

# Digital agriculture in improving spatial economic development of rural municipalities in Russia

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**Abstract**— Digitalization of economy taking place in the Russian Federation poses new challenges to smaller and less developed municipalities, such as municipal districts, a type of rural municipalities in the Russian system of municipal division. Having fewer resources than larger urbanized municipalities they should be more cautious in making decisions about the involvement of new digital technologies in their spatial economic development. This paper aims to test the hypothesis whether and how introduction of technologies and practices of digital agriculture can help improving spatial economic development of municipal districts. The findings of the research indicate that agricultural production plays a substantial role in municipal districts’ economies even in regions with industrial specialization. Spatial economic characteristics of this type of municipality favour the development of agriculture. At the same time, spatial economic development of municipal districts can be substantially enhanced by introducing practices of digital agriculture, because it increases economically significant results, improves land exploitation, maintains or increases area under crops through effective distribution of resources (labour, equipment, etc.) and land management, and makes information flows between economic agents (including agricultural producers) more compact.

**Keywords**— *digital agriculture, rural municipality, economic space, spatial development*

## I. INTRODUCTION

Looking at space as “an economic phenomenon and conceptual form of socioeconomic system functioning” [1], we can treat spatial development in two ways: as progressive changes of the physical basis and socioeconomic environment present in it, and a set of practical measures in the field of regional economic policy aimed at improving the quality of citizens’ life. Concurrently, conceptual form of socioeconomic systems’ functioning is now being enriched with the emerging and evolving digitalization, which, in turn, transforms spatial context as well.

The necessity to allow for the spatial factor in practical activities on regional and municipal development is emphasized in a number of studies [2–4]. The failure to take the spatial factor into account in municipal governance leads to spatial differentiation between individual settlements belonging to the one municipality (in various spheres – places of employment, sufficiency with transport, engineering and other infrastructure), decreased capability of the municipality to compete for investment, financial and human resources.

At the same time, according to N.N. Kiseleva and V.V. Bratkova, spatial growth manifests in reduced concentration of population in central cities, economic growth in semi-periphery and peripheral territories, emergence of new growth areas, increase in even distribution of population and economic activities across territory, and “tools for managing spatial growth differ depending on the type of the growth zone” [5]. In line with this position, we can conclude that framing regional and municipal policies targeted at spatial economic development, as well as development and specification of the corresponding tools should be based on identifying spatial economic characteristics of an object of such policies. Furthermore, research on regional economic development is particularly important for developing countries, where the uneven spatial distribution of economic activities has been particularly marked and has tended to persist over time [6]. The statement is also true for Russia, which has the largest territory in the world and experiences problems with even distribution of both citizens and economic activities.

Digitalization significantly affects the nature of the spatial factor impact. It leads to the so-called communication shrinkage (with reference to A.I. Treyvish, increase in permeability, connectivity, accessibility of space (due to transport and communication infrastructure)) and distorts space. It makes distances shorter, information transmittance quicker, and, as a result, transactions faster and decisions to be taken more rapidly. Simultaneously, it enables processing huge amounts of information that can influence spatial planning of the territory. Large cities (usually, urban districts in terms of municipal division) were the first to test advantages of digitalization, but as time passes this process goes further to inner regions of Russia and concerns other municipalities, which have to decide, how they could benefit from digitalization and thus become more competitive.

The Decree of the President of the Russian Federation “On the national goals and strategic objectives of the development of the Russian Federation for the period up to 2024” of May 7, 2018 sets the objective to transform priority economics sectors and a social sphere with the use of digital technologies and platform solutions. Undoubtedly, this will lead to spatial economic transformations of regions, because structural shifts become possible. Agriculture, which is a basic sector of the national economy and quite important for rural municipalities, has some specifics in the context of digitalization:

- First, agricultural production is affected by many factors and conditions, especially physical and

geographical ones, which are of spatial nature. Economically, this results in growing management costs at the level of individual agricultural producers, which in turn influences financial and economic performance of municipalities;

- Second, agricultural economic agents in municipalities' space are dispersed, and this affects economic space coherence;
- Third, agriculture currently features low level of digitalization despite generally growth rates of agricultural information technologies market.

