HIGHER SCHOOL OF ECONOMICS
NATIONAL RESEARCH UNIVERSITY

~~Hidden Champions~~: What are the most digitalized industries in Russia and Why?

[very preliminary results]

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Introduction

- Digital transformation is not just limited to tech start-ups and companies operating in the high-tech sector (Weill and Woerner, 2018)
- Digitalization represents a paradigm shift that pervasively affects the most traditional of businesses and even impacts society as a whole (Gimpel and Röglinger, 2015; Sambamurthy et al., 2003)
- Digitalization and its implied changes do not only affect the way firms operate, but they also have a profound impact on value chains (Brynjolfsson and McAfee, 2014; World Economic Forum, 2016).

Introduction (2)

- There is a large gap in implementation of digital technologies among industries: most digitalized are services (finance, media), less digitalized are manufacturing (McKinsey, 2019)

- But what is inside the black box of digitalization of manufacturing industries?

- Even if particular manufacturing industries use some, but not all, digital technologies, the intensity of implementation of digital techs among sectors should be (statistically) different

    - If True, transmission channels are efficient, think about policy recommendations
    - If False, transmission channels are inefficient, differences are explained by characteristics of firms and incentives are not distributed properly, explore transition channels in details

Research question

- what are the differences in the implementation of digital technologies among Russian manufacturing industries?

and if the differences are just minor

- what are the transmission channels affecting the implementation of digital technologies among Russian manufacturing industries?

Data

- Survey of Russian manufacturing firms RUFIGE (HSE, 2018)
- Data is representative across manufacturing industries, but not regions
- 2 groups of digital technologies:
  (1) Automation: AI + robotics
  (2) Digitalization: cloud computing, big data, mobile server tech, VR, 3D printing, CRM+ERP
- control variables: size (small, medium, large, super large), age (established in 1992-1998, 1999-2008, 2009-2013, 2014-2018), foreign ownership, state ownership, markets (regional, national, EAEU, World)

Descriptive statistics

Variable		N	Mean	SD	Min	Max
Controls	Sub-national market	1,678	0,20	0,40	0	1
	Country-level market	1,678	0,60	0,49	0	1
	EAEU market	1,678	0,22	0,42	0	1
	World market	1,678	0,10	0,30	0	1
	Foreign owners	1,678	0,05	0,22	0	1
	State owners	1,678	0,03	0,18	0	1
Technologies	Cloud computing	1,678	0,35	0,48	0	1
	Big Data	1,678	0,20	0,40	0	1
	Mobile technologies and servers	1,678	0,24	0,42	0	1
	Artificial intellegence	1,678	0,35	0,48	0	1
	Robotics	1,678	0,12	0,32	0	1
	Virtual Reality	1,678	0,18	0,39	0	1
	3D printing	1,678	0,10	0,30	0	1
	CRM, ERP	1,678	0,36	0,48	0	1
Transmission channels	Consumers switch to new tech	1,678	0,10	0,30	0	1
	Consumers changes preferences	1,678	0,26	0,44	0	1
	Suppliers switch to new products production	1,678	0,07	0,25	0	1
	R&D of universities and research institutes	1,678	0,07	0,25	0	1
	Adjustment of tech standards	1,678	0,09	0,29	0	1
	Adjustment of tech standards in state procurement	1,678	0,05	0,22	0	1
	Support from federal / regional authorities	1,678	0,05	0,23	0	1

