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Model of Growth of the Region's Economy Based on the Index of Economic Complexity

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ABSTRACT

An important target of the UN Sustainable Development Goals (SDGs) is the efficient use of the planet's resources. In this study, the authors show a strong exponential relationship between the economic complexity index and the efficiency of resource use in a country. The economic complexity index is a characterization of the productive capacity of large economies. This index measures the level of knowledge accumulated by a society that enables production. Assessing the level of a country's index also makes it possible to predict future trends in the region's economy. The model of economic sophistication index proposed by the authors includes the service economy, retail trade and manufacturing. Thus, in the paper, the authors identify how the economic complexity index affects the product level by defining the product space for each country and identifying the main products that contribute to a high product complexity index and prospective scalability, indicating the potential to produce better products in the future. Policies focused on increasing economic complexity and investing in staple products appear to be a priority for achieving sustainable development.

Keywords: regional economy; business; financial system; innovations; investments; economic complexity index; economy; trade turnover; sustainable development

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INTRODUCTION

The process of development and innovation takes place within the city, when a new workforce is added to the old workforce, and new business categories emerge as divergent from existing ones [1]. According to this concept of innovation follows the idea of economic development as a process that is closely related to the diversification of economic activity of the country. Economic diversification plays an important role in promoting sustainable development in the region. Despite the fact that urban areas are crucial to the economic development of a country, the contemporary literature on the geography of innovation focuses on firms and entrepreneurship at the regional or national level [2]. In modern economic geography, economic complexity is considered as a key component for the analysis of the structure of economic activity on the territory of a country [3, 4]. The economic complexity of countries is also positively linked to their level of economic development.

The economic complexity index first appeared in the paper of C.A. Hidalgo and R. Hausmann [5], who described some iterative procedure on a two-fold graph, where part of the top corresponded to countries and part to exported products. The country's economic complexity was calculated as the average of the economical complexity of the products that the country exports, and the product's economy complexity as the mean of the economy of the countries that export these products. Improved complexity indicators correlated with the country's income level, and deviations from that dependency predicted future growth. This suggests that countries are striving for a level of income dictated by the complexity of their production structures, and indicates that development efforts should be aimed at creating conditions that would enable sustainable development. In

2011, C.A. Hidalgo and R. Hausmann published the economic complexity index, in which applications of macroeconomics appeared. From 2011 economic complexity began to be calculated as the own vector of some matrix [6].

Thus, the structure of this index contains two separate fragments. The first fragment is the calculation of some matrix, which characterizes the structure (export structure), the next fragment is calculating values, vectors.

The economic complexity index was interpreted as a characteristic of the production capabilities of large economic systems. Some of the papers showed such characteristics as the level of technological development of the national economy. But by 2015, economic complexity began to be characterized as the amount of knowledge expressed in economic activity. At the same time, human and social capital should be understood as knowledge. Social capital, in turn, is the ability of a country to create large social and production networks in order to accumulate implicit knowledge and use it in the production system.

All appendices and all index calculation schemes use two basic concepts: diversity and ubiquity. The concept of "diversity" refers to the national economy, to a country, i.e. diversity is the quantity of products that a country exports in a fairly large volume. The larger the security, the greater the economic complexity. The concept of "ubiquity" refers to the number of countries that export a given product in a sufficiently large volume. The lower the spread of goods, the greater the economic complexity of the country that exports them. This is due to the fact that this country has few competitors capable of producing science-intensive goods.

The idea of economic complexity of cities is also permeated by the availability of high-intensity, innovative products and services [7]. Large and well-connected cities tend to disproportionately concentrate innovation in their firms and production processes, which is usually associated with a post-industrial knowledge-based economy. The presence of creative services in cities also contributes to employment growth and the emergence of new enterprises [8–10]. However, not all sectors of the economy are included for the analysis of economic complexity [11]. Thus, understanding and understanding the complex economic structure of the country requires a holistic approach that includes many sectors of the economy developing in the cities (manufacturing, knowledge economy, service sector).

Table 1 provides data for countries with the highest and lowest estimates of economic complexity for 2021, including GDP and income distribution inequality index. The income distribution inequality index is an indicator that reflects the equal distribution of income or wealth among members of a society [12].

