the study is to determine the optimal criteria for setting transport taxes, not in the context of achieving some specific goals of the state (obtaining additional revenues for the budget, reducing the circulation of old cars, encouraging the purchase of transport taxes, etc.) but rather comprehensively in the frame of maximizing the transport tax contribution to the provision of environmental, economic and energy security. The research is built in the following sequence: the identification of common approaches for setting transport taxes, the formalization of research data summarizing common parameters to setting transport taxes, the justification of mathematical tools for evaluating the impact of the design of transport taxes on their effectiveness in ensuring national security, an assessment and interpreting the results.

The proposed study has no analogues in the scientific literature. Existing publications either have a theoretical conceptual nature [29,30], are related to the comparative assessment of different types of taxes affecting the use of transport [31,32] or are based on the study of the experience of one country [33].

2. Materials and Methods

Environmental taxation has a wide range of regulatory influence directions. Thus, taxes on the emissions of polluting substances have a direct restrictive and compensatory effect, to a greater extent. At the same time, energy, transport taxes, packaging taxes, etc. can provide incentives for the transformation of the economy in the direction of increasing its environmental and energy efficiency while maintaining the pace of economic development. Summarizing the directions of the regulatory influence of environmental taxes allowed for singling out three target blocks, reflecting the results of their functioning. This forms a background of the hypothesis that the result of establishing environmental taxes is the national security for the country (Figure 1).

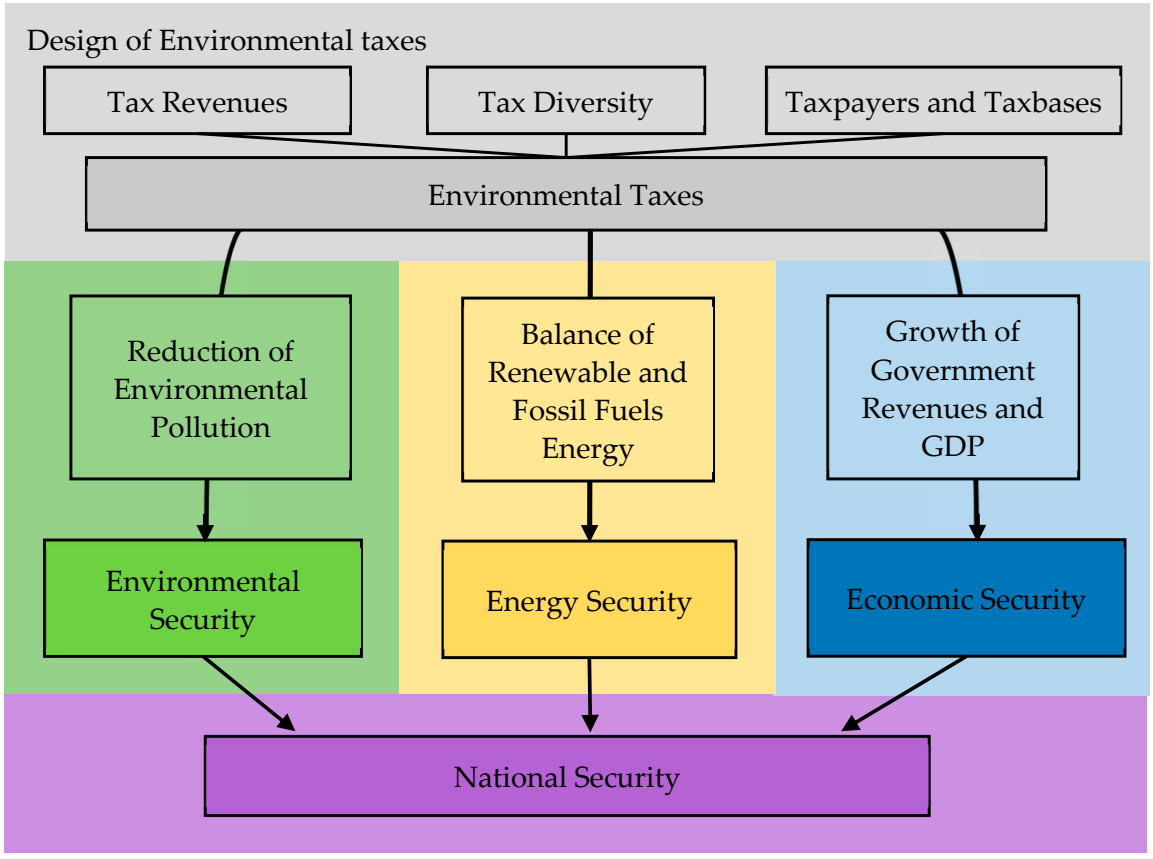

Figure 1. Conceptual background of the research of environmental taxes and their impact on national security.

