

## EVALUATION OF SIGNAL INDICATORS OF THE DIGITAL TRANSFORMATION OF THE RUSSIAN ECONOMY

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### **Abstract:**

*A new development stage of the Digital Economy is connected with traditional management adaptation of national scientific and technological (S&T) policies, which is why it is necessary to use modern assessing tools of the digital economy transformation. Innovative-technological economic changes character is wide-ranged at the same time the transformation becomes the decisive trend of its modern development, that is associated with the fundamental future system - digital economy. The authors suggest to use the leading and signal indicator system of the digital economy level assessment. The purpose of the study is the condition and dynamic monitoring of the Russian digital economy development, based on signal indicators. Main goal is to analyse leading and signal system of the digital economy transformation development. The methodological basis of the study is the systematization of publications by national and foreign economists on the problem of the development of the digital economy. We use the Russian and international normative base; statistical and economic-mathematical methods to analyse the indicators of the development of the digital economy. Authors also used systematic approach to assessing the level of development of the digital economy in Russia based on leading and signal indicators. The results of the study: digital transformation and assessment of digital economy indicators. Calculations showed that the digital economy development indicator gives the best signal for the digitization of Russian economy and can be a leading indicator, reflecting the internal research costs and the ICT sector organizations development. Gross value added of the ICT sector, domestic costs of research and ICT sector organizations development, Russian authors publications in scientific journals, indexed on international databases are "signal" indicators that determine the intensity of ongoing economy transformations.*

**Keywords:** transformation of economy; signal indicators; digitalization

**JEL classification:** O11, M15, M21

### **INTRODUCTION**

Digital technologies and platforms not only help to improve the internal business processes organization of enterprises, they also reduce transaction costs and provide direct access opportunity and communicate with business partners and government agencies more closely. Thus, a digital (electronic) economy based on network services is being formed.

The digital economy is a global system, which is why it is necessary to address comprehensively. All government informatization and digitalization projects, based on an integrated coding system and identification of the economic and management information.

Currently, the world is actively working on the tools formation for forecasting the economy development based on the measurement of leading and signal indicators. Each country forms its own macroeconomic basis indicators of a proactive nature, which is fundamental for building short-term forecasting models.

## LITERATURE REVIEW

The leading indicator is an integral indicator that reflects the market situation, indicating possible changes in the state of the socio-economic system in the near future. These indicators accumulate the most important information about short-term indicating processes of economic agents' future behaviour, and the main trends in the economy during the lead period.

The Macroeconomic Policy Department of the Eurasian Economic Commission in 2010 proposed to calculate leading indicators, and nowadays they are widely used by the Organization for Economic Co-operation and Development (OECD) where the Composite Leading Indicator (CLI) and The Conference Board methodology of indicator are built [1, 2].

According to the experience of developed countries in the world in building leading and signal indicators allows us to create a system of indicators, which are aimed at the likely nature of changes determining in future economic development Lupton, D. (Lupton, 2013.) [3], Garcia, D., Tessone, C.J., Mavrodiev, P., Perony, N. (Garcia, Tessone, Mavrodiev, Perony, 2014) [4] Antonelli, C. (Antonelli, 2003) [5], Grimes, S. (Grimes, 2003) [6]. World practice suggests that leading indicators are used in selection of the economic policy tools of economy preventive regulation. The main advantage of using leading indicators of prediction of socio-economic systems and processes development is prediction ability of turning points of the studied indicator dynamics, regardless of the retrospective dynamics.

However, it is impossible to use traditional forecasting method in prediction of the digital economy transformation.

Russian and foreign economists, influential companies, government agencies are trying to form sets of indicators characterizing the degree and intensity of the digital economy transformation, Carlsson, B. (Carlsson, 2004.) [7], Sui, D.Z., Rejeski, D.W. (Sui, Rejeski, 2002) [8], Perrons, D. (Perrons, 2004) [9].

