Productivity growth drivers in Poland: technological readiness and management skills

Results from the TFP decomposition
and Technology Adoption Survey

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Presentation outline

Introduction and a sneak peak of the recommendations

Productivity of Polish enterprises in 2009-2019

How to measure the firm-level technology sophistication?

Technology Adoption Survey – results from Polish enterprises

Policy recommendations

Evidence-based policy making: introduction to the project

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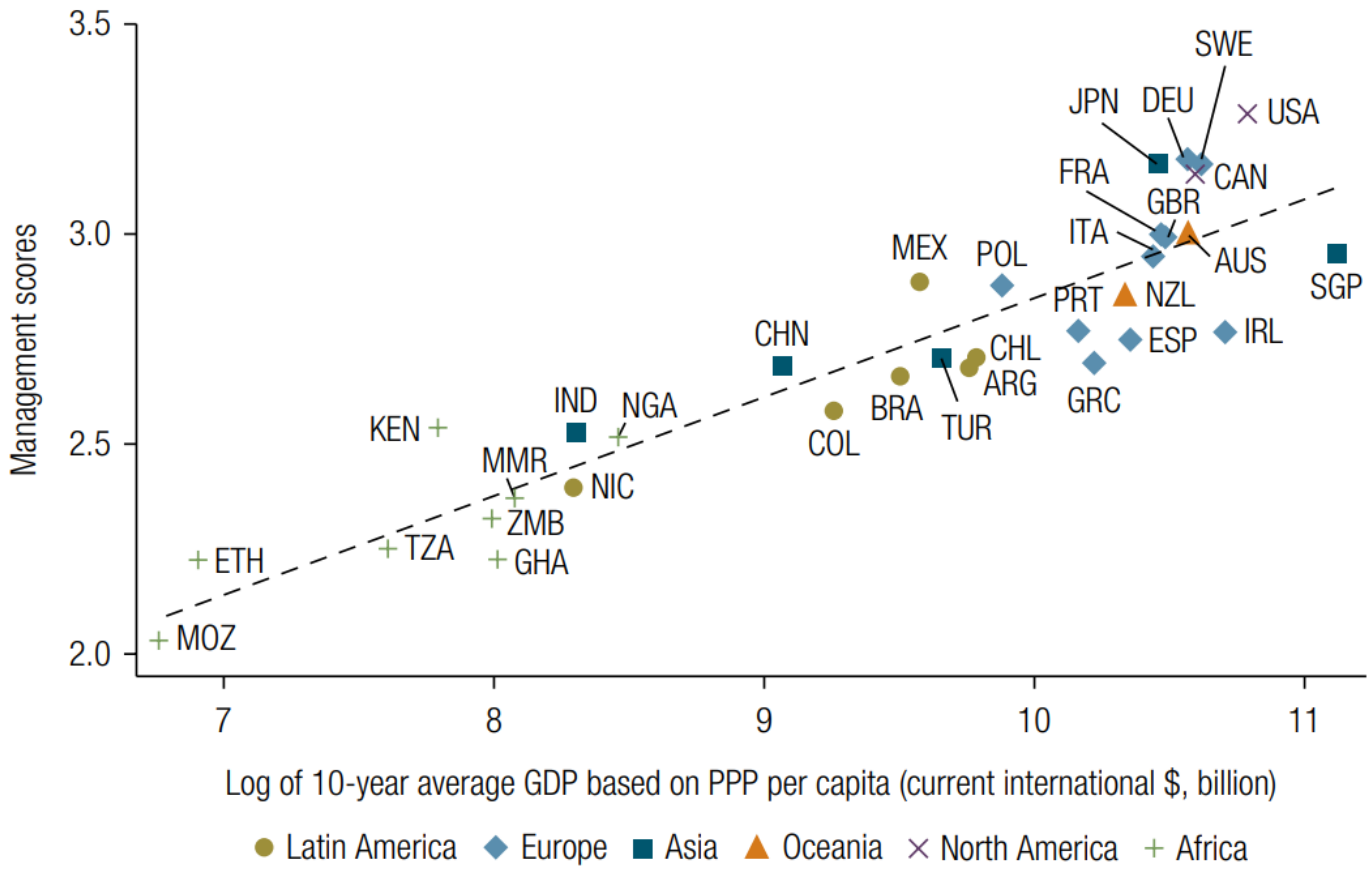
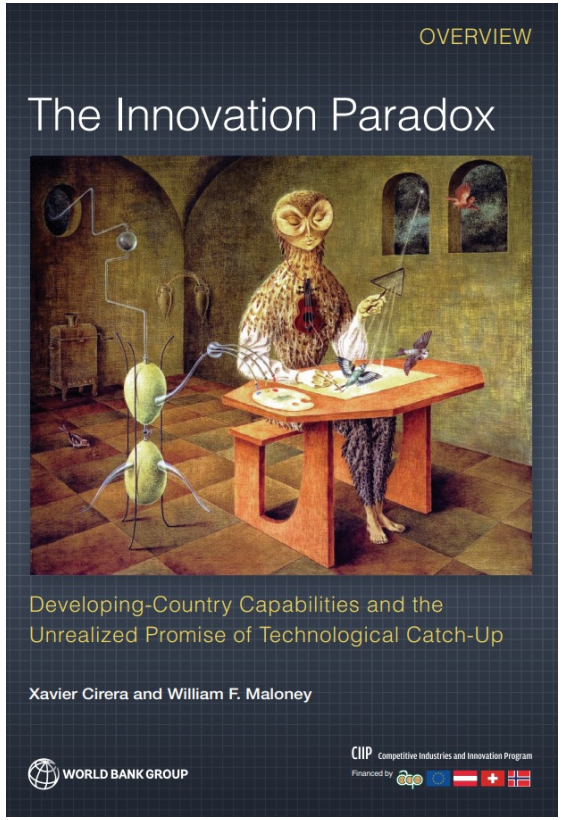
The project's starting point was the new evidence suggesting that firm-level capabilities and technology adoption play a key role in productivity improvements…





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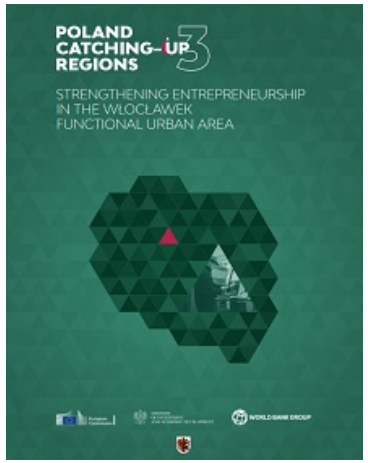
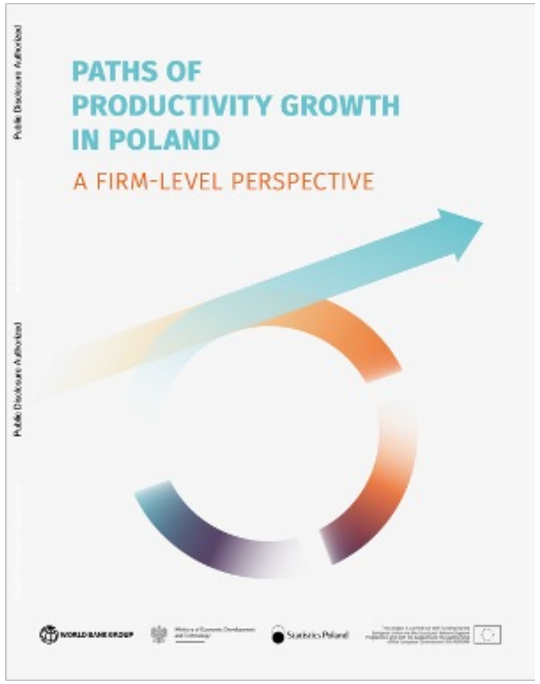
...and the results of the completed World Bank's projects related to the development of the private sector in Poland





The project links the productivity growth rate of Polish enterprises with their level of technological sophistication and, with policy mix analysis derives evidence-based recommendations

1A. Productivity decomposition
productivity growth paths and drivers (within and between components), best and worst performing industries and firm groups, areas for policy interventions

1B. Portfolio mapping
portfolio mapping of interventions supporting managerial capabilities and technology adoption in Polish enterprises

2. Technology Adoption Survey and analysis of the policy mix
measuring the level of technological sophistication (firms of different sizes and sectors); barriers to, and reasons behind adopting new technologies

3. Evidence-based capacity building:
working with Polish Agency for Enterprise Development on Development Services Database and Certification

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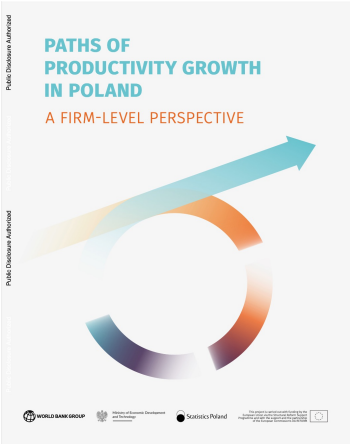
World Bank systematically builds upon ever-expanding knowledge about firms' productivity and turns it into effective policies supporting SMEs and the development of the private sector in Poland

Selected projects implemented **in Poland**



Selected projects **currently underway in Poland**

Smart specialization evaluation

Selected projects **currently underway in EU countries**

DIGITRANS
Promoting Digital Transformation and Managerial Practices for Productivity

Technical assistance in the preparation of 2021-27 EU operational programs and implementation of National Recovery Plans

Summary of the recommendations

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Evidence proves that the level of effectiveness of public policies in accelerating technology adoption and digitization in Polish businesses requires addressing non-obvious areas of intervention

1. Improve enterprises' self-awareness
2. Support technology adoption
3. Enhance firms' capabilities
4. Remove firm-level barriers to growth
5. Coordinate support and improve data accessibility

