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EFFECTS OF INFLUENCE OF ECONOMIC AND TECHNOLOGICAL DEVELOPMENT OF IT SEGMENTS ON DIGITAL TRANSFORMATION OF RETAIL TRADE

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This paper presents the results of measuring cross-sectoral economic and technological effects, allowing to determine the degree of dependence between the segments that produce digital technologies and implement them. The basis for empirical calculations was the survey data of leaders among Russian IT companies and retail organizations on the current state of digital and business activity.

The purpose of the work is to identify the presence and establish the strength of the relationship between these segments in terms of existing localized industry effects, expressed in the transfer of technology from the IT segments to retail. The authors of the work identified and tested several specific hypotheses, the general meaning of which was to suggest that retail trade in the current stage of economic development in Russia is susceptible to emerging trends in the rapidly changing IT services sector that can quickly and efficiently respond to the growth of the IT companies digital activity by increasing investments in digital technologies and increasing the intensity of their application in business processes.

In particular, hypotheses were tested regarding the impact of business activity in the IT services segments on the growth of electronic commerce turnover, the use of online marketplaces, Big data technologies, virtual and augmented reality technologies in retail trade organizations, as well as hypotheses suggesting a connection between the development of mobile applications in the IT segments and the use of mobile technologies, expectations regarding the growth of electronic goods turnover in retail organizations.

The obtained results confirmed the majority of the hypotheses put forward, thereby supporting the authors' general assumption about the existence of specific effects of the development of the IT segments on intersectoral technological transfers, revealed the existing specifics of penetration and spread of modern technological trends in trade, and also showed that the IT is currently important component in the process of digital transformation of Russian retail trade organizations.

Keywords: digitalization, digital technologies, IT segment, retail, cross-sectoral connections, conjuncture observations.

JEL Classification: L81, L86, O33.

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Introduction

Over the past few years, the process of transition to digital channels has been observed all over the world, and the ongoing transformations are radically transforming the economy. The variety and number of digital services is increasing exponentially, changing everything and thereby contributing to the creation of innovative products based on a set of advanced technologies.

One of the main factors of the transformation is the growing use of information and communication technology (ICT). ICTs form the infrastructure for digitalization and act as the core element of the digital economy. According to UNCTAD, we can identify several levels in the ecosystem of the digital economy: in particular, the core, consisting of hardware manufacturing, software development, telecommunications and information technology services (IT), and a broad area of the digital economy, which includes electronic commerce (e-commerce), industrial Internet of things, etc. [UNCTAD, 2019].

Being an integral parameter for qualitative transformations in the economy and other areas, IT is an important mechanism of social mobility and the successful implementation of innovations that contributes to the more rapid progress of technological changes. Despite the relatively small absolute share occupied in the economies of developed countries (in the USA - 6%), the IT segment is actively growing and begins to dominate in the service sector [Brookings Institution, 2019]. The share of IT in Russian GDP is also small - about 1% (in 2018), but in recent years it has been growing steadily at a rate faster than the growth rate of the economy as a whole: for example, in 2018 its growth was ahead of the growth of the Russian economy as a whole by 1.4% [Rosstat, 2019a]. A large contribution to the economic development of IT services is due to the fact that they account for a significant share of research and development in the businesses [Eurostat, 2018].

The introduction of artificial intelligence technologies, machine learning and robotic automation among the world's leading companies in the IT segment supports the prospects for its sustainable development [Brookings Institution, 2019]. According to an IBM study, retailers and brands have high hopes that smart automation can increase the profitability of their organizations. In particular, the study shows that artificial intelligence can lead to an average decrease in operating costs by 7%, as well as an increase in average annual revenue growth by 10% (about 2000 companies from 23 developed and developing countries took part in the survey) [IBM Institute for Business Value, 2019].

The important role of the IT segment in the development of the economy as a whole is connected with two channels of influence: firstly, with the development of the latest advanced technologies

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and, secondly, with the spread of the scale of existing innovations in other sectors of the economy, which can potentially have significant multiplier effects on value chains [Brookings Institution, 2019]. Consequently, along with the spread of IT and the increasing use of computing and communication devices, the dependence of other sectors of the economy on the IT segment is increasing. A particularly profound influence can be observed in high-tech and consumer-oriented segments such as electronics, communications, entertainment and retail [BCG, 2018]. The McKinsey Global Institute (MGI) estimates that by 2030, digital technology can contribute 13 trillion US dollars to global GDP [McKinsey & Company, 2019].

The digital transformation of retail is primarily associated with the diffusion of technologies for the development of e-commerce. Being an important institution of the digital economy, it penetrates into a growing number of legal relations and covers their entire spectrum – direct interaction of consumers with consumers (C2C), sellers with consumers (B2C) and between entrepreneurs (B2B), business and government (B2G) etc. According to UNCTAD estimates, the global e-commerce turnover in 2017 approached the level of 30 trillion US dollars, which means an increase in its volume by 13% compared to the previous year. In particular, global B2B trade in 2017 amounted to 25.5 trillion US dollars, which is 87% of all electronic commerce, while B2C trade amounted to 3.9 trillion US dollars in 2017 [UNCTAD, 2019].

In general, the most important digital technologies in retail at the moment include e-commerce, electronic payments, Big data, smartphones, radio frequency identification (RFID) systems, social media, mobile applications, the Internet of Things, virtual and augmented reality, customer relationship management (CRM) systems, cloud computing, load balancing systems, geographic information systems, blockchain, and algorithmic automation [Kern, 2018; Abdrakhmanova et al., 2019].

Digitalization creates new opportunities for Russian retail, becoming not just a global challenge, but also a key factor in the escalation of new technologies and services, which, in turn, contributes to the implementation of innovations. In recent years, telecommunications, banks, and retail have become the most successful industries for introducing digital technologies in Russia. Given that among the sectors of the Russian economy, retail and wholesale trade is the leader in terms of the number of jobs created (about 20% of the total employed population of the country) [Rosstat, 2019b], the digital transformation of retail has great potential to contribute to the country's economic development. As a result, Russian business is becoming increasingly involved in the digitalization process, recognizing the need to maintain its own competitiveness, although it is in no hurry to invest in fundamentally new directions [NRU HSE, 2018].

