Productivity growth drivers in Poland: technological readiness and management skills

Results from the TFP decomposition and Technology Adoption Survey

World Bank FCI ECA
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
The project’s starting point was the new evidence suggesting that firm-level capabilities and technology adoption play a key role in productivity improvements...
...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.
Introduction

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

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
Policy recommendations

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
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.
Productivity of Polish enterprises in 2009-2019

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.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than two decades of uninterrupted growth driven mainly by increasing capital stock</td>
<td>Declining investment rate, less than 17% of GDP (1/3 lower than Czech Republic, Slovakia, Hungary)</td>
</tr>
<tr>
<td>The proximity of large markets (EU) has driven exports and integration into value chains</td>
<td>Investment structure: infrastructure &gt; human capital + intangibles (low digital skills)</td>
</tr>
<tr>
<td>Public investment (NRRP, EU Operational Programs 2021-27) in green transformation and digitization</td>
<td>Negative demographic trends and labor market uncertainty</td>
</tr>
</tbody>
</table>
Productivity of Polish enterprises in 2009-2019

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)
Productivity of Polish enterprises in 2009-2019

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 firm (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.
Productivity of Polish enterprises in 2009-2019

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*).
Productivity of Polish enterprises in 2009-2019

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

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).
Productivity of Polish enterprises in 2009-2019

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

1. **Within firm** (*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**
How to measure firm-level technology sophistication?

Technology Adoption Survey
Technology Adoption Survey – methodology

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.

<table>
<thead>
<tr>
<th>Representativeness</th>
<th>Poland’s representative sample of <strong>1,500 companies</strong> with more than 5 employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm sizes (6)</td>
<td>(1) 5-9, (2) 10-19, (3) 20-49, (4) 50-99, (5) 100-249, (6) 250+ employees</td>
</tr>
<tr>
<td>Sector of activity</td>
<td>agriculture, manufacturing (food processing, apparel, automotive, pharmaceuticals and others) and services (trade, financial services, land transport, health care and others)</td>
</tr>
<tr>
<td>Macroregions (7)</td>
<td>Mazowieckie, central Poland, southern Poland, northwestern Poland, southwestern Poland, northern Poland, eastern Poland</td>
</tr>
</tbody>
</table>

| 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. |
Technology Adoption Survey – methodology

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.

<table>
<thead>
<tr>
<th>Technologies and capabilities</th>
<th>Firms characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Business Functions (GBF)</td>
<td>General characteristics of the firm</td>
</tr>
<tr>
<td>Sector-specific Business Functions (SBF)</td>
<td>Balance sheet and HR (finances, employment, labor productivity)</td>
</tr>
<tr>
<td>7 typical technologies applied to all firms</td>
<td>11 business functions applied to firms in a specific sector</td>
</tr>
</tbody>
</table>
TAS provides information on 7 business functions that every company performs in its daily operations- General Business Functions (GBF)

<table>
<thead>
<tr>
<th>Business administration</th>
<th>Production planning</th>
<th>Sourcing and procurement</th>
<th>Marketing and product development</th>
<th>Sales</th>
<th>Payment methods</th>
<th>Quality control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handwritten processes</td>
<td>Handwritten processes</td>
<td>Manual search of suppliers, without centralized database</td>
<td>Informal chat (face-to-face)</td>
<td>At the establishment</td>
<td>Cash</td>
<td>Manual, visual or written processes without the support of digital technologies</td>
</tr>
<tr>
<td>Computers with standard software (e.g., Excel)</td>
<td>Computers with standard software (e.g., Excel)</td>
<td>Computers with standard software (e.g., Excel)</td>
<td>Online chat</td>
<td>Direct sales by phone or email</td>
<td>Bank wire</td>
<td>Manual, visual or written processes with the support of digital technologies</td>
</tr>
<tr>
<td>Mobile apps or digital platforms</td>
<td>Mobile apps or digital platforms</td>
<td>Mobile apps or digital platforms</td>
<td>Structured customer surveys</td>
<td>Sales through social media</td>
<td>Credit or debit card</td>
<td>Manual, visual or written processes with the support of digital technologies</td>
</tr>
<tr>
<td>Computer with specialized software</td>
<td>Computer with specialized software</td>
<td>Supplier Relationship Management (SRM)</td>
<td>Customer Relationship Management (CRM)</td>
<td>Online sales via platforms (e.g., eBay)</td>
<td>Online banking</td>
<td>Automatic processes control</td>
</tr>
<tr>
<td>Enterprise Resource Planning (ERP)</td>
<td>Enterprise Resource Planning (ERP)</td>
<td>SRM Integrated with production planning</td>
<td>Big Data or Artificial Intelligence (AI)</td>
<td>E-commerce</td>
<td>Online through a platform (PayU)</td>
<td>Automated systems for inspection</td>
</tr>
</tbody>
</table>

