NATIONAL RESEARCH UNIVERSITY

Yuri Simachev, Mikhail Kuzyk
Center for Industrial Policy Studies

DIGITAL TRANSFORMATION OF RUSSIAN COMPANIES: FEATURES AND LIMITATIONS

Analytics for Management and Economics Conference
HSE Campus in St. Petersburg
September 28, 2019

Digital Transformation: Optimistic Views

*"**The digital revolution continues apace**… Flows of information generated by digital technologies and **digitally enabled activities are growing at an unprecedented pace**."* OECD, 2019.

*"**We are at the beginning of the digital age where computing and data are ubiquitous**."* Wonki Min, Vice-Minister, Ministry of Science and Information Communication Technology, Korea, 2019.

*"**The world is being transformed by new technologies**, which are redefining customer expectations, enabling businesses to meet these new expectations, and changing the way people live and work. **Digital transformation, as this is commonly called, has immense potential to change consumer lives, create value for business and unlock broader societal benefits**."* WEF, 2018.

*"**The importance of digital technologies to the modern economy is undeniable**. All around the world, in every industry and every company, we are digitalizing the things we do… **The digital economy is now firmly established as a core driver of global growth.**"* Adrian Cooper, CEO of Oxford Economics Ltd., 2017.

*"…**We are at the beginning of a Fourth Industrial Revolution, a new era that builds and extends the impact of digitization in new and unanticipated ways**."* Nicholas Davis, Head of Society and Innovation, WEF, 2016.

***

"***The digital revolution gives much cause for optimism…*** *The harmonizing effect of being digital is already apparent as previously partitioned disciplines and enterprises are now collaborating, not competing."* Nicholas Negroponte, Director of MIT Media Lab, **1995**.

The Current Stage of Digital Transformation: Distinctive Features

PwC (2016): While Industry 3.0 focused on the automation of single machines and processes, Industry 4.0 focuses on **the end-to-end digitisation of all physical assets** and integration into digital ecosystems with value chain partners.

OECD (2014): The scope of digital technology is constantly expanding, many technologies (e.g. big data analysis, predictive analytics) **cross the boundaries of the sectors** in whose interests they were originally developed.

Huawei (2017): In 2016, the digital economy worldwide was worth 15.5 percent of global GDP. **By 2025**, the digital economy is expected to grow further, to **24.3 percent of global GDP**.

The current stage of digital transformation is characterized by **significant state intervention**. In many countries, national governments implement special programs to promote the development of digital technologies (advanced manufacturing, the Internet of things, 5G Internet, etc.).

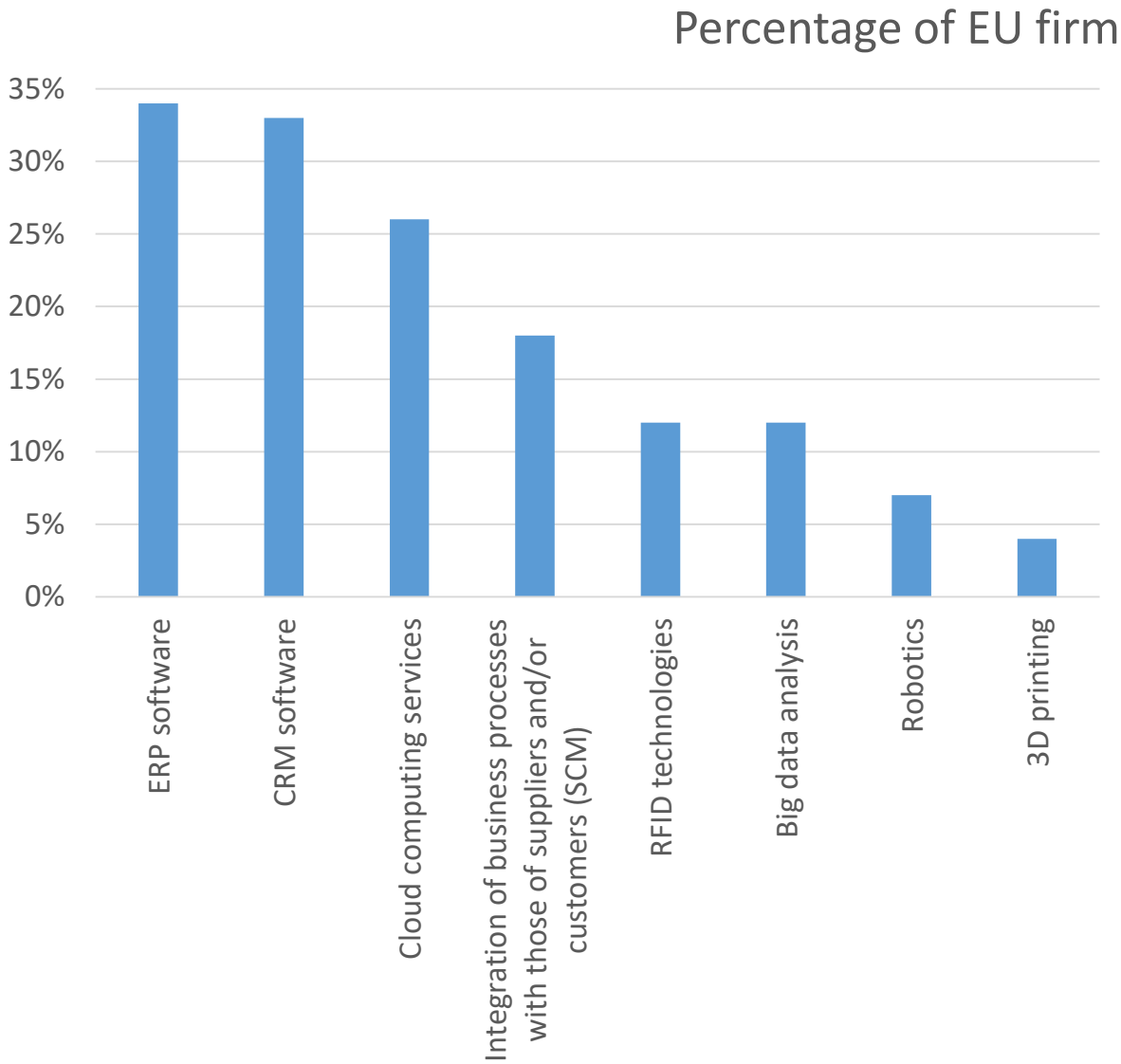
Digitalization provides companies with significant potential benefits, but at the same time increases **uncertainty and risks**. The introduction of digital technology is often costly. However, in conditions of rapid technological development, it is not always clear which technologies a particular business should “rely on”.