In recent years, the e-commerce market has also shown dynamic development. According to Morgan Stanley analysts, now Russia is close to the "inflection point", and a sharp increase in the number of online purchases may begin in the coming years. Their forecast shows that the volume of the e-commerce market will reach 31 billion US dollars by 2020 [Morgan Stanley, 2018]. At the same time, according to the estimates of the Association of Internet Trading Companies (AKIT), in 2018 the volume of the Russian e-commerce market reached 1.66 trillion rubles, and small and medium-sized Internet sellers developing their business in the regions made a significant contribution to market development. The alternative forecast by AKIT shows that the volume of the e-commerce market will be about 2.18 trillion rubles in 2019, while cross-border trade will account for 680 billion rubles [AKIT, 2018].

According to Rosstat, in 2017, 19.9% of the total number of wholesale and retail organizations in Russia made electronic purchases, and 19.7% – electronic sales, and 43.2% used CRM, ERP, and SCM systems in their activity, which is the second result after the telecommunications sector for this indicator [NRU HSE, 2019].

Thus, a review of international trends indicates that the IT segment is a major provider of technological solutions that contribute to the formation of a global infrastructure for digitalization of retail trade. Companies continue to invest heavily in digital technology to accelerate sales growth, attract customers, reduce future costs and increase overall productivity. According to IDC's forecast, by 2020, total global corporate investment in the development and implementation of digital technologies will increase to 2.4 trillion US dollars. It is expected that 42% of them will be on the Internet of Things, 25% – on mobile and social technologies, 10% – on cognitive technologies, including artificial intelligence and big data analytics, 6% – on robotics and 15% – on other digital technologies [World Economic Forum, 2018].

As various researches show, manufacturing is the leader in terms of investments in R&D and infrastructure technologies [Dernis et al., 2019; IDC, 2019]. Among other factors, it can be probably due to the wider presence of investment projects that require huge investments to benefit from them in the manufacturing sector, as compared to the services sector and particularly retail. Then, from the point of view of industry specifics, due to lower volumes of required expenditures, the spread of digital technologies in retail can be relatively quick, and, accordingly, delays in reactions to changing situations in IT services may not be so large.

The economic and technological dependence of retail on the IT segment is obvious, but, nevertheless, it is still difficult to measure the extent to which IT activities contribute to the transfer of technology to retail, due to the complexity and versatility of this process. The effects

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of the introduction of digital technologies vary depending on the country, industry, company size, its financial potential and future development strategy [OECD, 2019b]. MGI's attempt to measure in its study the speed of introduction and implementation of digital technologies by companies in the USA, Europe and China in 2018 showed that on average they use only about 25% of the existing potential realized in the ICT sector [McKinsey & Company, 2019]. At the same time, a recent OECD analysis shows that some sectors, such as agriculture and mining, lag significantly behind the rest in terms of investment in software and the use of ICT [Calvino et al., 2018].

Thus, the views on digital development and its implications are polar. It is clear that digitalization creates opportunities for increasing productivity growth through the introduction of digital innovation and the optimization of business processes [OECD, 2019b]. However, despite evidence of the rapid development of digital technologies in recent years [World Economic Forum, 2018], such as robotics and automation, the Internet of things, artificial intelligence, mobile and social platforms, their potential positive impact on economic growth and labor productivity is not much reflected in statistics [Syverson, 2017]. Researchers that are more skeptical attribute this to excessive excitement and false expectations about digitalization, while others say that existing statistics do not fully take into account the effect of the introduction of digital technologies or this effect is delayed [Goldfarb et al., 2019]. As McKinsey's analysis shows, digitalization has a strong positive effect on productivity, but it only shows up when companies absorb digital technology into everyday business practice [McKinsey & Company, 2019]. According to their forecast, only by 2045 will it be possible to talk about the global interaction effect and the full disclosure of the potential of such digital technologies as intelligent automation or artificial intelligence.

In our opinion, all existing points of view are valuable and can be taken into account to get a more complete picture of the complex and multidimensional process of integrating breakthrough digital technologies from the IT segment into industry-specific business models.

Given the relevance of the growing digital effects coverage and the current problem of responsiveness and reliability issues in measuring technological transfers, the goal of our study is to identify the presence and strength of the link between economic and technological development of the IT segment and the digitalization of retail. To do this, we will test several specific hypotheses on the example of Russian companies, the general meaning of which is the assumption that retail is indeed subject to new trends in the rapidly changing IT services sector

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and is able to quickly and efficiently respond to the growth of digital activity[5] of the IT segment by increasing investments in digital technologies and increasing the intensity of their implementation in business processes.

Given the lack of quantitative estimates for measuring such industry effects directly in Russian statistical practice, using our study, which is based on the opinions of IT and retail trade company executives, we try to find out if there really are influence effects and technological transfers between the Russian IT segment and retail. Which of the technologies transferred by the IT segment are most successfully implemented in retail and which have not yet received wide distribution in the Russian context? To increase the detail of our study, we focus not only on assessments characterizing the technological parameters of development, but also on some key results of the business climate surveys (indicators of operational performance). Considering the current potential of the IT segment as a driving force for the development and spread of digital technologies, as well as the growing scale of digital transformations in retail trade, we considered this goal timely for the current and future stages of digital and economic development of Russia.

In this regard, based on two results of conjuncture observations, our work is aimed at measuring the localized industry effects of technology transfer from the IT segment to retail, which allows us to detail the technological transformation taking place in Russia and identify its specifics. The key hypotheses of the study are aimed at revealing the existing relationships between the segments and their characteristics.

