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SPECIFIC ASPECTS OF ECONOMIC CRISIS THEORY AMID DIGITALIZATION OF RUSSIAN ECONOMY

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Abstract: *The aim of this paper is to define the main elements of crisis theory in the context of digitalization. The authors sum up concepts and approaches of crisis analysis and positive and negative aspects influencing crisis management, its scope and implications in the context of digitalization. An important point is strategic planning and the role of the state in the economy, with specific substantiation of the need to develop uniform information systems for managing the Russian economy. The hypothesis is carried out whether the level of digitalization of Russian regions is directly linked to their stable development or not. The empirical study integrates some elements of the methodology of regional economic security analysis by V. K. Senchagov and the Industry 4.0 concept. The conclusion is made on the importance of transition toward more complex multi-modal models (smooth transition models). That, in turn, creates the need to accumulate and analyze major missives of data using machine algorithms.*

Keywords*: economic crisis, crisis theory, digitalization, Industry 4.0, regional development.*

INTRODUCTION

Analyzing crises, their causes, factors of development and scope of consequences gains specific relevance in 2020. In the spring of 2020, we came across an abrupt and rapidly developing crisis. According to most researchers and economists, the apparent cause of this crisis is the pandemic. Border closures and quarantine measures adopted by many countries due to the extremely adverse epidemiological and sanitary situation have led to numerous negative consequences in nearly all countries, including Russia, and the overall global economy, specifically, unemployment growth, lower GDP, consumer demand and investment flows and mass bankruptcies primarily in services, tourism, entertainment and other industries. The spring of 2020 accelerated many processes, uncovered opportunities and exacerbated many problems. It was arguably a global test of the economy for digital accomplishment.

The Internet of Things market size in Russia was roughly $3.7 billion in 2018. This corresponds to 0.5% of the global market total. The share of Russians ordering goods online in 2020 rose to 70%. Approximately 50% of buyers in Russia make purchases via smartphones. Of those who order food, 80% do it via mobile applications. The global 3D printer market is poised to grow by $14.5 billion during 2020-2024, progressing at a CAGR of 39%. According to expert estimates, the global IoT healthcare market is expected to grow at a rate of 19% per year for the next several years to reach $322.2 billion by 2025 (Makarenko, n.d.). As observed in the paper by V. Papava and V. Charaia, the economy becomes a hostage to medicine. Arguing for free trade, they emphasise that during the post-crisis period, it is necessary to diversify value and supply chains (Papava, Charaia, 2020). On July 30, 2020, the World Economic Forum published a guide on sharing sensitive health data in a federated data consortium model (Sharing Sensitive Health Data in a Federated Data Consortium Model, 2020).

The pandemic-induced crisis exacerbated the existing uncertainty in international trade caused by trade disputes and tensions. This may lead to supply chain disruptions and, consequently, a revision of models of further growth and recovery after the crisis. M. A. Caratas, E. C. Spătariu and R. A. Trandafir analyze economic crises in the context of trade wars, political turmoil and distrust of institutions and seek to define triggers of financial crises (Caratas, Spătariu, Trandafir, 2019). L. Sottnik completes the analysis and synthesis of concepts, such as automation, innovation and economic crisis, which are indispensable to the Fourth Industrial Revolution (Sottnik, 2018). J. Bloomberg analyses the use and mutual relation of the notions of "digitalization", "digitization" and "digital transformation" (Bloomberg, 2018).

Globally and particularly in Russia, the digital economy is young, uncertain and unstable. However, in 2020, many organizations have learned practical lessons from the experience of the digital transition. E. g., N. Urbach and M. Roeglinger provide cases of 21 organizations from different countries and industries illustrating best practices of disruptive innovation, developing digital business models and digital transformations (Urbach, Roeglinger, 2019). The issues of foreseeing and forecasting economic crises and charting ways to overcome them are addressed in papers by Russian researchers, such as M. U. Tumgoev (2020), Iu. A. Danilov, D. A. Pivovarov and I. S.Davydov (2020), L. V. Shmaneva and S. V. Shmanev (2020) and others. Some researchers, including A. Psychogios, M. Nyfoudi and R. Prouska, emphasise the socio-psychological component of crises (Psychogios et al., 2020). Despite its high-technology profile, the digital economy largely relies on trust. During the current crisis, many organizations have switched

employees to remote jobs. After this forced step, many employees and executives plan to stick with this practice in the future.