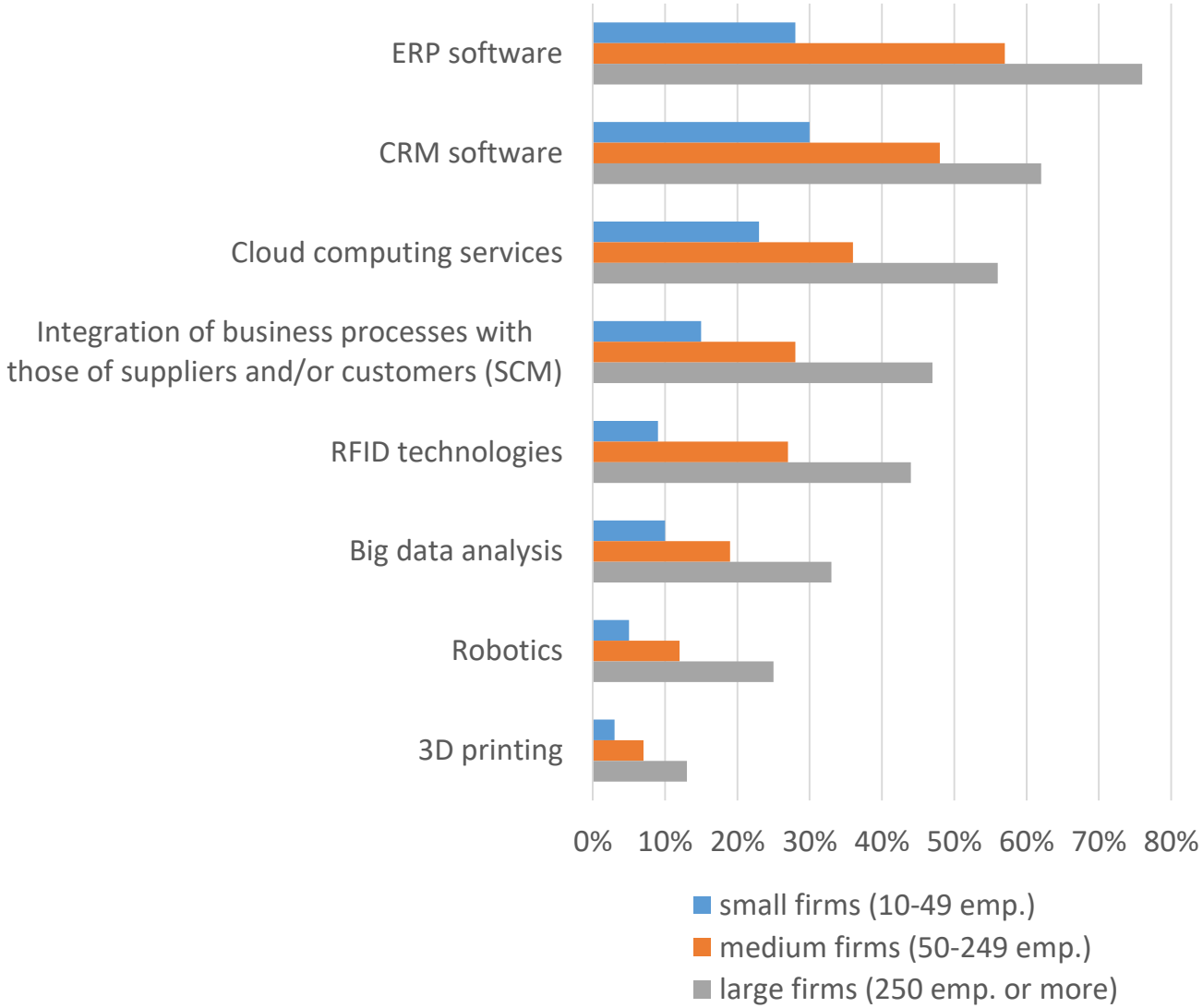
The specific problems of digitalization in Russia are the low innovative susceptibility of firms, weak science-business cooperation, and underdeveloped engineering services market.

Types of Digital Technology: Different Views

Digital technologies	Schwab, 2016	MIT, 2016	PwC, 2016	OECD, 2017	Huawei, Oxford Economics, 2017	Digital Economy, 2017	WEF, 2018	OECD, 2019	HSE, 2019
Internet of Things (IoT)	V	V	V	V	V	V	V	V	V
Big data analysis		V	V	V	V	V	V	V	V
Artificial Intelligence (AI)		V		V	V	V	V	V	V
Cloud computing services		V	V	V	V		V	V	
Advanced manufacturing, incl. 3D-printing		V	V	V		V	V		V
Virtual and augmented reality		V	V			V			V
Automation, robotics and sensorics						V	V		V
Digital platforms	V						V	V	
5G networks					V	V		V	
High Performance Computing (HPC), Quantum Computing (QC)						V		V	V
Blockchain	V					V			V
Portable internet-devices		V	V						
Customer Relationship Management (CRM) systems			V	V					
Unmanned vehicles				V			V		
Use of social media		V		V					
Cybersecurity software		V	V						
Biometric authentication			V						
Radio frequency identification (RFID)	V			V					
Enterprise resource planning (ERP) systems				V					
Supply chain management (SCM) systems				V					
System integration				V					
Smart sensors			V						
Geolocation			V						
Advanced human-machine interface			V						

