PATHS AND DRIVERS OF PRODUCTIVITY GROWTH IN POLAND

A FIRM LEVEL PERSPECTIVE ON TECHNOLOGY ADOPTION AND FIRM CAPABILITIES

EXECUTIVE SUMMARY

European Commission
Ministry of Economic Development and Technology
Statistics Poland
WORLD BANK GROUP

PATHS AND DRIVERS OF PRODUCTIVITY GROWTH IN POLAND

A FIRM LEVEL PERSPECTIVE ON TECHNOLOGY ADOPTION AND FIRM CAPABILITIES

EXECUTIVE SUMMARY

WORLD BANK GROUP

Ministry of Economic Development and Technology

Statistics Poland

This project is carried out with funding by the European Union via the Structural Reform Support Programme and with the support and the partnership of the European Commission's DG REFORM

1818 H Street NW
Washington DC 20433
Telephone: 202-473-1000
Internet: www.worldbank.org

This document was produced with the financial assistance of the European Union. The views expressed herein can in no way be taken to reflect the official opinion of the European Union.

Trust Fund (No. TF073493) — EC Contract No REFORM/GA2020/007.

Cover design:
Wojciech Wołocznik, Cambridge, United Kingdom

Interior design and typesetting:
Piotr Ruczynski, London, United Kingdom

KEY FINDINGS

1. In Poland, labor productivity growth equalled 4 percent per year between 2009 and 2019, three-fourths of which resulted from increases in total factor productivity (TFP); remaining gains reflected growth of capital used by each worker.

2. Even though the aggregate productivity measured by TFP grew during the analysis period, the manufacturing and services sectors followed distinctly different productivity paths: the TFP in Polish manufacturing stagnated starting in 2012, while services experienced an uninterrupted rate of TFP growth of 4 percent per year.

3. The manufacturing sector's productivity stagnation between 2012 and 2019 resulted mainly from deterioration in the allocative efficiency—capital and labor were allocated in less productive firms than the sectoral average—in the largest manufacturing industries: metals and food (together one-third of manufacturing's gross value added). During that period, the low-productivity firms in these industries grew and expanded their market share to the detriment of more productive firms.

4. Deterioration in allocative efficiency pulled down the aggregate productivity of the entire manufacturing sector. This negative pattern changed the trend observed since 1997 of improvements in allocative efficiency driving TFP growth in Poland's manufacturing sector.

5. Starting in 2016, productivity growth accelerated in both manufacturing and services, to the point that firm-level efficiency improvements, such as innovation, better managerial capabilities, or adoption of more efficient technologies, drove most productivity growth. To gain insight into the source of productivity improvements at the firm level, the novel World Bank's Technology Adoption Survey (TAS) was conducted among 1,500 Polish firms.

6. 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.

7. Polish firms employing more advanced technologies are on average more productive than others.

8. The scale of a business matters most for its level of technological sophistication. The chances that a small business will adopt the most sophisticated technologies are slim; technology advancements require firms to upscale.

9. Management capabilities and practices are crucial for general-purpose technology adoption and seem to be more important than workers' skills. Firms that participate in international trade are more likely to be more technologically advanced.

10. Polish firms in need of technological upgrading may be the most reluctant to adopt new technologies due to overconfidence and self-assessment bias. The least technologically advanced firms perceive their capabilities as being higher than they actually are.

11 Polish firms either consider themselves financially constrained or assume that returns on technology adoption are insufficient. This differentiates Poland from other countries, and Polish firms, also as compared to other countries, appear less concerned about their competition, giving depreciation as their main reason for adopting new technology.

KEY RECOMMENDATIONS

1. **Improve enterprises' awareness to overcome their self-assessment bias, overconfidence, and undervaluation of technology adoption.** Enterprises' awareness of their gaps in and returns from technology adoption could be increased by including obligatory needs assessments in the instruments supporting technology adoption, as well as by enhancing the capabilities of the Future Industry Platform, the Digital Innovation Hubs network, and other business support institutions. The role of Digital Innovation Hubs can be expanded, and they can perform as one-stop-shop information sources for addressing the broad range of enterprises' technological needs.

2. **Support technology adoption.** Technology adoption should be fostered by maintaining the supply of public support for adoption of operational technologies, that is, those crucial to the largest manufacturing productivity improvements. Since no one-size-fits-all solutions exist for supporting technology adoption, to maximize impact on adoption of various technologies simultaneously interventions must account for heterogeneity of various technologies' adoption paths. The linkages between SMEs and larger entities, including both international firms and SOEs, must be increased through, for instance, supplier development programs in tradable sectors.

3. **Enhance firms' capabilities.** The widespread adoption of off-the-shelf general business function technologies should be supported, including adoption of less advanced technologies, by a broader group of MSMEs. Programs should include nonreturnable components for complementary capabilities; offering returnable support for investments in technology acquisition would encourage companies to develop the capabilities necessary to take advantage of opportunities to adopt new solutions. Support for building supplementary capabilities should not be limited to key managers, but should also include acquisition and development of talent, given that a workforce with adequate skills and in-firm incentives for using newly adopted technologies are key to promoting productivity.

4. **Investigate barriers for growth and improve allocative efficiency in manufacturing.** Deterioration in allocative efficiency in manufacturing calls for attention to the structure and targeting of incentive programs in the form of tax relief, subsidized credits, grants, and other types of firm-specific interventions. Supporting potential high-productivity firms should not be limited to subsidizing selected growth-enhancing investments but should primarily focus on improving the business environment, increasing competition, and facilitating access to finance. Since large establishments are on average more technologically sophisticated, there is an empirical call for removing regulatory barriers to firm scale-up.

5. **To ensure continuous learning, monitoring and evaluation procedures must be strengthened, and data accessibility should be improved.** It is necessary to establish functional coordination mechanisms for technology adoption policies and to enhance the supplementary capabilities of various institutions. Building the institutional capacity of national statistical offices is essential for evidence-based policy design. Moreover, delivering high-quality research depends on government openness to sharing data. In this regard, Poland could establish an Innovation and

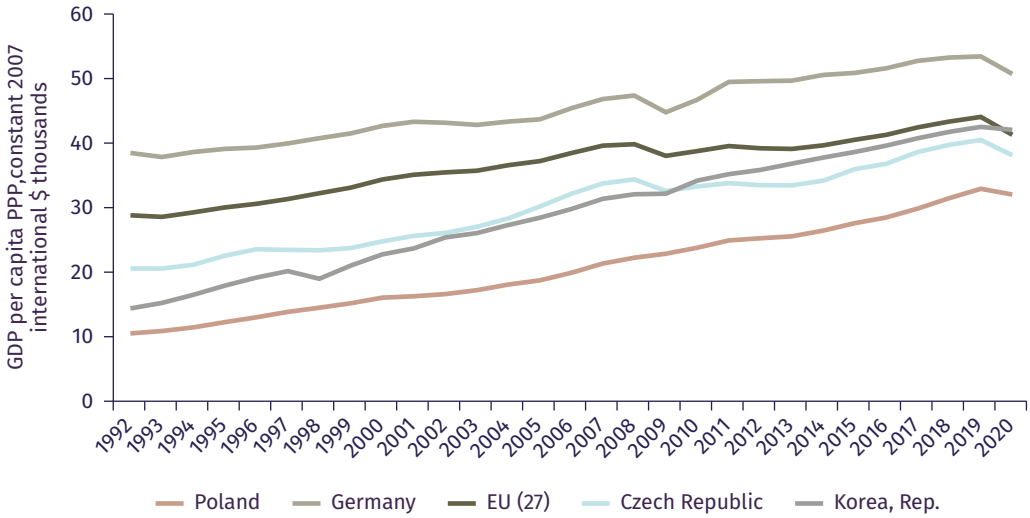
Productivity Excellence Centre or a similar entity (see also World Bank 2019) to provide analytical inputs for designing policy instruments and facilitate a knowledge platform with a repository of best practices related to policy design, implementation, and evaluation.