All that potentially leads to a new model of economic growth and crisis management based on the prevalent role of trust and human capital and investment. There is already a new spree of publications on the emergence of a new type of economy, the "trust economy" (Ghose, 2020). Accordingly, based on the existing scholarly views on the discussed problem, one may observe that researchers primarily specify and focus on individual aspects of crisis management. However, in our view, there is yet no comprehensive description of the general theoretical and methodological fundamentals of crisis theory specifically for the context of economic and social digitalization; the relation between digitalization and the level of economic development has not been established. Digital transformation of the economy creates new models of interaction for all economic subjects, leads to higher labour and capital productivity, eases access to markets by cutting transaction costs and opens up other opportunities. However, it also creates some new threats, some of them potentially systematic.

The aim of this research is to define the main elements of crisis theory in the context of digitalization. Alongside this, the **hypothesis** is carried out whether the level of digitalization of Russian regions is directly linked to their stable development or not. Understanding the aspects of economic crises in the context of digitalization would contribute to more precise crisis forecasting and navigating faster and less damaging ways out, which, in turn, would benefit not only industrial development but also social advance in general.

MODERN APPROACHES TO CRISIS THEORY

Theory is an organized, structured and consistent system of notions, principles and methods uncovering and explaining the principal qualities and relations in a certain domain of studies. The purpose of any theory should go beyond mere interpretations of the observed facts, phenomena and relations toward identifying trends and making forecasts for the future. There are various approaches to analyzing economic crises and explaining what causes them. These include natural theories of externalities, underconsumption theory, theory of the industrial cycle, theory of overproduction, psychological theories of economic cycles, Keynesian business cycle theory, monetary theory of cycles, long wave theory and diverse synthetic crisis theories. Even though economic crises stand out among the most widely discussed issues now, a review of works on the subject suggests that there is no clearly defined system of propositions of crisis theory as a single and consistent whole. None of the existing theories studying economic crises is deemed immaculate or a definitive single source to identify and prevent economic crises. Generally, in our view, there may be two groups of approaches to analyzing the causes of economic crises.

1. Economic concepts explaining the origin of crises based on economic phenomena and processes: 1.1. shifts in equilibrium between supply and demand, underconsumption (T. Malthus, Ch. Sismondi, J. A. Hobson and others); 1.2. imbalance of production of factors vs. consumer goods (M.I. Tugan-Baranovskii, A. Spiethoff, G. Cassel and others); 1.3. monetary causes, imbalances of cash flows (I. Fisher, C. Juglar, A. Gann, J. Keynes, A. Hansen, N. Kaldor, R. Solow, J. Robinson and others); 1.4. economic "survival of the fittest" (evolutionary approaches of Iu.V. Yakovets, S. Iu. Glazev, A. I. Subetto, V. I. Maevskii, I. Adizes and others).

2. Group of approaches linking the origin of crises to non-economic causes: 2.1. natural phenomena, including acts of God, epidemics, solar activity (natural approaches of L. Gumilyov, A. L. Chizhevsky, H. Schwabe, R. Wolf, A. P. Hansky, V. Belkin and others); 2.2. speculative motives of businessmen in commodities and stock markets (V. Pareto, W. Jevons); 2.3. expectations of profits from new production investment and the relation between actual and expected income (A. Pigou); 2.4. behaviours of economic subjects and perceptions of economic indicators (R. Lucas, A. A. Psychogios, M. Nyfoudi, R. Prouska); 2.5. wars including trade and information wars (D. Ricardo, D. V. Manushin, M. A. Caratas, E. C. Spătariu and R. A. Trandafir and others).

Quite important for the establishment of crisis theory is the development of the theory of financial instability, which is a powerful indicator of a looming financial crisis. A new common idea formed in foreign literature after 2008-2009 that the main goal of economic policies of the state should be the analysis of financial stability (Ülgen, 2018). M. Malkina and A. Ovcharov sum up theoretical thinking concerning the essence, causes of financial instability and assess the current situation in the Russian economy in this context (Malkina, Ovcharov, 2019). In their view, financial instability is not an isolated stage of economic development, but it ripens within stability. It implies the conjugation of change in the financial sector and the real sector and spreading financial contagion via different channels. Financial instability integrates institutional, structural, balance-sheet, behavioural and regulatory aspects, among others. Another important observation is that most modern theories of economic and financial crises were built on assumptions and propositions describing developed economies. To foster economic resilience to internal and external crisis influences, we need to rethink such classical approaches to ensure their applicability in the Russian context. Russian specifics should be taken into account, particularly the commodity-driven export profile, institutional instability and inadequacy, sanctions regime and isolationism, limited fiscal and monetary policy potential, specific behavioural patterns and so on.