Productivity of Polish enterprises in 2009-2019

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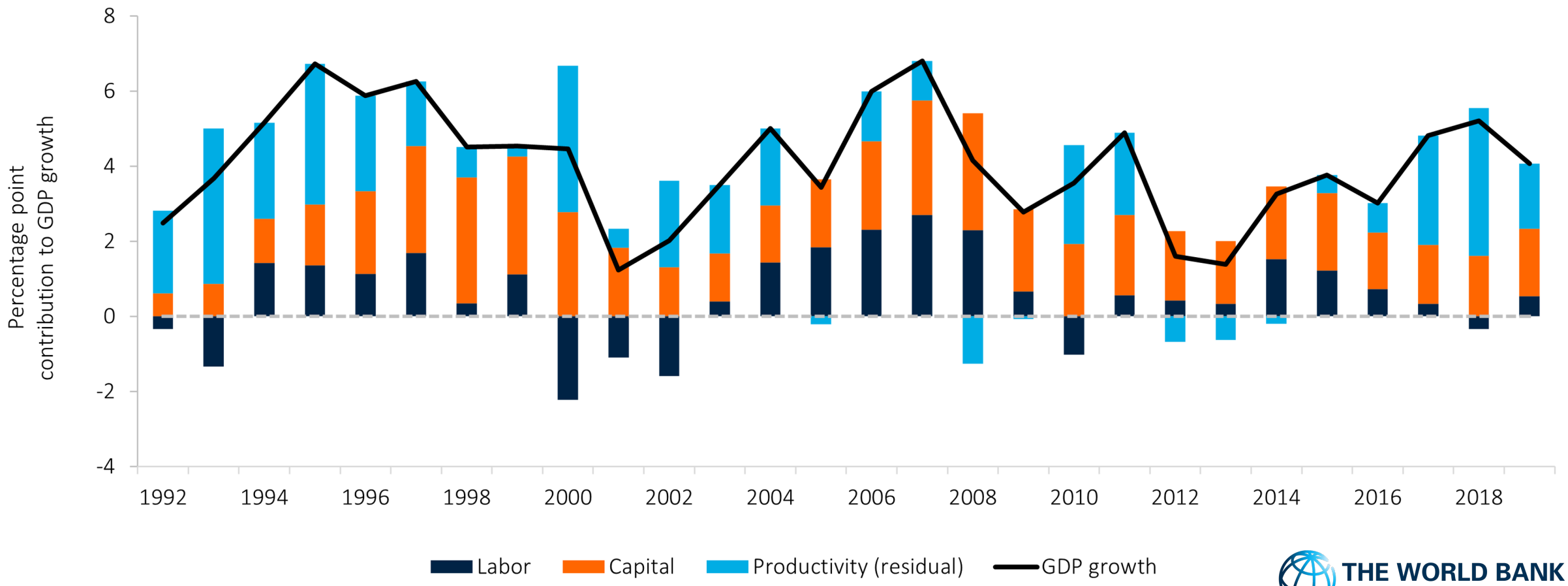
Productivity of Polish enterprises in 2009-2019

Poland's economic growth depended and increasingly depends on improvements in productivity, that is, on the rate of progress in the firm-level efficiency of production of goods and services



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Compared to other EU countries, Poland has an investment structure unfavorable for economic growth – public investment focused on infrastructure and a low rate of private investment

Advantages	Challenges
More than two decades of uninterrupted growth driven mainly by increasing capital stock	Declining investment rate, less than 17% of GDP (1/3 lower than Czech Republic, Slovakia, Hungary)
The proximity of large markets (EU) has driven exports and integration into value chains	Investment structure: infrastructure > human capital + intangibles (low digital skills)
Public investment (NRRP, EU Operational Programs 2021-27) in green transformation and digitization	Negative demographic trends and labor market uncertainty

Productivity can be quantified by two main indices: labor productivity (simpler) and TFP (more complicated). We focus on TFP because it measures the efficiency of production due to unobservable factors

TFP
Total Factor Productivity

- Measures the efficiency of converting factors of production (capital, labor) into product
- Reflects an increase in output that is **not** due to a change in the number of inputs used in the production process
- The higher the TFP, the fewer inputs are needed to produce the same amount of product
- Growth follows the implementation of **innovations**, improvement of work organization (improvement of **management practices** and **technology adoption**)
- Unobservable in data, requires production function estimation (panel data)

Country's productivity grows due to (1) firms improving their capabilities, (2) high-productivity firms increasing their market share, (3) the exit of less successful firms and entry of more efficient ones

1. Within fim *(within)*
Increasing firms capabilities through innovations, technology adoption, better organizational and managerial practices, improvements of labor force digital skills

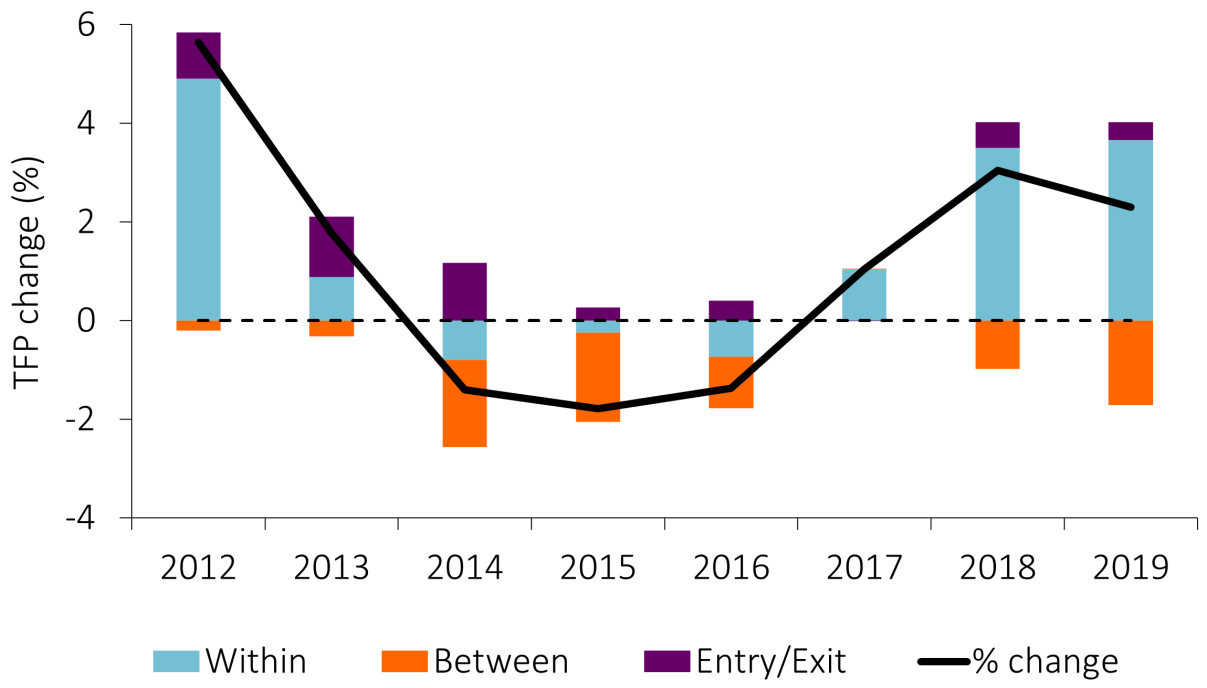
2. Between firms *(between)*
High-productivity firms increase their market share at the expense of less productive firms; allocating resources from less efficient to more efficient firms

3. Productive entry and exit *(entry/exit)*
Entry of high-productivity firms to the market and the exit of low-productivity firms from the market

Country-level productivity growth

The TFP in Polish manufacturing stagnated starting in 2012 – the low-productivity firms from metals and food industry expanded their market share to the detriment of more productive firms

Productivity decomposition in the Polish manufacturing sector, 2009-2019



Starting in 2012, Polish productivity grew (on average, 3% annually). However, it grew in services, not manufacturing.

Reversal of the positive trend
Until 2012 (since 1997), the improvements in allocative efficiency (*between*) drove TFP growth in Poland, suggesting that high-productivity firms increased their market share during that time.

It means that since 2012, firm-level productivity gains (*within*) in Poland have not (on average) translated into market share increases (*between*).

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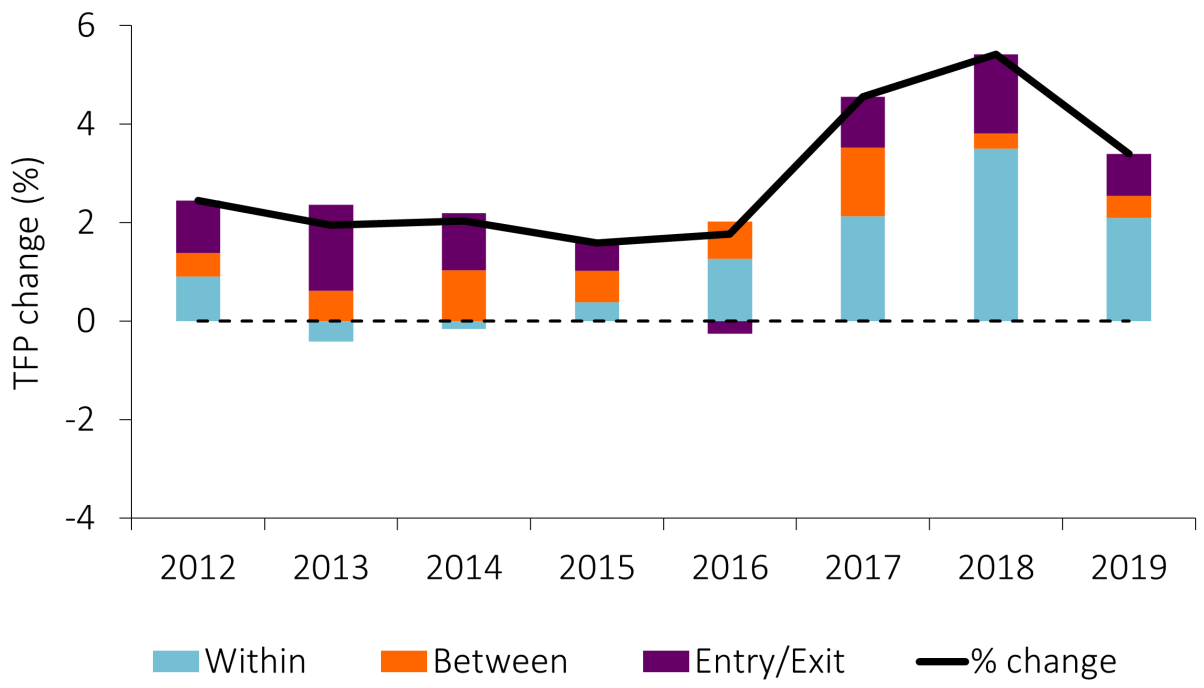
Services experience uninterrupted productivity (TFP) growth. Starting in 2016, productivity growth accelerated in both manufacturing and services due to the within-firm efficiency improvements

Productivity decomposition in the Polish service sector, 2009-2019



Service productivity continuously grows, which might be driven by the base effect.

