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Digitalization of industrial markets: Regional characteristics*

Victoria V. AKBERDINA
Dr. Sc. (Econ.), Professor of the RAS, Head of Regional Industrial Policy and Economic Security Dept.

Institute of Economics (Ural Branch of the Russian Academy of Sciences)
29 Moskovskaya St., Yekaterinburg, 620014, Russia
Phone: +7 (343) 371-45-36
E-mail: akb_vic@mail.ru

Abstract

The paper explores the issues of digitalization of the industrial complex and industrial markets in the context of the information network paradigm. The author presents an approach to assessing the process of the industrial complex transformation under deep penetration of digital technologies to the material sector of economy. We formulate the theoretical research platform based on the four approaches – neo-industrial, transaction, networking and marketing. The research findings show that industrial markets' digitalization is integrated into the overall process of digital transformation of the industry, which consists of five consecutive stages – from the primary information and communication digitalization and to the industrial Internet. The author pays special attention to digitalization of producer-customer relationships in industrial markets on the basis of discrete-event and agent methods. The results of the empirical research pertain to the sectoral and regional characteristics of the digitalization of industrial markets in Russia. The author looks at nine enlarged industrial markets, identifies the distinctive features of their digital transformation and demonstrates a significant differentiation of industrial markets by both the level of the primary digitalization and the level of digitalization of relationships with suppliers and customers. We prove that the degree to which high technologies are applied by manufacturing sectors is dependent primarily on the level of digitalization, automation and networkization. When it comes to regional disproportions of industrial markets' digitalization, the author concludes that the poor development of certain regions is due to their historical background and confirms the hypothesis that the concentration of high technologies influences the development of the regional digital society.

Keywords

DIGITALIZATION
DIGITAL COMMUNICATIONS
INDUSTRIAL MARKETS
NEW INDUSTRIALIZATION

JEL classification

L16, O33

INTRODUCTION

The industrial market in a narrow sense is a complex of relationships between producers and customers of industrial products that take place within a particular territory and at a given time. In a broad sense, this definition also covers intermediaries, engineering and service companies, financial organizations, public authorities, etc. Both core segments of the industrial market – buying and selling companies – are equally active in choosing business partners; they analyse and evaluate potential suppliers, pour significant resources into making decisions about concluding a deal and signing agreements and contracts. Consequently, communications in the industrial markets embrace all relationships and ties emerging between the market actors in the course of their activity. In the context of relationships between a large enterprise and maintenance companies, communications can be of a production-related or technological nature; communications between buying and selling companies are of commercial character; in the case of building loyal customer relationships, communications can be characterized as personal, etc. The variety of forms and types of communications, as well as time spent on effective transactions, underlie the *critical need for digitalization of producer-customer relationships*.

Economic activity of society and a set of socio-economic relationships cultivated in the process of production, distribution, exchange and consumption of goods are the essence of the *real, or analogue, economy*. For this reason, the digital econ-

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Цифровизация индустриальных рынков: региональные особенности*

Аннотация

Статья посвящена актуальным вопросам цифровизации промышленного комплекса и индустриальных рынков в условиях формирования информационно-сетевой парадигмы. Автором представлен подход к оценке процесса трансформации промышленного комплекса в условиях глубокого проникновения цифровых технологий в материальный сектор экономики. Сформулирована теоретическая платформа исследования, базирующаяся на комбинированной теоретической платформе, включающей четыре подхода – неоиндустриальный, трансакционный, сетевой и маркетинговый. Автором показано, что процесс цифровизации индустриальных рынков интегрирован в общий процесс цифровой трансформации промышленности, который включает в себя пять последовательных стадий, начиная с первичной информационно-коммуникационной цифровизации и заканчивая промышленным интернетом. Особое внимание в статье уделено цифровизации взаимоотношений «производитель–потребитель» на индустриальных рынках на основе дискретно-событийного и агентного методов. Результаты эмпирического исследования касаются отраслевых и региональных особенностей цифровизации индустриальных рынков в России. Автором рассмотрено девять укрупненных рынков промышленной продукции, выявлены особенности их цифровой трансформации, показана значительная дифференциация индустриальных рынков как по уровню первичной цифровизации, так и по уровню цифровизации взаимоотношений с поставщиками и потребителями. В статье доказано, что степень высокотехнологичности отраслей промышленности определяется, прежде всего, уровнем цифровизации, автоматизации и сетезации. В отношении региональных диспропорций процесса цифровизации индустриальных рынков автор делает вывод об исторической предопределенности низкого уровня развития отдельных регионов, а также подтверждает гипотезу о влиянии доли высокотехнологичных отраслей на уровень развития цифрового общества в регионе.