TECHNOLOGICAL PARADIGM SHIFT AND THE INDUSTRY 4.0 CONCEPT

Among economic drivers of crises, significant input was found to be made by business cycle trends and scientific and technological advances. The principal cause of crises and economic cycles is for many modern economists to be found in industrial revolutions and technological paradigm shifts. According to S. Iu. Glazev, technological paradigms are understood as groups of technology structures connected by the same type of technological chains and forming reproducible wholes (Glaziev, 2019). Technological paradigm shifts occur as a result of the exacerbation of old and generation of new crisis influences; i. e., technological paradigm shifts require a technological revolution. The idea of a paradigm shift is in sync with the Industry 4.0 concept, i.e., the Fourth Industrial Revolution. Every industrial revolution produced permanent total effects not only for the economy but for all spheres of social life. The unfolding Industry 4.0 connects people, machines and objects in the real and virtual worlds, facilitates process and stage automation and digitalization across production types and leads to industrial digital transformation, product quality improvement and shorter time to market due to pre-production virtual testing, production planning and leveraging artificial intelligence and big data.

Since 2013-2014, governments began to initiate digitalization programs: "High-Tech Strategy", "Digital Strategy 2025" (Germany), "National Innovation Plan", "Digital

Strategy" (UK), "New Face of Industry in France" (France), "Industrial Internet Consortium" (USA), "Smart Factory Clusters" (Italy), "Industry 4.0 Platform" (Austria), "New National Strategy on Industry 4.0" (Brazil), "Digital India" (India), "Made in China 2025" "Digital Economy of the Russian Federation" (Russia) and so on. 117 Industry 4.0 initiatives have been launched in 56 countries worldwide consisting of five regions: Europe (37%), North America (28%), Asia and Oceania (17%), Latin America and the Caribbean (10%), and Middle East and Africa (8%). The worldwide percentage was estimated at 25% (Bongomin et al., 2020). Digitalization trends are imminent as they shape the specifics of the post-industrial society.

IMPACT OF DIGITALIZATION IN CRISIS DEVELOPMENT

Largely on the back of globalization, all areas in our life, including economy, industry, politics, healthcare, culture, education, etc., are gradually conquered by digitalization. As with any other influences, there are two sides to digitalization in terms of crisis development. We identified the most important characteristics determining the impact of digitalization for crisis development.

Positive aspects helping to reduce the scope and consequences of crises include: 1. Prompt gathering and processing of crisis signals due to the use of big data and, consequently, better decision quality; 2. Digital modeling capabilities to assess crisis scenarios and consequences in decision-making; 3. Opportunity to set up cross-regional teams for solving specific problems; development of interactive distributed communities without personal attendance; 4. Prompt feedback, e. g., on resource appropriation for countering crises, "Digital democracy".

Negative influences complicating crisis management and exacerbating the scope and consequences primarily include the following: 1. Centralized attacks to build pools of unreliable data potentially leading to inefficient decision-making on overcoming crises; 2. Increasing outlays for energy consumption for digital equipment and modernization; 3. Discrete decisions of artificial intelligence and the growing number of accidents in high-precision and hazardous production cycles due to the complexity of the equipment; 4. Deliberate behaviours to create artificial deficits of goods, "Digital Dictatorship".

SPECIFICS OF CRISIS THEORY IN THE CONTEXT OF DIGITALIZATION

In this paper, we defined the following specifics of crisis theory in the context of digitalization: 1. Acceleration of all processes, from the emergence of crisis influences and to recovery from the crisis and transition toward a new level of development, availability of wide-spanning broadband digital networks between subjects; 2. High sensitivity of all systems to crisis influences as a result of tight digital connections driven by the use of 5G, the Internet of Things (IoT and IIoT), machine-to-machine communications (M2M); 3. Very fast, nearly instant spread of crisis-related information, significant information noise; 4. Transformation, emergence of new markets and jobs, causing additional risk factors for the development of new crisis; 5. Business digitization; 5. Increasing role of social media and messaging tools as a medium of communication not only for people, but for businesses to connect with community and for authorities and officials to communicate between themselves and with community, businesses, non-profit organizations both within the country and at the global information ground; 6. Prevalence of non-cash settlements not only at the intergovernmental or corporate level but also in

various types of transactions; 7. Development of electronic money and the cryptocurrency market, growing uncertainty in legal and economic aspects of their operation; 8. Administration of state control and governance in the digital form; 9. Leveraging artificial intelligence in forecasting and crisis management; 10. Increasing role of cybersecurity due to the digitalization of many governance functions at the micro and macro levels.