The system of environmental taxation has significant differences across the world, which does not always make it possible to compare the specifics of the same environmental taxes. In the structure of environmental taxes, it is transport taxes that have wide variability in their applications in different countries. Vehicle registration taxes, road taxes, car import duties, vehicle sales taxes, etc. successfully function in different countries. Previous research has shown that the most diverse in terms of the installation of functional elements are taxes for the registration and use of vehicles. Therefore, this group of taxes was chosen for the simulation.

To form the research sample, it is necessary to provide a description of the main features of the functioning of these taxes in different countries. An analysis of environmental taxation systems and direct transport taxes made it possible to form a research sample from nine countries (i.e., the Czech Republic, Finland, France, Ireland, Israel, Portugal, Romania, Slovakia and Turkey). The conducted analysis of the design of transport taxes in different countries of the world proved that in these countries, different criteria for the taxation of transport taxes are used, and there are also common features of transport taxation. This makes it possible to build an economic-mathematical model that will consider the specifics of taxation in several countries at the same time and, consequently, to obtain broader conclusions about the effectiveness of transport taxes in ensuring national security. A general description of these taxes is presented in Table 1.

Table 1. Characteristics of taxes for registration/use of vehicles operating in different countries.

Country	The Name of the Tax	Tax Base	Tax Rates
Czech Republic	Road tax	Vehicle type and weight	In Czech crowns per year
Finland	Car tax	Cost of the vehicle/Emissions from the vehicle	In % of the cost/In euros
	Transport tax	Vehicle type and weight	In euros for 1 day per 100 kg of vehicle weight
France	Annual tax on company cars	The amount of carbon dioxide emissions from the car	In euros for 1 g of CO_2 emissions per 1 km
Ireland	Tax on vehicles Vehicle registration tax	Type of vehicle The cost of the vehicle	In euros per year In % of the cost
Israel	Vehicle registration or use tax	Cost and age of the vehicle	In new Israeli shekels per car
Portugal	Vehicle turnover tax	Type of vehicle	In euros per year
Slovakia	Transport tax	Vehicle type and weight	In euros per year
Romania	Annual transport tax	Volume of engine cylinders	In Romanian lei for 500 cm^3
Turkey	Vehicle ownership tax	Type, age and volume of engine cylinders	In euros per year

Note: This table was built based on the data from [34].

The Czech Republic has established a road tax, the purpose of which is to tax the registration or use of vehicles. Tax rates are set in Czech crowns per year per vehicle and are differentiated according to two criteria: for passenger vehicles, the tax rate depends on the volume of the engine cylinders, and for other vehicles, it depends on the number of axles and the total weight of the vehicle. A similar practice of establishing a transport tax is observed in Slovakia. In Ireland, the transport tax is set in fixed amounts calculated per year, and its amount depends on such criteria as the type of vehicle, its weight and the volume of carbon dioxide emissions generated during the operation of the vehicle. In addition, Ireland has also established a tax for the first registration of a vehicle, the rates of which are set at a percentage of the market value of the vehicle, differentiated by the categories of cars. It is important that the minimum amount of this tax is also determined for each category.

Portugal also has fixed vehicle tax rates that vary by car type. The criteria for setting tax rates are the category of the vehicle, the type of fuel used and the volume of the engine cylinders.

On the other hand, the tax for the first registration of vehicles operating in Finland is also set differently for the two categories of vehicles. For motorcycles and buses, the rate is set as a percentage of the value of the vehicle, whereas for minibuses and cars, it depend on the generated emissions of harmful substances. In addition to this, Finland also uses a transport tax, which is charged per 100 kg of vehicle weight for each day of use of such a

vehicle. Moreover, the rates that will be charged to vehicles are differentiated depending on the type of vehicle and on the type of fuel used by the vehicle.