АКБЕРДИНА Виктория Викторовна
Доктор экономических наук, профессор РАН, заведующий отделом региональной промышленной политики и экономической безопасности

Институт экономики Уральского отделения РАН
620014, РФ, г. Екатеринбург, ул. Московская, 29
Тел.: +7 (343) 371-45-36
E-mail: akb_vic@mail.ru

omy as an independent economic sphere does not exist; there is a digital segment of the material economy, i.e. a virtual environment that complements the reality. The digital economy is an infrastructure add-on to the material sector of economy designed to increase the efficiency of interaction between participants in the processes of production and selling of industrial products, as well as the relationships between individuals in the process of economic activity. The digital interactions of industrial enterprises are complex, multi-structural and multi-stage, and therefore it is of critical importance to identify and systematize their forms and types.

The purpose of the research is to substantiate the methodological approach and methods for assessing the level of producer-customer relationships digitalization in the industrial markets, as well as to discover sectoral and regional characteristics of digital communications.

Obviously, the study of digital communications in the industrial markets should be based on discrete-event simulation that describes the process of digital communications in the form of a sequence of events influencing the change in the digital parameters of objects. In addition, agent-based modelling methods also look very promising; they suggest describing the process of digital communications on the basis of a set of active agents that demonstrate a certain level of primary computerization and informatization and constantly interacting with each other within the digital environment.

Ключевые слова

ЦИФРОВИЗАЦИЯ
ЦИФРОВЫЕ КОММУНИКАЦИИ
ИНДУСТРИАЛЬНЫЕ РЫНКИ
НОВАЯ ИНДУСТРИАЛИЗАЦИЯ

JEL classification

L16, O33

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THEORETICAL AND METHODOLOGICAL ASPECTS OF THE INDUSTRIAL MARKETS DIGITALIZATION

While examining the industrial markets digitalization, we should determine the theoretical framework. It is clear that the methodological approach and methods for assessing the level of digitalization of producer-customer relationships in the industrial markets can only be developed on an *integrated theoretical platform* that includes four approaches: neo-industrial, transactional, network-based and marketing.

New industrialization is associated with the rise of the Fourth Industrial Revolution that initiates innovative industrial and economic models using hybrid NBIC technologies, in which information technologies are technology integrators [14; 20]. New industrialization implies the inevitable transition from simple digitalization (the Third Industrial Revolution) to innovations based on hybrid and convergent technologies (the Fourth Industrial Revolution), which results in fully automated digital production that can be later united into a global industrial network of goods and services [12; 15]. For this reason, during the last decade economists, sociologists and political scientists have been debating on post-industrial society which is if not utopian [16; 18], but at least premature [3; 4; 5]. There is no economy capable of growing without the material segment, and therefore reindustrialization of economy is the number-one priority of economic development in many countries [5; 9; 10].

According to *Coase's transaction cost approach* [11], it is particularly difficult to guarantee efficient transactions in the context of formation of transaction environment, since the number of stakeholders is substantial and negotiating with all the participants is expensive. The use of digital technologies and network-based principles of online interactions contributes to a significant decrease in transaction costs in the industrial markets. Digital transactions are less labor-intensive in terms of collecting and processing information, selecting counterparties, preparing decisions about transactions, making payments and providing legal support. The seller, whose business is easier to find, access online, be contacted and make a deal, is more efficient. Information and communication technologies form new factors of growth in value added that are linked, on the one hand, with the ability to reduce production costs by increasing the speed of information processing and decision-making, and on the other hand, with an increase in product competitiveness due to a shorter period of innovation product development. Introduction of information and communications technologies to the traditional spheres of material production leads to the spread of information management systems that allow cutting both production and transaction costs by optimizing information flows and speeding up the decision-making process.

The *network-based approach* is perhaps the major one when substantiating the effects of digitalization. From the theoretical perspective, the catalysts for the spread of digital technologies in the industrial markets are the fundamental patterns, in the scientific community known as Moore's law and Metcalfe's law. Moore's law describes one of the most powerful economic factors operating on today's digital world, i.e. there is a minimum cost at any given time in the evolution of technology [19. P. 115]. This pattern made it possible to spur rapid development of digital technologies in business. From the standpoint of marketing, the consequences of the regularity highlighted by Moore provide a unique opportunity to build up and strengthen the relationships between industrial enterprises through enhancing the intensity and mass character of digital communications. Metcalfe's law reflects the correlation between the number of a network's users and its value and explains the fact that the development of the Internet not only expands the communication opportunities for particular users, but also increases its public value [8]. According to Metcalfe's law, the effect of a telecommunications network is proportional to the square of the number of connected users of the system. It is worth mentioning that the greater the network, the higher its value for each member. The correlation between the size of the network and its network-wide value for an individual company is converted into an increase in the productivity of its activity, a more economical use of resources and implementation of a more effective communication policy.