Thus, the first five hypotheses of our study suggest that the growth of business activity in the IT segment (business conditions) contributes to an increase in the share of retail organizations, whose leaders indicate:

H1: increase in e-commerce turnover;

H2: increased investment in digital technology;

H3: the use and development of technologies in the field of e-commerce[6];

H4: the use and development of Big Data[7] technologies in the context of consumer analytics and research;

H5: the use and development of virtual[8] and augmented reality[9] technologies;

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[5] This refers to the level and tendencies in the spread of digital technology.

[6] The use of online platforms, marketplaces and online stores.

[7] Technologies for collecting structured and unstructured arrays of information characterized by a large volume and high rate of change (including in real time), which requires special tools and methods for working with them [Chto takoe cifrovaya ekonomika? Trendy, kompetencii, izmerenie, 2019].

[8] Technologies of computer modeling, three-dimensional image or space, through which a person interacts with a synthetic (virtual) environment, followed by sensory feedback [Chto takoe cifrovaya ekonomika? Trendy, kompetencii, izmerenie, 2019].

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In addition to these basic hypotheses, in order to detail the industry technological effects, we added two additional ones to the study, suggesting that an increase in the share of companies in the IT segment in which mobile applications are developed contributes in retail organizations to:

H6: an increase in the share of companies using and developing wireless[10] and mobile technologies to search for data;

H7: growth of positive predictive assessments of the business in terms of e-commerce turnover.

This paper succeeds as follows. First, a literature review is provided discussing the major academic works, then, the methodology is explained including a description of the data used. Finally, results are presented and conclusions drawn.

Literature review

At the international and Russian levels, studying the impact of digitalization on the economy is primarily based on identification of global effects and trends in digital activity. The general trend in this practice is a much smaller distribution of theoretical studies and empirical work aimed at measuring cross-sectoral effects, including not strongly expressed ones, which make it possible to identify relationships and establish the degree of dependence between segments that produce digital technologies and implement them.

The measurement of global and localized digitalization effects has been the subject of a great number of large studies published in recent years. In particular, one can highlight the OECD's report "Measuring the Digital Transformation" [OECD, 2019a], the UNCTAD report on the digital economy [UNCTAD, 2019], the IMF report on measuring the digital economy [IMF, 2018], the ongoing World Bank research on digitalization, one of which was dedicated to the digital economy in Russia [World Bank, 2018]. Country and regional ratings are calculated to identify leaders and outsiders of digitalization (see, for example, The Digital Economy and Society Index (DESI) [European Commission, 2019], Digital Business Indicators [World Bank, 2019], Digital Adoption Index [World Bank, 2016], The IMD World Digital Competitiveness Ranking [IMD, 2018]). Among the Russian ratings, we can mention the Digital Russia index, calculated for the constituent entities of the Russian Federation by the Center for Financial Innovations and Cashless Economy of the Moscow School of Management Skolkovo [Skolkovo, 2019].

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[9] Visualization technologies based on adding information or visual effects to the physical world through the imposition of graphic and / or sound content to improve user experience and interactive capabilities [Chto takoe cifrovaya ekonomika? Trendy, kompetencii, izmerenie, 2019].

[10] Technology for transmitting data through a standardized radio interface without using a wired network connection [Chto takoe cifrovaya ekonomika? Trendy, kompetencii, izmerenie, 2019].

Available scientific publications on the topic of retail digitalization relate to its various aspects: technological [Taylor, 2016], marketing [Morimura & Sakagawa, 2018; Ferracuti et al., 2019], industrial [Reinartz et al., 2019], monetary [Chen et al., 2017]. In addition, there is literature that measures the micro and macroeconomic benefits of digital retail transformation and makes predictions about the future of the industry [Grewal et al., 2017].

If we turn to a narrower topic on the factors of the spread of digital technologies, then at present a significant part of the scientific literature in our area is devoted to studying the process of introducing digital technologies from the point of view of consumer perception: for example, the process of acceptance by consumers of digital innovations, based on the expansion of "Technology Acceptance Model" (TAM) [Perry, 2016], augmented reality applications, personal shoppers, and other smart retail technologies [Rese et al. , 2017], the social impact of the introduction of digital technology in retailing [Bailey et al., 2017; Chi, 2018; Kaushik and Rahman, 2015].

In addition to the consumer aspect, much attention is paid in the literature to the implications of the introduction of digital technologies for business management: new strategies for managing technological integration [Hagberg et al., 2016; Pantano et al., 2018a; Willems et al., 2017], supply management, developing new forms of pricing, combining digital technologies with human capabilities [Hagberg et al., 2016; Pantano et al., 2018a; Poncin et al., 2017; Roy et al., 2017; Vrontis et al., 2017; Willems et al., 2017].

Closer to our problem are existing papers on the introduction and spread of digital technology. However, they most often focus on the characteristics and capabilities of the enterprises themselves (see, for example, [Ferreira et al., 2018; Chou et al., 2016]), or pay attention to diffusion of innovations within the industry from advanced enterprises to more backward ones (see, for example, [Pantano et al., 2017, 2018b; Pantano & Vannucci, 2019]), leaving for the most part cross-sectoral relations out of focus.

At the same time, the possibilities of analyzing the causes and consequences of industrial digital transformation are still very limited due to the lack of relevant quantitative data, which is associated with the high speed of transformation of the digital economy both in Russia and abroad. From our point of view, under such conditions, conjuncture observations based on surveys that can quickly receive aggregated assessments directly from participants in business processes are able to become an additional modern measurement tool.

Data and Methodology

The empirical basis of this study was the primary data of the results of two conjuncture observations characterizing the current digital and business activity in the segments of IT and retail in 2018. The surveys were conducted by the ANO Information and Publishing Center "Statistics of Russia" commissioned by the Institute for Statistical Studies and Economics of Knowledge of the Higher School of Economics within the framework of the Basic Research Program on the topic "Conjuncture Monitoring of the Economic Sentiment of Enterprises and Organizations of Various Types of Economic Activities".