The practice of applying a transport tax in France is quite interesting. The annual amount of the tax is calculated differently depending on the total volume of carbon dioxide emissions generated by the car. At the same time, for each category of car, the tax consists of two parts: a basic fixed amount and an amount calculated by multiplying the rate by 1 g of carbon dioxide emissions per 1 km (for example, for cars generating CO_2 emissions in the amount of 141–160 g per kilometre, the basic amount is 290 euros, and the settlement amount is 11.5 euros per 1 g of CO_2). Moreover, it is important that vehicles that generate less than 50 g of carbon dioxide emissions per kilometre not be taxed.

The practice of applying the transport tax in Israel also attracts attention. Fixed rates are set in national currency per year and are differentiated according to two criteria, namely the cost of a new car and its age, while tax rates are progressive relative to the value of the car and regressive relative to its age. In Turkey, the basis for the application of fixed tax rates is also the type and age of the vehicle, as well as, for certain categories, the volume of the engine cylinders.

In Romania, the annual vehicle tax differs for the three categories of vehicles: buses and minibuses, cars with an engine cylinder volume of up to 2000 cm^3, and cars with an engine cylinder volume of more than 2000 cm^3. Moreover, the tax amount is calculated by multiplying the established rate for every 500 cm^3.

Thus, it was found that 6 (the Czech Republic, Finland, Portugal, Romania, Slovakia and Turkey) out of the 9 studied countries establish tax on vehicles according to the vehicle's type. At the same time, the Czech Republic, Slovakia and Finland consider the weight of vehicles when setting transport taxes. Among the studied countries, only Finland, France and Israel do not differentiate transport taxes depending on the power of the vehicle's engine. It is important that in Portugal the criterion for establishing transport taxes is the type of fuel, and in Finland, France and Ireland it is the level of CO_2 emitted into the atmosphere. Turkey and Israel tax vehicles based on their age, and the value of the vehicle was a criterion found only in Israel. It was found that different criteria (both the cost and physical characteristics of the car) are used for taxation. For example, in France, differentiated transport tax rates depending on the amount of CO_2 emissions show that the criterion of stimulating the environmental safety of cars is also important for the government. On the other hand, the establishment of different taxes rates depending on the volume of the engine cylinder, as well as on its age, not only can have a fiscal purpose (collecting additional revenues from the more expensive cars) but also can regulate the use of the most environmentally harmful cars. In addition, it is also interesting to investigate whether transport taxes that are established according to the principle of the value of the car perform any regulatory function.

For further calculations, it is important to form the most homogeneous sample of transport environmental taxes. That is why, in the further study of the two taxes operating in Finland, we will choose only the transport tax, leaving out the tax for the first registration of vehicles, and we will also not consider the tax for the first registration of a vehicle while studying environmental taxation in Ireland.

Given the wide spectrum of influence of environmental taxes on various aspects of ecological development, energy efficiency and environmental consequences, it is advisable to choose a single measure of the resulting parameters. Research in the field of national security proves that its measurement involves the construction of integral indicators that characterize individual aspects of national security depending on the goals of the analysis [35].

To characterize the indicator of national security, we will use an integral indicator that summarizes the parameters of environmental, energy and economic security that are sensitive to the impact of environmental taxation. The method of calculating the defined integral indicator is presented in detail in [27,28].

Figure 2 presents the dynamics of the values of the calculated integral indicator for the studied sample of countries. As we can see, during the analysed period, the level of national security grew most dynamically in Finland, France, Portugal, Romania and Slovakia. The Czech Republic and Israel were characterized by moderate values of the indicator without sharp deviations during the year. On the other hand, it is important that the integral level of national security in Turkey has almost halved during the studied period. At the same time, it is important that during the studied period, the integral indicator of ecological, economic and energy security has a rather high level of volatility in almost all the studied countries. This indicates the fact that the latest trends in the development of national economies are characterized by significant transformations under the influence of political decisions, limited resources and the growth of public consciousness. However, given the heterogeneity of global development, it is of scientific interest to identify the reasons for such fluctuations in the levels of national security. This will allow for establishing vectors of the application of regulatory measures in countries across the world.