At the level of the global information economy, there emerge numerous informational-network effects. In essence, these are synergistic network effects taking various forms. Verian finds that Moore's law, the Internet, computer involvement and novel financial tools taken together start the "fast innovation" period [7]. Vayber states that, unlike the traditional economy, the network economy is not influenced by the law of diminishing marginal returns. Direct network effects and positive feedback provide increasing marginal profitability [6]. At that, the processes of integration and networkization of developers, producers, sellers and customers of intellectual information goods, as well as processes of adding value to network effects, are subjected to a significant scaling.

In the context of information and communication technologies, the *marketing approach* formulates the concept of digital marketing [13]. The term "digital marketing" was coined in the 1990s, and by 2010, there was a significant rise in the complexity of digital marketing tools used to forge strong and enduring customer relationships. The customer service was one of the first business spheres which experienced significant savings due to the use of internet marketing. When providing technical maintenance to customers, using online messaging service and emails instead of expensive phone calls helps large companies to save millions of rubles.

METHODS FOR EVALUATING THE LEVEL OF INDUSTRIAL MARKETS DIGITALIZATION

The process of industrial markets digitalization is integrated into the overall process of digital transformation of the industry, which consists of five consecutive stages rang-

ing from the primary information and communication digitalization to the industrial Internet [1]. *Producer-customer relationships are digitalized during the first two stages of the overall digitalization of the industry.*

The *first stage* of digital transformation of the industry embraces the primary information and communication digitalization. This stage implies computerization in the broad sense of the word, namely a massive introduction of electronic computing machines into the various fields of industrial production. Computerization is a central and indispensable condition for the development of information relationships that underlie industrial progress. The indicators characterizing this stage are the share of enterprises equipped with personal computers, servers, local area networks, electronic mail, global information networks, websites, cloud storage, Internet-enabled personal devices (smart phones, tablets, GSM/GPRS/UMTS/CDMA/3G/LTE modems) both in the industry and individual sectors.

The *second stage* of digital transformation of the industry is electronic data interchange (EDI) with external network partners. Coupled with the Internet, EDI allows conducting electronic transactions in real time, thereby accelerating the processes of interaction between suppliers, contractors, cooperators and consumers. The exchange of hard copies of commercial documents (production orders, delivery, accounts, bank transfers, etc.) involves mainly manual data entry to the computer system of partnering companies. The use of electronic document management standards allows avoiding it; the application of automatic procedures improves the speed and accuracy of data collection.

Among the indicators characterizing this stage are the following:

- the share of enterprises applying EDI in the exchange format (EDIFACT, EANCOM, ANSI X12; those based on XML standards, e.g. ebXML, RosettaNet, UBL, papiNET; proprietary standards) both within the entire industrial complex and according to the types of economic activity designated as industrial;
- the share of the cost of purchase (sale) of products (services, works) for the orders transferred (received) by the enterprise via the Internet, other global information networks (using websites, the system of automated data exchange between organizations (EDI-систем));
- the share of companies using the Internet to communicate with suppliers (including getting information about products (services, works) and their suppliers, providing information about companies' needs for products (services, works), placing orders for products (services, works), paying for products (services, works) delivered, receiving electronic products, etc.);
- the share of companies using the Internet to communicate with customers (including publishing information about the company, its products (services, works), receiving orders for products (services, works), making online payments, distributing electronic products, after-sales service, etc.).

EMPIRICAL STUDY OF SECTORAL AND REGIONAL CHARACTERISTICS OF INDUSTRIAL MARKETS DIGITALIZATION IN RUSSIA

Information base and research assumptions

The information base of the study is the results of the federal statistical monitoring by the Form No. 3-inform "Information on the use of information and communication technologies and the production of computers, software and the provision of services in these spheres" presented in the context of OKVED[1] (sectoral characteristics) and OKATO[2] (regional characteristics). The research assumptions include the localization and the sectoral composition of the industrial markets. In the current research, a regional industrial market refers to a seller's market for industrial products sold by producers that are registered in the territories within administrative boundaries of federal districts. Industrial markets refer to markets for industrial products classified as the result of the manufacturing activity.

Based on the method justified above, let us look at two stages of digitalization of the industry associated with digitalization of producer-customer communications in the industrial markets of macro-regions.