EXECUTIVE SUMMARY

Why is productivity important?

Ever since a long period of economic transformation that included a series of market-oriented reforms and joining the European Union (EU), Poland has been one of the fastest-growing economies in the world. The Polish gross domestic product (GDP) per capita tripled between 1992 and 2020, and the country reached high-income status in 2009. Despite this remarkable growth, Poland still lags many European comparator countries, with an income per capita currently at three-quarters of the EU average (Figure 1). Factors delaying the catch-up with advanced economies include weak innovation performance, insufficient technology adoption, and labor force digital skills below the EU average (European Commission 2021). With investment at an all-time low — as of 2021, the investment rate was the lowest since the 1990s and amounts to less than 17 percent of GDP — and with challenges related to population's aging, Poland's long-term growth will increasingly depend on productivity advances, likely more so than in other advanced economies.

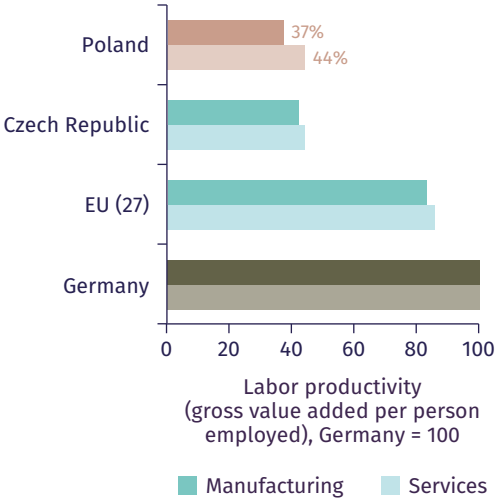
FIGURE 1 GDP per Capita, 1992–2020



Note: EU = European Union; GDP = gross domestic product; PPP = purchasing power parity.
Source: Elaboration based on World Development Indicators.

Despite Poland's remarkable economic growth, a manufacturer in Poland still needs almost three times as many employees to produce the same output as an average manufacturer in Germany. In 2019, gross value added per person employed in a manufacturing firm in Poland, a measure of labor productivity (see Box 1), was only 37 percent of the German average and slightly lower than in the Czech Republic (Figure 2). Labor productivity across manufacturing and services in Poland is substantially lower than in the EU. In fact, an average firm in Poland needs more than twice as many workers to produce the same output as an average EU firm. However, the difference in labor productivity is not only caused by lower efficiency of production, but also by the less valuable products manufactured (see Box 1). Given that larger firms are on average more productive, the size structure of establishments in Poland matters for aggregate productivity. For instance, in Poland, more than one-third of employees work in micro companies, while in Germany only one-fifth do. Similarly, 41 percent of Germany's labor force is employed in the largest companies (those with more than 250 employees), compared to 30 percent of Poland's.

FIGURE 2 Labor Productivity as Share of Germany's, 2019



Note: Latest available data is for 2019. EU = European Union
Source: Elaboration based on Structural Business Survey (Eurostat 2022).

Digitization and technology adoption can lead not only to significant productivity improvements but can also increase the economy's resilience to external shocks, such as the COVID-19 pandemic. An empirical consensus holds that digital technology adoption can bring substantial productivity-enhancing and competitiveness-increasing benefits, as well as improve firm-level economic resilience. The pandemic outbreak uncovered the importance of digital technologies, such as cloud storage, e-commerce, and mobile banking, that help firms not only improve their efficiency but also ensure business continuity. Even though firms have made significant progress in digitalization, especially since the beginning of the COVID-19 pandemic, Poland still struggles to keep up with its European comparators. Given the relatively low willingness of Polish entrepreneurs to train their labor force or adopt firm-level technology, as well as the only slow improvements made in managerial practices, policy interventions that facilitate the digital transformation of the economy may be needed.

BOX 1 What is productivity?

Productivity measures the technical efficiency in production — how the economy transforms the factors of production, such as capital and labor, into output. Productivity can be quantified using two main indices: **labor productivity and total factor productivity (TFP)**.

Labor productivity indicates how much value added is produced per employee. Thus, it indicates how efficiently labor is employed in production, which also depends on the intensity of capital used in the production process. Consider two hypothetical textile manufacturers that produce the same number of shirts. The first produces handcrafted shirts with two workers. The second uses high-tech equipment to produce shirts of similar quality with only one machine operator. As labor productivity is measured as the value of output over the number of employees, it would be two times lower for the producer that handcrafts shirts, even though both producers make the same number of shirts of the same quality and price. Moreover, it is important to consider that **labor productivity comprises the price effect**. If producing a handcrafted shirt requires employing two sewers but the shirt is sold for a price twice as high as a shirt produced with high-tech equipment and one operator, the labor productivity of both textile manufacturers would be the same.

TFP captures how efficiently firms transform inputs into outputs. Thus, it captures the increase in output that is not attributed to a change in the quantity of factors of production (labor and capital). The higher the TFP, the less labor or capital is needed for a given output. TFP can depend on a range of factors, such as skills, organizational structure, managerial talent, and adaptation or innovation of new or better technologies and processes to produce larger amounts or higher-quality products or services with fewer resources. Again, consider two hypothetical textile manufacturers. Both produce handcrafted shirts. The first implemented an innovative method of cutting out the material and trained its employee in it; that employee is now able to sew a second shirt from the leftover material. (Before innovation the leftover material was discarded as production waste.) Due to innovation, the TFP of the first textile manufacturer has doubled, but labor productivity has stayed the same, as he still produces the same number of shirts. **TFP also comprises the price effect.** Consequently, if two hypothetical countries employ labor and capital in the production process with the exact same efficiency but the first country is producing Ferraris and the second one Skodas, both the labor productivity and TFP would be higher for the country hosting the Ferrari factory.