Based on two market observations, the total sample amounted to more than 1,100 organizations, geographically concentrated in the thirty regions of the Russian Federation11. The sample is representative of all observation units, multidimensional, stratified, and representative of the main economic indicators of the thirty regions of Russia. In particular, the results on the digital and business activity of the IT segment are presented by 412 organizations that specialize in e-commerce, marketing, and are involved in software development. According to OKVED 2 section J (services of organizations in the field of information and communications), these organizations in Russia include economic agents engaged in the following activities: computer software development, advisory in the field of computer technology, computer equipment management activities, data processing activities, provision of services for posting information and related activities [Indikatory cifrovoj ekonomiki, 2019]. The results of this activity can be implemented both in the domestic and foreign markets. At the same time, the total number of retail organizations (OKVED 2 section G – retail trade) involved in our work amounted to 736 units. In general, the sample sizes were sufficient to obtain the necessary accuracy of the estimates of indicators at all levels of development in the relevant sections of OKVED 2. Surveys were conducted on specially designed questionnaires – "Survey of business and digital activity of organizations providing information and computer services" and "Survey of business tendencies and digital activity in retail trade", which includes extended thematic blocks of questions. At the end of the second half of 2018, the questionnaires were filled out by respondents (company executives, managers) with the necessary level of competence in relation to the questions asked. Using respondent assessments from the retailing enterprises survey, the most important tendencies were identified that characterize the dynamics of indicators of business and digital activity of organizations, technologies that are used, planned, and necessary

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[1] Krasnodar krai, Krasnoyarsk krai, Primorsky krai, Stavropol krai, Khabarovsk krai, Arkhangelsk oblast, Vladimir oblast, Volgograd oblast, Vologda oblast, Nizhny Novgorod oblast, Irkutsk oblast, Tver oblast, Kemerovo oblast, Samara oblast, St. Petersburg, Leningrad oblast, Moscow , Moscow oblast, Novosibirsk oblast, Rostov oblast, Sverdlovsk oblast, Smolensk oblast, Tula oblast, Tyumen oblast, Chelyabinsk oblast, Republic of Bashkortostan, Republic of Dagestan , Republic of Tatarstan, Udmurt Republic, Sakha Republic.

for the implementation, the expected effects of digital transformation and obstacles for this, as well as strategic initiatives in the field of digitalization. The blocks of questions addressed to respondents assessing the main aspects of the development of e-commerce (e-commerce turnover in total sales, investment activity in technology, the use of digital technologies for the development of e-sales, etc.) were separate fragments in the IT and retail trade surveys.

In particular, based on the potential of the conjuncture observations instruments, as well as the hypotheses and the general goal indicated in the paper, Table 1 presents a preliminary system of selected indicators of business and digital activity. Nine candidates were selected as initial empirical material for inclusion in subsequent calculations, among which we determined 2 independent and 7 dependent variables.

Independent variables included the change in business conditions and the development of mobile applications in IT organizations of the selected population group, designated as X1 and X2, respectively.

The dependent variables were the change in electronic goods turnover (Y1), the level of investment in digital technologies (Y2), the use and development of e-commerce technologies (Y3), the use and development of Big data technologies (Y4), the use and development of virtual and augmented reality technologies (Y5), the use and development of wireless and mobile technologies (Y6), and expected e-commerce turnover (Y7) in retail companies.

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Table 1. Preliminary system of indicators of business and digital activity for inclusion in the calculations

Indicators from the observation form – "Survey of business and digital activity of organizations providing information and computer services"		Indicators from the observation form – "Survey of business tendencies and digital activity in retail trade"	
Indicator / Designation	Description	Indicator / Designation	Description
The Change in Business Condition (X1)	The share of companies (of the total number of enterprises providing IT services in the fields of electronic commerce, marketing and software development representing a specific constituent entity of the Russian Federation), whose executives noted that the conditions of their business in 2018 compared to 2017 "has significantly improved" or "has got somewhat better"	The Change in E-commerce Turnover (X1Y1)	The share of companies (of the total number of retail enterprises representing a specific constituent entity of the Russian Federation), whose executives noted an increase in the share of e-commerce turnover in total sales compared to 2017
		Digital Investment in the field of Digital Technologies (X1Y2)	The share of companies (of the total number of retail enterprises representing a specific constituent entity of the Russian Federation), whose executives noted the "high" and "medium" level of investment in digital technology in 2018
		The Use and Development of E-commerce Technologies (X1Y3)	The share of companies (of the total number of retail enterprises representing a specific constituent entity of the Russian Federation), whose executives noted the use and development of e-commerce technologies (Internet platforms, market places and online stores)
		The Use and Development of Big data Technologies (X1Y4)	The share of companies (of the total number of retail enterprises representing a specific constituent entity of the Russian Federation), whose executives noted the use and development of Big data technologies in terms of consumer analytics and consumer research
		The Use and Development of Virtual and Augmented Reality Technologies (X1Y5)	The share of companies (of the total number of retail enterprises representing a specific constituent entity of the Russian Federation), whose executives noted the use and development of virtual and augmented reality technologies
Mobile Application Development (X2)	The share of companies (of the total number of enterprises providing IT services in the fields of electronic commerce, marketing and software development representing a specific constituent entity of the Russian Federation) in which mobile applications were developed	The Use and Development of Wireless and Mobile Technologies (X2Y6)	The share of companies (of the total number of retail enterprises representing a specific constituent entity of the Russian Federation), whose executives noted the use and development of wireless and mobile technologies for search for data
		Expected E-commerce Turnover (X2Y7)	The share of companies (of the total number of retail enterprises representing a specific constituent entity of the Russian Federation), whose executives noted the expected increase or absence of changes in the dynamics of e-commerce turnover

Source: authors' calculations

Descriptive statistics of the studied variables are presented in Table 2.