## RESULTS AND DISCUSSION

The study built a composite leading index (TSLI), which will reflect the level of digital economy development in the future. In our view, we can use several indicators that can act as leading indicators for assessing the development of economy digitalization, they are presented in Table 1. The following formula was used to calculate the leading indicator:

$$TSLI = \sum_{i=1}^n DLI_i \cdot R_i,$$

where TSLI is the value of the composite index of leading indicators;  $DLI_i$  is average of the standard deviation of the leading index ( $DLI_i$  is the diffuse leading index equal to the standard deviation within the original series);  $R_i$  - rank.

According to the table. 5, the leading indicator will be equal to::

$$TSLI = (0,078 \cdot 331,368) + (0,097 \cdot 9874,820) + (0,117 \cdot 170,314) + (0,087 \cdot 8,990) + (0,097 \cdot 10,548) + (0,107 \cdot 11,003) + (0,058 \cdot 2,899) + (0,087 \cdot 10,147) + (0,097 \cdot 6,790) + (0,058 \cdot 0,000) + (0,068 \cdot 0,300) + (0,049 \cdot 0,622) = 1009,052.$$

**Table no. 1. Calculation of the leading index for each of the indicators of digitalization of the economy**

Index	Diffuse Leading Index $DLI_i$	Total Rank $R_i$
Gross value added of the ICT sector, bln. Rub.	331.386	0.078
Gross domestic expenditure on research and development in the ICT sector organizations, one million rubles.	9874.820	0.097
Publications Russian authors in scientific journals in the direction of "Computer Science", indexed in the database Web of Science data units.	170.314	0.117
The share of households with Internet access, the total number of households%	8.990	0.087
The share of the population has ever used the Internet, in the general population aged 15-72 years,%	10.548	0.097
The share of the population has ever used the Internet almost every day, in the general	11.003	0.107

population aged 15-72 years,%		
Telephone density of fixed communications (including payphones) per 100 population, units.	2.899	0.058
Penetration of mobile radiotelephone (cellular) per 100 population, units.	10.147	0.087
The proportion of households with a personal computer, the total number of households%	6.790	0.097
Adult literacy rate,%	0.000	0.058
The share of students of educational institutions in the total population,%	0.300	0.068
The share of students enrolled in educational programs of higher education - undergraduate, Specialty, Master's, in the total population,%	0.622	0.049

Source: observed by authors

Table 1 shows that the indicator of the digital economy development gives the best signal for the digitization of the Russian economy and can be a leading indicator, reflecting the domestic costs of research and development in organizations of the IT sector.

In addition to leading indicators, "signal" indicators can be used for prediction the digital economy transformation. Signal approach, proposed by *Kaminsky G., Lizondo S., Reinhart C. (Kaminsky et al., 1998) [9]* was used for anticipation of the global financial crisis in 2008. They offered signal indicators that foreshadowed the economic crisis in 1998, 2001 and 2008.

The authors propose the following approach to signal fixation: select a specific series that explains the binary variable of the crisis, that is, this series is a signal indicator. Further explore this series within the threshold of the indicator. If the value of the series has exceeded (or has become lower) the threshold, then this indicates the onset of a crisis within the signaling gap Table 2.