The Use of Digital Technologies in the EU

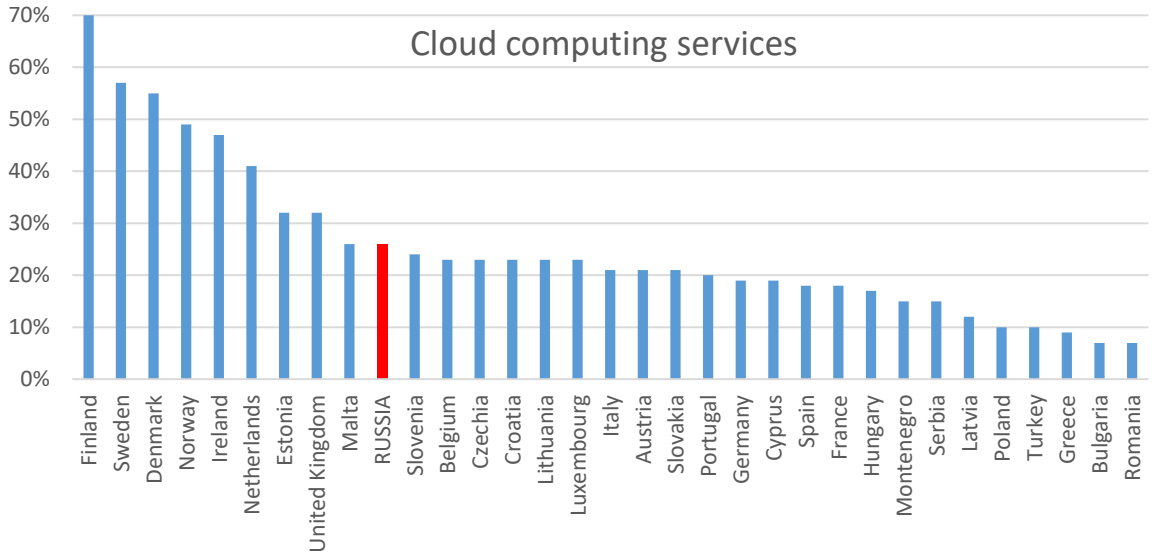


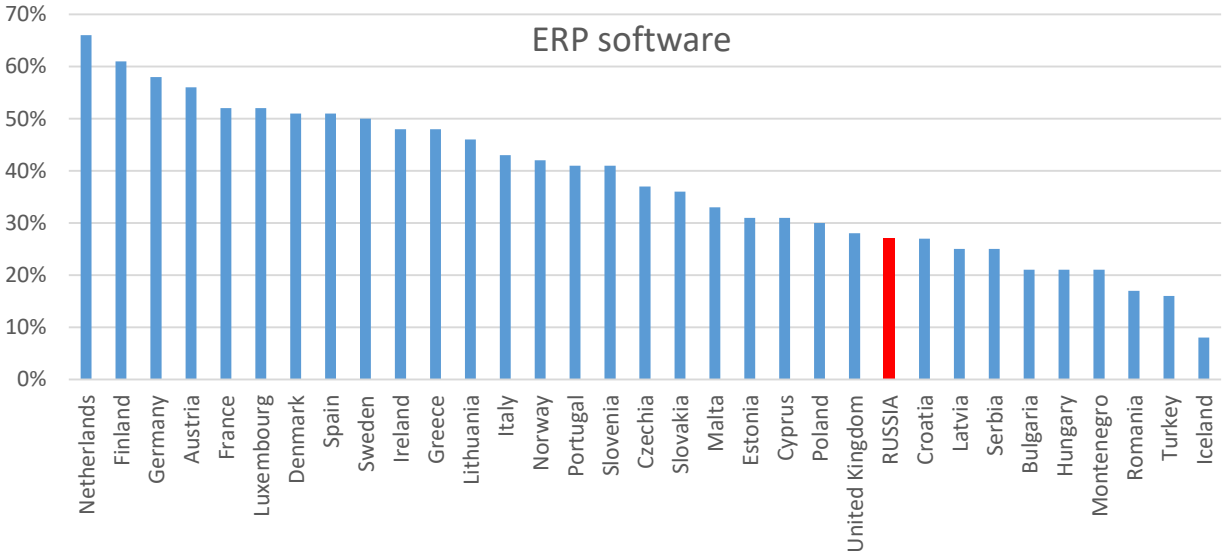


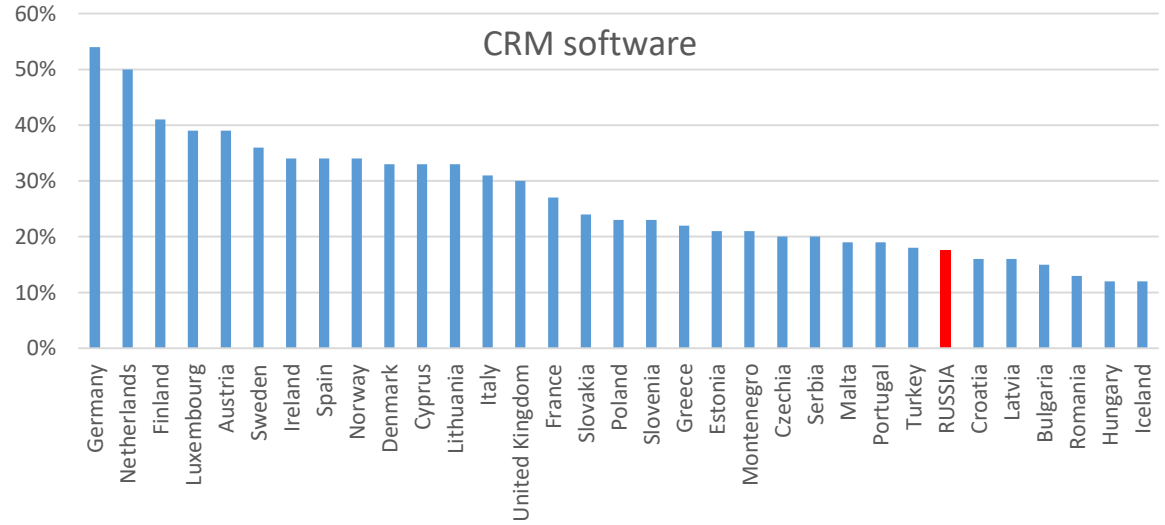
Source: Eurostat, 2018 (or the nearest).

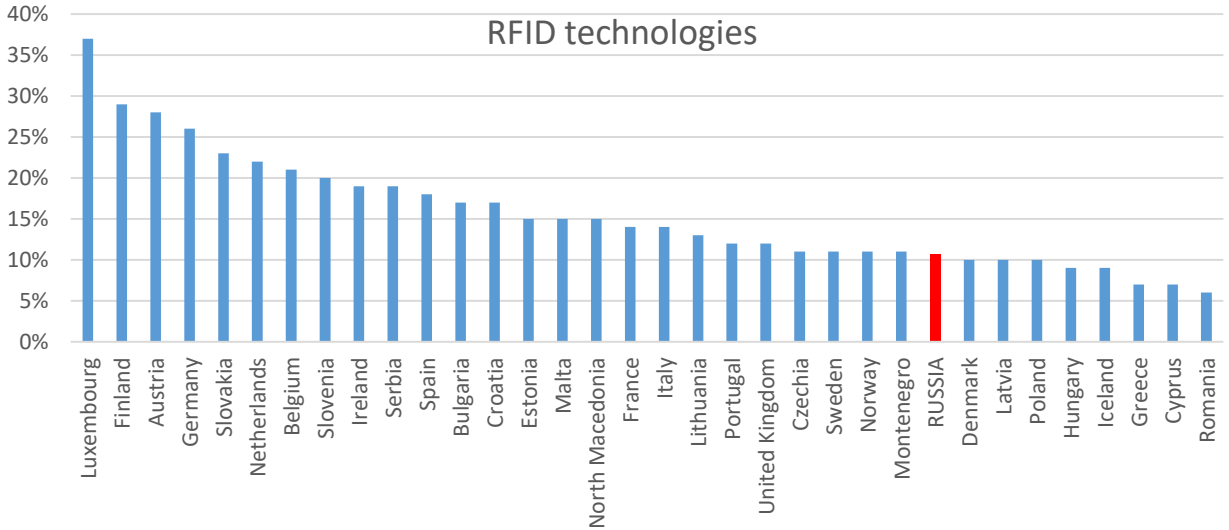
The Use of Digital Technologies: Cross-Country Comparisons

Percentage of manufacturing firms using digital technology









Source: Eurostat, Rosstat, 2017 (or the nearest).

Key Research Questions and Hypothesis

- How much are Russian firms involved in the digital transformation? What types of digital technologies do they use most often?
- Which firms most commonly use digital technologies?
- Which innovation channels are most conducive to the spread of digital technologies?
- In which business activities do firms most often use digital technologies?
- What are the main barriers to digital adoption by firms?

H1. Digital technologies are more often used by large companies than SMEs. At the same time, relatively young firms play a significant role in the application of digital technologies.

H2. The use of digital technology is most typical of “global innovator” companies producing completely new products.

H3. A significant obstacle to the introduction of digital technology is the lack of standards.

H4. Public support fosters firms’ digitalization. The greater effect is provided by “less rigid” support instruments: tax incentives and state development institutions.

Empirical Data

The data used in this work were collected as a part of the research project "Factors of Competitiveness and Growth of Russian Manufacturing Enterprises" implemented in 2018 within a framework of the Basic Research Program at the National Research University Higher School of Economics.

Research sample includes 1,716 manufacturing enterprises.