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Table 2. Descriptive statistics of the analyzed variables

	X1	X2	Y1	Y2	Y3	Y4	Y5	Y6	Y7
Mean	0.25	0.55	0.29	0.41	0.19	0.21	0.21	0.41	0.87
Standard deviation	0.04	0.04	0.04	0.03	0.03	0.04	0.05	0.04	0.02
Minimum	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.73
Maximum	0.78	0.92	1.10	0.86	0.67	1.00	1.00	1.00	1.00

Source: authors' calculations

Currently, business surveys are a common source of economic information both in national and international practice, which allows to receive arrays of information that are so-called "soft" non-quantitative statistical data in "almost real" time mode. Conjuncture observations are used as a tool to obtain data on the specific number of economic agents that make up the sample in order to draw significant conclusions about key trends in the total population. This method makes it possible to get digitized answers from respondents to many important questions that are often not available in official quantitative statistics. The information obtained through qualitative surveys describes the perception by the economic community of the observed tendencies, while standard quantitative statistics reflect changes in objective conditions. A detailed description of the methodology for the quantitative determination of such qualitative information for its subsequent analysis can be found in [Kitrar et al., 2018].

The survey methodology is based on international practice of researching the business climate, taking into account the specifics of the functioning of the Russian economy, developed and updated using the scientific and practical potential of international organizations and institutions [European Commission, 2016]. At the same time, an integrated and comprehensive approach forms a base for the methodology of conjuncture monitoring of digital activity, in which the results of surveys for various sectors of the economy – the indicators and other relevant output information – are integrated in the context of measuring the "digital footprint". This is ensured by the unity of the main blocks of questions in each survey program regarding the degree of spread, potential for use, actual and expected digitalization trends in all sectors of the economy surveyed [Lola & Kitrar, 2019].

The system of conjuncture meters has a multi-level structure, focused on the approaches of building the European composite indicator "The Digital Economy and Society Index" (DESI) and monitoring the digital economy, conducted by the European Commission [European Commission, 2019].

Thus, among the key criteria of the digital measuring system involved in our work are the unification of industry survey programs, the homogeneity and significance of target groups of

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respondents, the possibility of identifying homogeneous sample populations and their stratifications according to established activities, unity with well-known international standards and recommendations that facilitate cross-country comparisons.

Guided by the recommendations of the Organization for Economic Co-operation and Development (OECD) and the Statistical Department of the European Commission on the metric presentation of tendencies in business and digital activity indicators, the following standard methodological principles can be distinguished, which became the basis of the indicator system and the structure of the questions of these surveys:

— questions relate to the characteristics of the organization's activities that is being surveyed;

— questions describe the annual dynamics of indicators;

— assessments of indicator tendencies are based on three-category graduation of answers: the number of respondents reporting growth (improvement) (+), no change (=), and decline (deterioration) (–) when responding to the corresponding directions of change in the activities of organizations in the study period compared to the previous and next periods, as well as "high", "medium", "low" level when answering the level of one or another aspect (indicator) of activity.

Based on the responses of the executives of organizations providing IT services, opinions of managers of companies were obtained on assessing tendencies in the indicators of business activity of companies, their areas of activity, technologies being developed and planned for development, competitive advantages, as well as factors conducive to development and impeding their activities.

The traditional procedure for quantifying the qualitative features of conjuncture observations includes, firstly, formalizing indicators in accordance with the substantive model in the form of a specific question from the survey questionnaire, with the help of which the relation is established between the surveyed objects, and, secondly, the "compression" of the survey results and combining information on all the features into the most related groups to simplify interpretation and analysis using the methods of "horizontal" and "vertical" integration (for more details see [Kitrar et al., 2018]).

As a rule, the analysis of this kind of qualitative information is based on the accumulated dynamics of quantified results of regular surveys. However, the specifics of our data, available only from 2018, imposed certain restrictions on possible approaches to analysis. At our disposal

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were only cross-sectional data for one year, which served as the reason for choosing standard microeconomic statistical tools.

We abandoned horizontal and vertical aggregation and worked with detailed estimates of individual indicators. Despite the obvious advantages of aggregation methods, in our case they can lead to the loss of valuable information. As practice shows, the potential of conjuncture observations is not limited to a cyclical analysis based on calculations of respondents' opinion balances and composite indicators of the business climate [Lola & Kitrar, 2016; Crosilla et al., 2010; Mitchell, 2002], and more detailed approaches to analyzing survey results may be of interest to researchers.

The respondents' answers, obtained on the basis of the results of conjuncture surveys and represented in binary format (ones meant the choice of one or another answer by the respondents, otherwise zeros were set), were presented in the form of statistical observations, with which a correlation and regression analysis was subsequently conducted. For this, we calculated the average values of the responses of company executives in the regions of the Russian Federation in which the organizations they represent are registered. In other words, for each of the 30 subjects of the sample, we received the share of respondents who chose a particular answer from the total number of the executives representing a particular subject of the Russian Federation.

Preliminarily, the data were checked for the presence of outliers and the proximity of the distributions to the normal form, since the Pearson correlation coefficient is sensitive to outliers and should be used in the analysis of variables whose distribution is close to normal. The number of outliers detected using the constructed "box plots" tended to zero, therefore, they were not excluded from the analysis in order to preserve representativeness of the samples. The results of checking variables for conformity of distributions to normal form by visual analysis of the histograms, calculation of the asymmetry coefficients, kurtosis, and the one-sample Kolmogorov-Smirnov criterion indicate that the distributions of variables describing the use and development of Big data ($Y4$) and virtual and augmented reality ($Y5$) technologies are far from the normal form, therefore, to analyze their relationship with the indicator of changes in the state of the business ($X1$), the Spearman's rank correlation coefficient was calculated that is a nonparametric analog of the Pearson correlation coefficient. When calculating it, not the distribution-related indicators of the studied variables (arithmetic mean and variance) are estimated, but ranks. A similar tool is the Kendall correlation coefficient, which in most cases is characterized by higher significance levels and lower values of correlation coefficients. The

distribution of the remaining indicators studied is close to normal, therefore, Pearson's correlation coefficients were calculated from them.