Thus, the relationship between the economic complexity and inequality of income distribution in countries *Table 1* is as follows (*Fig. 1*).

Fig. 1 reflects the economic complexity on the abscess axis and the income distribution inequality index on the ordinate axis. The figure shows a negative dependency, which means that with increasing economic complexity there is a tendency to decrease income distribution inequality.

According to *Table 1*, Russia is ranked 51st in the index of economic complexity, improving its position by 4 places. Thus, growth can be attributable to the process of diversifying know-how to produce a wider and increasingly complex range of goods and services [13].

Fig. 2 shows a chart of the Russian market share, which shows the region's share of the world market by 10 sectors of production.

The largest products of Russian exports are low complexity goods, minerals and agriculture.

The traditional process of structural transformation has not yet been learned in Russia [14, 15]. It is a key source of economic growth, diverting economic activity from low-performing to high-performance sectors. Mainly, agricultural activities are transferred to the textile industry, then to electronics and/or mechanical engineering. [16]. Russia's textile export share in the world market has stagnated during the previous decade; electronics and

Table 1

Economic Complexity Index for 2021

Ranking by economic complexity index	Country	GDP per capita, thous. dollars	Economic complexity index	Income distribution inequality index
1	Japan	42.9	2.22	67.1
2	Switzerland	77.2	1.97	66.9
3	Germany	57.8	1.83	68.1
4	South Korea	47.2	1.69	68.6
5	Singapore	116.4	1.87	65.5
6	Czech Republic	45.0	1.78	75.0
7	Austria	58.4	1.70	69.2
8	Sweden	59.3	1.59	70.0
9	Hungary	36.7	1.54	70.4
10	UK	49.6	1.54	64.9
…	…	…	…	…
51	Russia	27.9	0.20	62.5
…	…	…	…	…
115	Botswana	16.3	–0.96	46.7
116	Mozambique	1.34	–0.98	46.0
117	Ghana	5.9	–1.02	56.5
118	Mali	2.3	–1.02	67.0
119	Ecuador	11.7	–1.10	54.3
120	Cuba	1.3	–1.16	-
121	Azerbaijan	15.8	–1.24	73.4
122	Democratic Republic of the Congo	1.1	–1.27	51.1
123	Mauritania	5.8	–1.27	67.4
124	Côte d'Ivoire	5.8	–1.35	58.5

Source: Compiled by the authors.

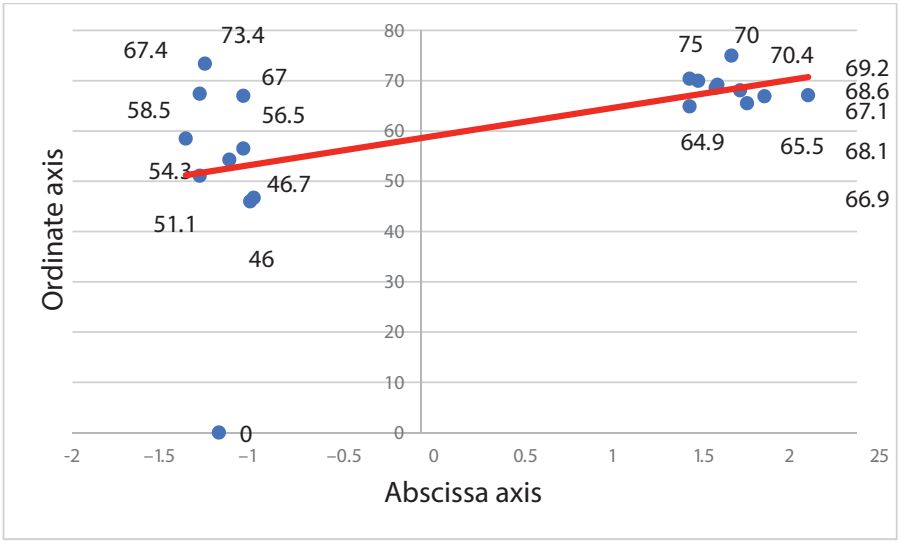

Fig. 1. **The Relationship Between Economic Complexity and Income Distribution Inequality**

Source: Compiled by the authors.

mechanical engineering in Russia have not yet begun to develop, which limits its revenue growth [17, 18].