Regardless of the sector, **TFP growth is positively correlated with the presence of foreign capital** in the company and **the firm's activities in the growth markets and growth sectors**

There is an empirical justification for the supplier development programs (merging domestic SMEs with larger companies), as well as facilitating coming into foreign markets (e.g., support for certification)

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Technology Adoption Survey (TAS) translates the within-firm efficiency improvements into a level of technology sophistication and hence into tangible methods and technologies firms employ

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Increasing firms capabilities through innovations, technology adoption, better organizational and managerial practices, improvements of labor force digital skills

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Country-level productivity growth

How to measure firm-level technology sophistication?

Technology Adoption Survey

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TAS is an advanced survey for collecting information on technologies used by companies and creates a measure that is comparable between companies (size, sector), regions and countries

Representativeness	Poland's representative sample of **1,500 companies** with more than 5 employees **Firm sizes** (6) (for European and international statistical comparability): (1) 5-9, (2) 10-19, (3) 20-49, (4) 50-99, (5) 100-249, (6) 250+ employees **Sector of activity** (11): agriculture, manufacturing (food processing, apparel, automotive, pharmaceuticals and others) and services (trade, financial services, land transport, health care and others) **Macroregions** (7): Mazowieckie, central Poland, southern Poland, northwestern Poland, southwestern Poland, northern Poland, eastern Poland
Comparability	10 countries (mainly developing + Korea), **Poland is a benchmark for high-income European countries.**
Measurability	Comparability made possible by using a standardized measure of technological sophistication.

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Each company answers questions in 5 areas, including business methods, technology specific to the business area, financial situation, employment, attitude to change, public support received

Technologies and capabilities			Firms characteristics	
General Business Functions (GBF)	**Sector-specific Business Functions (SBF)**	Barriers and drivers of technology adoption	General characteristics of the firm	Balance sheet and HR (finances, employment, labor productivity)
7 typical technologies applied to all firms	*11 business functions applied to firms in a specific sector*			

TAS provides information on 7 business functions that every company performs in its daily operations- General Business Functions (GBF)

The higher the technological sophistication, the higher the index value

	Business administration	Production planning	Sourcing and procurement	Marketing and product develop.	Sales	Payment methods	Quality control
1	Handwritten processes	Handwritten processes	Manual search of suppliers, without centralized database	Informal chat (face-to-face)	At the establishment	Cash	Manual, visual or written processes without the support of digital technologies
					Direct sales by phone or email	Bank wire	
2	Computers with standard software (e.g., Excel)	Computers with standard software (e.g., Excel)	Computers with standard software (e.g., Excel)	Online chat	Sales through social media	Credit or debit card	Manual, visual or written processes with the support of digital technologies
3	Mobile apps or digital platforms	Mobile apps or digital platforms	Mobile apps or digital platforms	Structured customer surveys	Online sales via platforms (e.g., eBay)	Online banking	
4	Computer with specialized software	Computer with specialized software	Supplier Relationship Managment (SRM)	Customer Relationship Managment (CRM)	E-commerce	Online through a platform (PayU)	Statistical process control
5	Enterprise Resource Planning (ERP)	Enterprise Resource Planning (ERP)	SRM Integrated with production planning	Big Data or Artificial Intelligence (AI)	Electronic orders integrated into the supply chain	Virtual or cryptocurrency	Automated systems for inspection

TAS provides information on industry-specific technologies used in 11 sectors – Sector-Specific Business Functions (SBF)

Example
Food Processing

The higher the technological sophistication, the higher the index value

	Input testing	Mixing, blending and cooking	Antibacterial processes	Packaging	Food storage
1	Sensory systems (visual, smell, etc.)	Manual processes	Minimal processing preservation methods	Manual packing in bags, bottles, or boxes	Minimal protection, some exposure to outside elements
2	Review of supplier testing on Certificate of Analysis	Mechanical equipment requiring human force to operate	Antibacterial wash or soaking	Human-operated mechanical equipment for packaging in bags, bottles, or boxes	Ambient conditions in closed building
3	Non-computer-controlled testing kits	Power equipment requiring routine human interaction	Thermal processing technologies	Automated process with minimal human interaction	Some climate control in secured building
4	Computer testing such as chromatography or spectroscopy	Power equipment controlled by computers or robotics, with minimal human interaction	Other advanced methods such as high-pressure processing (HPP) and pulsed electric field (PEF)	Fully automated with robotics	Fully automated climate- and security-controlled building
5					

For each of the 7 functions, the survey asks about each technology used (*extensive* margin) and the technology used most often (*intensive* margin) and creates a technology sophistication index

The higher the technological sophistication, the higher the index value

	Business administration	EXTENSIVE MARGIN: What methods are used for business administration?	INTENSIVE MARGIN: Which of the technologies used is employed most often?
1	Handwritten processes	YES	
2	Computers with standard software (e.g., Excel)	YES	Computers with standard software (e.g., Excel)
3	Mobile apps or digital platforms	NO	
4	Computer with specialized software	YES	
5	Enterprise Resource Planning (ERP)	NO	

Technology Index on the *extensive* margin = 4 (maximum)

Technology Index on the *intensive* margin = 2

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Results from Technology Adoption Survey in Polish enterprises

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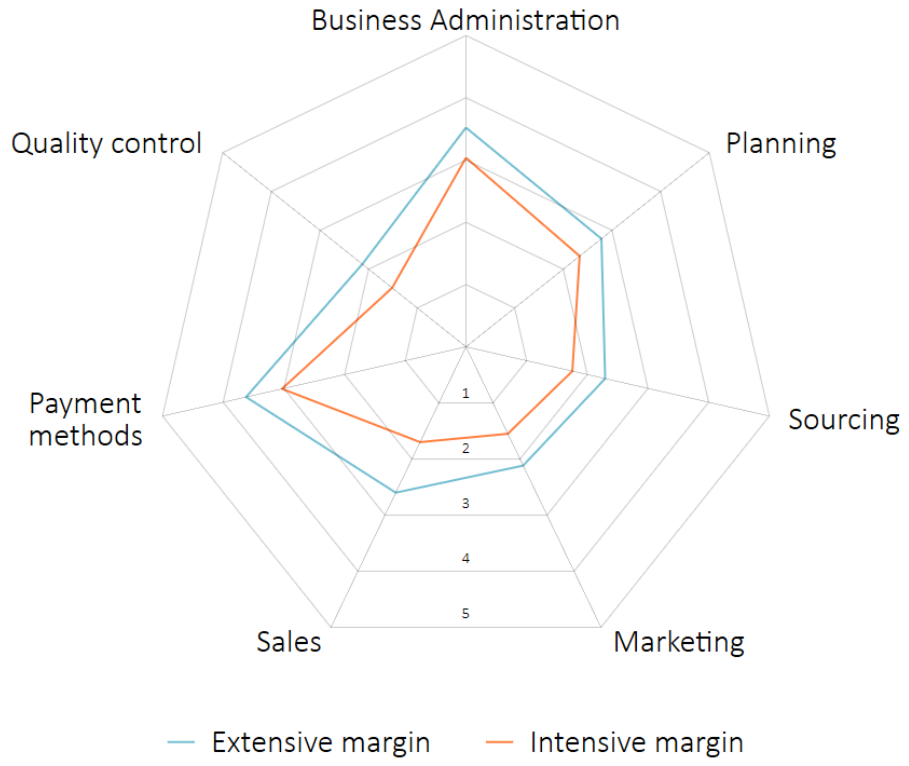
An average firm in Poland most frequently uses rather basic technologies to perform typical day-to-day business functions, even though the firms have access to more advanced technologies

Technological sophistication across General Business Functions (GBF) for the *extensive* and *intensive* margin



The General Business Functions Index for Poland on the *intensive* margin is 2.14.