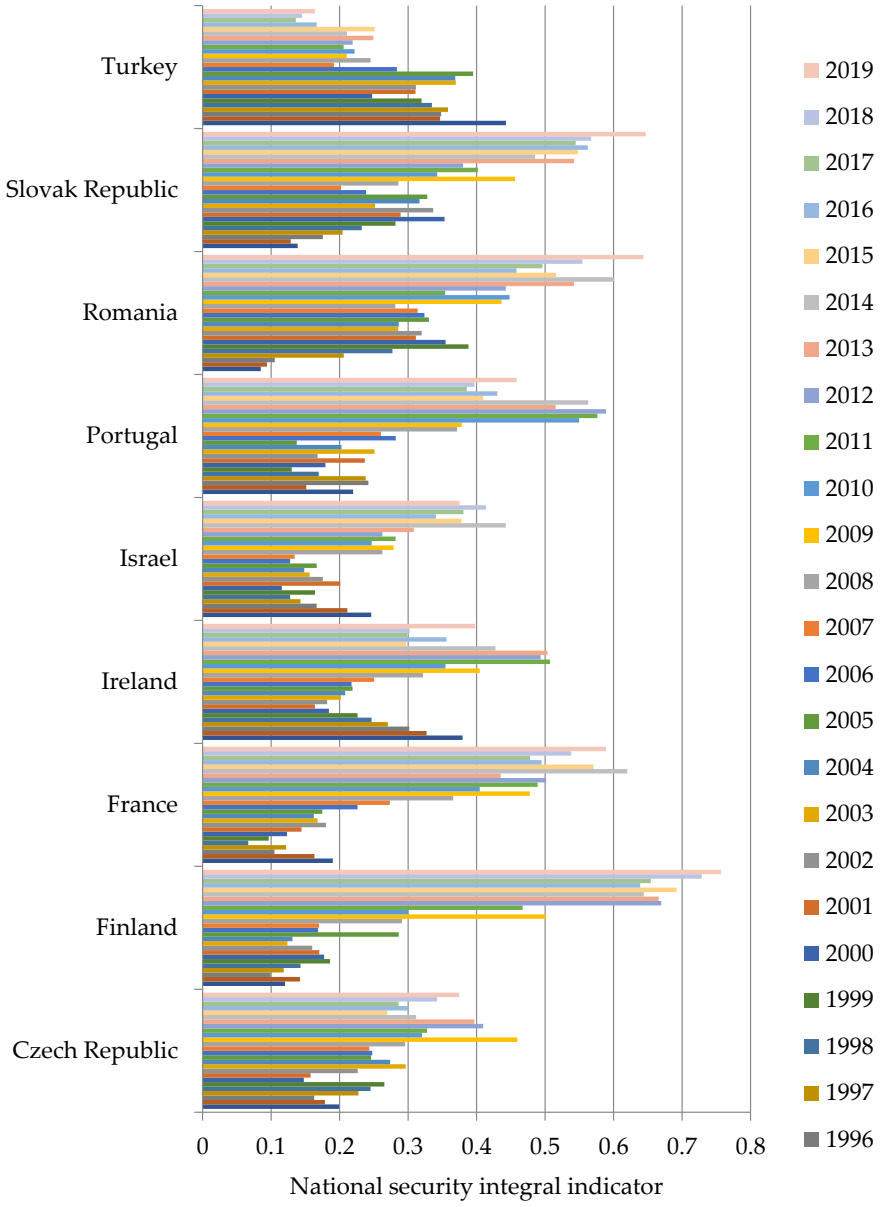

Figure 2. Dynamics of the integral indicator of national security in European countries for the period 1994–2019, in units. Note: This figure was built according to the data from the author's calculations [27,36].