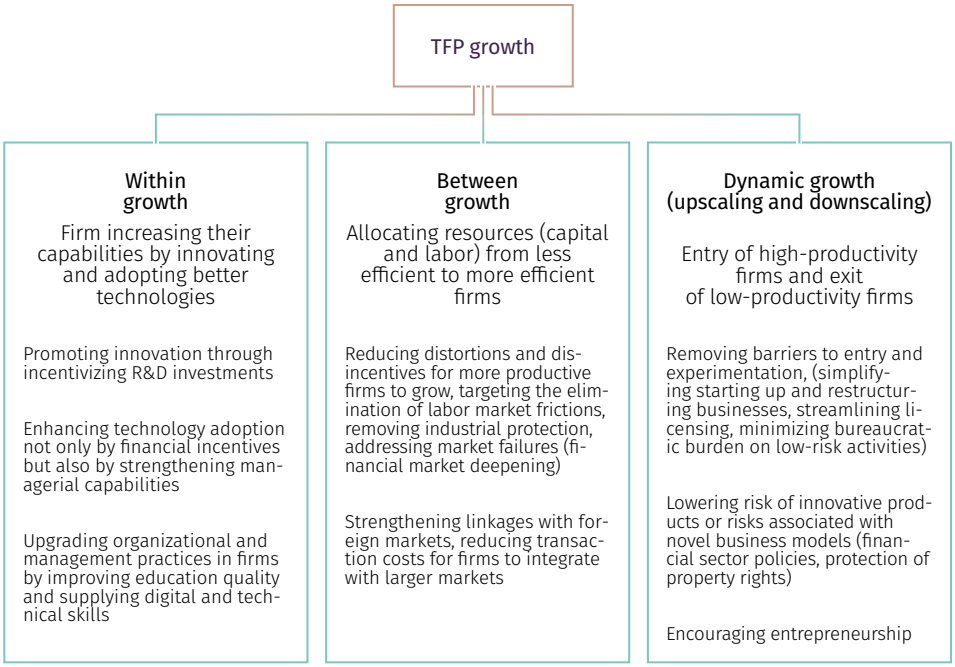
How to improve aggregate productivity

Effective policy design to boost productivity requires comprehensive knowledge about the drivers and barriers to efficiency improvements, which requires a very high level of detail and analyses using firm-level data. Productivity can grow through three main channels: (i) by improving efficiency within firms, e.g., by adopting better technology, increasing managerial skills, or innovation; (ii) by reallocating resources between firms and sectors to more efficient companies (market shares of more productive companies increasing); and (iii) by enabling higher-productivity firms to enter and less successful establishments to exit. Even without productivity growth due to innovation or adoption of better technology, reallocating production factors such as capital and labor from less to more productive establishments increases economy-wide productivity.

Therefore, barriers to such reallocation suppress an industry's productivity performance and, hence, aggregate productivity growth. However, significant productivity improvements require progress on every front. Even if the business environment is crystalline, growth will not occur if entrepreneurs do not have the human capital necessary to take advantage of it. To support productivity, Poland must design and adopt an effective mix of policies to improve market functioning, create an efficient business environment, and provide incentives for upgrading entrepreneurship and firms.

BOX 2 How to boost productivity

Aggregate productivity can grow in four ways. First, firms can increase their capabilities (within-firm productivity growth). Second, resources can be reallocated from less productive to more productive firms (between-firm productivity growth). Third, more productive firms can enter the market (upscaling). Fourth, less successful firms can exit the market (downscaling). The latter two can be considered together as dynamic productivity growth or net entry. Boosting productivity requires policy actions addressing all components of productivity growth.

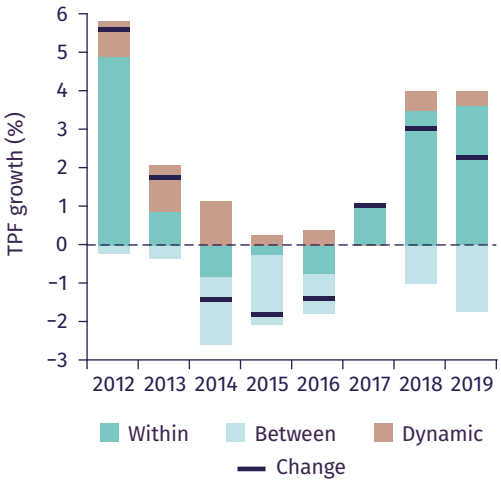


Sources: Cirera and Maloney 2017; Cusolito and Maloney 2018.

Two-speed productivity growth in Poland

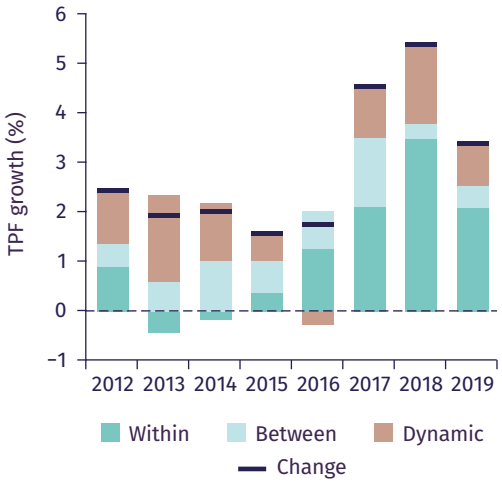
Despite Poland's remarkable economic growth, productivity growth in the manufacturing sector has stagnated since 2012 and is significantly lower than productivity growth in services. The analysis of small, medium, and large firms indicates that economy-wide TFP grew annually on average by 3 percent between 2009 and 2019. However, manufacturing and services have followed distinctly different productivity trends. TFP in manufacturing has not improved significantly since 2012 (Figure 3), while the service sectors demonstrate continuous modest TFP growth of 3 percent per year (Figure 4). Except for 2012, labor productivity follows an overall increasing trend in all sectors over the entire 11-year sample period. Faster labor productivity growth compared to TFP suggests an increasing capital intensity of production methods between 2009 and 2019. In other words, to a large extent, firms expanded production by using more machines per employee rather than by improving production efficiency.

FIGURE 3 Manufacturing Sector Productivity Growth Decomposition between 2009 and 2019



Note: The figure shows the results of decomposing 3-year productivity growth rates in manufacturing using the Melitz-Polanec method, smoothed to represent an annual change.
Source: Elaboration based on Statistics Poland calculations.

FIGURE 4 Service Sector Productivity Growth Decomposition between 2009 and 2019



Note: The figure shows the results of decomposing 3-year productivity growth rates in services using the Melitz-Polanec method, smoothed to represent an annual change.
Source: Elaboration based on Statistics Poland calculations.

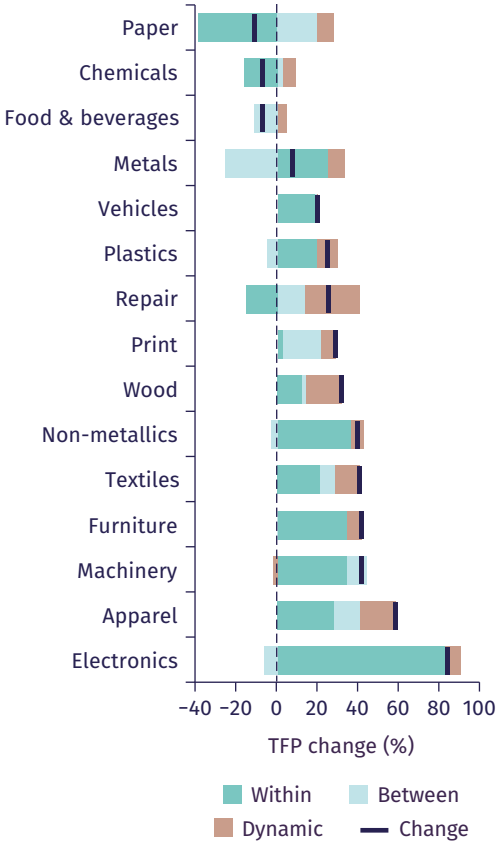
Declining efficiency of resource allocation (between-firm change) was responsible for the productivity slowdown in manufacturing, while in services, efficient allocation drove productivity growth in the same period. Manufacturers with a below-average pace of productivity growth were able to increase

their share in the sectoral revenue at the cost of more productive firms — this means that the production inputs were not allocated to firms in which they would be most efficiently used. This calls for policy attention because the worsening allocative efficiency in manufacturing broke the trend observed since 1997 in which between-firm components drove aggregate productivity growth in Poland (World Bank 2017). It points to the importance of removing barriers to the undisturbed flow of production factors and removing regulatory restrictions on competition. Economic policy in Poland would reap positive benefits for the country by supporting business ecosystems rather than by helping inefficient establishments survive. At the same time, the mechanism of improving allocative efficiency contributed positively to the productivity of firms in services. The service sector in Poland had uninterrupted positive productivity growth throughout the sample period, with an increase in the growth rate after 2016 (Figure 4). This indicates that productivity performance across Polish sectors is heterogeneous and that designing effective policies to boost productivity requires a great deal of sophistication and evidence-based targeting.