In these circumstances, we side with researchers from Vilnius T. Limba, A. Stankevičius and A. Andrulevičius focusing on national security (2019). Digital technology development invites not only methodological challenges for businesses or individual interests but also an integrated approach to national security. Hybrid threats, economic crises, social inequality and labour migration are among the main challenges to global security. If such scenarios are overlooked in crisis management, there will be no balanced progressive and competitive digital economy in Russia.

MAIN PROPOSITIONS OF CRISIS THEORY FOR THE RUSSIAN ECONOMY IN THE CONTEXT OF DIGITALIZATION

Consider the main elements of crisis theory: aim, objectives, principles, functions and methods adopted in the context of digitalization. The aim of crisis theory can be approached as achieving economic security in Russia and ensuring its sustainable development. The objectives are as follows: securing the territorial integrity of Russia; enhancing spatial consolidation and leveling of the territory; early diagnostics of crisis influences at initial stages for timely response to potential opportunities to optimize crisis impacts using big data and artificial intelligence; implementing the principles of strategic planning for predicting and forecasting economic crises.

Principles of crisis theory in the context of digitalization:

1. Human priority over artificial intelligence in the decision-making sequence;
2. Participants' and stakeholders' social responsibility for all steps they take (consensus approach);
3. Principle of strategic balance of all elements of the digital ecosystem and interests of all participants of the digital economy;
4. Focused approach (the foundation of this principle relates to "managing by objectives", alignment of goals with requisite resources and taking into account the influence of the weakest element in the system as a potential source of failure);
5. Interrelation and interconnectedness of different levels of crises in the context of accelerating digital processes;
6. Balancing the principles of governance centralization and decentralization;
7. Principle of cybersecurity at all levels (including national data processing centers and their physical location within the country).

Functions of crisis theory are invariable regarding the applicable territorial, socioeconomic and process conditions. The following functions of crisis theory can be defined:

1. Gnoseological function captured in the aspiration to discover the laws and patterns of the analyzed domain: explanatory function helping to explain and understand the specific facts of economic crises and connect diverse phenomena and objects; accumulative function relates to the accumulation and perpetuation of knowledge on economic crises;
2. Systematization function showing in analysis, classification and systematization of the wealth of facts;

3. Praxeological function relates to practical application in crisis management;

4. Predictive function of crisis theory enables forecasting crises and modeling various scenarios of development;

5. Informational and motivational function represents the capacity of crisis theory to transfer, between macro and microeconomic subjects, the data on crises of the past and their consequences and on measures to be taken for crisis control.

Note that the dominant function for crisis theory is the predictive function, as it is concerned with forecasting economic development in general. The methods of crisis theory can be grouped as follows: methods of crisis diagnostics; methods of crisis forecasting; methods of crisis resolution. Diagnostics and forecasting are interrelated. On the one hand, forecasts of crisis occurrence are based on the results of diagnostics of socioeconomic conditions. On the other hand, forecast estimates make the basis for diagnostics of crisis occurrence in the future.

The methods of crisis diagnostics include (Korotkov, 2020): Express crisis diagnostics is a method involving comparisons of several calculated parameters against standards or set limits, presenting a time-effective solution to evaluate socioeconomic conditions against a sequence from the worst-case state toward a more benign stage of crisis; Quantitative methods. As a rule, discriminant analysis prevails, which represents a multifactor statistical forecasting method with a set of economic indicators; Qualitative methods are based on identifying the causes and factors of crises.

The most common methods of crisis forecasting are mathematical modeling methods and methods engaging systems of leading indicators. The latter are often preferable (Grinyaev et al., 2010). Methods of crisis resolution include (Eskindarov, Zvonova, 2020): 1. monetary stimulus: cutting the key rate; expanding refinancing operations; large-scale purchases of securities; liquidity injections in foreign currency; lowering reserve rates; 2. support of the financial sector: boosting capital levels; buyout of bad assets; state guarantees; 3. fiscal stimulus: cutting tax rates; tax reliefs; scaling budget spending; government investment.

