Internalization tool for external effects from emissions of pollutants by motor vehicles

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Abstract. The article proposes an approach to justify the tool for internalizing external effects from emissions of pollutants by motor vehicles in the territory. It is based on the proposed methods to determine the environmental sustainability criterion, taking into account the characteristics of the ecosystem of the territory, estimating the masses of pollutant emissions by different vehicles in the territory and the economic damage to the ecosystem from the emission of toxicants. The direction of development of the regional tax system with its greening is presented. The features of the formation of an environmental tax on cars depending on the development objectives of the territory and the mechanisms for their implementation are considered. The consequences of the influence of proposals on various sectors of the economy as a whole and the agricultural sector in particular are determined.

1. Introduction

One of the main tasks of regional management is to ensure the right of the population to a favorable ecological and economic environment in which residents of the regions are both consumers of natural goods and direct participants in market relations. The necessity to meet primary human needs is dictated by the availability of a sufficient quantity of high-quality products on the market, which is ensured by active commodity circulation. The presence of manufacturers from other regions of the Russian Federation and foreign countries indicates an open policy of interaction between producers and consumers. Active commodity circulation is implemented using an inalienable condition - transport infrastructure, and thanks to the set logistic links, an uninterrupted supply of goods is carried out. One way or another, but the operation of vehicles (V) leads to environmental degradation, both throughout the country territory and in individual regions. Currently, significant damage to the ecosystems of urbanized areas is created by emissions of polluting substances (PS) of vehicles [1]. The need to reduce economic damage requires more effective measures in terms of environmental (E) protection. Therefore, improving the tools of ecological and economic regulation of technogenic impact on the atmosphere of the regions is an urgent scientific and practical task.

The subject of the study is the organizational, economic and managerial aspects of compensation for economic damage from emissions of polluting substances of vehicles in the context of the transition to sustainable development of the territory.

The working hypothesis of the study is the advisability of forming the direction of the transition to sustainable development of the territory by stimulating economic activity and reducing damage from vehicle emissions on the basis of the developed approaches for assessing the negative impact of vehicles on environment and greening the tax system.
The aim of the study is to form an element of a regional ecological and economic strategy for the transition to sustainable development, including the development of an environmental tax on vehicles and the direction of greening the regional tax system.

2. Methods
In modern studies, the following main types of external effects of vehicles are distinguished: impact on land use, unreimbursed part of parking costs, traffic jams, air pollution, risk of accidents, external infrastructure costs, water pollution, noise pollution, waste [2].

In modern ecological and economic practice of regulation, there is a tendency towards an increase in attempts to increase the internalization efficiency of emerging externalities. Each state chooses for itself the main types of externalities for compensation. Due to the fact that today the market economy does not allocate resources efficiently, A. Pigou's approach is more often used in the world [3–4]. In conditions of the low transaction costs, the internalization process will not require government intervention; the time will come for effective internalization according to R. Coase [5].

Prospects for the development of the regional economic system are largely determined by its ecological and economic potential, the effectiveness of its use and existing economic conditions, both in the country and in the region. In modern economic activity, the tasks of regional development are of paramount importance, the necessary condition for which is the development, consideration and practical application of existing methods for assessing, growing and rationally using the ecological and economic potential of the territory.

The analysis of literary sources made it possible to single out three main economic instruments for internalizing the external effects from emissions of polluting substances [2–5]:
1. Ecological taxes;
2. Issue payments;
3. The mechanism for the sale of rights to environment pollution.

Fuel taxes are an attractive economic tool for the adoption of negative externalities from vehicles [6].

In this case, fuel taxes are ineffective and limited [7] tools for the external effects of the territory, which depend on the time and place of the trip, the characteristics of the vehicle [8], engine operating conditions [9]. Nevertheless, fuel taxes are an ideal tool for internalizing the external costs of CO₂ emissions, since CO₂ emissions are closely related to fuel consumption [8]. However, due to the fact that toxic pollutants enter the air environment of the territory with products of incomplete fuel combustion during transport work [9], additional tools to improve the quality of the environment must be used.