Source: Authors' calculations

Implementation of digital technologies by industry

Share of firms that implemented technologies by technology and industry

	Cloud systems	Big Data	Mobile server software	Virtual Reality	Artificial Intelligence	Robotics	3D Printing	CRM, ERP
Food production	28%	14%	22%	4%	7%	12%	4%	34%
Textiles	3%	2%	3%	2%	2%	2%	1%	2%
Wearing apparel	4%	2%	5%	3%	3%	3%	2%	6%
Leather and leather products	2%	2%	3%	1%	1%	2%	1%	2%
Wood processing and production of wood products	8%	5%	5%	2%	2%	2%	2%	7%
Furniture	8%	3%	5%	3%	3%	3%	3%	7%
Paper and paper products	5%	4%	5%	1%	2%	4%	2%	3%
Coke and petroleum products	2%	2%	1%	0%	0%	1%	0%	3%
Chemicals and chemical products	13%	7%	7%	4%	4%	4%	3%	11%
Pharmaceuticals	5%	5%	3%	1%	1%	2%	1%	4%
Rubber and platics products	15%	8%	10%	4%	5%	7%	6%	14%
Other non-metallic mineral products	18%	10%	9%	5%	4%	9%	3%	18%
Basic metals	5%	3%	3%	1%	1%	2%	2%	7%
Fabricated metal products	21%	13%	14%	7%	9%	12%	6%	22%
Computers, electronic and optical products	9%	5%	6%	5%	5%	7%	6%	12%
Electrical equipment	11%	5%	6%	4%	3%	7%	4%	13%
Machinery and equipment	17%	10%	10%	5%	7%	11%	4%	19%
Motor vehicles, trailers and semi-trailers	5%	2%	4%	1%	2%	3%	1%	6%
Other transport equipment	6%	5%	5%	3%	4%	5%	3%	8%
Repair and installation of machinery and equipment	15%	6%	9%	4%	3%	4%	2%	8%

Source: Authors' calculations

Empirical models

- **Model #1 (Differences among industries)**

$$P(Tech = 1 \mid X_1, X_2, \dots, X_i) = \beta_0 + \beta_1 * Size + \beta_2 * Age + \beta_3 * Foreign + \beta_4 * State + \beta_5 RegionalMarket + \beta_6 NationalMarket + \beta_7 EAEU + \beta_8 World + \beta_9 Industry$$

*8 technologies * 9 industries = 72 regressions*

- **Model #2 (Transmission channels)**

$$P(Tech = 1 \mid X_1, X_2, \dots, X_i) = \beta_0 + \beta_1 * Size + \beta_2 * Age + \beta_3 * Foreign + \beta_4 * State + \beta_5 RegionalMarket + \beta_6 NationalMarket + \beta_7 EAEU + \beta_8 World + \beta_{9-16} Industry + \beta_{17-24} Transmissionchannels$$

What was the incentive for your company to introduce new or significantly improved products or technology in 2016-2017?

Model #1 (1)

Industries	Cloud computing	Big Data	Mobile technologies and servers	Artificial intelligence	Robotics	Virtual Reality	3D printing	CRM, ERP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Food	—	—	—	—*	—**	—***	—***	+
Light	—***	—	+	+	+	+*	+	—**
Wood and Furniture	—	+	—	—	—	—	+	—**
Chemical and Pharma	+ **	+**	+	—	—	+	+	+
Non-ferrous metal	—	—	—**	—	—	—	—**	—
Metal work	—	+	—	—	+	—	+	+
Machinery	+	—	—	+	+	—	—	+
Electro mach	+	—	+	+	+***	+***	+***	+
Transport mach	+	+	+	+*	+	+	+	—
N	1,678	1,678	1,678	1,678	1,678	1,678	1,678	1,678

Control variables are: size (small, medium, large, super large), age (1992-1998, 1999-2008, 2009-2013, 2014-2018), foreign ownership, state ownership, markets (regional, national, EAEU, World)
*** p<0.01, ** p<0.05, * p<0.1

- Implementation of digital technologies are mostly explained by firm characteristics, industry type in most of the cases is insignificant
- Electro machinery is the only high-tech industry in our sample which is strongly and positively statistically different from other industries in prob. of tech implementation => what's wrong with Transport machinery and machinery?
- Food industry is strongly negatively different in prob. of tech implementation

Model #1 (2)

Industries	Cloud computing	Big Data	Mobile technologies and servers	Artificial intelligence	Robotics	Virtual Reality	3D printing	CRM, ERP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Food	—	—	—	—*	—**	—***	—***	+
Light	—***	—	+	+	+	+*	+	—**
Wood and Furniture	—	+	—	—	—	—	+	—**
Chemical and Pharma	+ **	+**	+	—	—	+	+	+
Non-ferrous metal	—	—	—**	—	—	—	—**	—
Metal work	—	+	—	—	+	—	+	+
Machinery	+	—	—	+	+	—	—	+
Electro mach	+	—	+	+	+***	+***	+***	+
Transport mach	+	+	+	+*	+	+	+	—
N	1,678	1,678	1,678	1,678	1,678	1,678	1,678	1,678