STRATEGIC PLANNING AND DIGITALIZATION OF ECONOMIC GOVERNANCE

Failure to maintain a proportionate structure of the economy in planning leads to crisis development. With growing digitalization in Russia, forecasting and planning should become principal. The current development of the Russian economy requires a comprehensive resolution of the hangover of systemic problems and disproportions in the economy and society. Currently, strategic planning in Russia is accomplished in accordance with Federal Law No. 172-FZ "On Strategic Planning in the Russian Federation". A strategy of socioeconomic development, a strategic forecast for Russia, major legal regulations and laws were developed, as well as a system of national programs and projects, including the national program "Digital Economy" with the constituent federal projects. The 2050 Strategy is expected to be adopted by the end of 2020.

Digitalization means it is particularly effective to use the potential of big data to reinforce the scientific toolkit of strategic modeling of Russian economic development and crisis theory. A useful methodological toolkit can be found, for example, in the propositions developed by the Soviet economist and cyberneticist Prof. N. I. Veduta and his school of strategic planning concerning the dynamic model of cross-sectoral balance

(Veduta, 1999), which, combined with Industry 4.0, will facilitate an integrated approach and balanced development.

In other words, endorsing Keynesian ideas of the big potential of the state as an economic force, we propose that the potential of digitalization is leveraged for digital modeling of the systems of governance of the Russian economy. A. N. Shvetsov and V. N. Rysina (2020) also argue for digitalization of governance in Russia in their papers. As they draw comparisons of Russian practices in the area with the best global approaches, the conclusion is that Russia is following global trends in this respect. In the context of digitalization, it is crucial to establish clear and transparent, fair and predictable standards and algorithms. The algorithm of decision-making and implementation with the alignment of interests of the state and economic subjects in complex economic systems under the Industry 4.0 concept is detailed in (Trofimov et al., 2019).

EMPIRICAL TESTING OF THE HYPOTHESIS OF A DIRECT RELATION BETWEEN REGIONAL STABILITY AND DIGITALIZATION LEVELS

Studies of digitalization levels are conducted at various levels of governance. Here, a special note should be given to the work by N. A. Ganicheva and O. B. Koshovets (2020) presenting a systematization of approaches and methods of such assessments. The paper explores the regional aspect and tests the hypothesis of a direct relation between stability and digitalization levels of Russian regions. The selection of indicators for analysis and their threshold values was based on the methodology of economic security analysis by V. K. Senchagov (2012). Crisis indicators were grouped into four categories: the indicators of economic development, social development, innovation development and environmental development. Below there is a grouping of Russian regions based on indicators of stability (crisis indicators) taking into account the level of digitalization.

Based on the number of indicators diverging from the respective standards, each of the regions can be assigned to one of the following groups: absolutely stable regions, with indicators suiting standards; stable regions, with 0 to five diverging indicators; unstable regions, with six to 10 diverging indicators; pre-crisis regions, with 11 to 15 diverging indicators; crisis-hit regions, with 16 to 20 diverging indicators. Regional data from the Federal State Statistics Service of Russia for 2018 was used. Calculations for 20 indicators across 82 Russian regions were laid out in Table 1.

Table 1. Analysis of Russian regions by the level of stability in 2018

Item	Region	Number of diverging indicators	Digitalization Index	Item	Region	Number of diverging indicators	Digitalization Index
1	Belgorod Region	13	73.09	42	Chechen Republic	11	48.61
2	Bryansk Region	13	47.44	43	Stavropol Territory	14	53.58
3	Vladimir Region	13	62.03	44	Republic of Bashkortostan	15	74.43
4	Voronezh Region	11	70.93	45	Mari El Republic	12	46.66
5	Ivanovo Region	13	50.76	46	Republic of Mordovia	14	57.5