Municipal districts are a type of rural municipalities in the Russian Federation, often distant from large urbanized areas and basically experiencing the outflow of inhabitants. Their population density is usually lower than the regional average. Consequently, they encounter smaller financial base and have to direct meticulous attention to spatial planning. At this, we should take into account, that digital infrastructure in rural municipalities is usually developed insufficiently. One of the areas, where digitalization can contribute to municipal districts' spatial development, is promoting efficiency of economic activities due to: (1) a large-scale transformation of agricultural sector, (2) reduction of production costs in agricultural organizations, (3) increase in investments in creation of technologies, equipment, platforms in agricultural facilities, (4) automation

of decision-making, (5) development of e-learning technologies in agricultural education, and (6) introduction of technologies of intellectual agricultural production.

The present paper is concerned with the issue of whether and how introduction of technologies and practices of digital agriculture can help improving spatial economic development of municipal districts and in line with the aim will deal with the following tasks: (1) identify spatial economic characteristics of municipal districts on the basis of studying different concepts of economic space, (2) analyze the structure of municipal districts' economy using the case of an industrial region and test the hypothesis that agriculture plays significant role in economic development of municipal districts even in industrial regions, (3) summarize the results of analysis and identify the characteristics of economic space, which can be improved through the use of digital agriculture practices.

**II. LITERATURE REVIEW**

The literature shows no consensus on the essence of economic space. The review shows that there are at least four concepts of economic space, which are generally accepted: a territorial concept, a resource-based concept, an information concept, and a process-focused concept. The approaches to defining economic space are systematized in table 1.

TABLE I. CONCEPTS OF ECONOMIC SPACE

Concept of economic space (approach to defining it)	Researchers	Treatment of economic space
Territorial concept	A.G. Granberg E.G. Animitsa, N.M. Surnina Yu.G. Lavrikova	“a saturated territory (with various objects and ties between them: settlements, industrial enterprises, economically utilised and recreational places, transport and utility networks)” [8] “state territory, within which the system of people’s life support is being created, used and reproduced, and inhabitants’ activities aimed at satisfying their needs take place. In a broad sense, economic space covers the land area, internal and territorial waters, which are necessary to maintain and improve the living conditions of the population. In the narrow sense, economic space is an economically developed territory of a country in which activities related to the production, distribution, exchange and consumption of goods and services are carried out.” [9] “the unity of the physical basis and socioeconomic environment of economic entities’ interaction formed by the mechanisms of economic regulation applied in the territory” [10]
Resource-based concept	P. Krugman V.V. Radaev	“economic landscape ... refers, instead, to an abstract landscape, one that represents the dynamics of resource allocation across activities and locations” [11] economic space is determined by the commission of an economic action, which, in turn, is interpreted as “the non-violent use of limited resources with different uses to achieve a quantifiable goal related to maintaining people’s life” [12]
Information concept	S.A. Dyatlov S.I. Parinov	S.A. Dyatlov develops a thesis on the information unity of the world. In his opinion, in the 21st century, the informational capacity of the economy increases, as a result of which the world is involved in global hypercompetition, expressed in the “dynamic, inclusive process of innovation-based (informational, ideological, scientific, educational, service and technological, organizational management) competition in the global markets among the leading high-tech companies”. Thus, the economic space is formed through the rivalry of economic agents possessing competitive advantages in various types of information [13] S. I. Parinov attempts to incorporate the phenomenon of information interactions between participants in economic activities into the economic picture of the world. The researcher believes that the exchange of proposals between economic agents on new business options and the desired recombination of relations between them takes place in the information space of the economic system. In other words, the emergence of economic space results from the exchange of signals in the process of economic activity [14]
Process-focused concept	O.A. Biyakov	The essence of this approach is in understanding the development of economic space through the economic process, interpreted as “the relationship between economic actors in this institutional environment acting in their economic interests, aimed at the possible results of joint activities” [15]. In this vein, O. A. Biyakov defines the economic space as “the relationship between the economic processes of business entities and the aggregate economic process focused on possible results of economic activities” [15]