Control variables are: size (small, medium, large, super large), age (1992-1998, 1999-2008, 2009-2013, 2014-2018), foreign ownership, state ownership, markets (regional, national, EAEU, World)
*** p<0.01, ** p<0.05, * p<0.1

Comments on control variables:

- Effect of the size increases with the size of the firm: large firms have higher probability, super large firms – the highest
- Effect of the age decreases with the age: younger firms have higher probability, the youngest – the highest
- Both, foreign and state ownership are not significant

Model #2 (1)

VARIABLES	Automation	Digitalization	Cloud computing	Big Data	Mobile server tech	Virtual Reality	AI	Robotics	3D printing	CRM, ERP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Change in tech requirements of industry customers	+	+***	+***	+**	+***	+	+	+	+*	+***
Product innovations by suppliers	—	+**	+	+	+	—	+	—	+	+
R&D of universities and research institutes	+**	+**	+	+	—	+*	+	+	—	+
Adjustment of tech standards	+	+	—	+	+	+	+	+	+	+***
Adjustment of tech standards in state procurement	+	+	—	+	+*	+	—	+*	+***	+
Support from federal / regional authorities	+	+	+	—	+	+	+	+	+	—
N	1,678	1,678	1,678	1,678	1,678	1,678	1,678	1,678	1,678	1,678

Automation = Robotics + AI
Digitalization = Cloud computing + Big Data + Mobile server tech + IoT + VR + 3D printing + CRM, ERP
Control variables are: size (small, medium, large, super large), age (1992-1998, 1999-2008, 2009-2013, 2014-2018), foreign ownership, state ownership, markets (regional, national, EAEU, World), industry fixed effects
*** p<0.01, ** p<0.05, * p<0.1

- we find positive and robust impact of changes in tech requirements of industry customers on the probability to implement digitalization at the aggregate and individual level
- some evidence on the effects of state procurement regulation
- no effect of governmental support

Model #2 (2)

VARIABLES	Automation	Digitalization	Cloud computing	Big Data	Mobile server tech	Virtual Reality	AI	Robotics	3D printing	CRM, ERP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Change in tech requirements of industry customers	+	+***	+***	+**	+***	+	+	+	+*	+***
Product innovations by suppliers	—	+**	+	+	+	—	+	—	+	+
R&D of universities and research institutes	+**	+**	+	+	—	+*	+	+	—	+
Adjustment of tech standards	+	+	—	+	+	+	+	+	+	+***
Adjustment of tech standards in state procurement	+	+	—	+	+*	+	—	+*	+***	+
Support from federal / regional authorities	+	+	+	—	+	+	+	+	+	—
N	1,678	1,678	1,678	1,678	1,678	1,678	1,678	1,678	1,678	1,678

Automation = Robotics + AI
Digitalization = Cloud computing + Big Data + Mobile server tech + IoT + VR + 3D printing + CRM, ERP
Control variables are: size (small, medium, large, super large), age (1992-1998, 1999-2008, 2009-2013, 2014-2018), foreign ownership, state ownership, markets (regional, national, EAEU, World), industry fixed effects
*** p<0.01, ** p<0.05, * p<0.1

Results on control variables:

- Effect of the size increases with the size of the firm: large firms have higher probability, super large firms – the highest
- Effect of the age decreases with the age: younger firms have higher probability, the youngest – the highest
- Foreign ownership increases the probability of robotics and AI

Discussion

- we find that implementation of digital technologies in Russian industries is explained by age and size of firms, where larger and younger firms tend to adopt digital technologies.
- we control for these factors and find that statistical differences in digitalization among Russian manufacturing firms are weak. Only Electro machinery, chemicals+pharmaceuticals have positive statistical differences “from the average”

- we explore transmission channels of digital technologies and find that changes in the demand (industry customers / state procurement) and innovations by suppliers increase the probability of digitalization
- => firms in value chains are more prone to implement digitalization
- => weak demand for innovations in value chains hinders digitalization