Sectoral characteristics of industrial markets digitalization

The rates of primary and secondary digitalization of manufacturing industries are presented in Tables 1–3. In general, the informatization level of the first two sectors is quite high. More than 90% of industrial enterprises use personal computers, email and global information networks.

Enterprises engaged in high-tech industries achieved nearly 100% with the maximum values in metallurgy (98.7%), mechanical engineering (97.7%) and chemical industry (96.7%). The labour productivity level in these industries is 2–2.5 times higher if compared with the industries with low primary informatization, such as light industry (94.9%) and wood industry (90.5%). At the same time, that is not to say high primary computerization guarantees high rates of primary informatization. Oftentimes, personal computer functions as a typewriter with a simple set of office software. At that, only 74.5% of manufacturing enterprises exploit servers and only 6.3% of companies maintain websites.

Industrial enterprises are well integrated into information flows with counterparties, however, there is a quite curious paradox here: industrial enterprises are more intensively engaged in digital exchange with suppliers rather than with customers, which proves once again that these companies suffer from a lack of customer focus.

Generally, 98.2% of enterprises in all manufacturing industries use global networks to communicate with suppliers, but only 87.2% connect with customers via the Internet. Information exchange about products and needs comprises the largest share in the digital exchange. Thus, using global networks, 94.4% of enterprises receive information from sup-

[1] OKVED stands for the All-Russia National Classifier of Types of Economic Activity.

[2] OKATO stands for the Russian Classification on Objects of Administrative Division.

Table 1 – Rates of primary digitalization of manufacturing industries in 2017, % of the total number of enterprises

Industry	The share of enterprises using					
	personal computers	servers	local area networks	electronic mail	global information networks	websites
Metallurgy	98.7	86.3	84.8	98.5	98.3	70.9
Mechanical engineering (electrical equipment)	97.7	83.9	85.4	96.4	97.1	80.1
Chemical industry	96.7	76.7	78.0	96.2	96.4	69.7
Mechanical engineering (vehicle)	96.4	82.5	81.0	94.8	96.0	70.9
Construction materials	96.4	78.7	77.5	93.9	95.9	70.2
Mechanical engineering (machinery and equipment)	96.3	81.2	81.9	94.9	95.8	74.7
Food industry	96.0	76.2	76.4	91.8	94.9	59.6
Pulp and paper industry	95.9	66.9	70.4	93.0	94.6	57.3
Light industry	94.9	65.8	76.9	94.0	94.4	70.9
Wood industry	90.5	69.3	68.0	88.7	89.2	49.2

Table 2 – Rates of secondary digitalization of manufacturing industries: communication with suppliers in 2017

Industry	The share of enterprises using the Internet to				
	get information about products (services, works)	provide information about products (services, works) needed	place orders for products (services, works) (excluding orders by e-mail)	pay for products (services, works) supplied	receive electronic products
Light industry	96.0	73.9	56.3	65.8	37.2
Chemical industry	94.6	73.3	52.0	61.4	51.0
Metallurgy	94.9	72.9	53.5	59.8	50.6
Machinery, equipment and transport	95.3	72.3	49.4	67.8	52.0
Construction materials	95.3	68.2	45.1	65.6	45.5
Wood industry	92.8	63.0	39.8	65.5	43.6
Electrical equipment	94.2	74.3	52.5	65.2	47.9
Food industry	92.5	64.8	44.0	67.6	45.6
Pulp and paper industry	95.2	73.2	50.5	63.3	49.0

Table 3 – Rates of secondary digitalization of manufacturing industries: communication with customers in 2017

Industry	The share of enterprises using the Internet to				
	provide information about the enterprise and its products (services, works)	receive orders for products (services, works) (excluding orders by e-mail)	settle online accounts with customers	distribute electronic products	after-sales service
Light industry	89.9	57.3	54.8	6.0	6.0
Chemical industry	80.1	47.2	50.3	5.9	13.5
Metallurgy	82.3	38.0	47.2	5.6	8.7
Machinery, equipment and transport	89.1	52.8	53.8	11.6	26.4
Construction materials	84.9	45.4	49.8	6.1	7.9
Wood industry	80.9	36.7	49.2	4.1	6.6
Electrical equipment	87.9	52.3	52.5	9.3	23.0
Food industry	77.7	53.1	53.1	6.1	7.2
Pulp and paper industry	86.6	47.6	48.1	10.0	11.4

pliers, 81.3% of enterprises provide information about their products to customers and only 68.8% of enterprises provide information about their needs. At that, only 48.7% of enterprises use the Internet to place orders for raw materials, consumables and components, whereas the share of companies receiving commercial orders online is even lower – 47.6%.