Significant productivity differences between industries in Poland

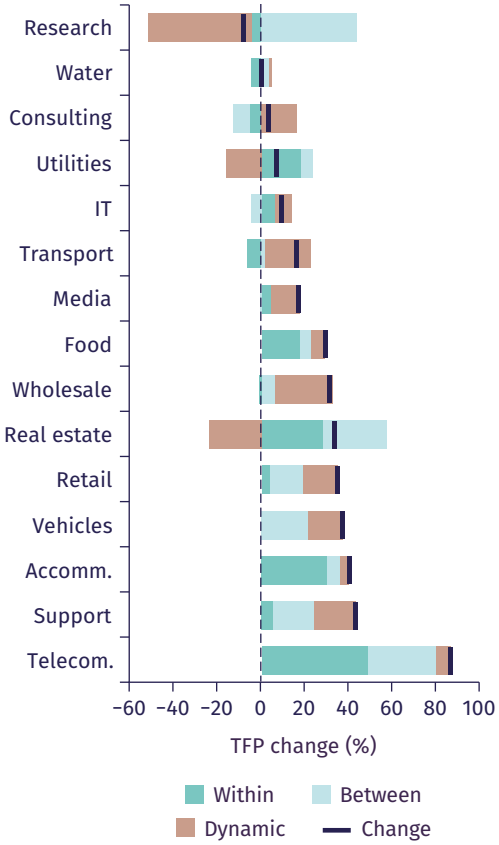
Large low-productivity producers in the two biggest manufacturing industries — food and beverages and metals — increased their market share over time at the cost of more productive firms within their industries, reducing the manufacturing sector's aggregate productivity performance. Given the substantial differences across sectors due to characteristics of production, market structure, or surrounding business environment, analyzing the heterogeneity of productivity growth is necessary to understand the paths it can take. Each industry faces unique market conditions and has distinct technologies and skills. Without comprehensive knowledge about the nature of this heterogeneity, it is difficult to successfully design a cost-effective system of productivity-enhancing incentives. Moreover, the results of productivity decomposition on the industry level, depicted in Figures 5 and 6, have revealed not only that manufacturing and services follow distinctly different productivity paths but that productivity performance varies widely within sectors. Food and metals sectors experienced decreases in the between-firm component, but at the same time allocative efficiency improved in some manufacturing industries, such as electronics, apparel, or textiles. Simultaneously, many industries within services — ICT, real estate, retail, etc. — benefited from the market mechanism of properly allocating resources (in the case of services, mostly labor).

FIGURE 5 Productivity Growth Decomposition in Manufacturing Industries between 2009 and 2019



Note: The figure shows the results of decomposing productivity growth rates using the Melitz-Polanec method. The green and red vertical bars represent the positive and negative productivity change, respectively.
Source: Elaboration based on Statistics Poland calculations.

FIGURE 6 Productivity Growth Decomposition in Service Industries between 2009 and 2019



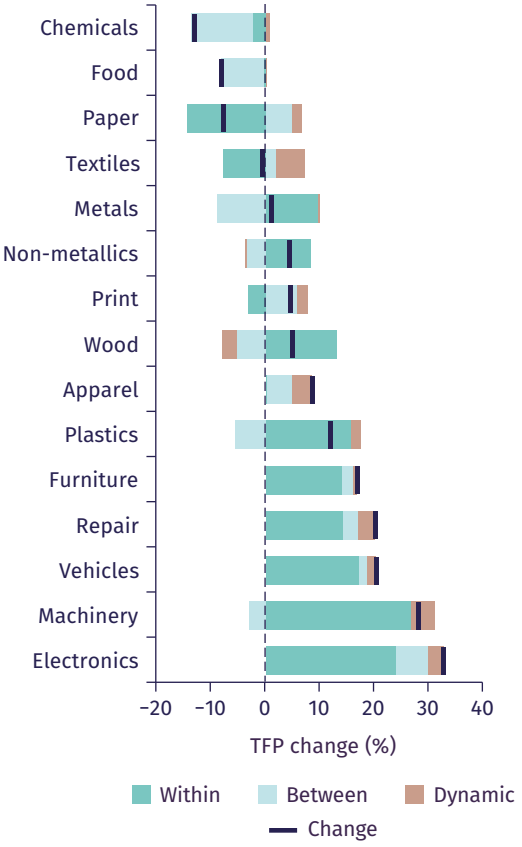
Note: The figure shows the results of decomposing productivity growth rates using the Melitz-Polanec method. The green and red vertical bars represent the positive and negative productivity change, respectively.
Source: Elaboration based on Statistics Poland calculations.

Positive productivity shock starting from 2016

Since 2016, Poland has experienced a universal positive productivity, driven mainly by within-firm productivity growth. After 2016, both in manufacturing and services, firms' own productivity performance was the main driver of the accelerated aggregate productivity performance (Figures 5 and 6). To illustrate the positive productivity growth phenomena, Figures 7 and 8 depict the decomposition of productivity growth within manufacturing and services between 2016 and 2019. The figures make it clear that only after 2016 was positive within-firm

performance in manufacturing able to counteract the worsening resource allocation. Moreover, the industries with the biggest efficiency improvements owe their outstanding productivity performance to the within-firm component. In services, on the other hand, those positive within-firm productivity improvements were significantly strengthened by the market mechanism that allocated resources to the most efficient enterprises, allowing more productive firms to grow and expand. Moreover, those within-firm improvements were not as substantial as in manufacturing. One possible reason is that large efficiency improvements usually come from significant capital deepening attributed mainly to manufacturing firms.

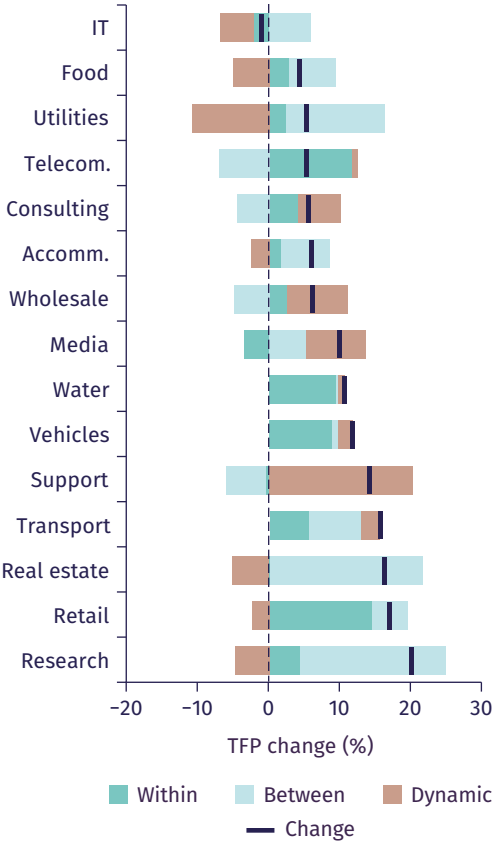
FIGURE 7 Manufacturing Sector Productivity Growth Decomposition between 2016 and 2019



Note: The figure shows the results of decomposing productivity growth rates using the Melitz-Polanec method. The green and red vertical bars represent the positive and negative productivity changes.