This paper proposes to study the influence of the specifics of the choice of functional elements of environmental transport taxes on the national security of a country with the help of regression modelling tools using dummy variables characterizing a certain feature of transport taxation. The choice of an approach to modelling with dummy variables is determined by the need to formalize the parameters of transport taxes in different countries in order to enter into the model notations regarding their application in the panel data sample. This approach allows for comparing the effectiveness of transport taxes applications in the countries that used a certain criterion for transport taxation with the countries that ignored such a criterion. The general appearance of the model is in Equation (1):

$$NSI = \beta_0 + \beta_1 ETR + \beta_2 ET_p + \varepsilon \quad (1)$$

where NSI is the resulting variable denoting the integral indicator of national security; ETR is a factor variable denoting the amount of revenue from the payment of the investigated environmental tax in the country; β_1 is the coefficient that takes into account the influence of the factor variable amount of revenues from the environmental tax on the integral indicator of national security; ET_p is a dummy variable denoting the use in the country of a certain criterion for determining the tax base for an environmental transport tax, which takes the value 1 if the criterion is used and 0 if it is not used; β_2 is the coefficient that takes into account the effect of the dummy variable on the resulting characteristic; and ε is the measurement and specification errors.

The main factor variable is the total annual amount of revenue from the investigated transport tax in each country. To ensure the proportionality of the statistical sample of data, the indicators of tax revenues are measured in millions USD.

Figure 3 shows the summary statistics of the revenues from the environmental tax for the registration/use of vehicles in the cross section of the studied countries.

The criteria for the formation of dummy variables characterizing the tax base with environmental taxes for the registration/use of vehicles in a country are the selected parameters of the specificity of taxation, revealed during the preliminary analysis. Table 2 forms a matrix of dummy variables. The dummy variables measured as 1 characterize the application in the country of a certain criterion of environmental taxation, and those as 0 characterize its absence.

Table 2. Matrix of dummy variables characterizing the specificity of taxation with environmental taxes for the registration/use of vehicles in different countries.

Country	Type	Weight	Type of Fuel	Volume of Engine Cylinders	CO_2 Emissions	Cost	Age
Czech Republic	1	1	0	1	0	0	0
Finland	1	1	0	0	1	0	0
France	0	0	0	0	1	0	0
Ireland	0	0	0	1	1	0	0
Israel	0	0	0	0	0	1	1
Portugal	1	0	1	1	0	0	0
Romania	1	0	0	1	0	0	0
Slovakia	1	1	0	1	0	0	0
Turkey	1	0	0	1	0	0	1