The market for metallurgical products is the most digitalized market. In 2017, 98.7% of enterprises used information and communication technologies (Fig. 1), which is undoubtedly determined by the industry's financial sustainability. Metallurgy is one of the leading industries of the Russian economy, as well as one of the most affluent and highly profitable sectors. The share of metallurgy in Russia's GDP is 2.5%, in the value added of the manufacturing industry is 17.4%. Over 80% of enterprises use servers and local area networks. In terms of digital communications, the metal products market takes only the third place (Fig. 2), while metallurgical enterprises are more focused on digital relationships with suppliers. Thus, the share of enterprises communicating with suppliers via the Internet is 98.5%; however, most of them publish solely information about products and services they need. Only 87% of metallurgical enterprises maintain digital contacts with customers – this is one of the lowest results among all manufacturing industries. To a large extent, the explanation of this fact is the scale and high cost of supplies, which makes personal contacts and individual conditions preferable to electronic communications – only 38% of metallurgical enterprises receive orders for products via the Internet (excluding orders sent by e-mail) (see Table 3).

The market of *electrical equipment and electrical engineering* occupies the second place in terms of primary digitalization (see Fig. 1). Among all the mechanical engineering markets, this one is the most successful with regard to an average annual capacity. As for labour productivity, such enterprises are far ahead of the general and transport engineering companies. By the indicator "the share of enterprises maintaining their official website", the enterprises of the electrical industry hold the top position with 80.1%. This allows companies of the industry to actively interact with counterparties in a digital format. For example, 98% of enterprises use the Internet to communicate with suppliers of raw materials and components, and 91.8% of enterprises use the Net to connect with customers (see Fig. 2). Speaking of electrical equipment manufacturers, they demonstrate the moderate results by the indicator "the share of enterprises using the Internet to provide information about their products", but they keep the leading position (74.3%) in providing the exhaustive information about their needs for components (see Table 2). This is the highest rate among all industrial enterprises indicating their real interest in cooperation with suppliers. Thus, the industry's enterprises are quite active when providing information to consumers (see Table 3): 87.9% use the Internet to impart information about their activity and products and 52.3% receive online orders (excluding orders via e-mail). At the same time, the share of electronic payments through companies' websites is nearing that in consumer markets – 52.5% of the electrical industry enterprises use online payment systems to receive payments for their products. In terms of after-sales service and online maintenance,

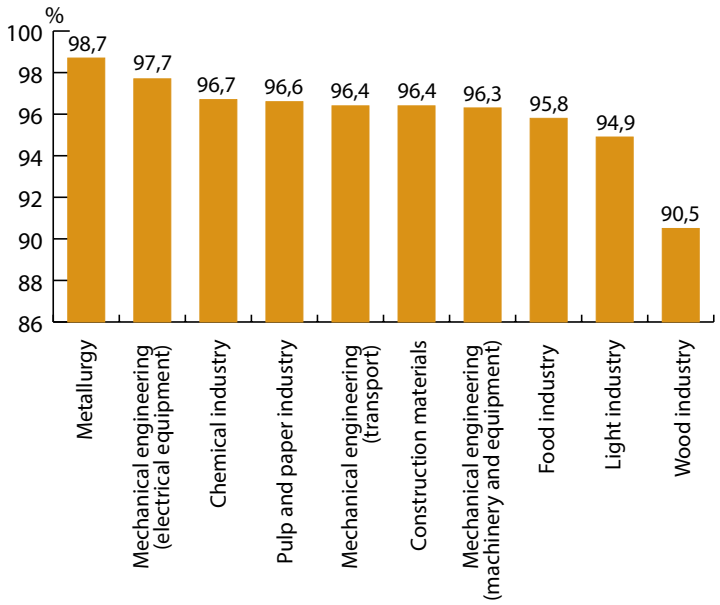

Fig. 1. Ranking of industries by general index of primary digitalization (the share of enterprises applying information and communication technologies) in 2017