At the next stage of the work, OLS regression was used to evaluate the strength of the connection between the economic and technological development of the IT industry and the ongoing digital transformations in the retail trade. The normality of the distribution of the residues of the obtained models was checked using the Jarque-Bera test, and the absence of autocorrelation and heteroscedasticity using the Durbin-Watson and Breusch-Pagan-Godfrey tests, respectively. All calculations were carried out in the statistical packages IBM SPSS Statistics and EViews.

The results of the correlation and regression analysis are presented in the next section. Along with them, we tried to visualize the results in a diagram reflecting the comparative degree of influence of the selected forms of business activity of the IT segment on the digital transformation in retail.

Results

Figures 1-5 show the results of the correlation analysis in the form of scatter plots characterizing the relationships between the considered indicators of business activity of organizations that provide IT services in the field of e-commerce, marketing and software development, and indicators of digital technology development by retailers. The proposed visualization reflects the results of calculations of the Pearson correlation coefficients (r) and their significance levels (p).

According to the results, Spearman's rank correlation coefficients calculated to check the relationship between the indicator of business conditions change (X1) and variables describing the use and development of Big data technologies (Y4), as well as the use and development of virtual and augmented reality technologies (Y5) had a low level of statistical significance (p-values were 0.463 and 0.926, respectively). Therefore, we can conclude that the hypotheses H4 and H5 that we have indicated (see the section "Literature Review and Hypotheses") are not confirmed, and scatter plots for those two pairs of variables were not included in this section.
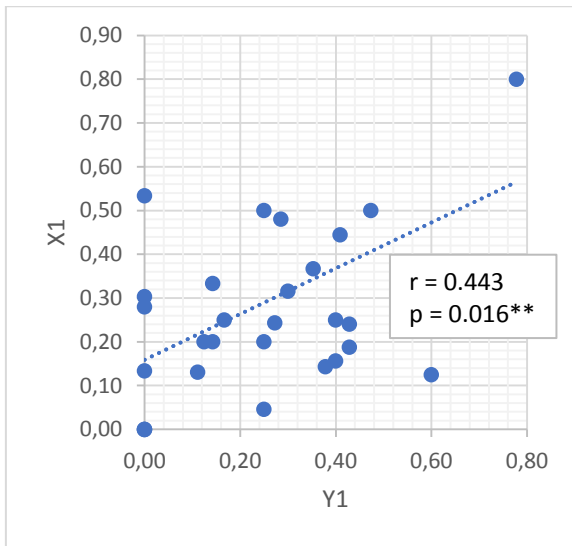
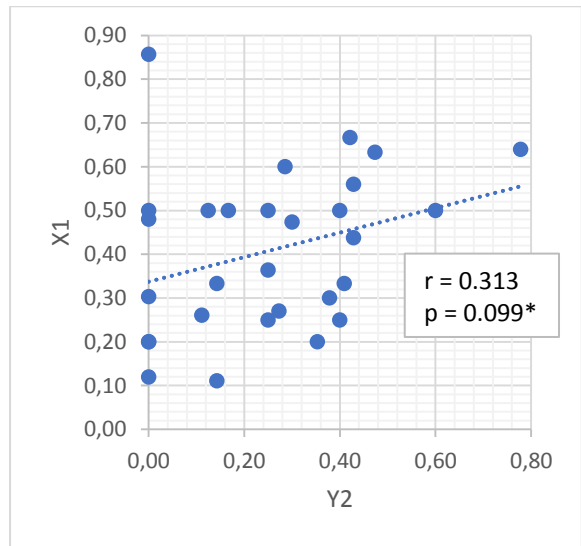**Fig. 1. Scatter plot for X1 and Y1**

Source: authors' calculations

Fig. 2. Scatter plot for X1 and Y2
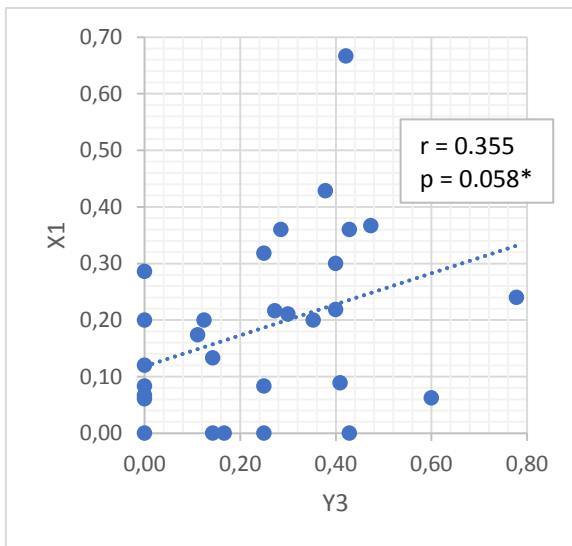
Source: authors' calculations

Fig. 3. Scatter plot for X1 and Y3
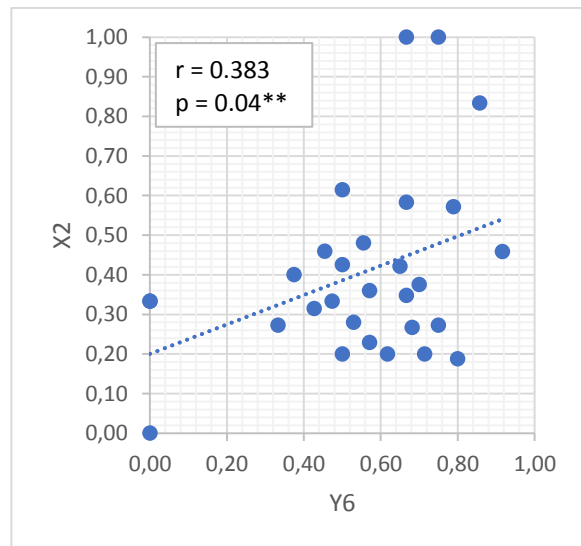
Source: authors' calculations