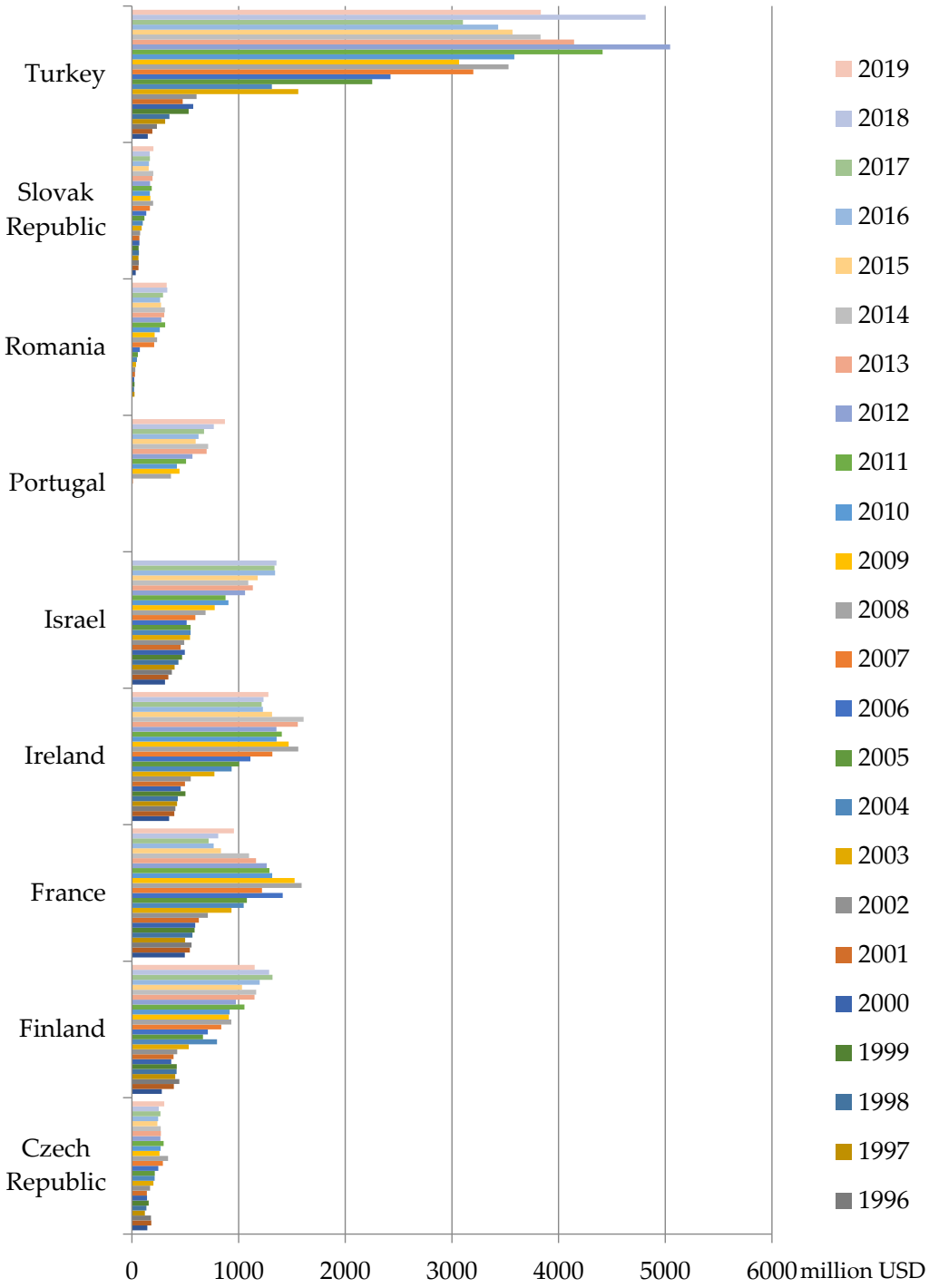

Figure 3. Dynamics of tax revenues from transport taxes for the registration and use of vehicles in European countries for the period 1994–2019, in millions USD. Note: This figure was built according to data from [34].

Therefore, this paper proposes to model the influence of the specificity of the establishment of the functional parameters of environmental taxes on national security by using the panel regression toolkit, which allows for the simultaneous assessment of the effects in terms of the general sample of countries. A model specification with panel-adjusted standard errors based on the use of the Durbin–Watson test was chosen for the calculations. The choice of the model specification was determined by the peculiarities in the input statistical data. At the beginning of the study, an OLS regression was built; however,

the model-adequacy criteria turned out to be unsatisfactory. Given the selection of panel data for the evaluation, it was assumed that the input data would be characterized by the heteroscedasticity of the residuals, which would not allow the use of classical linear models. The conducted White's test confirmed the heteroskedasticity in the input data. To eliminate this problem, the contemporaneous correlation model, namely the panel-adjusted standard errors, was chosen. The testing of various modifications of this model revealed that the most adequate was the model based on the Durbin–Watson criterion. The assessment involved the construction of separate models using dummy variables that characterized the application of each of the criteria for determining the tax base. Calculations were made for the period 1996–2019. The choice of research period was informed by the availability of a complete data set of transport tax revenues and by indicators of national security factored into the model.

3. Results

The first of the built models describes the impact of accounting for the type of vehicle (car, truck, bus, etc.) for differentiating the rates of transport tax paid for registration or use of a vehicle. The results presented in the Table 3 demonstrate that the effect of the specified dummy variable is statistically significant; in countries where this criterion is factored in when setting a transport tax, the integral level of national security is on average 0.0375 higher than that in countries where this criterion is not used. This demonstrates the fact that the establishment of transport taxes by type of vehicle is effective in the context of ensuring national security.

Table 3. Results of assessing the impact of setting transport tax rates depending on the type of car on the change in the integral level of national security.