The higher the technological sophistication, the higher the index value

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

### Example Food Processing

<table>
<thead>
<tr>
<th>Input testing</th>
<th>Mixing, blending and cooking</th>
<th>Antibacterial processes</th>
<th>Packaging</th>
<th>Food storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sensory systems (visual, smell, etc.)</td>
<td>Manual processes</td>
<td>Minimal processing preservation methods</td>
<td>Manual packing in bags, bottles, or boxes</td>
</tr>
<tr>
<td>2</td>
<td>Review of supplier testing on Certificate of Analysis</td>
<td>Mechanical equipment requiring human force to operate</td>
<td>Antibacterial wash or soaking</td>
<td>Human-operated mechanical equipment for packaging in bags, bottles, or boxes</td>
</tr>
<tr>
<td>3</td>
<td>Non-computer-controlled testing kits</td>
<td>Power equipment requiring routine human interaction</td>
<td>Thermal processing technologies</td>
<td>Automated process with minimal human interaction</td>
</tr>
<tr>
<td>4</td>
<td>Computer testing such as chromatography or spectroscopy</td>
<td>Power equipment controlled by computers or robotics, with minimal human interaction</td>
<td>Other advanced methods such as high-pressure processing (HPP) and pulsed electric field (PEF)</td>
<td>Fully automated with robotics</td>
</tr>
</tbody>
</table>
**Technology Adoption Survey – methodology**

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.

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

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

Technology Index on the **intensive margin** = 2
Results from Technology Adoption Survey in Polish enterprises
Technology Adoption Survey results from Polish enterprises

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.

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

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)
Technology Adoption Survey results from Polish enterprises

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.

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

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

**General Business Functions**
- Technological Index for the extensive margin = 2.92
- Technological Index for the intensive margin = 2.14

*THE WORLD BANK*
Technology Adoption Survey results from Polish enterprises

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

Note: In a representative sample for Poland (1500 firms): 11% exporters only, 8% importers only, 9% exporters and importers, 72% neither exporters nor importers.
Technology Adoption Survey results from Polish enterprises

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

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).

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.
Technology Adoption Survey results from Polish enterprises

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.

The level of technological sophistication (GBFs) across sectors

- **Horizontal line inside of the box**: median
- **Dot**: average
- **Lower hinge**: 25th percentile
- **Upper hinge**: 75th percentile
Technology Adoption Survey results from Polish enterprises

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.

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<th>Sectors</th>
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<th>Exporters</th>
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<td>&lt;1%</td>
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<td>Food Proces.</td>
<td>2%</td>
<td>15%</td>
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<tr>
<td>Apparel</td>
<td>&lt;1%</td>
<td>46%</td>
</tr>
<tr>
<td>Automotive</td>
<td>16%</td>
<td>75%</td>
</tr>
<tr>
<td>Pharma.</td>
<td>22%</td>
<td>67%</td>
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<tr>
<td>Trade</td>
<td>&lt;1%</td>
<td>20%</td>
</tr>
<tr>
<td>Finance</td>
<td>3%</td>
<td>1%</td>
</tr>
<tr>
<td>Transport</td>
<td>&lt;1%</td>
<td>20%</td>
</tr>
</tbody>
</table>
Technology Adoption Survey results from Polish enterprises

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.

### Technological sophistication (SBFs) across sectors

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Technology Adoption Survey results from Polish enterprises

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.
Technology Adoption Survey results from Polish enterprises

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

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

<table>
<thead>
<tr>
<th>Sectors</th>
<th>Share of firms Poland</th>
<th>Share of firms Korea</th>
<th>Share of large firms (100+) Poland</th>
<th>Share of large firms (100+) Korea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>1%</td>
<td>8%</td>
<td>2%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>22%</td>
<td>42%</td>
<td>8%</td>
<td>3%</td>
</tr>
<tr>
<td>Services</td>
<td>77%</td>
<td>50%</td>
<td>3%</td>
<td>2%</td>
</tr>
</tbody>
</table>

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

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)?
Policy recommendations

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.
Policy recommendations

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.
Policy recommendations

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.
Policy recommendations

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.
Policy recommendations

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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