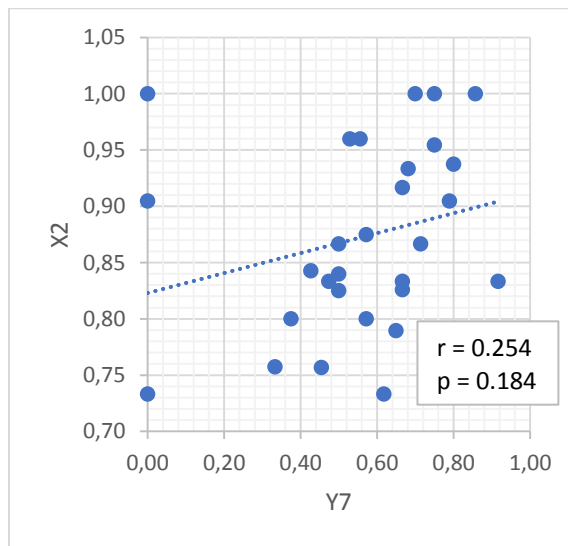**Fig. 4. Scatter plot for X2 and Y6**

Source: authors' calculations

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Fig. 5. Scatter plot for X2 and Y7

Source: authors' calculations

At the same time, the Pearson correlation coefficients calculated for the remaining pairs of indicators (X1Y1, X1Y2, X1Y3, X2Y6 and X2Y7) are statistically significant at the indicated significance levels. In accordance with the Chaddock scale used for a qualitative assessment of the size of coefficient of correlation, we can state a moderate positive relationship between all pairs of variables, with the exception of the relationship between X2 and Y7, which is characterized by weak strength. Thus, the conducted correlation analysis allows us to conclude that there are four alleged positive relationships between the variables.

The next iteration was a regression analysis, the purpose of which was to identify the strength of the influence of the indicators of business activity of organizations providing IT services in the field of e-commerce, marketing and software development on the use and development of digital technologies among retail companies. Its results are presented in Table 3.

Table 3. Regression Analysis Results

Source: authors' calculations

Model	Dependent variable	Independent variable	Coefficient (beta)	Model significance	R^2
1	Y1	X1	0.523	0.016**	0.197
2	Y2	X1	0.28	0.099*	0.098
3	Y3	X1	0.275	0.058*	0.126
4	Y6	X2	0.371	0.04**	0.147
5	Y7	X2	0.089	0.184	0.064

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The results presented in Table 3 demonstrate the presence of statistically significant relationships between the majority of the analyzed variables at the indicated significance levels, thereby confirming the hypotheses H1, H2, H3, H6 about the supposed positive impact of business activity indicators of IT organizations on various digitalization indicators of retail companies.

Interpreting the first, second and third regression models, we can conclude that a positive change in the business conditions in IT organizations (X1) has an impact on changes in the following indicators of retail organizations:

- E-commerce turnover (Y1);
- Level of investment in digital technology (Y2);
- The use and development of e-commerce technologies (Y3).

In general, the identified regression models are statistically significant and, therefore, confirm our general assumption about the positive local impact of the business activity of IT organizations that provide IT services on the digitalization of retail trade.

At the same time, the results of the regression analysis, characterizing the fourth and fifth models, confirmed only one of the two hypotheses put forward (H6 and H7). It was found that the activity of IT companies aimed at developing mobile applications (X2) has an impact on the use and development of wireless and mobile technologies in retail organizations (Y6), thereby confirming hypothesis H6.

Fig. 6 presents a visualization of the results obtained with respect to the entire set of hypotheses.
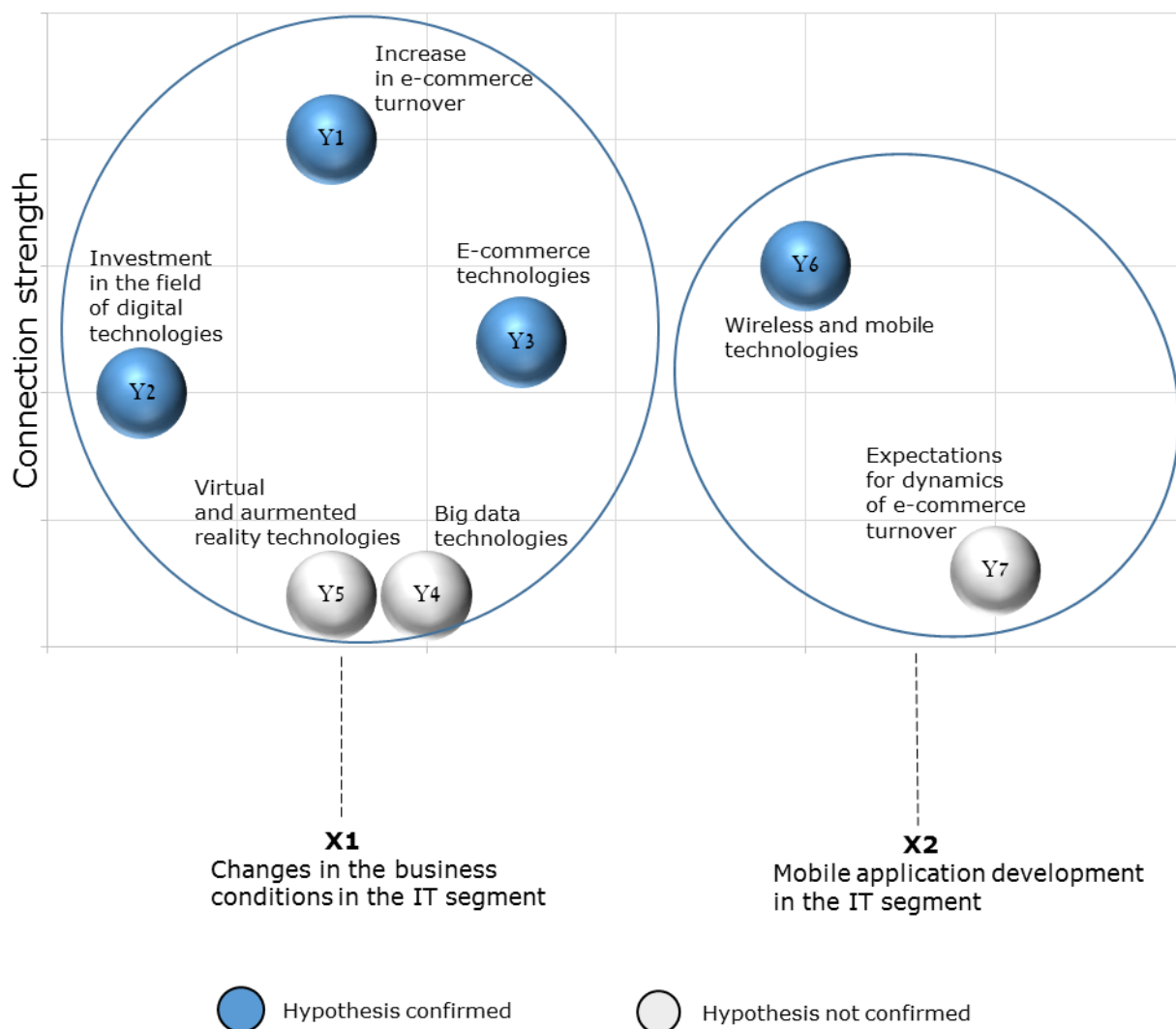
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Рис. 6. Connection between the IT segment and retail in the field of digital technologies: visualization