It means that an average Polish firm is most likely to use for:

Administration
standard or specialized software

Planning
standard software

Sourcing
manual search without centralized database

Marketing
face-to-face chat

Sales
at establishment, via e-mail or telephone

Payment
online banking

Quality control
the most basic manual methods, without the support of digital technologies

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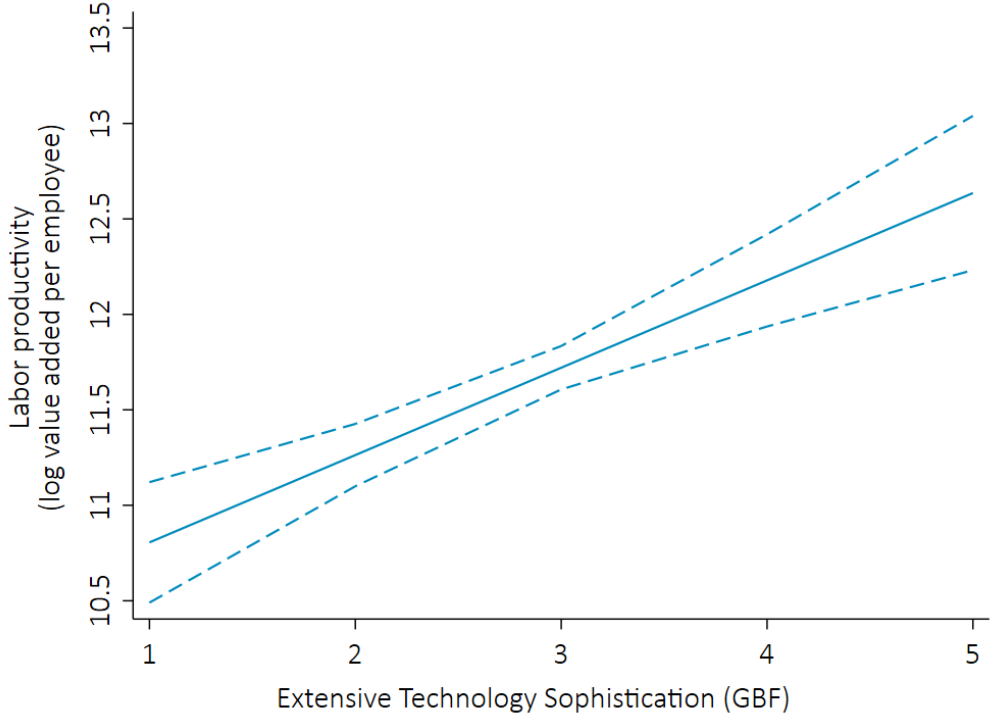
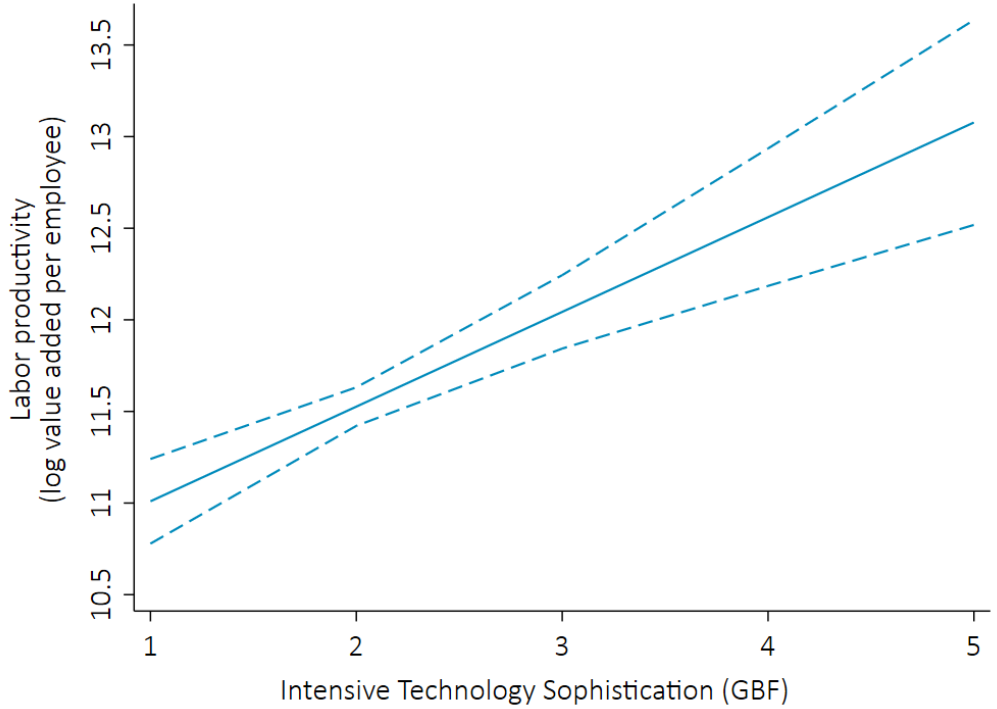
Polish firms that adopted or employ daily more advanced technologies are, on average, more productive than other enterprises

Relationship between firm's productivity and their level of technological sophistication *(extensive margin)*



Relationship between firm's productivity and their level of technological sophistication *(intensive margin)*



Both results hold for other countries surveyed by TAS (also on the regional level): Korea, Kenya, India, Bangladesh, Brazil, Burkina Faso, Ghana, Malawi, Senegal, and Vietnam. Source: Cirera, Comin and Cruz (2022)

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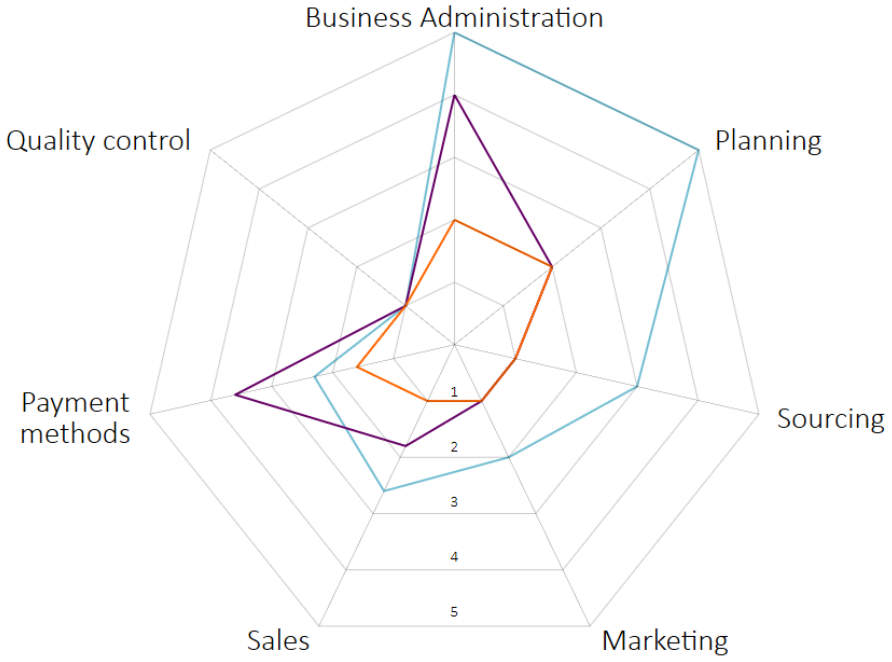
Firms are usually neither at the frontier nor using basic technologies for everything they do; they tend to use more sophisticated methods for some activities and less sophisticated technologies for others

Technological sophistication across GBFs for 3 types of firms:
(1) the most advanced (p90), (2) the least advanced (p10) and (3) median



*10% of **the most advanced** firms* ← p90 — median — p10 → *10% of **the least advanced** firms*

- Firms in terms of technology sophistication are **not developing evenly** across business functions

The lines on the graph intersect

- Firms are very **technologically diverse** *(large within-firm technological variation):* even large firms that have adopted the most advanced technologies, like ERP or SRM, use the most basic methods in other areas, for example, quality control or marketing

The p90 on the graph

- Large within-firm technological variation also means that **moderately less advanced firms can still use modern solutions** for certain business functions, for example, payment methods

Median firm on the graph

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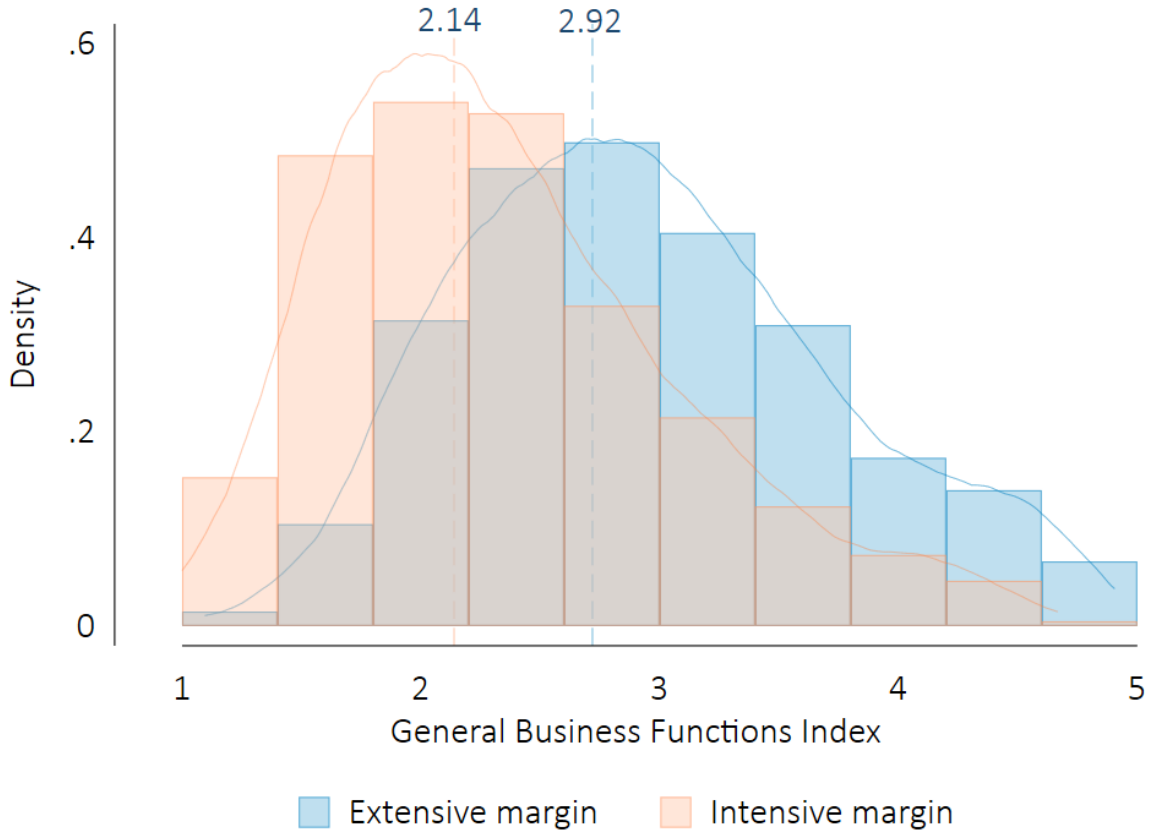
Most Polish firms rely on unsophisticated methods when running a business, but some firms are already on the technological frontier