By applying the reviewed concepts of economic space to municipal district and viewing it as an object in regional economic space, we can identify its following spatial economic characteristics:

- Municipal district has explicitly defined administrative borders within regional economic

space, is an element of municipal division, and, according to the Russian system of municipal division, includes two other types of municipalities within its territory: rural settlements and urban settlements.

- Municipal district represents part of regional economic space, where immobile economic resources tend to concentrate, which form centrifugal character of production.
- Municipal district is a part of regional economic space, where information flows are predominantly related to rural activities. In terms of information flows, municipal districts also generate statistical information flows for both municipal and agricultural statistics, and keep and exchange historical and cultural information due to many rural communities located in its territory.
- Municipal district is a part of regional economic space, where the reproduction process takes place formed as an intermediate result of the realized economic interests of actors and the economic interaction between different localities within the territory.

Therefore, we can argue that municipal districts have spatial economic characteristics that favour the territories' specialization in agricultural production. However, at this stage we cannot firmly conclude about the absolute importance of agricultural production in its economy and need to proceed to the next step to analyze the structure of municipal districts' economies.

### III. METHODS

To test the hypothesis whether agriculture is significant for economic development of municipal districts even in industrial regions, we considered the case of Chelyabinsk oblast, the territory of which is divided into 16 urban districts and 27 municipal districts. The region is notable for its metallurgical and machine-building industries and ranks the second in industrial output after only the Sverdlovsk region in the Urals. The principal question was whether municipal districts were more agriculture-oriented than urban districts or not despite quite diversified economies of both municipalities and presence of various types of localities (rural and urban) in their territories.

The statistical data used for the analysis are gathered by Russia's Federal State Statistics Service and its territorial office in Chelyabinsk oblast. The analysis is based on three statistics: (1) the volume of shipped own produced goods, works performed and services rendered in a region (sections B, C, D, E of the All-Russian Classification of Economic Activities (OKVED-2)), (2) agricultural production in farms of all types, (3) population number. First, we examined absolute values of agricultural and industrial production of municipal districts. Second, we calculated indices of presence to weigh industrial production against population of municipal districts. In our case, index of presence is calculated as a ratio between share of municipal district's indicator in the regional indicator and municipal district's share in regional population. It is an indicator balanced by population size and allows estimating how proportional the participation of municipal districts in regional reproduction process is according to the number of citizens. The index value lower than one means other territories dominate, equal to one – distribution of the indicator is proportional, higher than one – municipal districts are actively involved in creating value of a regional indicator.

### IV. RESULTS

The time series for agricultural and industrial production are presented in Fig. 1 and 2. It can be seen from Fig. 1 that municipal districts dominate in regional agricultural production and on average account for 88% of it. The remaining 12% are produced by urban districts.

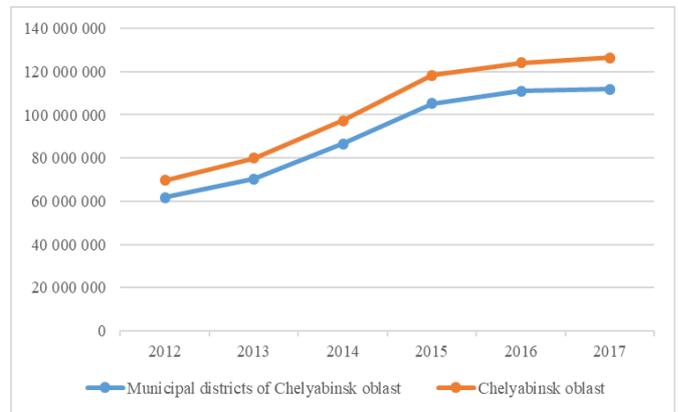


Fig. 1. Agricultural production of municipal districts in Chelyabinsk oblast, thousand rub.