**Table no. 2. Calculation intervals for signal indicators for 2010-2017**

Indicator	xmax	xmin	h - step	Interval		
				low	medium	high
Gross value added of the ICT sector, bln. rub.	2262	1354	303	1354-1657	1657-1960	1960-2262
Gross domestic expenditure on research and development in the IT sector organizations, one million rubles.	40584	6861	11241	6861-18102	18102-29343	29343-40584
Publications Russian authors in scientific journals in the direction of "Computer Science", indexed in the database Web of Science data units.	818	365	151	365-516	516-667	667-818
The share of households with Internet access, the total number of households%	100	48	17	48-65	65-82	82-100
The share of the population has ever used the Internet, in the general population aged 15-72 years,%	100	49	17	49-66	66-83	83-100
The share of the population has ever used the Internet almost every day, in the general population aged 15-72 years,%	100	26	25	26-51	51-77	77-100
Telephone density of fixed communications (including payphones) per 100 population, units.	58,8	23,3	12	23,3-35,3	35,3-47,3	47,3-58,8
Penetration of mobile radiotelephone (cellular) communication at 100, ed.	279	166,4	38	166,4-204,4	204,4-242,4	242,4-279,0
The proportion of households with a personal computer, the total number of households%	100	54,5	15	54,5-69,5	69,5-84,5	84,5-100
Adult literacy rate,%	100	99,7	0,3	99,7-99,8	99,8-99,9	99,9-100
The share of students of educational institutions in the total population,%	100	9,5	30	9,5-39,5	39,5-69,5	69,5-100
The share of students enrolled in educational programs of higher education - undergraduate, Specialty, Master's, in the total population,%	100	3	32	3-35	35-67	67-100

Source: observed by authors

The calculated intervals will be used to assign one of the three signaling indicators to each value over the period 2010–2016 for determining the level of Russian digital economy development of indicators [11].

For indicators of economy digitalization, we define the colour of the indicator, which signals the level of its development. Red colour means low level of development, yellow - medium, green - high. The results of the analysis are presented in Table 3.

Indicators numbered 7 and 12 show a negative development trend and low development dynamics in the digital economy, which indicates the existing problems in the field of information and communication technologies, as well as in the educational sphere. Indicators numbered 8 and 11 remain at a low level of digital economy development. Despite the annual increase in the numerical value, Indicators numbered 4, 5, 6, 9 has more positive development trend than the above Russian economy digitalization.

**Table no. 3. Signal indicators of the development level of the Russian digital economy**

№	Indicator	Year	2011	2012	2013	2014	2015	2016	2017
1	Gross value added of the IT sector, bln. Rub.		1354	1534	1780	1845	2149	2262	2258
2	Gross domestic expenditure on research and development in the IT sector organizations, one million rubles.		6861	9405	20609	16103	19696	33664	33977
3	Publications Russian authors in scientific journals in the direction of "Computer Science", indexed in the database Web of Science data units.		385	365	374	467	518	739	818
4	The share of households with Internet access, the total number of households%		48	57	60	69	70	72	75
5	The share of the population has ever used the Internet, in the general population aged 15-72 years,%		49	58	66	71	74	78	81
6	The share of the population has ever used the Internet almost every day, in the general population aged 15-72 years,%		26	33	41	48	52	55	58
7	Telephone density of fixed communications (including payphones) per 100 population, units.		31,4	30,9	30,1	28,9	26,8	24,8	23,3
8	Penetration of mobile radiotelephone (cellular) per 100 population, units.		166,4	179,0	182,7	193,3	190,8	193,8	197,8
9	The proportion of households with a personal computer, the total number of households%		54,5	60,1	66,5	71,4	71,0	72,5	74,3
10	Adult literacy rate,%		99,7	99,7	99,7	99,7	99,7	99,7	99,7
11	The share of students of educational institutions in the total population,%		9,5	9,6	9,6	9,7	9,8	10,1	10,4
12	The share of students enrolled in educational programs of higher education - undergraduate, Specialty, Master's, in the total population,%		4,9	4,5	4,2	3,9	3,6	3,3	3,0

Source: observed by authors

## CONCLUSION

So, already since 2012, many of them have reached the middle level of development, which indicates a gradual and large-scale computerization of the population and its growing involvement in the worldwide Internet.

State and technology are becoming increasingly connected in a single digital space format. Digitalization provides opportunities for creating new models of decision making. Also, digital transformation requires a major restructuring of the approach to interaction, decision-making, stimulation of innovation and the formation of a legislative framework. Thus, leading and signal indicators of the economic situation can be used to analyse and forecast macroeconomic dynamics and the level of digitalization of the economy.

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