Distribution of General Business Functions Index across Firms



General Business Functions Technological Index for the extensive margin = 2.92

General Business Functions Technological Index for the intensive margin = 2.14

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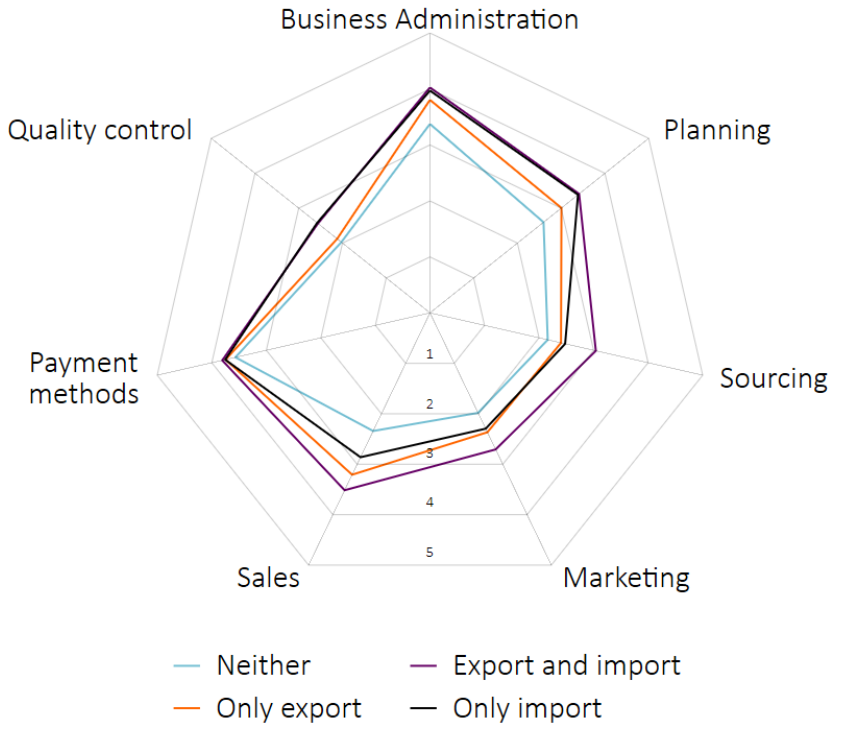
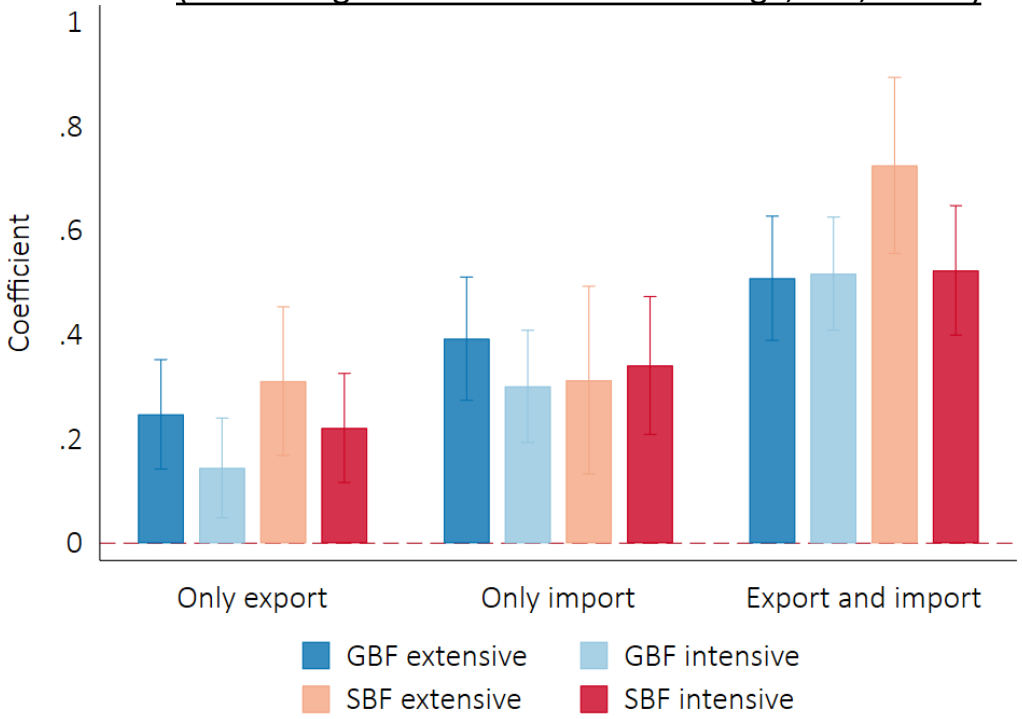
Linking companies into global value chains (GVC) and facilitating their integration into foreign markets can result in higher levels of technological sophistication

Technological sophistication across GBFs for firms dependent on their import/export status



Relationship between technological sophistication and import/export status
(controlling for firms characteristics: age, size, sector)



Note: In a representative sample for Poland (1500 firms): 11% exporters only, 8% importers only, 9% exporters and importers, 72% neither exporters nor importers.

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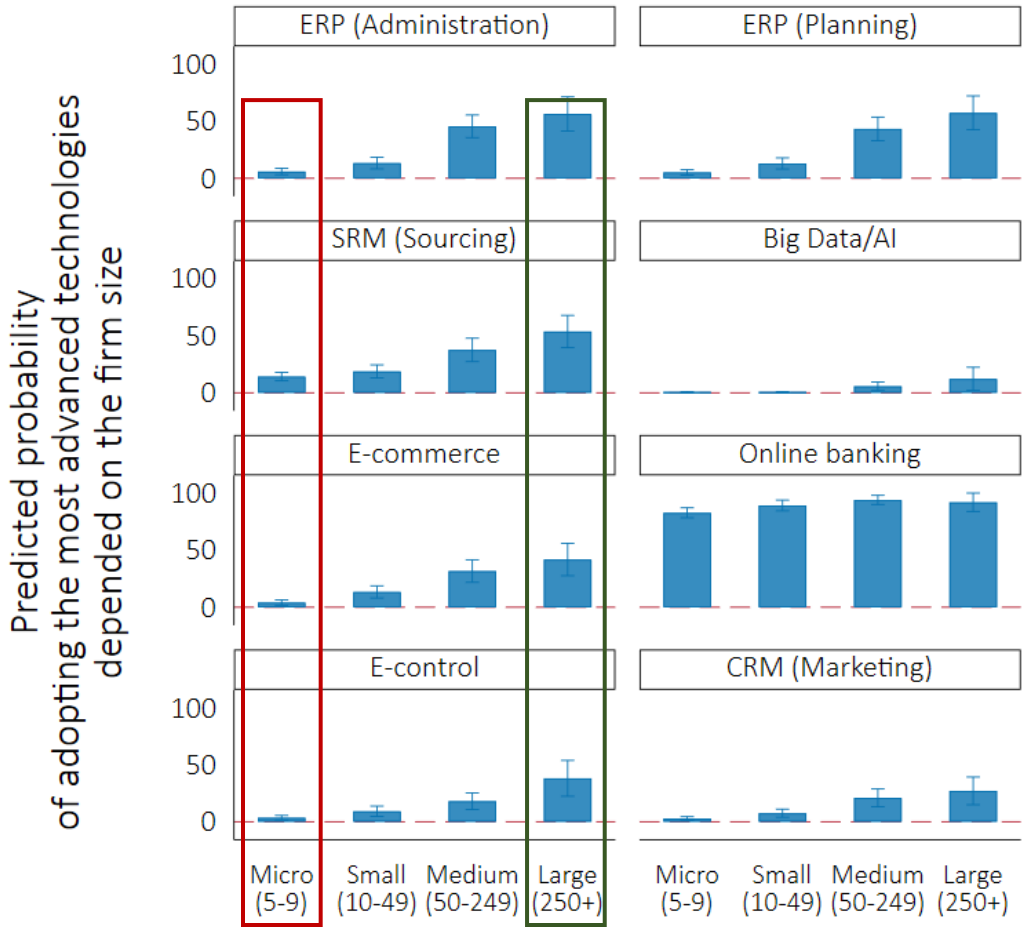
The scale of business matters most for its level of technological sophistication. Hence, country-wide technology advancement requires firms to upscale



The chances that micro and small businesses will adopt the most advanced technologies, like Enterprise Resource Planning (ERP), Supplier Relationship Management (SRM) systems, or Big Data Analytics, are slim.