The European Commission on Taxes and Customs Duties has divided ecological taxes into seven groups according to their areas of application. One of the directions is the transport tax (tax on kilometers traveled; annual tax on the owner; excise taxes on the purchase of a new or used car). Countries are characterized by various modifications of the transport tax. In their systems of ecological taxation, the dominant methods for assessing damage from emissions of polluting substances are implemented in this territory. At the same time, the problems and limitations of the methodology for ensuring and assessing the effectiveness of decisions that dominate in this territory can seriously affect the specific situation in the life of socio-economic systems, due to erroneous managerial decisions, inhibit the improvement of the population life quality and economic growth [9].

Evaluation of the effectiveness of territorial management should be a system of criteria and indicators, which together will determine the priorities for the development of individual elements of the system and maximize the final result. Thus, a necessary condition for ensuring and adequately assessing the effectiveness of decisions is the developed system of goals, a correctly selected system of performance indicators and the selection of criteria that should adequately reflect the goals and ways to achieve them. However, the obstacles to the implementation of this approach are due to the complexity of the socio-economic system and the specificity of the economic sector problems.
Effective management of complex processes and systems, which include the socio-economic development of regions, requires the use of a methodologically reasonable approach to assessing effectiveness. The basis of any approaches to the actual performance evaluation is the features, completeness and reliability of information support. Assessment of the acceptability of various investment projects in various sectors of the economy, for example, in environmental protection, agriculture, transport, etc. in many respects is connected both with primary information and with approaches to its substantiation and analysis [7, 9]. Thus, in ensuring and evaluating the effectiveness of territorial management, the methodology should take into account and mutually determine the goals of the process or the development of the system. This also includes indicators ensuring its implementation, approaches to obtaining initial data on the state of the system, its processing and analysis. For an adequate comparison of the assessment results of various research objects, it is necessary to take into account the features of each of its stages and elements.

An important stage in assessing and ensuring the effectiveness of ecological and economic policies is the justification of its tools.

Information support for making managerial decisions in the field of environmental protection, and in particular, the justification of an internalization tool for external effects from emissions of polluting substances by vehicles, presupposes an economic assessment of the negative consequences of pollution of this territory by actual emissions. In addition, when substantiating a tool, it is necessary to take into account the features of its implementation and administration. The solution to this problem can be reduced to the following main tasks:
1. The definition of environmental sustainability criteria, taking into account the features of the territory ecosystem;
2. Estimation of pollutant emission masses by different vehicles on the territory;
3. Economic assessment of the negative consequences from emissions of polluting substances (economic damage);
4. Economic damage relative to the criterion most acceptable for administration (relative economic damage that can be used as a tariff).

The definition, selection of the criterion of environmental sustainability and its assessment for the territory is a basic element in the formation of ecological and economic policies and largely affects the methodology for assessing and ensuring the effectiveness of decisions [7]. The model for the formation of a target for reducing the anthropogenic impact of polluting substances on the territory of cities will depend on the emission mass of stationary and mobile sources and take into account the features of the ecosystem. Consideration of the hazard of polluting substances in assessing the maximum permissible load on the ecosystem will be carried out by analyzing and identifying mechanisms for the disposal of pollutants by ecosystem elements. In addition, a safe level of emissions for the territory is determined taking into account the maximum permissible concentration of the relevant substances and the volume of supply air. The proposed target indicator (maximum permissible load on the ecosystem) allows us to predict the environmental situation taking into account various strategies for ensuring environmental stability and to increase the manageability of the territory.

Using a model ecosystem to assess the maximum permissible load will determine the maximum acceptable value of anthropogenic impact on the air environment of the territory [10].