Source: Elaboration based on Statistics Poland calculations.

FIGURE 8 Productivity Growth from the Within Component vs. Between Component in Manufacturing Industries between 2016 and 2019

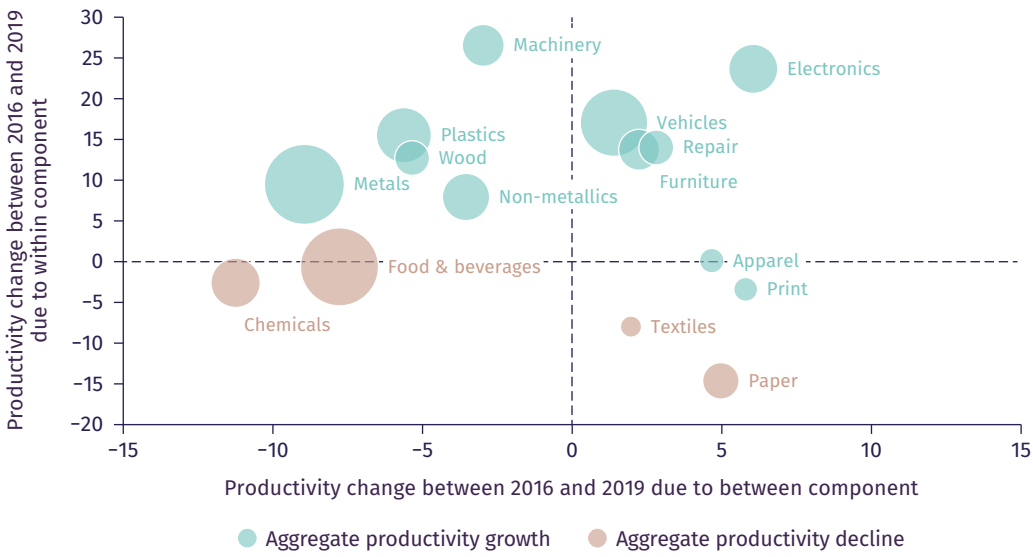


Note: An industry's relative size represents the percentage of revenues generated in that industry. The green and red bubbles represent the aggregate productivity growth and decline, respectively.

Source: Elaboration based on Statistics Poland calculations.

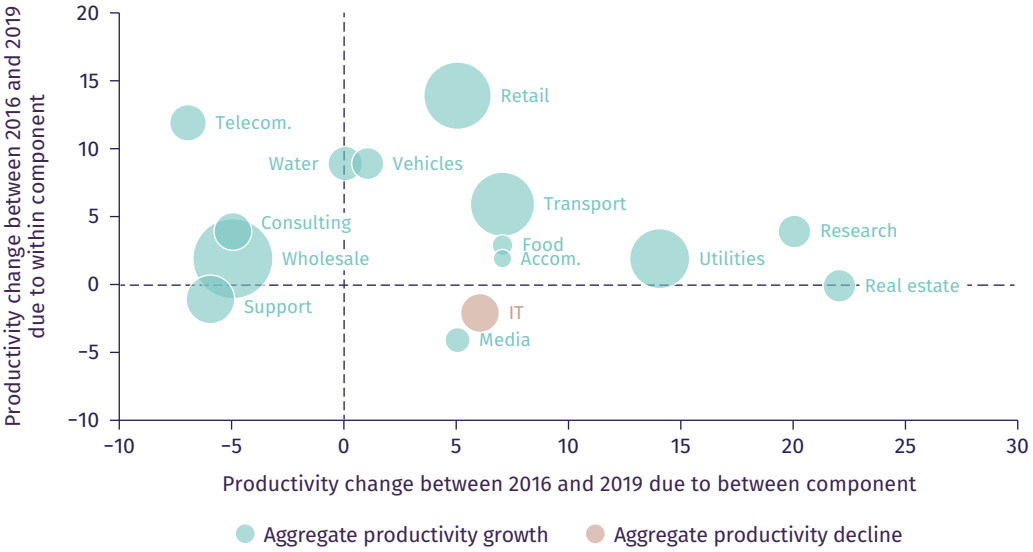
Reducing distortions and allowing markets to work efficiently is a never-ending job, but the empirical evidence suggests that at the current level of development, substantial economy-wide productivity improvements come mainly from firms improving their efficiency performance. Figures 9 and 10 depict the relative role within-firm and between-firm components play in improving aggregate productivity and the importance of the specific industries in the process (note the size and color of the bubble). First, the largest manufacturing industries — chemicals, food, and metals — experienced not only negative contribution from allocative efficiency but also within-firm productivity improvements below those reported in other industries (Figure 9). At the same time, services industries, regardless of market size, underwent comparable within-firm efficiency growth that for some was reinforced by favorable market allocation of resources (Figure 10). Besides significant differences between industries in their productivity performance, it's also important to realize that within-firm improvements represent a broad catalog of scenarios and hypotheses that could explain increasing productivity after 2016. Due to the methodological limitations, to some degree, the within component embodies the demand-side effects of productivity increases, reflecting demand shocks, possibly global, and whatever factors drive price variation. On the other hand, the improvements might result from firms adopting better technology, increasing managerial skills, or innovation. Without

FIGURE 8 Service Sector Productivity Growth Decomposition between 2016 and 2019



Note: The figure shows the results of decomposing productivity growth rates using the Melitz-Polanec method. The green and red vertical bars represent the positive and negative productivity changes.
Source: Elaboration based on Statistics Poland calculations.

FIGURE 9 Productivity Growth from the Within Component vs. Between Component in Service Industries between 2016 and 2019



Note: An industry's relative size represents the percentage of revenues generated in that industry. The green and red bubbles represent the aggregate productivity growth and decline, respectively.
Source: Elaboration based on Statistics Poland calculations.

looking specifically at what drives firms' efficiency, the within component remains a black box. Luckily, the World Bank's survey instrument — Technology Adoption Survey (TAS) —helps to open this box and translates the within-firm productivity growth into actual firm-level technology sophistication.

How technologically advanced are firms in Poland?

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 Function Index for Poland on a scale from 1 to 5, is 2.14 for the intensive margin and 2.92 for the extensive margin (see Box 3 and Appendix A.1). Thus, an average Polish firm is most likely to sell its products directly, either on the premises or via phone or email. It employs manual (handwritten) processes for quality control and standard computer software for planning (either production or services) and procurement. Administration processes such as accounting or HR are most likely performed with specialized or standard software, and enterprises benefit from online banking or simply pay with cash. Marketing and customer feedback methods are the most

basic: firms use face-to-face chat rather than sophisticated marketing techniques. The difference between intensive and extensive margin means that even though firms might have access to more advanced processes to run their businesses, they are prone to use less advanced ones or are shifting to a new technology. However, technology sophistication varies significantly across business functions, and the gap between intensive and extensive margin also depends on business function.

BOX 3 What is the Technology Adoption Survey?

The firm-level Technology Adoption Survey (TAS) is a tool designed and implemented by the World Bank (Cirera et al. 2020) to collect detailed information from a representative sample of firms about the technologies they use to run their businesses; the results are then used to rank the firms on the sophistication ladder, creating a measure of within-firm technology sophistication. The measure is comparable across countries, sectors, and firms with different characteristics such as size, ownership status, etc. Moreover, the firm-level approach allows researchers to investigate the multidimensionality of technology adoption and use, including existing heterogeneity, sector differences, impact on firm performance, and main barriers and drivers that explain technology adoption and use. Given the international nature of the instrument, the survey's results allow detailed comparison of technology sophistication across countries and identification of regional and world adoption leaders and front-runners.