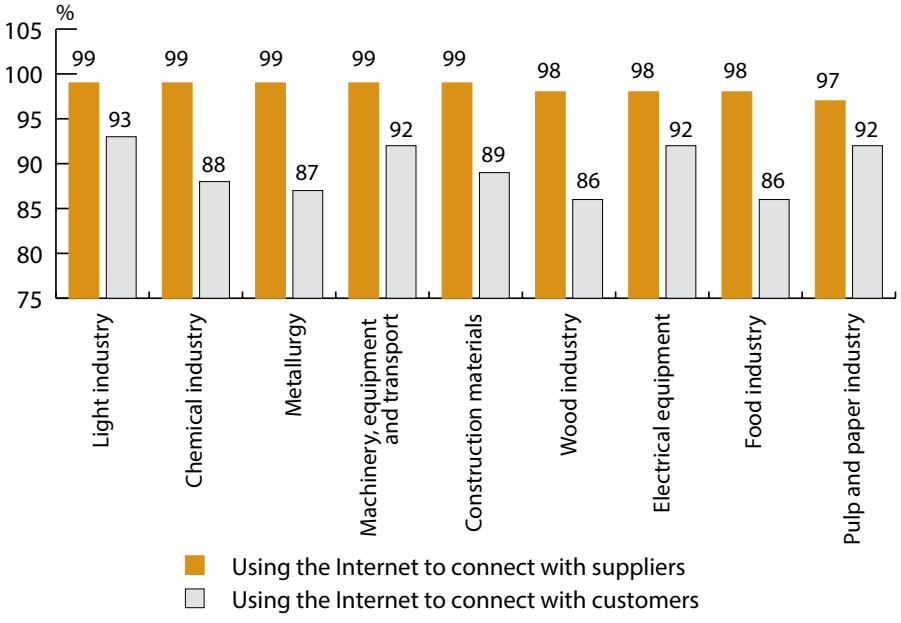

Fig. 2. Ranking of industries by secondary digitalization indices (the share of enterprises using the Internet to communicate with suppliers and customers) in 2017

enterprises of the industry exhibit one of the highest rates among industrial companies.

The third leading market in terms of digitalization is the *market for chemical products*: 96.7% of enterprises use information and communication technologies in their daily work with suppliers and consumers. This is partly due to the fact that the market is structurally heterogeneous. It embraces segments of both the industrial market (the actual chemicals and products, as well as rubber products) and the consumer market (drugs, cosmetics, household chemicals). The fact that a part of the market for chemical products is oriented towards the consumer segment largely determines the high rates of digital communication. At the same time, the huge capacity of the industrial segment implies digital communication to be more intensive with suppliers than with consumers. While 98.9% of the industry's enterprises have succeeded in building digital relationships with suppliers, only 88.4% of them interact with customers in a digital format (see Fig. 2). At the same time, digital communication in the sphere of cooperative supplies is quite frantic – 94.6% of enterprises provide information to suppliers about their activity and products via digital channels, 73.3% use the Internet to disclose information about their needs, and 52% place suggestions on cooperation online (see Table 2). The presence of the consumer segment in the industry results in high values of such indicators as the share of enterprises placing orders online (excluding email) (47.2%), the share of enterprises using electronic settlements with consumers (excluding non-cash bank payments) (50.3%).

The average rates of the primary and secondary digitalization are typical of the markets for *general and transport engineering, construction materials and pulp and paper production* (see Fig. 1, 2). In terms of capacity, productivity and profitability, these markets occupy a middle position among industrial product markets. The market for general and transport engineering as the most technologically advanced one stands out significantly among the markets of this group in terms of using servers and local area networks (more than 80% of enterprises). At the same time, engineering enterprises are more integrated into digital interactions with cooperators and maintenance companies – 72.3% post information about their needs on the Internet (see Table 2). As for consumer cooperation, mechanical engineering companies are leaders in using the Internet for after-sales service and maintenance (see Table 3).

The *markets for light, food and wood products* are the least developed in terms of digital technologies. Such enterprises display a low average industry profitability, and, consequently, the ability to introduce information and communication technologies. Here, we are talking about primary manufacturers, while the intermediary segment is actively introducing advanced information and communication technologies and digital sales channels. By level of primary digitalization, wood enterprises stand out negatively in this group – 10% of them are not equipped with personal computers (see Table 1). The enterprises of light industry, despite the low availability of computers, maintain the most intense digital communication with suppliers and consumers among all industrial enterprises (see Tables 2, 3).

Thus, the analysis of digitalization processes has shown a significant differentiation of industrial markets both in terms of primary digitalization (personal computer availability, use of servers, local networks, websites, etc.) and digitalization of supplier and consumer relationships (requesting and providing information, placing and paying for orders online, publishing the need for cooperative supplies, after-sales service, etc.).

Regional distinctive features of industrial markets digitalization

The level of economic digitalization of Russia's macroregions differs significantly (Fig. 3). The two territories especially active in digitalization are the Central and Northwest parts of the country. The share of enterprises using information and communication technologies in these macro-regions exceeds 95%. The Ural, the Far East and the Volga region also have relatively high digitalization rates. The Siberia macro-region is characterized by insufficient economic digitalization, despite the deep involvement in the digitalization of the region's key cities. The North Caucasus and the South of Russia demonstrate consistently low digitalization rates.