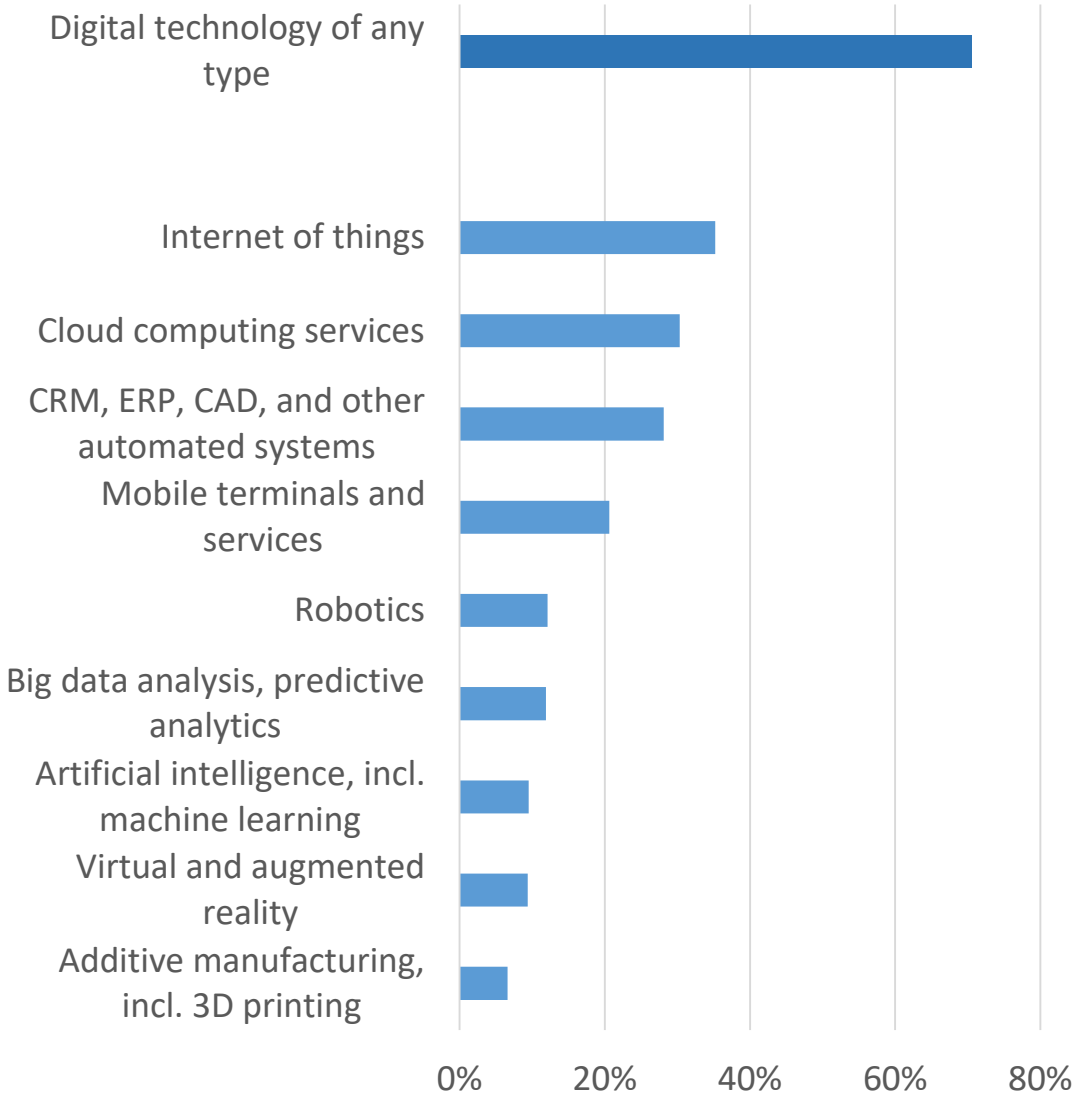
Industry	Percentage
Manufacture of food products, including beverages, and tobacco products	17.7%
Manufacture of textiles, textile products, leather, leather products, and footwear	6.9%
Manufacture of wood and wood products	5.3%
Manufacture of pulp, paper, and paper products; publishing and printing	2.3%
Manufacture of chemicals and chemical products	6.1%
Manufacture of rubber and plastics products	6.8%
Manufacture of other non-metallic mineral products	10.0%
Manufacture of basic metals	2.5%
Manufacture of fabricated metal products	10.0%
Manufacture of electronic and optical products	3.8%
Manufacture of electrical equipment	4.6%
Manufacture of machinery and equipment n.e.c.	7.7%
Manufacture of motor vehicles, trailers and semi-trailers	2.2%
Manufacture of other transport equipment	1.9%
Manufacture of furniture	4.5%
Repair and installation of machinery and equipment	7.1%

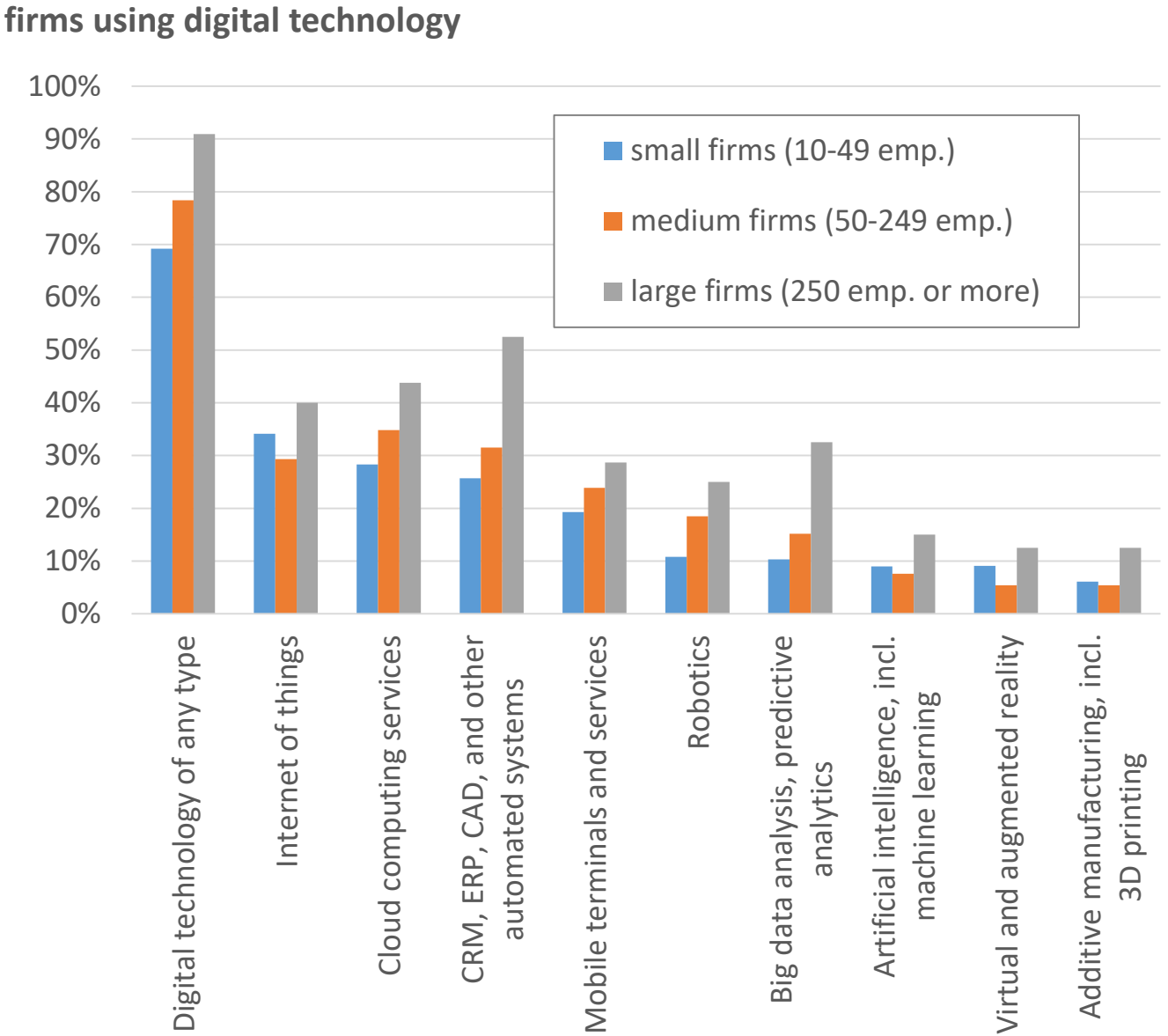
Location	Percentage
Moscow	14.9%
Central FD (except for Moscow)	23.8%
Northwestern FD	12.8%
Southern FD	6.9%
North Caucasian FD	2.4%
Volga FD	18.3%
Ural FD	8.3%
Siberian FD	8.6%
Far Eastern FD	4.0%

Number of employees	Percentage
up to 15	14.0%
16-25	14.3%
26-40	8.7%
41-100	11.9%
101-250	11.4%
251-400	18.8%
401-1,000	14.3%
over 1,000	6.6%

The sample is biased, so weighted data is used.