The survey differentiates **between the general business functions (GBFs)** that all firms conduct, regardless of the sector they operate in, including (1) business administration, (2) production planning, (3) sourcing and procurement, (4) marketing, (5) sales, (6) payment methods, and (7) quality control; and the **sector-specific business functions (SBFs)** associated with core production or service provision activities that are relevant only for firms in the sectors selected for the survey, which were (1) crops and livestock (agriculture), (2) food processing, (3) wearing apparel, (4) pharmaceuticals, (5) automotive, (6) wholesale and retail, (7) financial services, (8) land transport, and (9) health services. General business functions are presented with their corresponding ranks in the Appendix Figure A.1, and more details on the survey structure and the sector-specific businesses are included, with other results, in "Drivers of Productivity Growth in Poland — A Firm-Level Perspective on Technology Adoption and Firm Capabilities" and "Sectoral Approach to the Drivers of Productivity Growth in Poland: Technology Adoption and Firm Capabilities."

To analyze the level of adoption of a technology and its use in a systematic and comparable way, the technology sophistication index for each business function was constructed. The index varies between 1 and 5, where 1 stands for the most basic level of technology being used and 5 reflects the most sophisticated level being used. With the help of technology experts for each industry, the technologies in each business function were ranked according to their sophistication. The survey asks two types of questions about technologies employed: (1) whether the firm adopted a given technology to conduct the tasks of the given business function, and (2) which of these technologies is the most frequently used for a given business function. Hence, the technology sophistication for a given business function is measured on the extensive margin, the sophistication of technologies adopted (available in a firm), and on the intensive margin, the technology most frequently used to perform the task. By construction, the intensive margin index equals or is smaller than the extensive margin index.

The survey was implemented in collaboration with Statistics Poland (GUS) and conducted via phone interviews. It included a nationally representative sample of 1,500 firms with five or more employees across the agriculture, manufacturing, and service sectors. The survey began in August 2021 and ended in December 2021.

Polish firms usually do not present a clear-cut example of being either technologically backward or at the frontier in everything they do: they tend to use more advanced methods in some areas, and less advanced methods in others. Technology sophistication varies widely across firms in Poland. The gap is even larger for the average within-firm variation: for example, firms frequently use the most sophisticated enterprise resource planning (ERP) software for administration but basic manual processes for quality control. Not only does technology sophistication across and within firms vary widely, but advancement varies significantly across business functions as well. At a relatively early stage of technology sophistication, firms are starting to use relatively advanced payments and business administration processes but to adopt more advanced quality control, marketing, and sales technologies only at the later stages of their average technology sophistication, and therefore currently by a small share of firms in Poland.

What are the factors associated with technology adoption?

The scale of a business matters most for its level of technological sophistication — larger firms are more technologically advanced. Larger firms use more advanced general business function technologies than do smaller establishments, both on the extensive and the intensive margin. The chances that small businesses will adopt the most sophisticated technologies, like enterprise resource planning (ERP) or customer relationship management (CRM) systems, are slim, and technology advancements require firms to upscale. It is unnecessary to incentivize companies to adopt technologies they don't need. Companies are so diverse internally in terms of their level of technological sophistication that each company has certain areas (business functions) it could improve, without forcing itself to the frontier at all costs. Since a firm's growth is inseparable from adoption of more sophisticated technologies, at least two paths exist to bridge the technological gap between Poland and more advanced countries: (i) narrowing the technology gap for each size class, and (ii) changing the structure of the Polish economy and increasing the share of non-micro companies. The gaps between firms of different sizes can be explained by many factors. First, some technologies are used in large-scale business operations and are unsuited for use on a small scale. Second, advanced technologies require skills and capabilities that might be missing in smaller companies: a large company can employ a dedicated worker to introduce and maintain a new technology. Third, if technologies require customization, the costs may be prohibitive for small-scale businesses.

Management capabilities and practices are crucial for general purpose technology adoption and seem to be more important than the skills of workers. Technology adoption correlates positively with skills, capabilities, and learning. The profitability of a firm does not seem to associate significantly with technology adoption, indicating that the costs firms perceive as the main obstacle to adoption are, in fact, not the main barrier to upgrading. Rather, firms use more advanced technologies if they employ managers with the knowledge and capabilities to introduce more technologically sophisticated processes. Moreover, firms that trade internationally or are foreign-owned are more technologically advanced. This suggests that the skills and capabilities of managers and workers, as well as exposure to more advanced technologies used by foreign owners or the headquarters of multinational companies and import and export partners, may create a learning effect and result in adoption of more advanced technologies. On the other hand, the reverse may also hold true. More advanced technologies might require higher skills from managers and workers, multinational companies may require Polish subsidiaries to adopt more advanced technologies, and import and export partners may require more advanced technologies from their Polish trading partners to establish or facilitate the trade and keep up with the international competition.

Where does Poland stand compared to the Republic of Korea?

The average Polish firm is less technologically advanced than the average Korean firm but the difference in technology sophistication between countries is not equally distributed across business functions. Poland is more advanced compared to Korea in terms of payment methods and less advanced for the remaining six business functions. The gap in technology sophistication between an average Polish firm and an average Korean firm is widest for business administration and planning, meaning that average Polish firms employ computers with standard software to run day-to-day administrative and planning processes, while Korean firms use more sophisticated digital platforms for the same processes. When it comes to sourcing and procurement, Korean firms move past manual processes and rely mostly on computer software in this area. However, given Korea's level of economic development and its position as one of the world's leaders in innovation, one might expect a larger gap in technological sophistication between Poland and Korea.

The relatively small difference in average technology sophistication between Poland and Korea is mainly driven by firm sizes in both countries and the service-oriented structure of the Polish economy. A few features drive the

relatively small gap in technology sophistication between Poland and Korea. First, not only does Poland have relatively more large firms than Korea, but hardly any differences exist between the level of sophistication for large firms in the two countries. Second, probably due to Poland's accession to the European Union and the country's cultural and geographical proximity to Western economies, Poland offers attractive conditions for foreign direct investment, and hence the percentage of foreign-owned firms is higher in Poland than in Korea.[1] This may, in turn, influence the aggregate level of technological sophistication. Interestingly, the difference between the two countries on the intensive margin does not translate into the difference on the extensive margin. In comparison to Korea, it seems that fewer Polish firms most frequently use more sophisticated technology to run the business, but more Polish firms have access to more advanced technologies than Korean firms. One possible reason is that Polish enterprises are undergoing technological change, and even though they are not using some technologies most frequently, they have already been adopted. There may also be some managerial practice differences or general attitudes toward change that make the gap between the intensive and the extensive margins in Korean firms smaller than those in Poland.