6	Kaluga Region	13	71.76	47	Republic of Tatarstan	11	76.48
7	Kostroma Region	13	47.94	48	Udmurt Republic	14	66.97
8	Kursk Region	12	68.7	49	Chuvash Republic	14	58.97
9	Lipetsk Region	15	72.37	50	Perm Territory	16	71.53
10	Moscow Region	10	76.25	51	Kirov Region	14	52.03
11	Orel Region	14	46.3	52	Nizhny Novgorod Region	12	64.27
12	Ryazan Region	15	57.75	53	Orenburg Region	15	66.83
13	Smolensk Region	14	50.08	54	Penza Region	12	49.08
14	Tambov Region	12	55.86	55	Samara Region	16	71.44
15	Tver Region	13	51.28	56	Saratov Region	14	55.51
16	Tula Region	15	72.66	57	Ulyanovsk Region	12	65.4
17	Yaroslavl Region	13	68.02	58	Kurgan Region	13	44.94
18	Moscow	12	77.03	59	Sverdlovsk Region	14	65.66
19	Republic of Karelia	14	49.06	60	Tyumen Region	14	76.19
20	Komi Republic	14	68.64	61	Chelyabinsk Region	16	72.98
21	Arkhangelsk Region	13	59.26	62	Republic of Alta i	11	51.76
22	Vologda Region	14	69.47	63	Republic of Tyva	13	39.74
23	Kaliningrad Region	13	69.56	64	Republic of Khakassia	16	46.6
24	Leningrad Region	13	73.15	65	Altai Territory	13	54.71
25	Murmansk Region	14	68.84	66	Krasnoyarsk Territory	14	63.94
26	Novgorod Region	13	53.55	67	Irkutsk Region	14	67.07
27	Pskov Region	12	44.73	68	Kemerovo Region	17	62.09
28	Saint Petersburg	9	76.44	69	Novosibirsk Region	13	73.1
29	Republic of Adygea	13	42.78	70	Omsk Region	15	60.3
30	Republic of Kalmykia	11	41.36	71	Tomsk Region	12	64.24
31	Republic of Crimea	13	49.59	72	Republic of Buryatia	12	43.65
32	Krasnodar Territory	15	65.97	73	Republic of Sakha (Yakutia)	12	71.11
33	Astrakhan Region	16	52.88	74	Trans-Baikal Territory	12	44.75

34	Volgograd Region	15	61.64	75	Kamchatka Territory	10	52.91
35	Rostov Region	14	70.96	76	Primorye Territory	15	59.96
36	Sevastopol	11	45.84	77	Khabarovsk Territory	13	59.67
37	Republic of Dagestan	13	45.52	78	Amur Region	11	56.82
38	Republic of Ingushetia	11	40.42	79	Magadan Region	10	45.71
39	Kabardino-Balkarian Republic	13	47.06	80	Sakhalin Region	12	64.35
40	Karachayevo-Circassian Republic	13	40.31	81	Jewish Autonomous Region	15	39.76
41	Republic of North Ossetia-Alania	13	41.99	82	Chukotka Autonomous Area	11	41.64

Source: Calculated by the authors based on data from the Federal State Statistics Service (n.d.)

Below, the regions' sequential numbers from Table 1 are used as references. The resulting grouping is laid out in Table 2.

Table 2. Grouping of regions by indicators of stable development

Grouping	Criterion (number of indicators diverging from the standard)	Region
Absolutely stable	No	–
Stable	0 – 5	–
Unstable	6 – 10	10, 28, 75, 79
Pre-crisis	11 – 15	1-9, 11-27, 29-32, 34-49, 51-54, 56-60, 62, 63, 65-67, 69-74, 76-78, 80-82
Crisis-hit	16 – 20	33, 50, 55, 61, 64, 68

Source: developed by the authors

An analysis of the resulting insights showed that in 2018, there was not a single region in the "absolutely stable" or "stable" groups. Most regions are in a pre-crisis state. Analytical insights from Moscow School of Management SKOLKOVO were used in this paper for assessing digitalization levels (Digital Russia Index, 2019). The paper proposes to use the digitalization index to derive a grouping of regions between categories with high, medium and low degrees of digitalization. The resulting grouping for 2018 is laid out in Table 3.

Table 3. Groups of regions by the level of digitalization, 2018

Low	Medium	High
0-35	35-70	70-100
	2, 3, 5, 7, 8, 11-15, 17, 19-23, 25-27, 29-34, 36-43, 45, 46, 48, 49, 51-54, 56-59, 62-68, 70-72, 74-82	1, 4, 6, 9, 10, 16, 18, 24, 28, 35, 44, 47, 50, 55, 60, 61, 69, 73

Source: developed by the authors

In 2018, most regions showed medium levels of digitalization compared to high digitalization in 18 regions. There was no region in the "low digitalization" group. The resulting groupings can be used to compile an aggregate matrix as in the example in Table 4 for 2018. As results of the two groupings are combined, several segments appear: a "green" segment (stable regions in terms of crisis indicators, but showing different levels of digitalization); a "yellow" segment (unstable regions in terms of crisis indicators but showing different levels of digitalization) and a "red" segment (crisis-hit regions at various levels of digitalization). For each segment, a specific future strategy can be developed.