The Use of Digital Technologies by Russian Manufacturing Firms





The Use of Digital Technologies by Russian Manufacturing Firms: Regression Analysis

		Digital technology of any type	Internet of things	Cloud computing services	CRM, EPR, CAD, etc.	Mobile terminals and services	Robotics	Big data analysis, predictive analytics	Artificial intelligence, incl. machine learning	Virtual and augmented reality	Additive manufacturing, incl. 3D printing
Age	duration of operation (Ln)	- ***		- **	- **	- ***	- **	- ***	- ***	- ***	
Size	number of employees (Ln)	+***		+***	+***	+***	+***	+***	+***	+***	
Industry	manufacture of food, beverages, and tobacco products				- *		- ***	- *	- ***	- **	- **
	manufacture of textiles, leather, etc.		+*	- ***	- *			- **			
	manufacture of wood and wood products	- *			- ***		- ***		- **		
	manufacture of pulp, paper, etc.				- *	+***					
	manufacture of chemicals and chemical products			+**							
	manufacture of rubber and plastics products										
	manufacture of other non-metallic mineral products				- **	- *			- **		- *
	manufacture of basic metals		- **	-*		- *					
	manufacture of electronic and optical products	+**		+**		+ ***			+*	+***	+***
	manufacture of electrical equipment						+**				
	manufacture of machinery and equipment n.e.c.										
	manufacture of motor vehicles, trailers and semi-trailers					+*					
	manufacture of other transport equipment	100%		+ *		+*			+***	+*	
	manufacture of furniture									+*	+***
	repair and installation of machinery and equipment			+**	- ***		- **		- ***		
Ownership	state owners						+***				
	foreign owners		+***	+*	- *						- *
Export		+***			+***			- **	- **	- *	+*

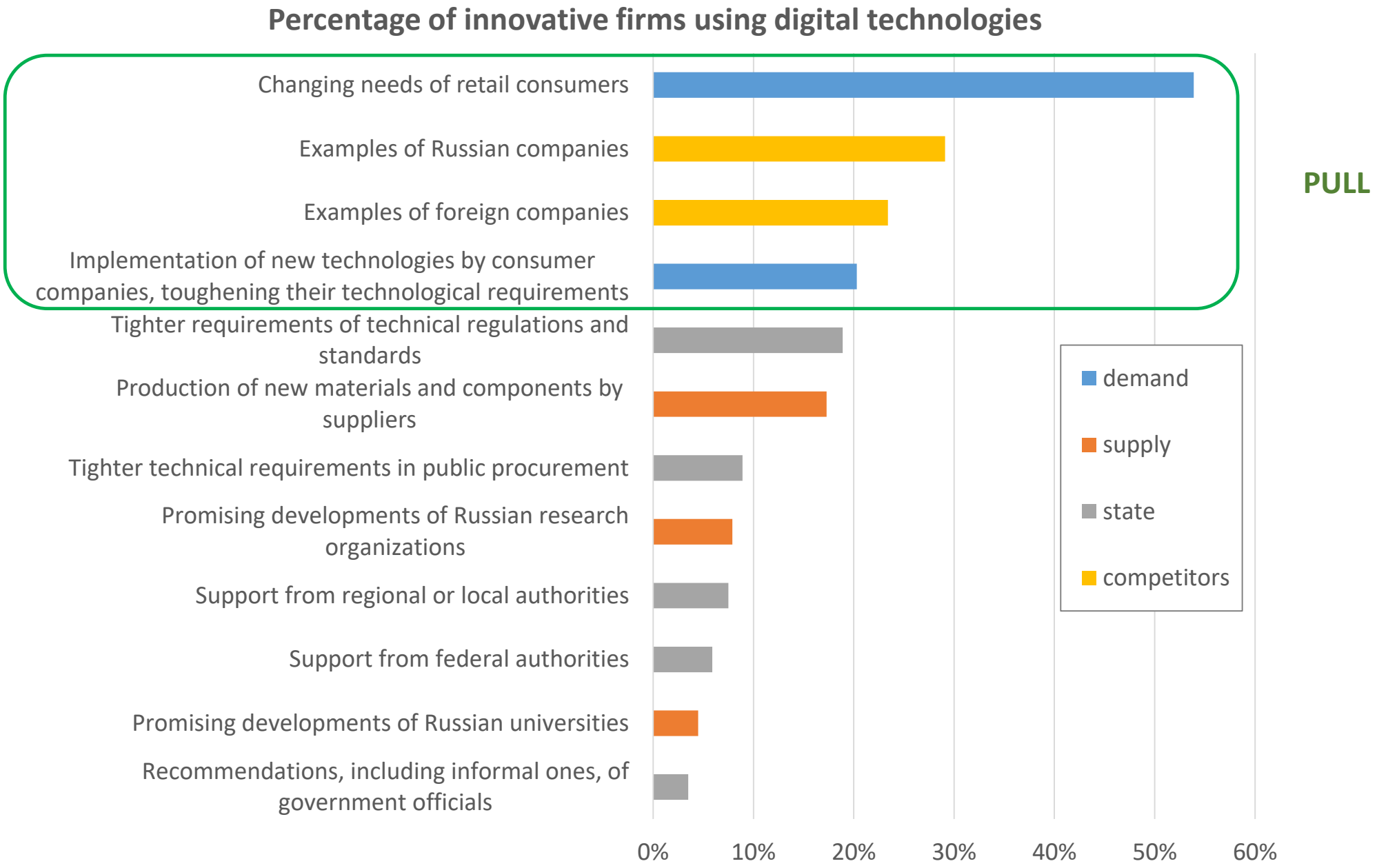
Logistic regression models estimation. Hereinafter, only significant relationships are given:

*** - significant at 0,01 level;

** - significant at 0,05 level;

* - significant at 0,1 level.

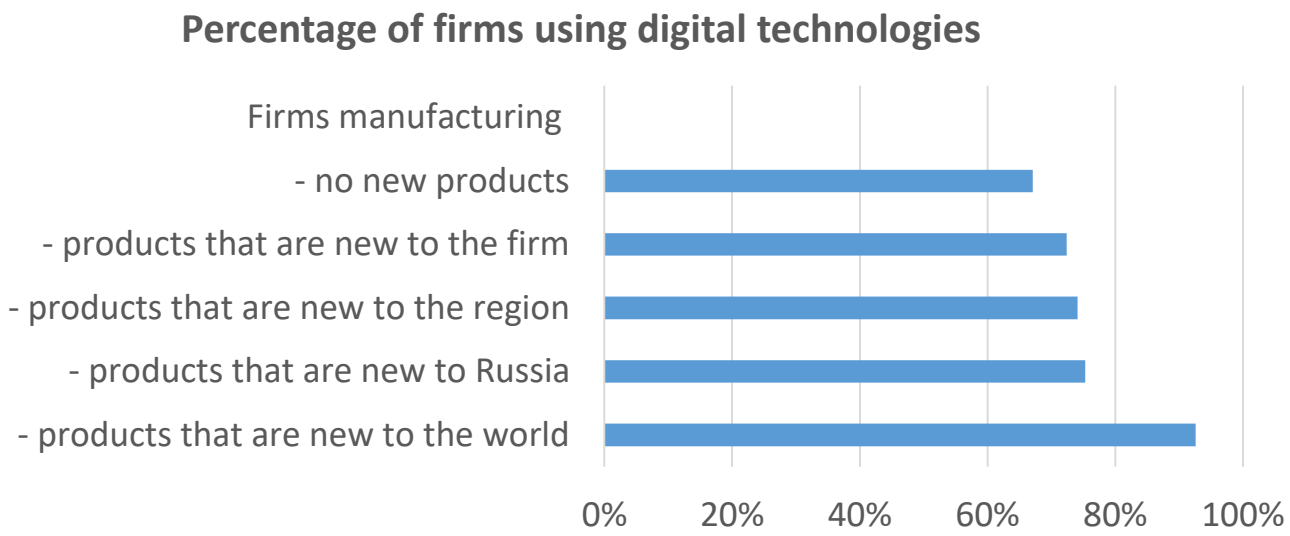
Incentives For Firms' Innovation



Incentives for Innovation and the Use of Digital Technologies by Firms: Regression Analysis