Payments is the only business function for which the small scale of operations is not an obstacle to the adoption of more advanced technologies
(role of the regulator and legislation)

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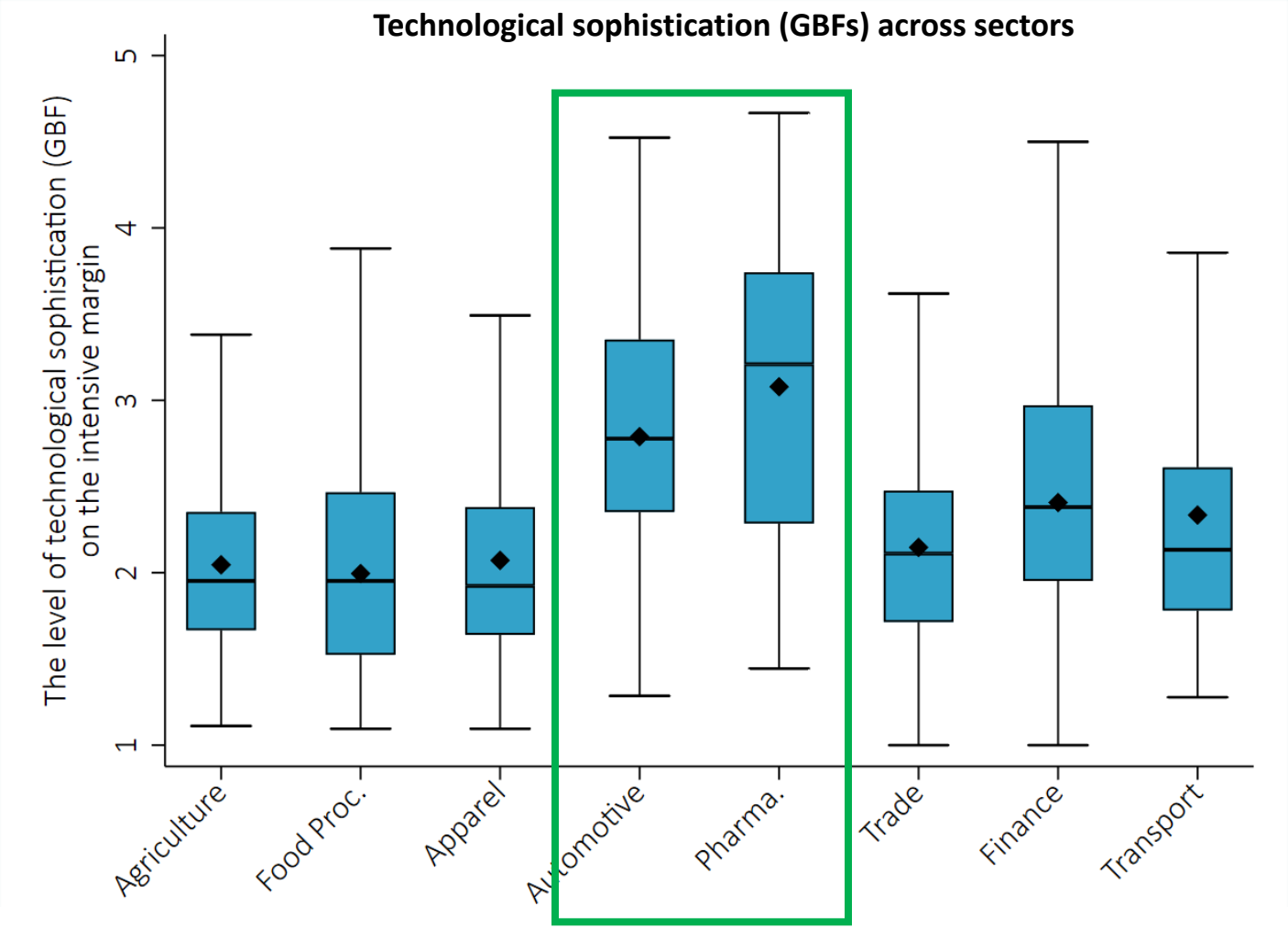
Sectors in Poland differ in technological sophistication. To a large extent, those differences are driven by the sectors' structural differences, such as number of large firms or share of exporters



Horizontal line inside of the box: median
Dot: average
Lower hinge: 25th percentile
Upper hinge: 75th percentile

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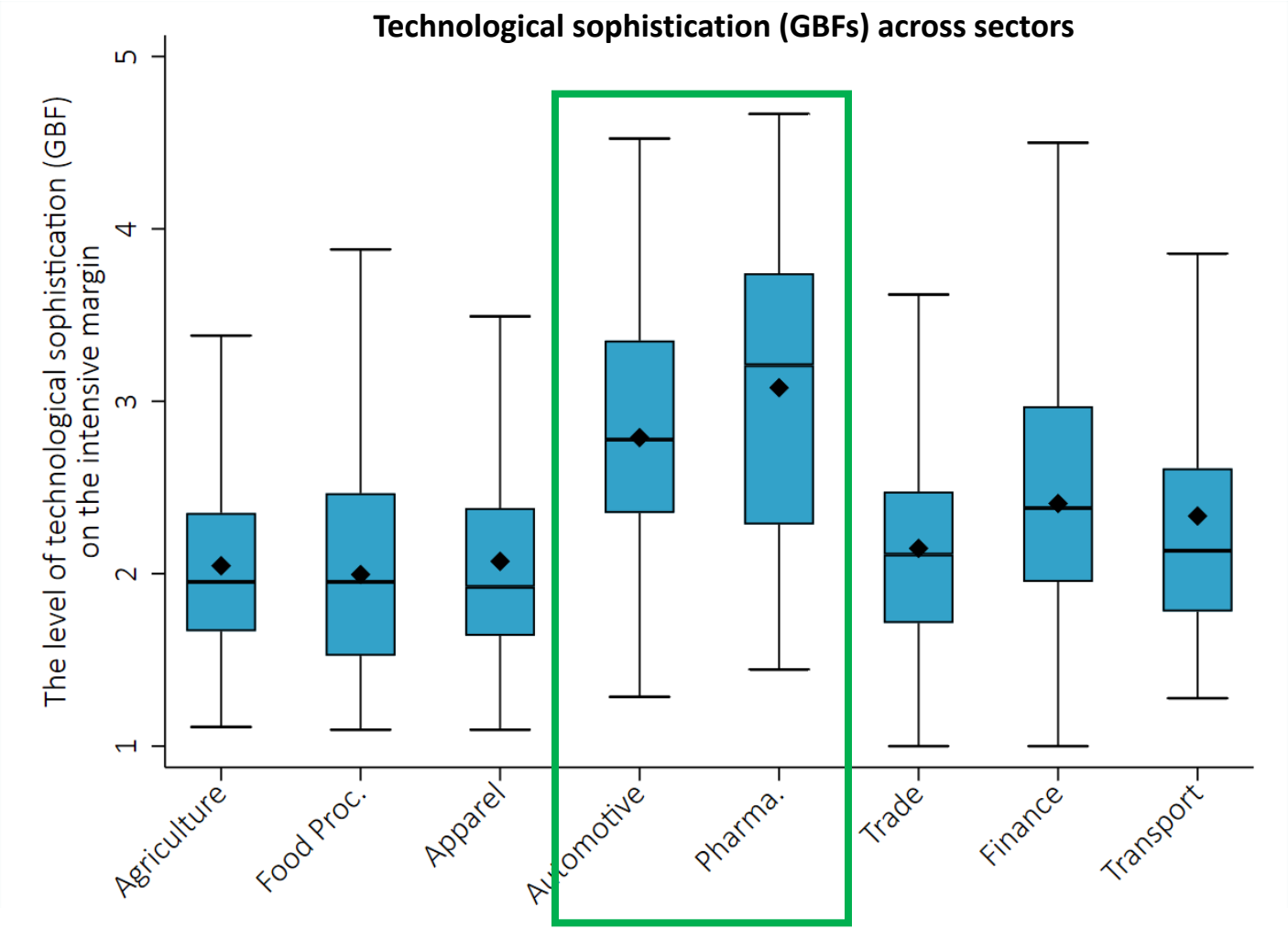

Sectors	Large firms (250+)	Exporters
Agriculture	<1%	11%
Food Proces.	2%	15%
Apparel	<1%	46%
Automotive	**16%**	**75%**
Pharma.	**22%**	**67%**
Trade	<1%	20%
Finance	3%	1%
Transport	<1%	20%

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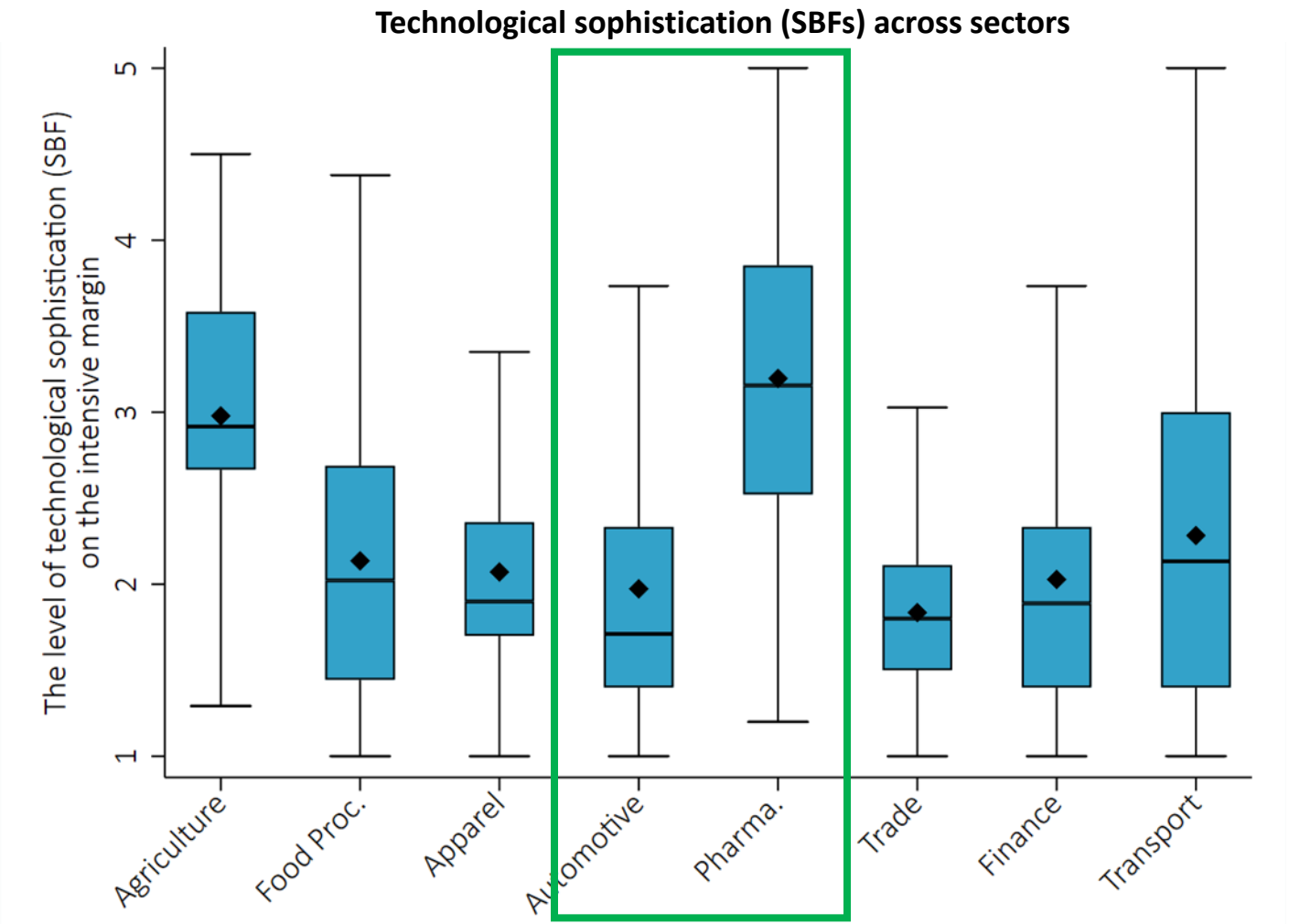
The sophistication of sector-specific technologies is generally low to moderate, with the pharmaceuticals and agriculture sectors leading the sectoral ranking. Automotive is surprisingly low advanced