The task of estimating the mass of emissions of polluting substances by different vehicles on the territory imposes restrictions on the selection of an acceptable method of internalizing externalities. The mass of emissions of polluting substances of vehicles is determined taking into account operating conditions and characteristics of the vehicles. For scientifically reasonable and reliable determination of the mass flow rate of pollutants by vehicles, it should take into account the mixture formation and combustion of the working mixture in the internal combustion engine. The author's approach to calculating the volumetric flow rate of exhaust gases is based on the characteristics of the vehicle's transport work available for operational control. Studies have shown that determining the value of the
volumetric flow rate of exhaust gases can be reduced to finding the relative engine power (a parameter that varies from zero to one) [9].

Economic assessment of the negative consequences of emissions of polluting substances can be carried out on the basis of various approaches. The basis for the use of these approaches may be the methods of assessing economic damage and the current standards for the payment for emissions of polluting substances (domestic and foreign). Economic damage to an ecosystem, part of which is the specific economic damage to a particular ecosystem (the ratio of the costs of building and maintaining of assimilation potential to the maximum allowable load of carbon monoxide on an ecosystem) takes into account the costs of neutralizing and utilizing of polluting substances by natural (and possibly artificial) elements of the ecosystem [7]. In order to make informed management decisions, the amount of money collected from the ecological tax on the vehicles must correspond to the damage according to one of the selected methods.

Task 4 can be solved taking into account the features of the method of estimating the mass of emissions of polluting substances by vehicles [9] and the administration system. Depending on this, a selection of a transport tax acceptable for a given territory is carried out.

The choice of approaches and methods used to justify the tool for internalizing the external effects of emissions of polluting substances by vehicles in the territory depends on information restrictions, the dominant methodology in this territory and development goals regarding the degree of exploitation of social, resource and environmental potentials.

3. Results
To take adequate ecological and economic measures and implement them in good faith, it is necessary to justify management decisions in the territory, taking into account the goals of its development. Based on the methods presented in the previous section, various approaches for the distribution of economic responsibility between the owners of vehicles, which can be used to justify the environmental tax in the territory, can be developed. Let us present an algorithm for substantiating the environmental tax rate on vehicles from engine power (Figure 1).
Figure 1. Algorithm for justifying the environmental tax rate on vehicles.

Note: $M_{ijk}$ - mass emission of the i-th polluting substance by the j-th vehicle using the k-th fuel, depending on its effective power, kg/year;

- i - type of polluting substance;
- n - number of types of polluting substance in the emissions of the vehicle;
- j - type of vehicle for its intended purpose (passenger - P, minibus - M, freight - F, bus - B), j=1...s;
- k - type of fuel used by the car (gasoline - B, diesel - D, liquefied gas - Gl, compressed gas - Gc), k=1...m;

$C_{jk}^i$, $C_{jk}^D$, $C_{jk}^F$ - is the cost of the mass of emissions of polluting substances from the j-th vehicle using the k-th fuel, calculated accordingly on the basis of Russian standards for payment, foreign...
standards for payment and economic damage to the ecosystem, rubles/year;
\(\gamma^R, \gamma^F\) - emission payment standards for emissions of polluting substances used in the Russian Federation and in foreign countries, rubles/kg;
\(k\) - coefficient taking into account environmental factors in the region, inflation and emissions of harmful substances into the atmospheric air of cities;
\(\gamma^D_A\) - specific economic damage to the ecosystem from emissions of polluting substances in the territory, rubles/cond. kg;
\(A_i\) - coefficient of relative aggressiveness of polluting substances for a particular ecosystem \([7, 10]\), cond. kg/kg;
\(N_{r,pow,jk}\) - average rated power of j-th vehicles using k-th fuel, W;
\(H^R_{jk}, H^F_{jk}, H^D_{jk}\) - environmental tax rate of the j-th vehicle using the k-th fuel, calculated accordingly using Russian payment standards, foreign payment standards and based on economic damage to the ecosystem, rubles/(\(W\times\text{year}\)).