	Internet of things	Cloud computing services	CRM, EPR, CAD, etc.	Mobile terminals and services	Robotics	Big data analysis, predictive analytics	Artificial intelligence, incl. machine learning	Virtual and augmented reality	Additive manufacturing, incl. 3D printing
Changing needs of retail consumers	+**			+***		- **			+***
Examples of Russian companies	+**				+**		+**		+***
Examples of foreign companies		+***		+***		+**		+**	+**
Implementation of new technologies by consumer companies, toughening their technological requirements			+***		- *		- *		
Tighter requirements of technical regulations and standards			+***				+**		
Production of new materials and components by suppliers	+*			+***			+***		
Tighter technical requirements in public procurement								+*	
Promising developments of Russian research organizations		+*		+***		+**		+**	
Support from regional or local authorities									+***
Support from federal authorities	+***			+***					
Promising developments of Russian universities	+*			- **					
Recommendations, including informal ones, of government officials			+**	+***			+***		
Age Size Industry	control								

The Use of Digital Technologies and Novelty of Firms' Products



Relationships between the novelty of products and the use of digital technologies - Spearman's rank correlation coefficients

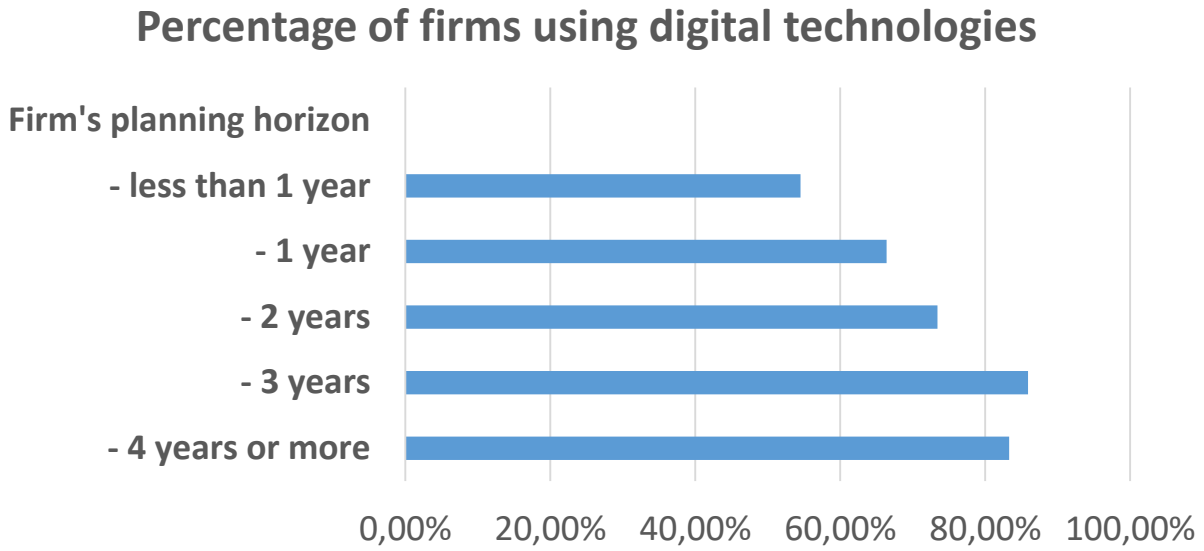
	No new products	Products that are new to the firm	Products that are new to the region	Products that are new to Russia	Products that are new to the world
Internet of things	-0.009	-0.019	0.020	-0.010	**0.071****
Cloud computing services	-0.047	0.009	0.004	0.006	**0,133****
CRM, EPR, CAD, and other automated systems	**-0.067****	0.016	0.045	0.019	**0.063***
Mobile terminals and services	-0.013	**-0.055***	0.025	0.029	**0.065****
Robotics	0.014	-0.030	-0.008	-0.024	**0.115****
Additive manufacturing, incl. 3D printing	**-0.125****	0.003	**0.075****	**0.053***	**0.162****
Big data analysis, predictive analytics	**0.055***	**-0.081****	**-0.068****	0.048	0.022
Artificial intelligence, incl. machine learning	**0.106****	**-0.089****	**-0.063***	-0.003	-0.021
Virtual and augmented reality	**0.098****	**-0.110****	-0.041	0.000	0.014

H2

** - significant at 0,01 level

* - significant at 0,05 level

The Use of Digital Technologies and Firms' Planning Horizon



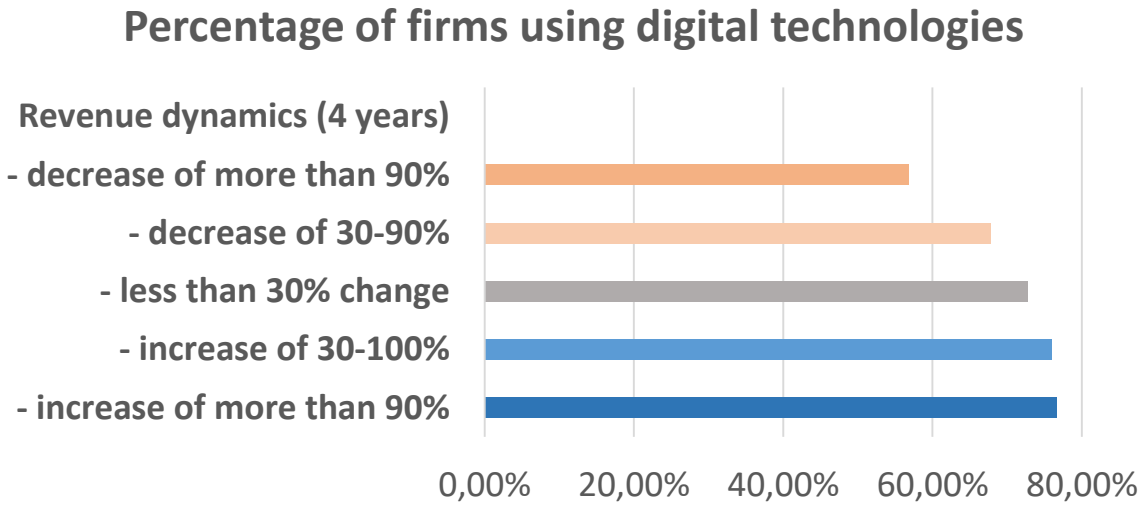
Relationships between the planning horizon and the use of digital technologies – partial correlation coefficients (age, size, industry, and ownership variables are controlled)

	Planning horizon
Internet of things	0.090**
Cloud computing services	0.140**
CRM, EPR, CAD, and other automated systems	0.171**
Mobile terminals and services	0.150**
Robotics	0.035
Big data analysis, predictive analytics	**0.212****
Virtual and augmented reality	**0.227****
Artificial intelligence, incl. machine learning	0.156**
Additive manufacturing, incl. 3D printing	0.067**

** - significant at 0,01 level

Future innovations?