Table 4. Matrix. "Indicators of stable development" – "Digitalization level" for 2018

		Groups of regions by crisis indicators				
		Absolutely stable	Stable	Unstable	Pre-crisis	Crisis-hit
Groups of regions by the level of digitalization	High			10, 28	1, 4, 6, 9, 16, 18, 24, 35, 44, 47, 60, 69, 73	50, 55, 61
	Medium			75, 79	2, 3, 5, 7, 8, 11-15, 17, 19-23, 25-27, 29, 30, 31, 32, 34, 36-43, 45, 46, 48, 49, 51-54, 56-59, 62, 63 ,65, 66, 67, 70-72, 74,76-78, 80-82	33, 64, 68
	Low					

Source: developed by the authors

The matrix shows that the crisis-hit regions with medium level of digitalization include the Astrakhan region, the Republic of Khakassia and the Kemerovo region. Crisis-hit regions with high levels of digitalization include the Perm Territory, the Samara region and the Chelyabinsk region. The above groupings are also used in the combined analysis of stable regional development taking into account the level of digitalization (Table 5).

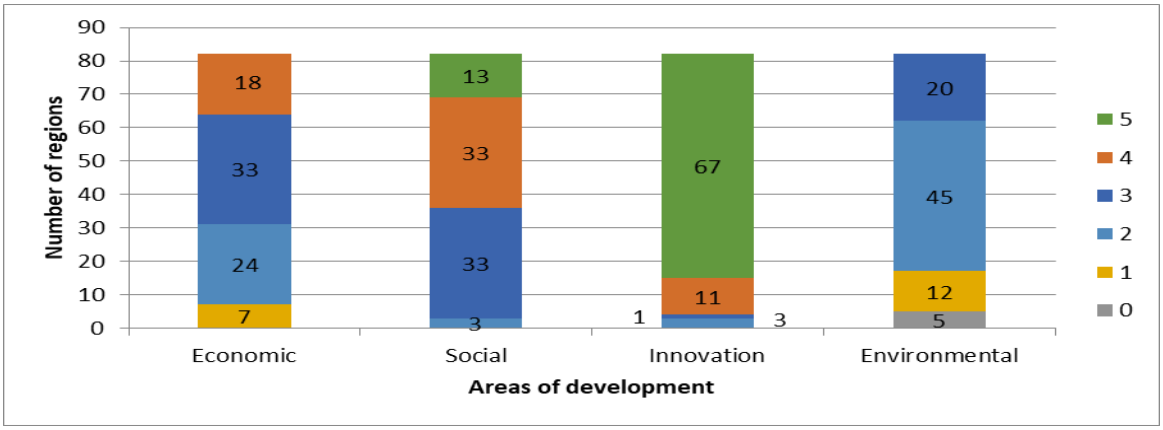
Table 5. Combined analysis of stable regional development taking into account the level of digitalization, 2018

		Number of regions with diverging indicators by areas of development			
		Economic	Social	Innovation	Environmental
Groups of regions by the level of digitalization	High	18 regions	18 regions	18 regions	18 regions
	Medium	64 regions	64 regions	64 regions	59 regions
	Low	–	–	–	–

Source: developed by the authors

Accordingly, Table 5 shows that all Russian regions demonstrate either high or (in most cases) medium levels of digitalization. Meanwhile, all regions with high levels have diverging indicators vs. standards in all areas. 64 regions with medium levels of digitalization have diverging levels of economic, social and innovation development. Five

medium-level regions by digitalization profile show no divergence in indicators characterising environmental development. These include the Republic of Kalmykia, the Mari El Republic, the Kamchatka Territory, the Magadan Region and the Chukotka Autonomous Area. Figures 1 and 2 represent data on the number of regions and the number of crisis indicators diverging from threshold levels in general for all areas and each area individually.