The dynamics of Russian exports in the last five years have been determined by exports of mineral raw materials, which, unfortunately, have decreased. As a result, Russia's economic growth is hampered by concentration in the declining sector of global exports.

Currently, countries are more successful in diversification when they switch to production that requires similar know-how and builds on existing capabilities.

Russia's product space illustrates the relationship between its exports and potential ways of diversifying the economy.

Consequently, existing in Russia know-how gives moderate opportunities for diversification into related types of products [19, 20]. In diversifying its economy, Russia may consider the following option, which involves extensive opportunities for diversification that enable us to use existing successes to move to more complex industries.

Thus, the country is growing through diversification into new products with increasing complexity. In view of current exports, sectors with high potential for new diversification in Russia include: industrial equipment and plastics.

ECONOMIC COMPLEXITY ASSESSMENT METHODOLOGY

The indicator of identified comparative advantages is used to describe the structure of the economy of the region:

$$RCA_{cp} = \left(y_{cp} / \Sigma_p y_{cp}\right) / \left(\Sigma_c y_{cp}\right) / \left(\Sigma_{cp} y_{cp}\right), \quad (1)$$

where y_{cp} — export volume of product p with economy c.

According to Hausmann, Klinger (2006) [21], if the value RCA_{cp} exceeds the unit, the economy of the country with the identified comparative advantage in the export of the product p is deemed to have; otherwise, there are no identifiable comparative advantages:

$$a_{c,p} = \begin{cases} 1, if\ RCA_{cp} > 1; \\ 0, if\ RCA_{cp} \le 1. \end{cases}$$

Thus, value 1 indicates that a country has an identified comparative advantage in the export of a particular product. As a result, the indicator RCA_{cp} вshows which sectors should be developed to the level of strong.

However, value 1 does not include all exported products, but only those that make up a significant share of the global export system.

Economic complexity of the country is proportional to the average level of economic