Conclusions

In this study, based on the results of two conjuincture observations, an attempt was made to measure cross-sectoral economic and technological effects that allow us to to identify relationships and establish the degree of dependence between the segments that produce digital technologies and implement them. The basis for empirical calculations was the data from surveys of the executives of Russian IT companies and retail organizations on the current state of their digital and business activity.

The specific goal of our study was to identify the presence and determine the strength of connection between the economic and technological development of the IT segment and the digitalization of retail, which may allow us to detail the assessments and tendencies of the

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technological transformation taking place in Russia and to reveal its specifics in the industry context.

To do this, we put forward seven hypotheses suggesting the existence of localized industry effects, expressed in the transfer of technology from the IT segment to retail.

The obtained results confirmed the majority of the hypotheses put forward, the general meaning of which may be narrowed down to the assumption that at present the IT segment is currently an important component of the digital transformation of Russian retail organizations. This indicates the importance of studying similar and other cross-sectoral effects of digitalization in future research.

In particular, we were able to identify some key cross-sectoral parameters of business and digital activity that determine the current features of the penetration and spread of modern technological trends in trade. For example, one of the most important results of the study should include the identified relationship between the business conditions in the IT segment and a change in one of key segments of trade – the e-commerce market, which functions and develops by virtue of the capabilities of digital infrastructure and digital business solutions transferred by IT companies. It was established that the growth of business activity in the IT segment is a determining factor in increasing the e-commerce turnover in retail organizations. At the same time, a favorable business climate in IT companies contributes to the growth of investments in digital technologies and the development of e-commerce technologies (the use of Internet platforms, marketplaces and online stores). In addition, we confirmed the existence of cross-sectoral connections at the level of individual technological developments, showing the high activity in the development of mobile applications in the IT segment being associated with the dynamics of the use of wireless and mobile technologies for searching consumer data in retail.

However, two hypotheses were not confirmed in the study. Why was there no connection found for Big data, virtual and augmented reality technologies in retail? From our point of view, these technologies are fundamentally different from others considered in the study. The current stage of digital development in retail trade both in Russia and in the world is characterized by the most widespread distribution of e-commerce technologies and mobile applications [Souiden et al., 2019], the assumption of the existence of cross-sectoral links for which in one form or another was supported by the results of our study. At the same time, according to existing forecasts, Big Data and virtual and augmented reality, which are closer to the zone of technology frontier, can only realize their potential in the future and become leading technologies in the services sector and, in particular, in retail trade [Deloitte, 2019; World Economic Forum, 2018; IBM Institute

for Business Value, 2019]. It can be assumed that the identified technological connections reflect the current state of digitalization of Russian retail as an industry included in local cross-sectoral economic relations, while the use of Big data and virtual and augmented reality is rather sporadic. E-commerce and related technologies are currently one of the fastest growing markets in Russia. Consumer confidence in online shopping of various categories of goods is growing every year, which, together with the spread of digital technology, digital infrastructure, and the digital transformation of business models, is becoming a powerful driver for e-commerce development.

Of course, the direction and properties of the cross-sectoral relations we have examined are somewhat ambiguous. In this regard, further industry research is needed to understand to what extent the demand and supply of technologies are the leading factors in strengthening cross-sectoral economic and technological connections, how important these links are for digital transformation, and in general, what role digitalization plays in the technological development of economies. Our research is capable of becoming the initial stage in a large direction of researching the causes and measuring the effects of digital transformations with an emphasis on industry specifics.

In particular, as part of the development of pilot conjuncture surveys of the digital activity in various industries, we will have access to time-series data from 2018, which will allow us to study more deeply the specifics of cross-sectoral digital effects and technological transfers, consider their development in dynamics and use more complex econometrics to study them. In order to expand the available set of information, the set of indicators of digital activity in conjuncture observations will continue to be updated.

Possible topics for future research in this area may be related to studying how the digitalization process affects the supply of labor and the market structure in retail (for example, the temporal dynamics of the number of small and medium-sized companies), with the development of new generalized aggregate indicators in the field of digital technologies.

The conducted and future studies within the framework of this topic will contribute to the development of the digital formation of industries, will help to implement national digital development programs, and will expand the existing infrastructure of statistical information.

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