The data on industrial production in Fig. 2 clearly indicate that in monetary terms municipal districts lag behind urban districts and make up not more than 12–15% of regional industrial production.

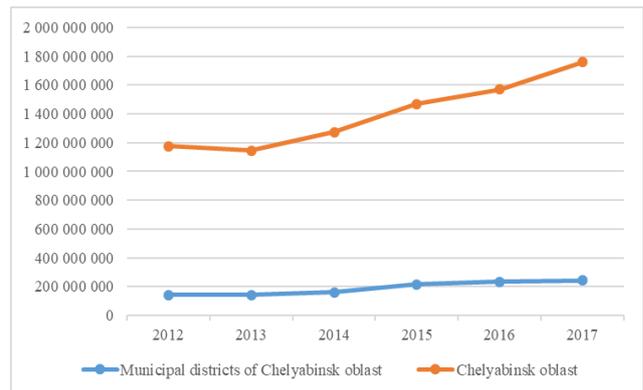


Fig. 2. Industrial production of municipal districts in Chelyabinsk oblast, thousand rub.

However, in absolute values industrial production outstrips agricultural production (Fig. 3) mostly due to higher prices of industrial products and higher value added. Industrial production is twice as high as agricultural production in municipal districts of Chelyabinsk oblast. We may assume that this is because the Chelyabinsk oblast is an industrial region, and territories with lower population concentration within it are involved in industrial specialization of the region as well, for instance, by providing raw materials to larger enterprises located in urbanized areas.

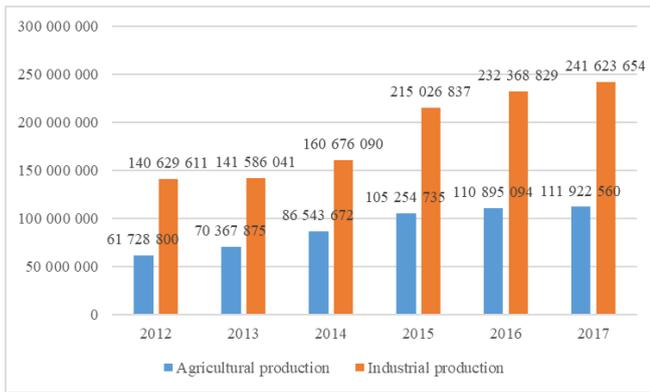


Fig. 3. Agricultural and industrial production of municipal districts in Chelyabinsk oblast, thousand rub.

To further prove our findings, we calculated indices of municipal districts' presence in economic space of Chelyabinsk oblast in terms of industrial production (Table 2). Rare cases of the indices exceeding one (in grey) as well as average index of municipal districts of Chelyabinsk oblast equal to 0.49 indicates that other municipalities (urban districts) are more involved in creating value of regional industrial production, than municipal districts.

TABLE II. INDICES OF MUNICIPAL DISTRICTS AND URBAN DISTRICTS' PRESENCE IN ECONOMIC SPACE OF CHELYABINSK OBLAST IN TERMS OF INDUSTRIAL PRODUCTION