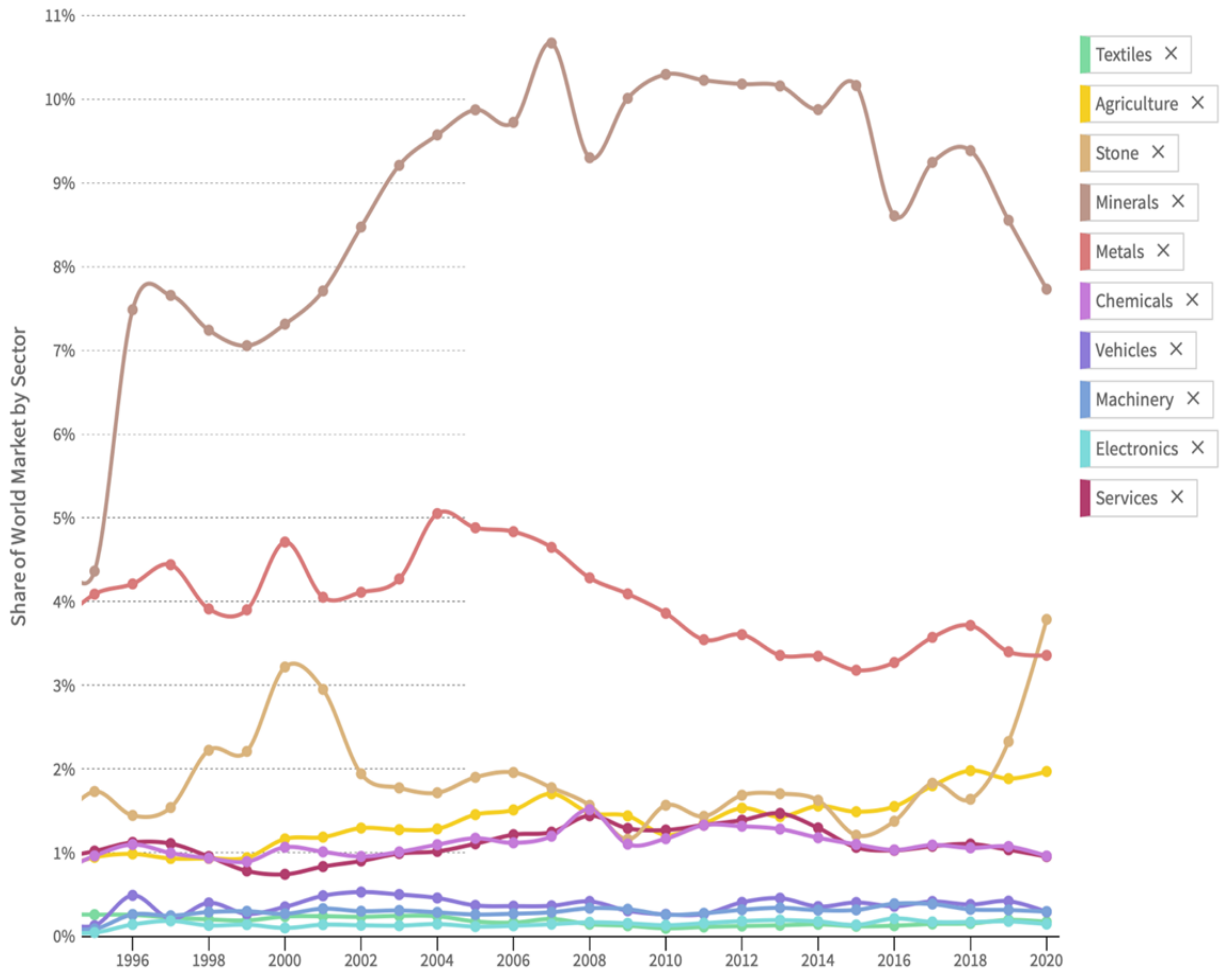

Fig. 2. **Russian Market Share Graph**

Source: Compiled by the authors.

complexity products exported by it at the level of identified competitive advantages:

$$ECI_c = a_1 \Sigma_p r_{c,p} ECI_p, r_{c,p} = a_{c,p} / k_{c,0}, k_{c,0} = \Sigma_p a_{c,p},$$
$$ECI_p = a_2 \Sigma_c r^*_{p,c} ECI_c, r^*_{p,c} = a_{c,p} / k_{p,0}, k_{p,0} = \Sigma_c a_{c,p}, \quad (2)$$

where a_1 — positive constant. Note that $k_{c,0}$ is not equal to zero, since for any *C* there is *p*, for which $a_{c,p} = 1$; a_2 — positive constant. The indicator $k_{c,0}$, equal to the number of strong products in the country *C*, will be called the diversification of the structure of the national economy *C*.

The economic complexity of the product is proportional to the average level of economic difficulty of the countries that export the product at the level of identified competitive advantages:

Thus, let $c = \left(ECI_{c_1}, ECI_{c_2}, \ldots\right)^T$ — this is a vector-pillar of economic complexity values for countries; $p = \left(ECI_{p_1}, ECI_{p_2}, \ldots\right)^T$ — this is a vector-column of economic complexity values for a product; $R_1 = (r_{c,p})$, $R_2 = (r^*_{p,c})$ — scale matrix.

It follows from the ratio (2) and (3) that $c = a_1 a_2 R_1 R_2 c$, $p = a_1 a_2 R_2 R_1 p$.

In this way, the economic complexity of countries is defined as the own vector of the $R_1 R_2$, matrix, and the economic complexity of products as the $R_2 R_1$.

The set of data allows to consider these elements as characteristics of the inclusion of the structure of the economy of one region in the economy structure of another region, and these elements of the matrix can be used to build a model for predicting the probability of the emergence of a new strong sector in the region.

Table 2

Sectors of the Extractive Industry of the Russian Federation

No.	Sector code	Sector name
1	1040	Fuel and energy mining
2	1050	Extraction of oil and natural gas
3	1075	Mining and processing of iron ore
4	1080	Non-ferrous metal ores mining
5	1081	Extraction of other mineral resources
6	1084	Provision of mining services

Source: Compiled by the authors.