Source: developed by the authors

Figure 1. Number of regions with diverging indicators by areas of development, 2018

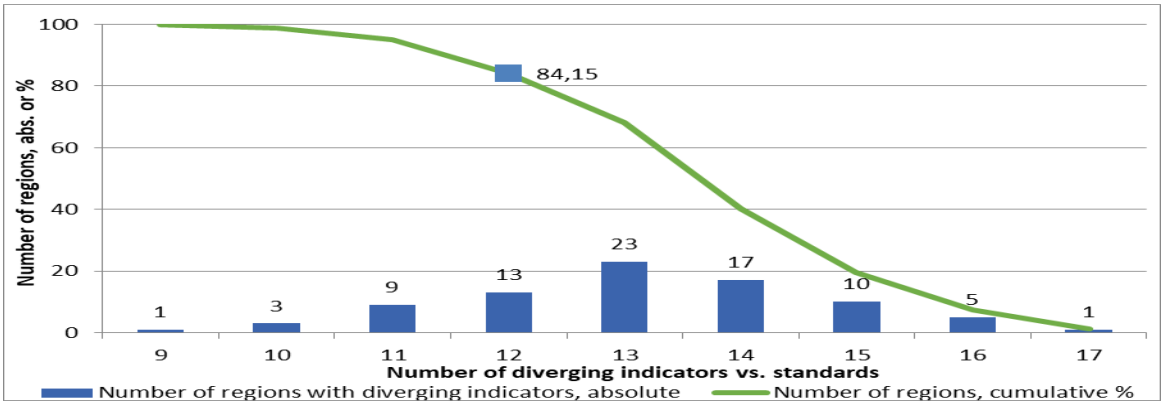
Figure 1 allows the following conclusions:

– as to economic indicators: 18 regions have four diverging indicators; 33 regions have three diverging indicators; 24 regions have two diverging indicators; seven regions have only one diverging indicator;

– as to social indicators: 13 regions have five diverging indicators; 33 regions have four and three diverging indicators respectively; three regions have two diverging indicators;

– as to innovation development indicators: most regions have five diverging indicators; 11 regions have four diverging indicators; three regions have two diverging indicators; one region has three diverging indicators;

– as to environmental indicators: most regions have two diverging indicators; 20 regions have three diverging indicators; 12 regions have one diverging indicator; five regions have all their indicators in line with standard values.



Source: developed by the authors

Figure 2. Combined data on the number of regions and number of crisis indicators diverging from threshold levels, 2018

Figure 2 indicates that most regions have 13 diverging indicators, a maximum level of diverging indicators (17) is registered for one region (the Kemerovo region). The most favourable situation by the analysed groups of indicators is in St Petersburg (nine indicators). The capital has 12 diverging indicators. The point plotted on the chart indicates that 84.15% regions have at least 12 diverging indicators. Accordingly, 100% regions have at least nine diverging indicators.

DISCUSSION

Correlation analysis for indicators in general and in each of the groups individually showed extremely weak or no correlation between them. Therefore, the hypothesis of a direct relation between regional stability and digitalization levels could not be confirmed based on data for 2018.

Thus, the following conclusions can be drawn:

– the higher the region's level of digitalization, the stronger its engagement in the global economy. What is specific for current crises is that they originate in individual markets and crisis transmission occurs through multiple channels of instant communications. For this reason, monitoring a well-developed region might indicate crisis influences that are not inherent to it but transferred from other economic subjects connected via the common information network. Following this logic, one may assume that, in terms of crisis influences, regions with low digitalization profile can be seen as shock absorbers of sorts;

– further dynamic research is needed in a horizon of several years;

– the link between digitalization and crisis influences can be represented by a non-linear multifactor model. In this situation, it becomes relevant to facilitate a transition toward more complex multi-modal models (smooth transition models). This, in turn, calls for accumulating and analyzing major missives of data using machine algorithms.

Theoretical conclusions and recommendations based on the findings of critical and correlation analysis, economic and mathematical methods and abstract methods are potentially useful for various practical applications and for building the foundation of a more profound understanding of economic crisis theory in the context of the wide-ranging digital shifts in the Russian economy.

CONCLUSION

The paper defines the main propositions of a modern crisis theory, describes the impact of digitalization on crisis development and the specifics of crisis theory in the context of digitalization and tests the hypothesis of a direct relation between stability and digitalization levels of Russian regions. We conclude that the leading role of the state is extremely important in determining strategic dimensions of the economy, in building a single infrastructure, facilitating balanced regional development and maintaining loyalty to change in the society. The Russian economy, characterized, among other aspects, by sectoral and territorial imbalances and dependence on imports and global oil prices, has accumulated significant practical experience and theoretical and methodological knowledge in cybernetics, effective government regulation, strategic planning and governance. Balanced government coordination of actions among all subjects and elements of the economy powered by digital technologies will contribute to improved

living standards and the development of uniform information systems for administering the economy as a further step in its evolution.

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