Municipality	2012	2013	2014	2015	2016	2017
Agapovsky dst	0.32	0.31	0.37	0.37	0.36	0.31
Argayashsky dst	0.33	0.37	0.37	0.37	0.36	0.29
Asha dst	0.93	0.88	0.98	0.92	0.94	1.01
Bredy dst	0.07	0.07	0.08	0.10	0.11	0.11
Varna dst	0.22	0.23	1.05	1.84	1.96	1.90
Verhneural'sk dst	0.13	0.11	0.12	0.13	0.15	0.09
Emanzhelinsk dst	0.37	0.37	0.46	0.40	0.43	0.49
Etkul'sky dst	0.19	0.18	0.20	0.41	0.56	0.37
Kartaly dst	0.16	0.16	0.16	0.16	0.16	0.15
Kasli dst	0.22	0.24	0.28	0.20	0.22	0.23
Katav-Ivanovsky dst	0.60	0.51	0.39	0.37	0.29	0.25
Kizil'sky dst	0.03	0.04	0.03	0.02	0.02	0.02
Korkino dst	0.41	0.49	0.44	0.37	0.34	0.30
Krasnoarmeysky dst	0.12	0.17	0.23	0.34	0.28	0.32
Kunashak'sky dst	0.01	0.03	0.04	0.25	0.25	0.31
Kusa dst	0.10	0.12	0.11	0.11	0.12	0.08
Nagaybak'sky dst	0.19	0.46	0.42	0.89	0.94	0.77
Nyazepetrovsk dst	0.13	0.23	0.21	0.16	0.09	0.12
Oktyabr'sky dst	0.09	0.10	0.09	0.11	0.12	0.10
Plastov'sky dst	1.04	1.04	0.93	1.55	1.84	1.43
Satka dst	1.20	1.18	1.12	1.05	0.97	0.99
Sosnov'sky dst	0.91	0.97	0.87	0.86	0.88	0.77
Troitsk dst	0.09	0.11	0.10	0.09	0.09	0.07
Uvel'skii dst	0.50	0.58	0.52	1.45	1.42	1.21
Uiskoe dst	0.02	0.02	0.02	0.04	0.04	0.04
Chebarkul dst	0.44	0.47	0.43	0.50	0.50	0.42
Chesmensky dst	0.10	0.08	0.07	0.07	0.06	0.05
Urban districts of Chelyabinsk oblast	1.23	1.20	1.19	1.18	1.17	1.19
Total index of municipal districts	0.43	0.44	0.46	0.54	0.54	0.51

V. DISCUSSION

The study revealed that agricultural production plays a substantial role in the economies of municipal districts even in the region with industrial specialization. Spatial economic characteristics of this type of municipality favour the development of agriculture, though it should be mentioned that the spatial factor is not the only one, influencing the structure of the local economy. At the same time, spatial

economic development of municipal districts can be significantly improved by introducing practices of digital agriculture.

Digital agriculture promotes the efficiency of agriculture through such practices as precision farming or smart farms. They appeared due to the cheapening of Internet technologies and cellular communications, and now provide agricultural producers with the opportunity to apply spot monitoring of the local climate, soil, plants, animals, and the movement of technology. This contributes to reducing the cost of fuel, seeds, water, fertilizers and plant protection products, feed. The accumulation of large amounts of data allows agricultural producers to map yield and make crop rotation more flexible [16]. Besides, the speed of transmitting and processing these data are much higher than without digital technologies.

At present, Russia's Ministry of Agriculture handles the task of creating an information platform on the basis of the Ministry, which will be a central link integrating regional systems and capable of receiving large amounts of data from the regions. Every region of the Russian Federation will have to initiate a similar project on digital development of agro-industrial complex with specified terms of implementation of every stage. At federal level, the government identified 5 basic directions for development of the digital agriculture, such as "efficient hectare", "smart contracts", agroexport "From field to port", "agrosolutions for agribusiness", "the Earth of knowledge". Digitalization of agriculture is designed for a breakthrough, which should lead to a considerable growth in agricultural production.

From the viewpoint of economic space, digital agriculture affects all three of its characteristics that we specified in our previous paper [17]: (1) saturation of economic space with economic agents' activities by improving economically significant results, (2) development of the spatial (physical) basis by increasing land exploitation, maintaining or increasing area under crops through effective distribution of resources (labour, equipment, etc.) and land management, (3) coherence of economic space (intensity of economic ties depending on the development of transport and communications infrastructure that supports interaction of economic agents) by making information flows more compact.

The results of the study can be of use to federal and regional authorities when setting priorities in spatial economic development.

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