Variable	Coefficient	Std. Error	*t*-Value	*p*-Value	Lower 95%	Higher 95%
ETR	3.26×10^{-6}	0.0000	0.32	0.752	−0.0000	0.0000
Dummy_Type	0.0375 ***	0.0099	3.78	0.000	0.0180	0.0570
Constant	0.2850 ***	0.0295	9.64	0.000	0.2271	0.3430
Model-adequacy parameters						
Wald chi2(2)	14.70					
Prob > chi2	0.0006					

Note: *** $p < 0.01$—statistical significance at the 99% level.

A common criterion next to the type of car is its weight, in terms of differentiating types of cars when setting tax rates. The results of calculations presented in Table 4 prove that using this criterion in a country has a positive and statistically significant effect on the growth of the integral level of national security—on average, its level for countries using this criterion is higher by 0.0272 compared with countries in which the specified the criterion is not used.

Table 4. Results of assessing the impact of setting transport tax rates depending on the weight of the car on the change in the integral level of national security.

Variable	Coefficient	Std. Error	*t*-Value	*p*-Value	Lower 95%	Higher 95%
ETR	4.84×10^{-6}	9.49×10^{-6}	0.51	0.610	−0.0000	0.0000
Dummy_Weight	0.0272 **	0.0122	2.22	0.027	0.0031	0.0513
Constant	0.2998 ***	0.0237	12.65	0.000	0.2534	0.3463
Model-adequacy parameters						
Wald chi2(2)	6.09					
Prob > chi2	0.0477					

Note: *** $p < 0.01$—statistical significance at the 99% level, ** $p < 0.05$—95% level.

In contrast to this, the results of calculations given in Table 5 prove that the use of the type of fuel used by a car as a functional criterion for establishing transport taxes was not a relevant factor in increasing the regulatory effectiveness of environmental taxes in ensuring national security.

Table 5. Results of assessment of the impact of setting transport tax rates depending on the type of fuel on the change in the integral level of national security.

Variable	Coefficient	Std. Error	*t*-Value	*p*-Value	Lower 95%	Higher 95%
ETR	1.89×10^{-6}	0.0000	0.18	0.854	−0.0000	0.0000
Dummy_Fuel	0.0168	0.0167	1.01	0.314	−0.0159	0.0496
Constant	0.3092 ***	0.0265	11.67	0.000	0.2572	0.3611
Model-adequacy parameters						
Wald chi2(2)			1.01			
Prob > chi2			0.6021			

Note: *** $p < 0.01$—statistical significance at the 99% level.

In addition, insufficient conditions for the effectiveness of environmental taxes also turned out to be the use of criteria of power and emissions from the car; this influence is statistically insignificant, as evidenced by the data in the Tables 6 and 7.

Table 6. Results of the assessment of the impact of setting transport tax rates depending on the power of the car on the change in the integral level of national security.

Variable	Coefficient	Std. Error	*t*-Value	*p*-Value	Lower 95%	Higher 95%
ETR	1.34×10^{-6}	0.0000	0.13	0.900	−0.0000	0.0000
Dummy_Capacity	0.0134	0.0210	0.64	0.522	−0.0277	0.0546
Constant	0.3024 ***	0.0400	7.56	0.000	0.2240	0.3808
Model-adequacy parameters						
Wald chi2(2)			0.63			
Prob > chi2			0.7300			

Note: *** $p < 0.01$—statistical significance at the 99% level.

Table 7. Results of assessing the impact of setting transport tax rates depending on vehicle emissions on changes in the integral level of national security.

Variable	Coefficient	Std. Error	*t*-Value	*p*-Value	Lower 95%	Higher 95%
ETR	-4.77×10^{-7}	0.0000	−0.04	0.966	−0.0000	0.0000
Dummy_Emissions	0.0186	0.0196	0.95	0.343	−0.0198	0.0571
Constant	0.3065 ***	0.0216	14.17	0.000	0.2641	0.3489
Model-adequacy parameters						
Wald chi2(2)			1.90			
Prob > chi2			0.3874			

Note: *** $p < 0.01$—statistical significance at the 99% level.

On the other hand, the establishment of environmental taxes depending on the value and age of the car is a factor that significantly reduces their effectiveness in the context of ensuring national security—in countries that use this criterion, national security is characterized by a significantly lower level compared with another countries (Tables 8 and 9).