The Use of Digital Technologies and Firms' Growth



Relationships between firms' growth and the use of digital technologies - Spearman's rank correlation coefficients

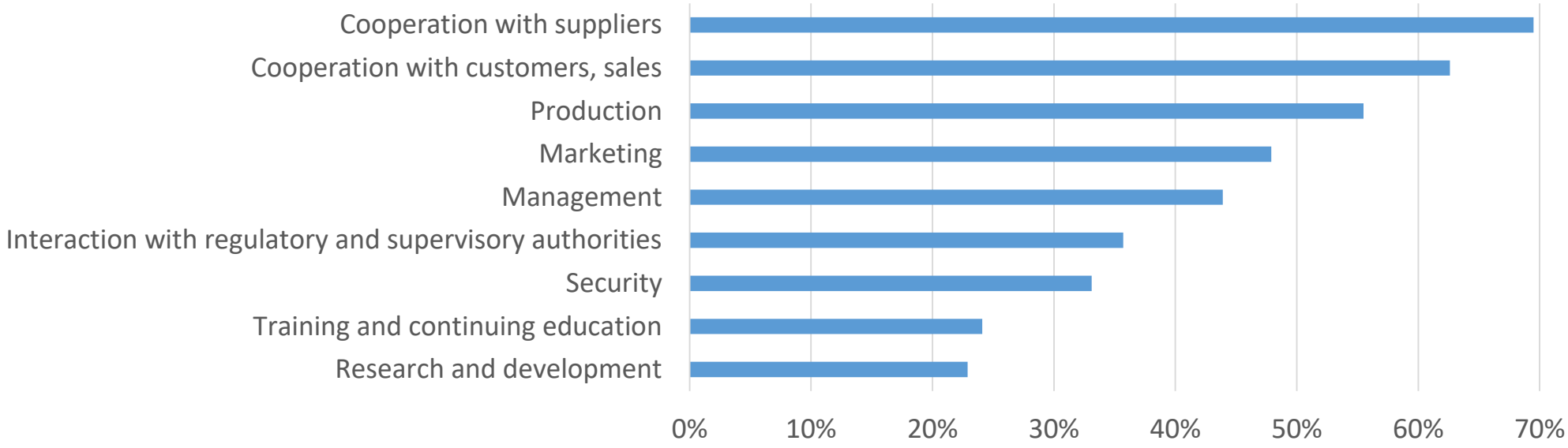
	Revenue dynamics
Internet of things	**0.099****
Cloud computing services	0.018
CRM, EPR, CAD, and other automated systems	0.022
Mobile terminals and services	0.013
Robotics	0.007
Additive manufacturing, incl. 3D printing	-0.060
Big data analysis, predictive analytics	-0.057
Artificial intelligence, incl. machine learning	0.029
Virtual and augmented reality	0.025

** - significant at 0,01 level

New sector?

Areas of Application of Digital Technologies by Russian Manufacturing Firms

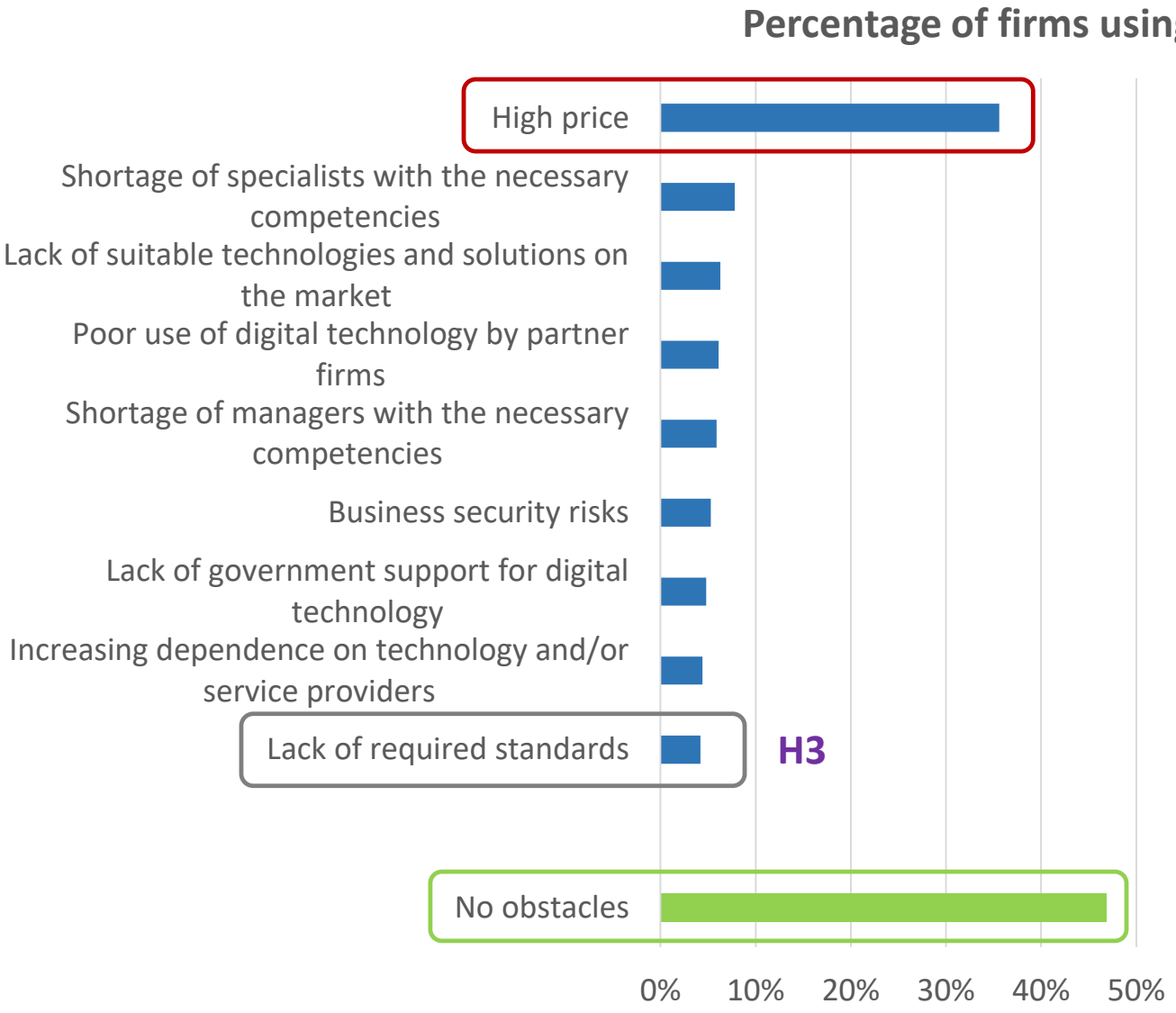
Percentage of firms using digital technologies