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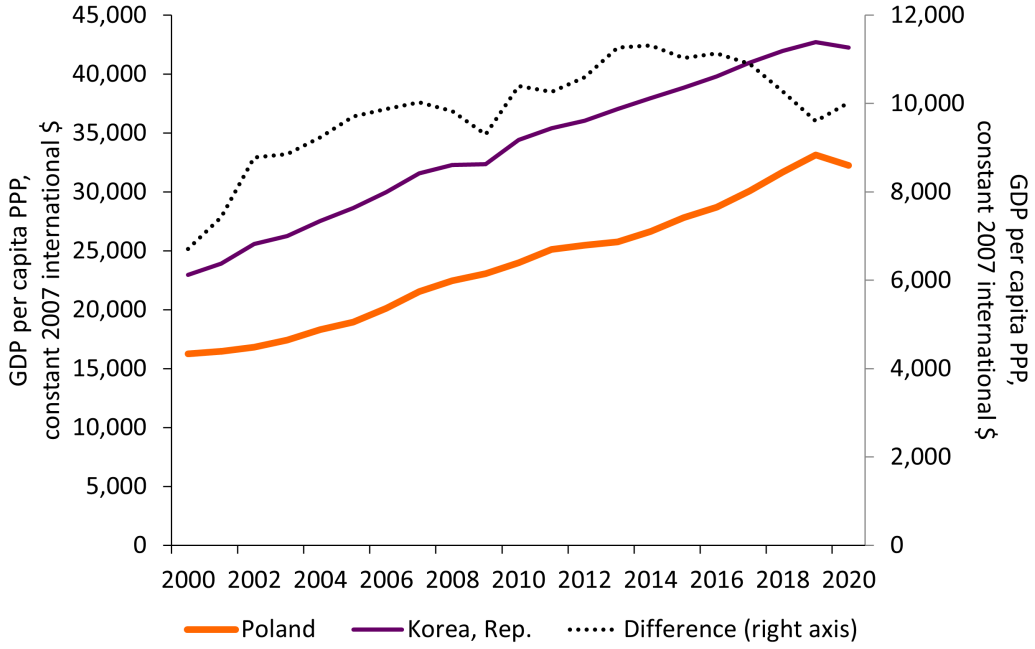
The average Polish firm is less technologically advanced than the average Korean firm. However, given the Korean level of economic development, the gap in sophistication seems small

Technological sophistication across GBFs in Poland and Korea for the *intensive* margin

GDP Per Capita in Poland and Korea, 2000-2020



Source: World Development Indicators.

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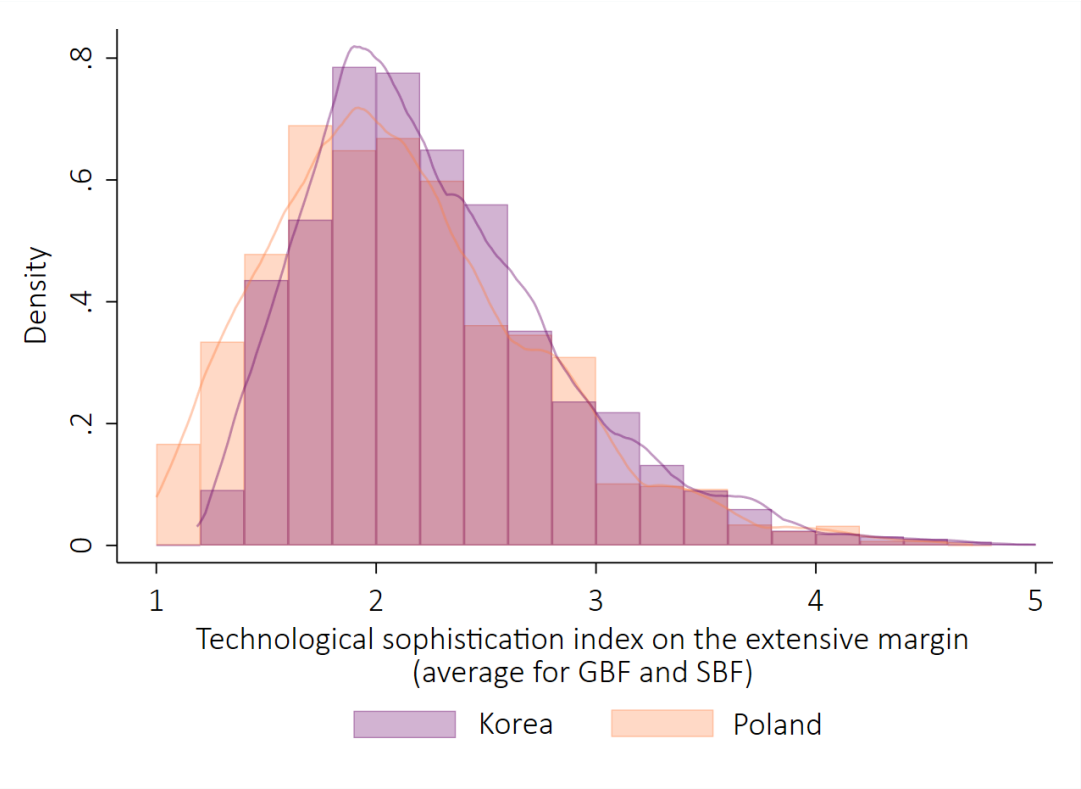
The relatively small difference in average technology sophistication between Poland and Korea results from the differences in the firm and sector sizes between countries

Distribution of Average Technology Sophistication Index across Firms in Poland and Korea



The structure of the Polish and Korean economy in the Technology Adoption Survey

Sectors	Share of firms		Share of large firms (100+)	
	Poland	**Korea**	**Poland**	**Korea**
Agriculture	1%	8%	2%	<1%
Manufacturing	22%	42%	**8%**	**3%**
Services	77%	50%	3%	2%

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Summary of the analytical results

- **Productivity** will increasingly determine economic growth – improving the quality of life and the pace of catching up with Western European countries. It is necessary to track its paths in order to know which areas need support and where intervention may distort the functioning of the market.

- **Productivity at the national level distinctly accelerated in 2017 due to companies that invested in improving their efficiency, including R&D activities, improving management practices, and technology adoption.**

- **Thanks to the Technology Adoption Survey, we know the extent to which Polish companies have adopted new technologies and their level of technological sophistication –** an average Polish company still uses rather unadvanced methods, but there is great diversity among companies and technologies.

- **Poland is far from the technological frontier and has a great potential for productivity growth,** which, among other things, requires companies to be incentivized and able to scale up their operations.

- **Companies that participate in international trade and employ managerial practices are more technologically advanced,** yet almost three-quarters of Polish companies do not participate in international trade; 90% of companies do not monitor or use efficiency indicators, and only two-thirds use any formal incentives for employees to motivate them to identify or use better methods of production or service delivery.

Policy recommendations

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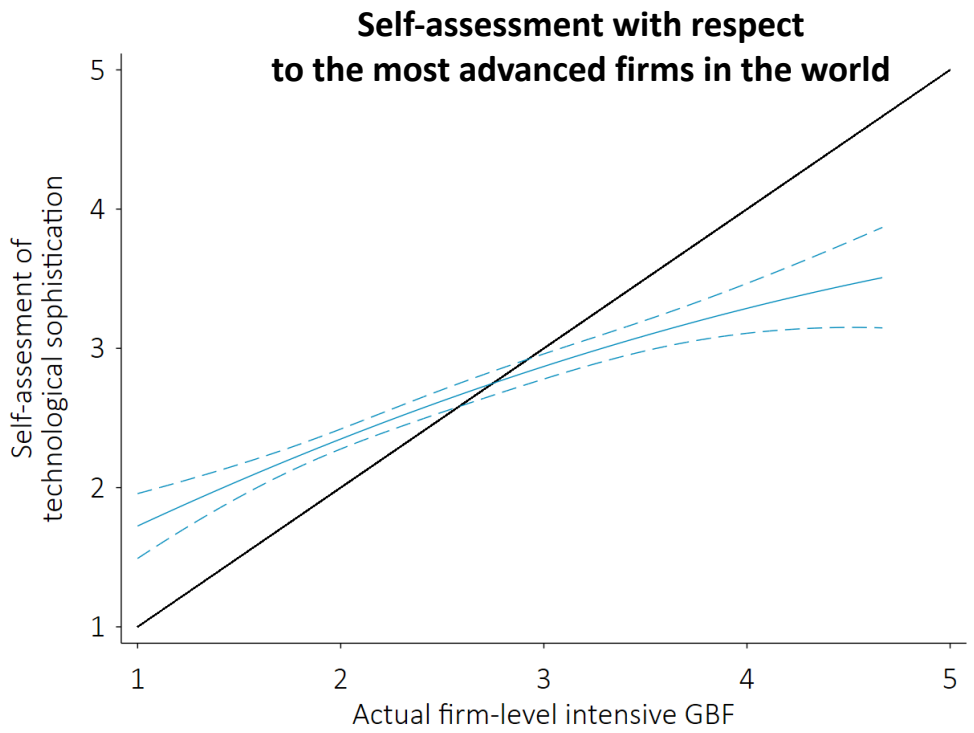
Evidence proves that the level of effectiveness of public policies in accelerating technology adoption and digitization in Polish businesses requires addressing non-obvious areas of intervention

1. Improve enterprises' self-awareness
2. Support technology adoption
3. Enhance firms' capabilities
4. Remove firm-level barriers to growth
5. Coordinate support and improve data accessibility

Improve enterprises' self-awareness

Firms in need of technological upgrading may be the most reluctant to do so due to overconfidence and self-assessment bias



On a scale from 1 to 5, where 5 means that the establishment is using the most advanced production processes available in its sector, where do you think this establishment stands with respect to other firms in Poland (on the left), most advanced firms in the world (on the right)?