Table 3

Estimates of the Economic Complexity of the Russian Federation by Extractive Industry Sector

No.	(1)	(2)	(3)	(4)	(5)
1	1040	0.081212	0.071585	0.070626	–1.34
2	1050	0.053407	0.069069	0.068478	–0.85
3	1075	0.052563	0.068992	0.068413	–0.83
4	1080	0.047159	0.068085	0.067996	–0.13
5	1081	0.032066	0.067207	0.066831	0.56
6	1084	0.028627	0.066614	0.066565	–0.07

Source: Compiled by the authors.

Table 4

Probability of Sectors Emerging as Strong Sectors in the Russian Federation

Sector code	1040*	1050	1075*	1080	1081	1084*
Probability	0.410	0.605	0.440	0.616	0.536	0.492

Source: Compiled by the authors.

In the event of the emergence of a new strong sector, the assessment of the economic complexity of the region can be assessed on the basis of both a standard approach and approximation:

$$\Delta ECI_{c^*} \approx \frac{a_1}{k_{c^*,0}+1}(ECI_{p^*} - \sum_{p \neq p^*} r_{c^*,p} ECI_p),$$

the value $ECI_{c^*} + \frac{a_1 \Delta_{p^*}(c^*)}{k_{c^*0}+1}$,

where $\Delta_{p^*}(c^*) = ECI_{p^*} - \sum_{p \neq p^*} r_{c^*,p} ECI_p$, is an assessment of the economic complexity of the region c^* after the emergence of a new strong sector p^*.

RESULTS

Table 2 shows the sector codes of the mining industry of the Russian Federation.

Table 3 presents accurate and approximate estimates of the economic complexity of the Russian Federation by sectors of the extractive industry in accordance with the data on tax revenues by sector of the economy.

Table 3 consists of (1) a possible sector, (2) an estimate of the economic complexity of the selected sector, (3) an estimation of the economical complexity as new and complex, (4) an assessment of the economy complexity based on the approximation approach, (5) errors for the sector.

From *Table 3*, we get the probability of emerging sectors as strong in the Russian Federation (*Table 4*).

According to *Table 4*, only 3 sectors have a sufficiently high rating of the emergence of a strong sector. This set of estimates is based on a description of the structure of the regional economy of the Russian Federation.

CONCLUSION

On the evaluation of the study were obtained estimates of the economic complexity of the Russian Federation, which determines the place on the index of economic complexity. It is shown that the Russian Federation with developed sectors of extractive industry has relatively low estimates of economic complexity. The Russian Federation can be divided into two groups with high and low assessments of economic complexity. For each group, the 2021 data revealed a significant relationship between the estimates of the economic complexity of the regions and the average per capita income indicators. It is estimated that the average income has increased as a result of the increased economic complexity of the region. The results obtained can be used in the selection of priority directions of development of structures of regional economies, taking into account the concept of economic complexity. Information on the impact of economic complexity on well-being is one of the possible forms of digital support for strategic decision-making. It can be used to prioritize regional development projects aimed at increasing jobs and material well-being in the region.

It emphasizes the relevance of the chosen topic of study. It follows that the economic complexity of Russian regions has a significant impact on their well-being and average per capita income. Using indicators of economic complexity in choosing priority areas for development of regional economies structures can contribute to more efficient use of resources and improving the level of well-being of the population. Understanding the impact of economic complexity on well-being can also help prioritize regional development projects aimed at improving economic performance. These results are important for the development of regional development strategies and for the identification of investment priorities. In general, the study provides important data for making informed strategic decisions in the area of economic development of the regions of the Russian Federation.

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A.L. Chupin — development of the article concept, research methodology, justification of the economic complexity index model, formation of conclusions and proposals.
V.N. Zasko — formulation of the problem, justification of the author's conclusions.
D.E. Morkovkin — development of the article concept, formulation of the aim and objectives, analysis and systematization of the research results, formation of conclusions and proposals.
O.I. Dontsova — collection of statistical data, analysis of macroeconomic indicators, tabular and graphical presentation of the results.

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