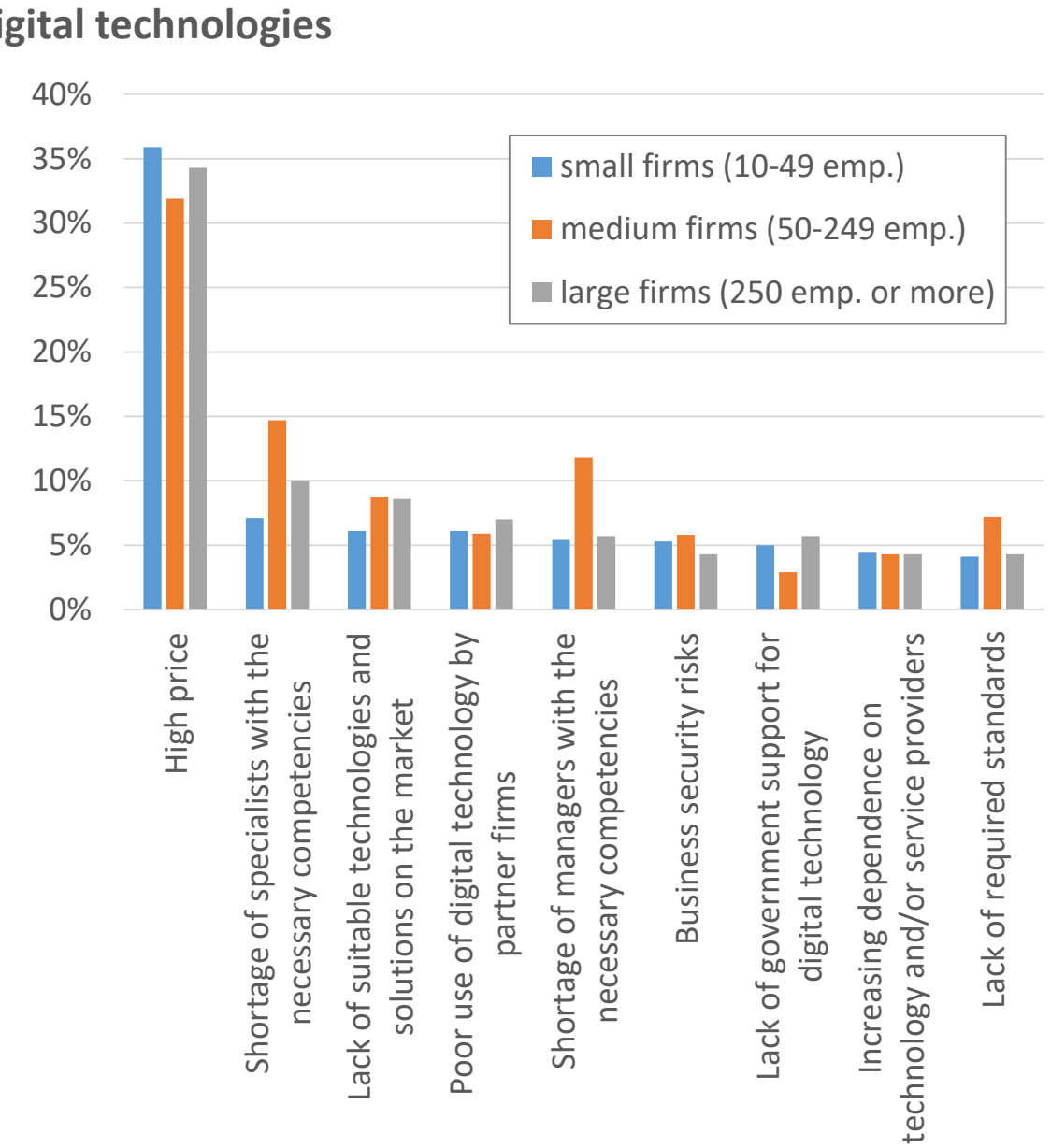


Logistic regression model estimation

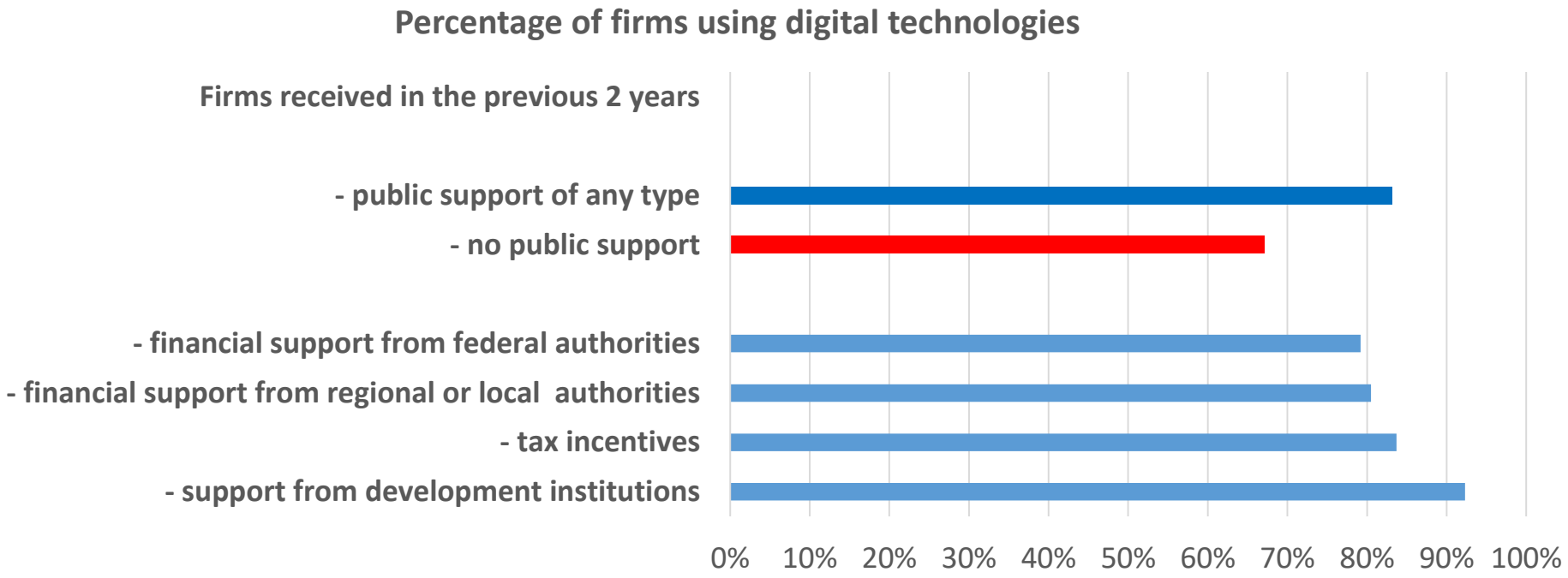
		Cooperation with suppliers	Cooperation with customers, sales	Production	Marketing	Management	Interaction with regulatory and supervisory authorities	Security	Training and continuing education	Research and development
Age	duration of operation (Ln)						+***			
Size	number of employees (Ln)			+***		+**		+**		+*
Ownership	state owners	- **				- **				
	foreign owners				+**					+**
Export		- ***	- ***				+***			
Industry		control								

Obstacles to the Use of Digital Technologies by Russian Firms





The Use of Digital Technologies and Public Support of Firms



Logistic regression model estimation

	Use of digital technology
Financial support from federal authorities	
Financial support from regional or local authorities	
Tax incentives	+**
Support from development institutions	+*
Age, size, industry, ownership	control

H4

Key Findings

- At present, digital technologies are quite widely used by Russian manufacturing companies. In terms of firms' digitalization, Russia is close to such European countries as Croatia, the Czech Republic and Estonia.
- In Russia, as well as abroad, digital technologies are more often used by large companies than by SMEs. One of the main reasons is probably the high cost of digital technologies, which is the main obstacle to their implementation.
- The main incentives for the innovative activities of Russian firms are changes in the needs and requirements of their consumers, as well as examples from competitors. At the same time, for the application of digital technologies, promising developments of scientific organizations are of considerable importance along with competitors' examples.
- The use of digital technology is more characteristic of newly created firms. At the same time, such technologies are more often used by firms with a longer planning horizon.
- The main areas of use of digital technologies by firms are relationships with their counterparties: suppliers and consumers. At the same time, large companies are more likely than others to use digital technology in their in-house processes.
- Digitalization of firms is positively associated with their state support: tax benefits, as well as support from state development institutions. However, the question of whether more frequent use of digital technology is the result of public support needs further study.

Policy Implications

Basic models of the innovation policy

Consolidating model	Search-oriented model
Consolidation of efforts on implementation in established areas of technological development	Identification of new promising areas of scientific-technological development, new growth drivers
Key driver – state priorities and programs	Key driver – demand from business and society
Interaction with the state occurs in accordance with the ‘classic’ scheme – top-down	Interaction with the state are of 'horizontal coordination' nature
Orientation towards the key leaders – economic or scientific and technological	Orientation towards groups of leaders, including those under formation
Participants are united around leaders	Participants are united by common vision of development opportunities and prospects
Direct results are important (number of created companies, production and export volumes, employment)	Indirect effects are important (demonstration, institutional effect, agreed vision), change in the attitude towards innovations
Combination of the initiative ‘from above’ (from the state) and ‘from below’ (mainly from large companies and organizations)	Initiative comes ‘from below’, from medium and small businesses, business associations, etc.
Priority of direct support tools	Considerable attention is paid to indirect tools and coordination mechanisms

Russian innovation policy traditionally gravitates to the consolidating model.

However, in order to support the digital transformation of business the search-oriented model is needed.