Spatial Heterogeneity of «Green» Economy and Transaction Costs in Forestry

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Abstract. In this paper authors provide the further elaboration in a quantitative spatial analysis of the Russian regions in the context of the green economy concept. Two quantitative factors characterizing the population welfare are considered: the total wage fund and the regional public financial fund from own revenues per capita. As key environmental indicators, the authors chose eco-intensity indicators for regional economic systems. Our estimates show substantial heterogeneity of the Russian sub-federal units on socio-environmental characteristics. It is shown that the population of many regions not only lives under high anthropogenic pressure (overall and per capita), but they are also not provided with additional resources “collective welfare” at the expense of own budget revenues, despite the disadvantageous environmental conditions. It was noted that “carbon regulation”, directed at development a low-carbon economy, should not be based on quantitative indicators, which is the same for the whole country. Due to the heterogeneity it will require fine-tuning, taking into account regional specificity of the relationships between factors of well-being and anthropogenic pressures. The aim to decline of carbon-intensity in local economies in different regions of the country will require different timelines, and the relevant “road maps” need to be taken into account. In public policy to reduce carbon emissions, special attention should be paid to the differentiation of transaction costs for managing, protecting and restoring forest ecosystems. In state policy on carbon reduction issues, one of the focuses of special attention should be on differentiating the transaction costs of managing, protecting and restoring forest ecosystems.

1. Introduction
When we discuss the issues of the “green” economy, the problems of reducing the negative impact on the environment in the process of economic growth are in the forefront. The task of reducing CO₂ emissions is one of the central issues in the scientific debate on the «green» economy and «green growth». Significant limitations of the transition to low-carbon life support systems in Russia are climatic features that require the production of thermal energy on a large scale. Climatic differences of a large country determine the heterogeneity of carbon intensity for different areas [1]. This paper is devoted to discussion of some relevant issues, in particular, social indicators of “green” economy and “green” growth.

2. Eco-intensity and heterogeneity
The base the model construction was P. Victor’s approach from [2] for Canadian value added indicators and dioxide carbon emission in dynamics. Adopting and combining his model with GIS analysis
we found significant heterogeneity in eco-intensity, which can be defined as a ratio of economic and environmental quantitative characteristics. The detailed description of the model and definition of ecological economics zones can be found in our resent articles [3, 4].

In this work we use several socio-environmental characteristics of Russian regions, which are important for individual and public welfare. Some of our results are illustrated on Fig. 1.

![Spatial heterogeneity of ecological-economic zones of Russian sub-federal units](image)

**Figure 1.** Spatial heterogeneity of ecological-economic zones of Russian sub-federal units a) by indicator $E_t$; b) by indicator $E_w$.

Two quantitative factors characterizing the population welfare of the regions are considered: the total wage fund and the regional public financial fund from own revenues per capita. As key environmental indicators, the authors chose eco-intensity indicators [5] for regional economic systems. $E_t$ is the quantity of carbon dioxide emission (CO) per a unit of the sum of taxes (which is equal to 1000 rubles here). This is an indicator of “environmental cost” of public welfare. $E_w$ is the quantity of CO emissions per a unit of total regional wage fund (which is also equal to 1000 rubles here). It shows the average “environmental cost” of individual/households welfare.

### 3. Heterogeneity in transaction costs

The carbon balance is largely provided by forest ecosystems. There is a substantial depletion and degradation of forest resources in almost all sub-federal regions of Russia. Market failures in the solution of problems of preservation of natural capital are well-known [6]. In these circumstances, the purposeful actions of state institutions are important. Because “institutions don't come for free” [7], their function requires specific transaction costs (TC) [8].

In the region forestry, TC can be estimated by the volume of expenditures on its management, including the institutional costs, which are used for the conservation and reproduction of resources, and to perform their ecological functions. Subventions of the Federal and regional budgets (FB and RB)
for the management of forest ecosystems, as well as receipts from other sources, are allocated for these costs.

Our calculations revealed a high differentiation in specific TC (per 1 ha of forest land) between regions of Russia from 0.1 ruble/ha (Republic of Bashkortostan) to 1826 rubles/ha in the Lipetsk region (see Fig. 2).

![Figure 2. Spatial distribution of the specific TC per unit area of forest land in the Russian regions](image)

Moreover, this heterogeneity is accompanied by significant differences in regional forest policy. In the Lipetsk region with the least successful social and environmental performance in the “green” economy context (“black degrowth”), we see the highest TC. In the Irkutsk and Kemerovo regions, on the contrary, in the conditions of “black degrowth” specific TC – one of the lowest, less than 20 rubles/ha. TC per 1 ha of forest land from all sources in the regions which are the largest exporters to the Asia-Pacific countries are relatively low (less than 20 rubles/ha per year), while in most of the subjects of the European part of the Russian Federation (with the exception of the largest exporting regions) they are above 100 rubles/ha.

4. Conclusion
The quantitative evidence of revealed heterogeneity suggests new challenge on the way to elaboration of carbon tax levels and procedures, which is now being discussed in connection with the Paris Agreement [9-11]. One of its key aspects is the commitment of countries to develop adaptation plans to climate features and processes of their dynamics. The introduction of carbon tax in the accession countries is considered as a tool. The main purpose of this tax should not be budget replenishment, but mostly “carbon regulation”, i.e. creating incentives for the transition to low-carbon technologies. This initiative primarily reflects the demand trends of an increasing number of consumers for goods and services with a strong environmental reputation. An export is going to be increasingly sensitive to the “carbon intensity” of products. Therefore, Russia will not be able to be on the sidelines of these trends. The loss of time and pace can lead to another economic and social loss, which can be expressed both in direct losses of the economy and in the increased migration of human capital towards a better quality of life.

In developing carbon management tools, it is essential to consider the relationship between emissions and welfare indicators, as well as the heterogeneity of their distribution between regions. In particular, it is crucial that “carbon regulation” should not be based on quantitative indicators that are the same for the whole large country. Regardless of whether it will be in the form of a “carbon tax”, or other instruments will be developed, it will require “fine-tuning” taking into account the regional specifics of the links between welfare factors and anthropogenic pressures. Given that a significant share of carbon monoxide emissions, especially in the Eastern regions of the country, falls on energy facili-
ties of vital importance, it is obvious, that the transition to a low carbon intensity in different regions of the country will require different terms, and this must be taken into account in the relevant “road maps”. The differentiation of institutional TC for forest management should be the important argument in the public and scientific discourse on carbon regulation.

5. References
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