The level of industrial development in the Russian macroregions is extremely differentiated, which is largely explained historically – by the availability of primary resources, the existing technological order and the dominating specialization branches. Accordingly, the scale of industrial digitalization in the regions also differs considerably. The comparison of the economic digitalization level and the industrial digitalization level of the macroregion is quite indicative (Fig. 3). In those macro-regions where the share of high-tech manufacturing sectors is high, the gap between the economic and industrial digitalization is small. Macroregions with a low share of industry are characterized by a low level of economic digitalization.

The Ural macroregion is the leader in terms of industrial digitalization: 97.3% of manufacturing enterprises actively use information and communication technologies while

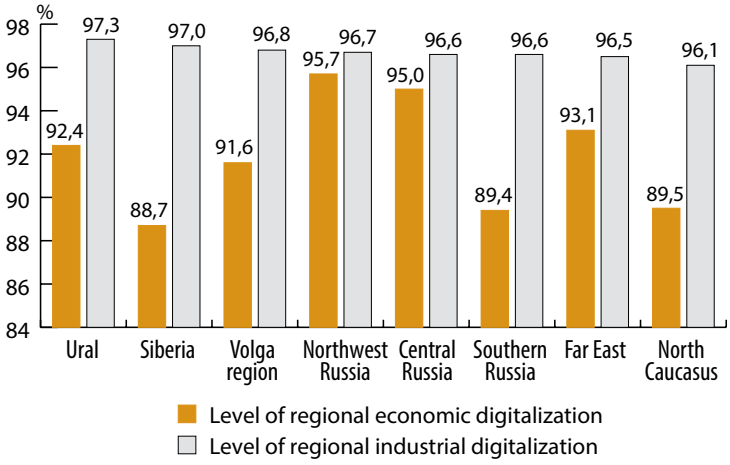

Fig. 3. Digital profile of macroregions: economy and industry in 2017

Table 4 – Structure of the shipping volume according to manufacturing industries in macro-regions, %

Industry	Russian Federation	Central Russia	Northwest Russia	Southern Russia	North Caucasus	Povolzhye	Urals	Siberia	Far East
Food industry	17,7	20,8	19,7	28,5	38,3	13,1	7,2	14,1	37,1
Metallurgy	16,3	10,7	12,9	13,4	5,0	9,3	39,4	30,6	4,6
Chemical industry	31,8	31,5	24,5	33,9	29,1	40,8	30,0	28,7	11,1
Electrical equipment	5,9	7,4	6,9	1,8	8,6	6,9	3,1	3,8	1,8
Machinery, equipment and transport	13,6	11,3	19,6	10,2	5,9	18,5	7,9	10,1	31,1
Construction materials	3,8	3,9	3,2	5,5	8,3	3,4	3,9	3,0	4,9
Pulp and paper industry	3,0	3,7	6,7	1,7	1,7	1,9	0,5	2,6	1,1
Textile and clothing industry	1,0	1,6	1,0	1,6	1,1	0,8	0,3	0,4	0,4
Wood industry	1,4	1,0	2,8	0,4	0,2	1,1	0,6	2,5	3,5
Other	5,5	8,1	2,7	3,0	1,8	4,2	7,1	4,2	4,4
Total	*100,0*	*100,0*	*100,0*	*100,0*	*100,0*	*100,0*	*100,0*	*100,0*	*100,0*

producing and selling industrial products (Fig. 3). The highest rating is due to the significant level of digitalization of the key industries of the macroregion's specialization.

Among the processing industries, metallurgical production accounts for 39.4% (mainly Sverdlovsk and Chelyabinsk oblasts), which demonstrate the highest rates of using information and communication technologies (Table 4). The second key branch the macroregion specializes in is the chemical and petrochemical industry, which accounts for 30% in the structure of the processing industry (mainly Tyumen oblast with autonomous districts). The significant involvement of the macroregion industry in digital information flows explains the macroregion's economic digitalization at the level of 92.4% (see Fig. 3).

The Siberia macroregion occupies the second place in the industrial digitalization ranking: 97% of industrial enterprises are active participants in digital relationships (see Fig. 3). The key branches of the macroregion's specialization are: metallurgical production – 30.6% (Kemerovo oblast, Krasnoyarsk kray), the chemical industry – 28.7% (Omsk, Tomsk and Kemerovo oblasts) and mechanical engineering – 10.1% (Irkutsk and Novosibirsk oblasts) (see Table 4). However, by the level of digital society's development, the Siberia macroregion appears among the last three territories, which is mainly due to the fact that some of its districts have weak industry and are characterized by poor digital development.