Based on the above algorithm, it is possible to determine the dependence of the environmental tax on a vehicle for a specific territory as follows:

\[T_V = N_V \times T_V,\]

where \(T_V\) - environmental tax from the vehicle, rubles/year; \(N_V\) - power of a specific vehicle, W; \(T_V\) - environmental tax rate, depending on the type of vehicle, rubles/(\(W\times\text{year}\)).

The results of calculating the tax burden per unit of vehicle on the basis of a reasonable environmental tax rate suggest a phased implementation of such a project, including a gradual tightening and approximation to a reasonable tax rate. Taking into account the data on the mass of emissions of pollutant substances from vehicles in the city of Rostov-on-Don \([9]\), the values of the environmental tax rate for a passenger car according to Russian standards for emissions of pollutant substances are comparable to the transport tax on engine power (if emissions of pollutant substances from vehicles are considered to be over limit). Payment assessment of foreign standards for emissions of pollutant substances is consistent with annual fees in Western countries. The annual environmental tax rate on vehicles for ecosystem damage is comparable to the cost of a budget car in the Russian Federation.

4. Discussion
The proposed algorithm allows, on the basis of the actual mass of emissions of pollutant substances by various types of vehicles in a particular territory conditions and the assessment of economic damage from actual emission of pollutant substances, using the chosen approach (depending on the goals and potential of the region), determining the environmental tax rate depending on the vehicle engine power.

In order to maintain the existing system of economic development of the territory due to the suppression of natural and human potential \([11]\), it is advisable to use the approach to compensation for damage from vehicle emissions based on Russian standards of payment for emissions of pollutant substances. Also, the value of the payment depends on coefficients that take into account environmental factors, mass of emissions of harmful substances into the atmospheric air of cities, inflation.

In order to reduce the load on the natural and human potential, it is necessary to increase environmental payments, for example, to the level of Western countries. In order to move to the sustainable development of the territory, it is advisable to choose a compensation approach based on an assessment of the economic damage to the ecosystem, taking into account the territorial coefficients of relative aggressiveness of harmful substances (determined on the basis of the values of maximum permissible pollutant load on the ecosystem \([7]\)) and specific economic damage to the ecosystem from emissions of pollutant substances. At the same time, such a transition should be accompanied by the creation of appropriate conditions in the territory: transport infrastructure, the use of the best available
technologies and products, openness and adequacy of information support for making managerial decisions, etc.

Given the stimulating effect of such a tax, it is advisable to adjust the environmental tax rate taking into account the actual emissions of pollutant substances by various types of vehicles in the territory.

Features of implementation and the consequences of implementing the approach to justify the environmental tax rate on vehicles for urbanized and rural areas will differ significantly. First of all, this is connected with the value of the environmental sustainability criterion: urban areas are more characterized by exceeding the maximum permissible load on the ecosystem and, accordingly, higher negative consequences from environmental pollution (the main factors here are damage to health, population size and density).

To improve the investment climate and maximize the effect, it is advisable to introduce an environmental tax on vehicles within the framework of the greening of the tax system (transfer of the center of gravity of the tax load from the payroll, property payment fund, etc. to environmentally harmful activities and products), i.e. reducing other taxes in priority areas of socio-economic development, for example, related to the commodity circulation of the region in question.

Depending on the priority development goals of the territory, the proposed environmental tax on vehicles can now partially or completely replace cost added taxes, personal income, payroll and profits. Other directions for solving the problem of the external effects of vehicles within the framework of the development of the tax system are subsidizing freight transportation with more environmentally friendly transport, levying tolls on the territory from the most dangerous sources of environmental pollution (freight vehicles, buses and minibuses), transport tax, etc. The decision-making process depends on the objectives pursued, specific conditions and should be borne by the regional authorities, so that the measures taken contribute to the maximum internalization of external effects from environmental pollution.