Table 8. The results of evaluating the impact of setting the rates of transport taxes depending on the value of the car on the change in the integral level of national security.

Variable	Coefficient	Std. Error	*t*-Value	*p*-Value	Lower 95%	Higher 95%
ETR	9.11×10^{-7}	0.0000	0.09	0.929	−0.0000	0.0000
Dummy_Price	−0.0807 ***	0.0104	−7.75	0.000	−0.1011	−0.0603
Constant	0.3204 ***	0.0269	11.88	0.000	0.2675	0.3738
Model-adequacy parameters						
Wald chi2(2)	68.31					
Prob > chi2	0.0000					

Note: *** $p < 0.01$—statistical significance at the 99% level.

Table 9. Results of assessing the impact of setting transport tax rates depending on the age of the car on the change in the integral level of national security.

Variable	Coefficient	Std. Error	*t*-Value	*p*-Value	Lower 95%	Higher 95%
ETR	0.0000 ***	7.02×10^{-6}	3.19	0.001	8.62×10^{-6}	0.0000
Dummy_Age	−0.0955 ***	0.0244	−3.91	0.000	−0.1434	−0.0475
Constant	0.3170 ***	0.0271	11.69	0.000	0.2639	0.3702
Model-adequacy parameters						
Wald chi2(2)	39.45					
Prob > chi2	0.0000					

Note: *** $p < 0.01$ (statistical significance at the 99% level).

4. Discussion

The obtained results made it possible to confirm the working hypothesis that the regulatory impact of environmental taxes depends not only on their presence in the country but also on the selected application criteria. At the same time, it is important that some of the built models turned out to be statistically insignificant, which indicates the presence of the influence of other factors on the resulting indicator of national security, which is stronger than the impact of several parameters of environmental taxation. At the same time, the presence of a generally positive impact of transport taxes, confirmed by many of the constructed models, indicates that their application is effective in order to balance environmental, economic and energy aspects of national security. Regarding the impact of individual functional parameters of transport taxes, three types of it were identified: strengthening the general impact of transport taxes on national security, the deterioration of the efficiency of transport taxes and an uncertain impact that requires further research.

Calculations of transport taxes impact on the structure of sales of vehicles, grouped by the level of impact on the surrounding natural environment, can become promising areas of research into the effectiveness of transport taxes in the context of ensuring national security. The study conducted on a selected sample of countries contains results that can also be used in benchmarking for other countries. At the same time, it is important that the developed approach can also be applied to other types of environmental taxes, given the specifics of their applications, in terms of being both objects and subjects of application. The proposed methodology can be adapted to predict the expected consequences of the implementation of environmental tax reforms, depending on their chosen design.

5. Conclusions

The developed scientific-methodical approach and the calculations based on it proved that the choice of functional criteria for setting environmental taxes was important in the context of comprehensively providing environmental, economic and energy security. It is more rational to choose the type and weight of the car as criteria for differentiating tax rates. Criteria such as the emissions generated by the vehicle, its power and the type of fuel used were conditionally neutral, as they did not provide a relevant impact on national

security. It was important that the criteria of the value and age of the car, which are used in the establishment of transport taxation in several countries, demonstrated inefficiency from the point of view of the regulatory impact of ensuring national security, which can instead be achieved by the action of environmental taxes.

The obtained results have significant practical value for the governments of countries that are formulating the policy of transport taxation or are in search of environmental tax reform. For example, in order to increase the comprehensive effectiveness of transport taxes, it is advisable to set them according to the type of car. In the long-term perspective, this guarantees not only tax revenues but also a reduction in the harmful effects of the motor transport industry on the environment and energy.

At the same time, the successful testing of the developed methodology opens up perspectives for further research. Particularly, it is promising to study the effectiveness of various options for the design of energy taxes and taxes on environmental pollution. It is important that the developed approach can be adapted to compare the effectiveness of different groups of environmental taxes to comprehensively ensure the achievement of various tax policy goals. On the other hand, future research should consider comparisons of efficiency according to different tax instruments and vehicle usage.

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