The Volga region occupies the third position in the industrial digitalization ranking: digitalization covers 96.8% of industrial enterprises of the territory. High positions in the industry digitalization rating are due to a significant number of high-tech industries with a high level of digitalization: the chemical and petrochemical industry (40.8% of the manufacturing industries, the key actors are Bashkortostan, Perm kray, Tatarstan and Orenburg oblast) and mechanical engineering (18.5% of the manufacturing industries, the key actors are Samara and Ulyanovsk oblasts, Tatarstan and Udmurtia). At the same time, low rates of digital society development leads to a gap between economic and industrial digitalization.

The macroregions of Northwest and Cental Russia, whose rates of industrial and economic digitalization are relatively similar, come the fourth and the fifth respectively in the industrial digitalization ranking. Their processing industries include the high-tech and digitalized chemical industry, mechanical engineering and metallurgy, as well as poorly digitalized food and construction industries. At the same time, these macroregions have the highest rates of digital society development as a whole. This is mainly due to the significant role of the financial and public management sectors characterized by the highest the level of digitalization.

Southern Russia with the industrial digitalization rate close to that of the Central macroregion comes the sixth in the ranking (see Fig. 3). However, the gap between industrial digitalization and the overall level of digital society development is quite significant. Among the processing industries, the chemical (33.9%) and food (28.5%) industries hold the leading positions (see Table 4). Of all the territories of Southern Russia, Volgograd oblast has the most developed chemical industry, whereas Krasnodar kray and the Republic of Adygea are leaders in the food industry.

The Far East ranks the seventh in terms of industrial digitization (see Fig. 3). The processing industries of the macroregion have an extremely heterogeneous sectoral and spatial structure. The key specialization areas are the food industry (37.1%), mechanical engineering (31.1%) and the chemical complex (11.1%). High-tech industries are spatially concentrated in two constituent territories – Khabarovsk and Primorsky Krays.

Finally, the North Caucasus, which has the lowest rates of both primary and secondary digitalization, hits rock bottom in terms of industrial digitization. Despite the fact that the territory's chemical industry is a high-tech sector, the overall level of digital society development does not allow the regions to develop effectively.

The ranking of Russian macroregions in terms of industrial digitalization proves once again that, without developing the material sector and primarily the industrial complex, digital society development id unable to guarantee a long-term competitiveness of a territory and cannot form prerequisites for improving well-being of the population [2].

CONCLUSION

Forming digital economy is not just a matter of national security, but also a chance to boost the competitiveness of Russian products in the global market in the future. According to McKinsey experts, due to the digital economy development, Russian GDP is predicted to increase by 4.1–8.9 trillion rubles by 2025, which will amount to 19–34% of the total expected GDP growth [17]. At the same time, the level of the digital society's development is largely dependent on the level of the material sector's digitalization. Our research has shown that digitalization is going to become the main driving force behind the development of the Russian manufacturing. According to the estimates by the Ministry of Industry and Trade of the Russian Federation, by 2024, a systemic transition to a digital development model will allow increasing labour productivity in the processing industries by more than 30% and the share of high-tech industries in the country's GDP will rise up to 15%[1]. Even if the real figures are lower, the trend will demonstrate a full-fledged and consistent digitalization of the Russian manufacturing. The current study proves that the degree to which high technologies are applied by manufacturing sectors is determined primarily by the level of digitalization, automation and networkization. Only those industrial markets whose participants are equipped with digital technologies and engaged in digital communications will end up being the most capacious and profitable and exhibiting the fastest growth.

Each macro-region of Russia displays its own uniqueness – the availability of primary resources, key sectors, financial and budgetary well-being and the standard of living of the population. From this perspective, there are solid grounds for differentiating macroterritories by the level of digital society development and the level of digital transformation of manufacturing. Digital inequality is a historical notion since it reflects the previous development of the region. However, there is one more reason. Year by year, Russian telecommunication companies spend millions of dollars on the development of broadband access, but it is more profitable for them to operate in urban agglomerations and large cities that provide more opportunities to return their investments. In terms of Internet penetration, Russia (72%) lags far behind developed countries that are nearing 100-percent coverage of their territories with broadband access. Consequently, without government support involved, it will take broadband access networks another 15 years to reach 100-percent coverage and the level of digital society development in the regions will continue to differ significantly. At the level of macroregions such differentiation is not so obvious, but when studying the level of certain municipalities' digitalization, the situation seems to be critical. ■

[1] Press release of the meeting of the Presidential Council on Strategic Development and Priority Projects (July 5, 2017). Available at: http://minpromtorg.gov.ru/press-centre/news/.

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