BOX 4 Korea — A benchmark country for Poland

The Technology Adoption Survey (TAS) allows researchers to compare technology sophistication across countries, and the Republic of Korea is set to be a benchmark country for Poland. Among the ten countries where TAS has been implemented so far, Korea is the only one comparable to Poland. Although geographically very distant, Korea is a good comparator for several reasons. First, both Korea and Poland are frequently called growth miracles, being among the fastest-growing economies in the world in recent decades, reaching high-income status in 1995 and 2009, respectively. Poland's GDP per capita in PPP in 2020 almost doubled since 2000, and the pace of GDP growth was even faster than for Korea: 98 percent growth in Poland, compared to 84 percent in Korea. Despite Poland's remarkable growth performance and the narrowing GDP per capita gap between the two countries, Poland's GDP per capita PPP in 2020 was still equivalent to only 76 percent of Korea's, making Korea an aspiration country for Poland. Surprisingly, when it comes to labor productivity (defined by GDP per hour worked), Poland and Korea follow very similar paths in terms not only of the pace of growth but also of levels. Second, Poland and Korea face similar challenges regarding an aging population, with dramatic increases anticipated in the old-age dependency ratio. Last, Korea is perceived as a global leader in innovation and technology, and Korean companies have been among key foreign investors bringing advanced technologies to Poland.

1. Actually, since 2013, when the two countries signed a strategic partnership, Korean firms (Samsung, LG, SK IE Technology) have been investing heavily in Poland, and Korea is now the largest Asian investor in Poland, with a cumulative value of Korean FDI reaching €3.1 billion as of 2020 (National Bank of Poland 2020).

How does technology adoption vary across Polish sectors?

The technology gaps between agriculture, manufacturing, and services are driven mostly by structural differences between those sectors and not by firm-level technology advancements. The average levels of general business functions indices differ between agriculture, manufacturing, and services, but when controlled by firm characteristics such as the firm size and region those differences become very small. The services sector adopts slightly more advanced technologies for general business functions than do the manufacturing and agricultural sectors, but the differences by sector are negligible and of a much lower magnitude than those by firm size. It seems that firm size is the main driver of technological sophistication but using a more detailed sector classification shows a large degree of heterogeneity in technology sophistication of general business functions within sectors as well.

The pharmaceutical companies in Poland (closely followed by automotive firms) on average use the most advanced general business function technologies. At the same time, pharmaceutical firms have adopted and used a wider range of GBF technologies than firms in other sectors. In the pharmaceuticals and automotive sectors, the intensive general business functions index is significantly larger compared to other sectors. Also, the gaps between the most and the least sophisticated firms in those sectors are the largest, as the within sector variance (the measure of dispersion) for the extensive and intensive margin GBFs indices is almost twice as large as in other sectors. Many differences between sectors stem from the structural or sectoral characteristics (participation in the global value chains or ownership structure). For example, more than 30 percent of establishments in the automotive and pharmaceuticals industries employ more than 100 workers, whereas the country average amounts to only 3 percent. When controlling for different observable firm characteristics, such as firm size or ownership structure, no significant differences emerge in general business functions technology sophistication across sectors.

Does technology sophistication matter for productivity?

In Poland, firms with more advanced technologies are on average more productive. The positive relationship between labor productivity and the firm-level general business functions index holds both for the extensive and the intensive margin, but the correlation is greater for the intensive margin. This implies that while introducing more advanced technologies to a firm is associated with higher productivity, making these technologies the most frequently used technology is accompanied

by even higher productivity levels. Of course, the relationship between labor productivity and technology sophistication is only correlational, so it might be an exaggeration to look for causality. What is also important when linking productivity with technical sophistication is to address the frequently voiced concerns that implementing cutting-edge technology will not be efficiency-enhancing. First, even though those concerns might be partly legitimate for AI solutions or big data analytics at this stage of those technologies' development, the median firm in Poland uses the most basic technologies, namely manual and handwritten methods (without centralized databases or the support of digital solutions) when searching for suppliers and performing quality control. Therefore, Poland is far from falling into the productivity trap. Second, the positive relationship between labor productivity and the firm-level general business functions index is also found in Korea, where the technology sophistication level is higher than in Poland. This might indicate that even in Poland's aspirational peer countries, the positive link still holds and the advanced technologies that might start to be unbeneficial for productivity are very far ahead.

Poland still has a high productivity growth potential realizable from within-firm technological upgrading: moving the bottom 25 percent of firms to median technology sophistication would increase labor productivity by an additional 1 percent. If the firms with an intensive GBF index below the tenth percentile caught up to the median firm in terms of technology sophistication, average labor productivity would increase by 0.8 percent. If the bottom 25 percent of firms caught up to the median firm, average labor productivity would increase by 1 percent. Given that over the last ten years labor productivity grew on average 4 percent every year, such an improvement would be significant (World Bank 2021). The switch is not unrealistic, as the technologies are easily available, still relatively unadvanced, and used by many other companies in Poland. *Ceteris paribus*, it would require the bottom 25 percent of firms to switch to online banking as the most frequently used means of payment and, for instance, to execute all administration, procurement, and planning processes using computer support (not necessarily with specialized software). Obviously, this is a hypothetical simulation, but it shows not only the scale of the potential but also that substantial productivity improvements are not necessarily extremely costly.

What inhibits and enables technology adoption?

Polish firms in need of technological upgrading may be the most reluctant to adopt new technologies due to overconfidence and self-assessment bias. The vast majority of firms in Poland tend to position themselves above the median

compared to other firms in Poland and at a relatively similar level of technology adoption, regardless of their actual technological advancement. The gap between the perceived and actual level of advancement is the largest for the least technologically sophisticated companies. When firms compare themselves to other firms in the world, their assessment is closer to their level of technological development. In both cases, the most sophisticated firms underestimate their level of technological advancement. If the firms' judgment is truly biased, firms need support to correctly identify their gaps and needs.

Polish firms, unlike firms in other countries, consider themselves financially constrained or assume that returns on technology adoption are not sufficient. Compared to those in other countries, Polish firms appear to be less concerned about their competition and list depreciation as the main reason for technology adoption. On average, around 60 percent of firms list finance-related barriers, namely costs or lack of finance, as their main obstacles to technology adoption, a significantly higher percent than in other countries. On the other hand, lack of capacity for technology is significantly less frequently mentioned compared not only to Vietnam and Brazil but also to Korea. Moreover, the differences in obstacles between small and large firms in Poland are more significant than in other countries. When providing reasons for technology adoption, 80 percent of Polish enterprises state that they adopt a new technology when they are forced to replace an old one; this response is much more frequent in Poland than in comparator countries, where either competition or an attempt to reduce costs is the main driver.

What does support for technology adoption look like in Poland?

Up to half of the budget for private sector development in 2021 – 2027 allows investments in technology adoption, totaling €16.7 billion. The need for supporting technology adoption among firms is recognized in strategic documents at the European, national, and regional levels. However, instruments contributing to this objective are broad, technology-agnostic, and follow a demand-driven approach, contrary to the sophisticated approach to advanced technology creation. In the demand-driven approach, it is assumed that firms are aware of their needs; thus, support program targeting is limited, and applicants are expected to identify their needs themselves. As a result, technology adoption is supported mostly through returnable instruments aimed at general improvement of SME competitiveness. Targeted instruments appear only in the context of sustainable technologies when considering the specifications of particular green solutions.

Complementary factors, such as managerial skills and digital readiness, are supported separately from programs aimed at advance technology adoption. Only one-third of all instruments to support technology adoption allow financing for skill upgrading, improving managerial capabilities, or enhancing digital readiness. Instruments aimed at developing firm capabilities are offered predominantly on the regional level and delivered by providers registered in the Development Services Database. Public support for firm-level digitization is concentrated in a dozen instruments aimed at multiple digital objectives. For non-digital technologies, interventions promoting digitization are technology-agnostic, although with higher use of nonrefundable support.

What should be done to increase productivity through technology adoption?