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Improve enterprises' self-awareness

Demand-driven instruments may be ineffective due to a lack of awareness of necessary investments and resistance to change

Include needs assessment component in instruments supporting technology adoption

Enhance capabilities of the Future Industry Platform in raising awareness of technology adoption
(Agency for Enterprise Development and The National Centre for Research and Development)

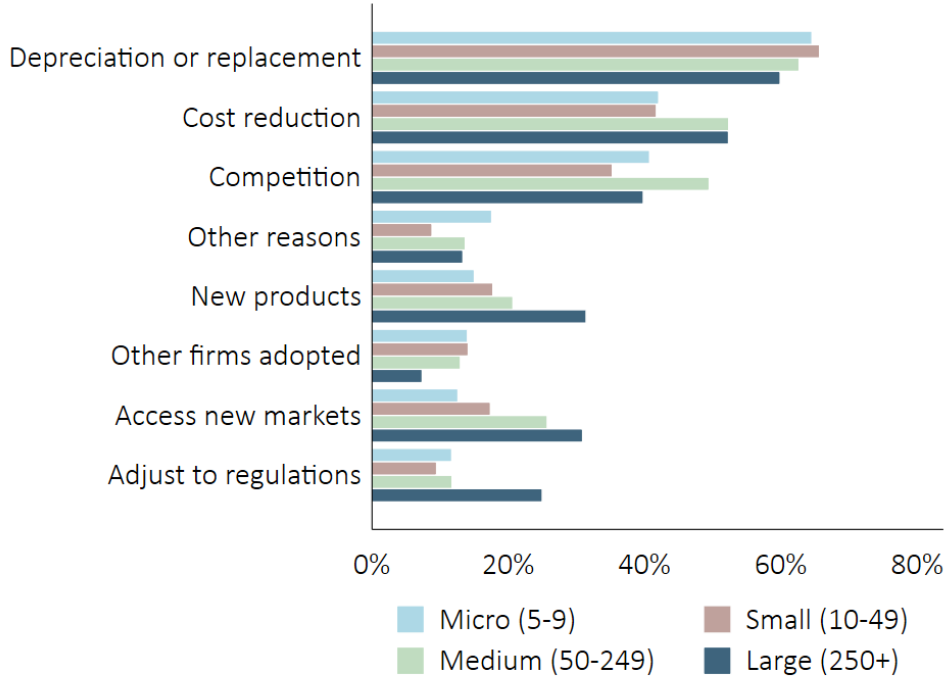
Revise approach to building awareness of technology adoption (communication and outreach activities)

Leverage Digital Innovation Hubs to serve as a one-stop-shop provider of information on technology adoption

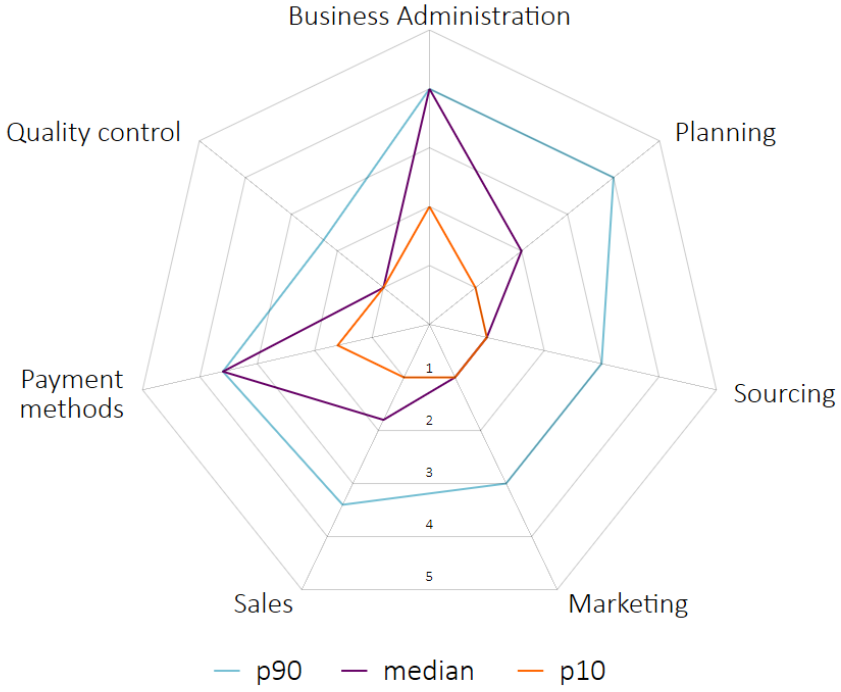
Support technology adoption

The variety of technologies and firms' motivations for adopting them requires policies to be tailored to the companies needs

Self-reported reasons for technology adoption



The technological sophistication across business functions according to their distribution



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Support technology adoption

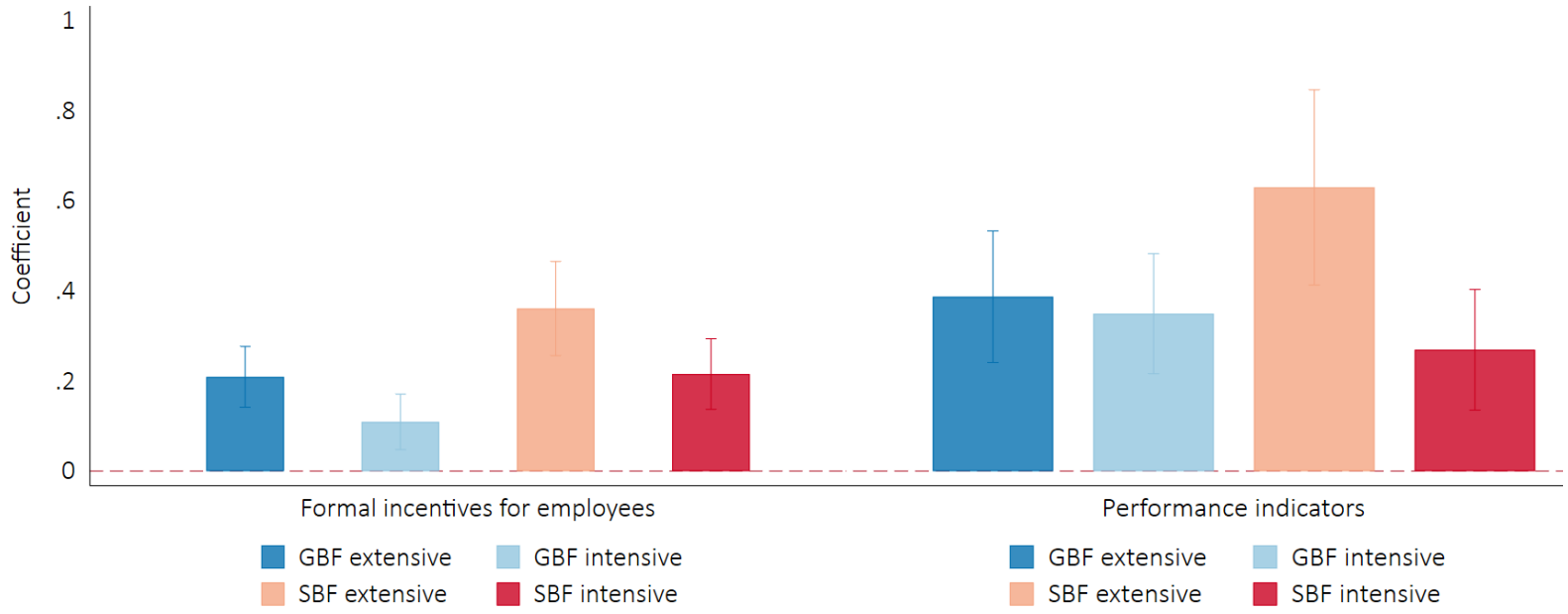
The results of the Technology Adoption Survey indicate the types of technologies and firms whose support have a high impact potential

- Facilitate widespread adoption of off-the-shelf general business function technologies at the core of private sector development
- Deviate from targeting fast-growing companies to supporting horizontal solutions
- Increase linkages between SMEs and larger firms (including SOEs) through supplier development programs
- Align instruments supporting the adoption of green technologies to the readiness of firms in respective sectors

Enhance firms' capabilities

Better managed companies are more likely to use more advanced technologies and achieve a higher return on technology investment

Relationship between technological sophistication and use of managerial practices
(controlling for firms characteristics: age, size, sector)



Broaden non-refundable support for supplementary capabilities in instruments for financing the digitization of enterprises

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Remove firm-level barriers to growth

Improving the efficiency of resource allocation will result in increased productivity not only *within* companies but also *between* them and might accelerate the exit of unproductive companies from the market

Facilitate widespread adoption of off-the-shelf general business function technologies at the core of private sector development

Deviate from targeting fast-growing companies to supporting horizontal solutions

Coordinate support and improve data accessibility

Improved flow of information among the stakeholders will strengthen the effectiveness of public intervention

Establish functional coordination mechanisms for policies on technology adoption and enhancement of supplementary capabilities undertaken by various institutions

Strengthen monitoring and evaluation procedures to inform continuous learning – Innovation, Technology, and Productivity Excellence Center

Improve access to statistical information on firm performance

Feel free to contact us with any questions

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