Toughening of environmental requirements under the reimbursement system should be phased. Replaced taxes can be represented as a useful effect of the strategy of ecological and economic development of the region. The usefulness of environmental protection measures is determined by the totality of changes that contribute to the achievement of the sustainable development of the territory (improving the unfavorable situation in the environmental and socio-economic spheres of life). Proceeding from this, the economic usefulness of the system of instruments is an assessment of the effectiveness of environmental protection according to the main life-forming parameters (resource, environmental, social) of the development of the economy in each specific region. The economic usefulness of environmental measures characterizes the totality of positive changes while meeting the needs of economic development, taking into account social interests. Thus, the proposed approach to justifying the internalization of externalities from emissions of pollutant substances by vehicles in the territory can be used in the greening of the regional tax system. The development of the tax system can be carried out on the basis of replacing tax payments related to economic development with an environmental transport tax.

5. Conclusions

With appropriate goal-setting and the development of administrative norms of the legislation, the implementation of the proposed approach can contribute to constructive changes in operating vehicles and the spread of various environmental measures [4, 6, 7]. In addition, government intervention in pricing processes by improving the tax system under the conditions of a functioning market mechanism will make it possible to influence the structure of the territory economy as a whole and the competitiveness of individual industries. In particular, the cost structure of the agro-industrial complex largely depends on the transportation of products to markets, the cost of maintaining the fleet of vehicles, etc. Consideration of local characteristics in the formation of managerial decisions at the regional level will provide benefits to local producers and increase food security of the territory.

At present, in the Russian Federation, the externalization of the external effects of vehicles on the environment is partially carried out through a tax on vehicles, which depends on the rated engine
power. In addition, toll roads have been introduced on some federal highways, where incoming cash is considered internalized. Fees on excise taxes on petroleum products vary on the territory of the Russian Federation. The money received goes to budgets of different levels. Further growth of the tax load and the development of the tax system as a whole should be carried out taking into account the greening of the tax system. When transforming the institutional environment, it is necessary to take into account development goals and the actual conditions of the territory. For example, the quality of life in many modern cities is declining: there are psychological stresses due to traffic jams and lack of space for safe movement (sidewalks are used for parking, roads with heavy traffic create congestion), public transport is in decline, the quality of environment is deteriorating, and the incidence of the population is growing.

As a result of the analysis of the current transport and environmental situation in the Russian Federation, it should be noted that with the current system of taxes on vehicles, all car owners pay the same amount, regardless of how often they are used. In other words, the system of economic instruments should fulfill not only a fiscal function, but also stimulate and coordinate the behavior of economic agents.

As a result, the fleet should be updated with better fuel economy and less toxic emissions. The automotive industry will be forced to adapt to new standards, introduce innovations, reduce the mass of vehicles when developing cars of the next generations, having reduced or "zero" emissions [6].

Moreover, it should be noted that the level of living of the population of the Russian Federation is far from European. Therefore, one cannot blindly adopt experience in the development of the tax system. Adaptation of positive experience and the development of new tools are needed.

An important is the targeted approach to solving accumulated problems, since the money received from paying taxes should be purposefully spent on solving specific problems of the corresponding sphere of socio-economic development.

To improve environmental welfare both in the Russian Federation and in the world as a whole, it is necessary to develop a clearly streamlined economic mechanism based on reliable information, which would provide for the rational use of natural resources in a market system and the use of a system of payments for environmental pollution and the use of natural resources, exclusively when the market mechanism failed.

Externalities can be reduced from vehicle emissions through the development of an institutional environment that governs the rules for implementing innovations and various environmental measures. The promotion of good environmental behavior can be carried out using a system of administrative and economic environmental policy instruments. Moreover, the justification of the economic mechanism and differentiation of pollution sources affects the achievement of environmental goals, economic goals of development of various industries and should be based on reliable information. Basic criteria for the formation of a system of information support and analysis [7] will improve the efficiency of decisions and the economic system as a whole. An increase in the effectiveness of territorial management will contribute to the release of financial resources that can be used to increase the food security of the territory, develop the economy, and improve the quality of life.

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