The level of technology sophistication in Polish firms could be increased by reforms in five key areas: building awareness, supporting firm-level technology adoption, strengthening firm capabilities, reducing barriers to scaling up, and improving coordination and use of data.

Enterprises' awareness of their gaps in and returns from technology adoption could be increased by including obligatory needs assessments in the instruments supporting technology adoption, as well as by enhancing the capabilities of the Future Industry Platform, the Digital Innovation Hubs network, and other business support institutions. Both the TAS's results on Poland and the vast literature on the topic indicate that many firms are unaware of their actual gaps in technology and organization and overestimate their level of technological sophistication and managerial capabilities. Moreover, most Polish firms perceive technology adoption as a replacement tool but not as a way to upgrade. To reduce the gaps and improve the selection of the most appropriate technologies and services, high-quality, standardized audits and assessments for critical areas related to technology adoption and firm capabilities should be developed and included as requirements in applications for technology adoption support. Moreover, Future Industry Platform, along with Polish Agency for Entrepreneurship Development and National Centre for Research and Development, could play a critical role in raising awareness about the benefits of adopting all types of technologies, going beyond currently covered Industry 4.0 technologies. The currently developed Digital Innovation Hub network should serve as a one-stop shop for information on addressing the wide technological needs of enterprises, while other business support institutions should be able

to provide basic services and refer interested companies to appropriate public and private service providers.

There is dire need to support widespread adoption of off-the-shelf general business function technologies, including less advanced technologies, by a broader group of MSMEs. Complementary firm capabilities should be supported, as well as linkages between SMEs and larger companies (including foreign companies). Polish firms still often rely on the most basic technologies to conduct some of their everyday operations, but even simple technology upgrades offer high potential for productivity improvements. Policies supporting technology adoption should include objectives related not only to diffusion of frontier technologies but should also promote incremental, gradual upgrades. In addition, embracing standardized technology audits to account for the heterogeneity of needs and adoption paths and an online marketplace with certified off-the-shelf solutions might decrease the search costs and costs of adopting technologies. Results of the TAS confirm the relation evidenced in the literature that successful adoption of technologies is conditional on complementary investments in, for example, managerial and digital skills and new product development. Thus, introducing nonreturnable components for complementary capabilities to programs offering returnable support for investments in technology acquisition would enhance the creation of capabilities necessary to exploit the full benefits of the new solutions. Moreover, opportunities for scaling up demand, in both domestic and foreign markets, will provide incentives for firms to make the technological switch. Stimulating connections between SMEs and larger firms (including foreign firms) can lead to cross-firm learning through standards, requirements, and knowledge sharing from larger to smaller entities.

Since large establishments are on average more technologically sophisticated, there is an empirical call for removing regulatory barriers to firm scale-up and for improving the efficiency of resource allocation, especially in manufacturing. Especially in the manufacturing sector, barriers block the flow of capital and labor between firms. The results show the existence of weak external incentives for adopting technologies, like anti-competitive regulations or subdued demand. Overall regulatory barriers for competition in Poland are higher than the OECD average, with a high degree of public ownership and excessive administrative burdens on the business (OECD 2019). When highly productive or technologically advanced firms encounter larger barriers to increasing their market share, and low-productivity firms remain on the market longer, the need for businesses to upgrade is limited. Liberalization of competition regulation has the potential to drive the pace of technology adoption by providing

market incentives for adoption and accumulation. While anti-competitive barriers should be addressed across the economy, the manufacturing sector requires particular attention, as it faces sector-specific challenges that significantly hold back allocative efficiency.

To ensure continuous learning, monitoring and evaluation procedures must be strengthened. To do so, it is necessary to establish functional coordination mechanisms for technology adoption policies and to enhance supplementary capabilities undertaken by various institutions. The M&E system of all support instruments is predominantly driven by the objective to maintain legal compliance with EU regulations. For this reason, the system focuses on collecting information on activities and outputs of support instruments, with limited insight into medium and long-term impact on beneficiaries. Information for M&E must be gathered in a timely and systematic manner, creating actionable information to adapt instruments, which is particularly important in technology areas, given the heterogeneity of factors driving technology adoption and the fast pace of technological development. Moreover, given the substantial number of institutions responsible for technology adoption, a functional body is needed for ongoing coordination of various initiatives and analysis of their fit with broader policies for private sector development. This coordination body should be supported by a unit with strong analytical capabilities that can generate knowledge based on the beneficiary's data and the rich data available in Statistics Poland.

What is the summary based on?

This document summarizes the results of the project Technological Readiness and Management Skills — Productivity Growth Drivers in Poland, conducted in collaboration with DG REFORM. The project aimed to support the Ministry of Economic Development and Technology in enhancing the effectiveness of firms' support systems in Poland by providing evidence-based information on firms' capabilities, context, and barriers to productivity growth. The project consisted of three phases. Phase 1 focused on understanding firm-level productivity dynamics and analyzing instruments supporting managerial skills and technology adoption. It was concluded with the report "Paths of Productivity Growth in Poland — A Firm-Level Perspective." Phase 2 provided evidence-based information on Polish firms' capabilities by implementing and analyzing a Technology Adoption Survey (following Cirera et al. 2020) and was concluded in two reports: (1) "Drivers of Productivity Growth in Poland: A Firm-Level Perspective on Technology Adoption and Firm Capabilities," and (2) "Sectoral Approach to

the Drivers of Productivity Growth in Poland: A Firm-Level Perspective on Technology Adoption and Firm Capabilities." Phase 3 aims to build capacity and support for the Polish Agency for Enterprise Development to redesign instruments to build firms' capabilities. This executive summary briefly describes the results of the above-mentioned reports.

ABBREVIATIONS AND ACRONYMS

bn	billion
DG REFORM	Directorate-General for Structural Reform Support
EC	European Commission
EU	European Union
EUR	euro
ERP	enterprise resource planning
FDI	foreign direct investment
GBF	general business functions
GDP	gross domestic product
GUS	Statistics Poland
ICT	information and communication technologies
M&E	monitoring and evaluation
MSMEs	micro, small, and medium enterprises
NACE	Statistical Classification of Economic Activities in the European Union
OECD	Organisation for Economic Co-operation and Development
PPP	purchasing power parity
R&D	research and development
SBF	sector-specific business functions
SMEs	small and medium enterprises
SOE	state-owned enterprise
SRM	supplier relation management
TAS	Technology Adoption Survey
TFP	total factor productivity
WBG	World Bank Group

REFERENCES

Cirera, X., and W. F. Maloney. 2017. *The Innovation Paradox: Developing-Country Capabilities and the Unrealized Promise of Technological Catch-Up.* Washington, DC: World Bank.

Cirera, X., D. A. Comin, and M. Cruz. 2022. *Bridging the Technological Divide: Technology Adoption by Firms in Developing Countries.* Washington, DC: World Bank.

Cirera, X., D. A. Comin, M. Cruz, and K. M. Lee. 2020. *Anatomy of Technology in the Firm* (No. w28080). Cambridge, MA: National Bureau of Economic Research.

Cusolito, A. P., and W. F. Maloney. 2018. *Productivity Revisited: Shifting Paradigms in Analysis and Policy.* Washington, DC: World Bank.

European Commission. 2021. The Digital Economy and Society Index. Brussels: European Commission.

Eurostat. 2022. EUROSTAT: Structural Business Survey. Statistical Office of the European Communities (Eurostat), Luxembourg.

National Bank of Poland. 2020. Balance of Payments Statistics. National Bank of Poland, Warsaw.

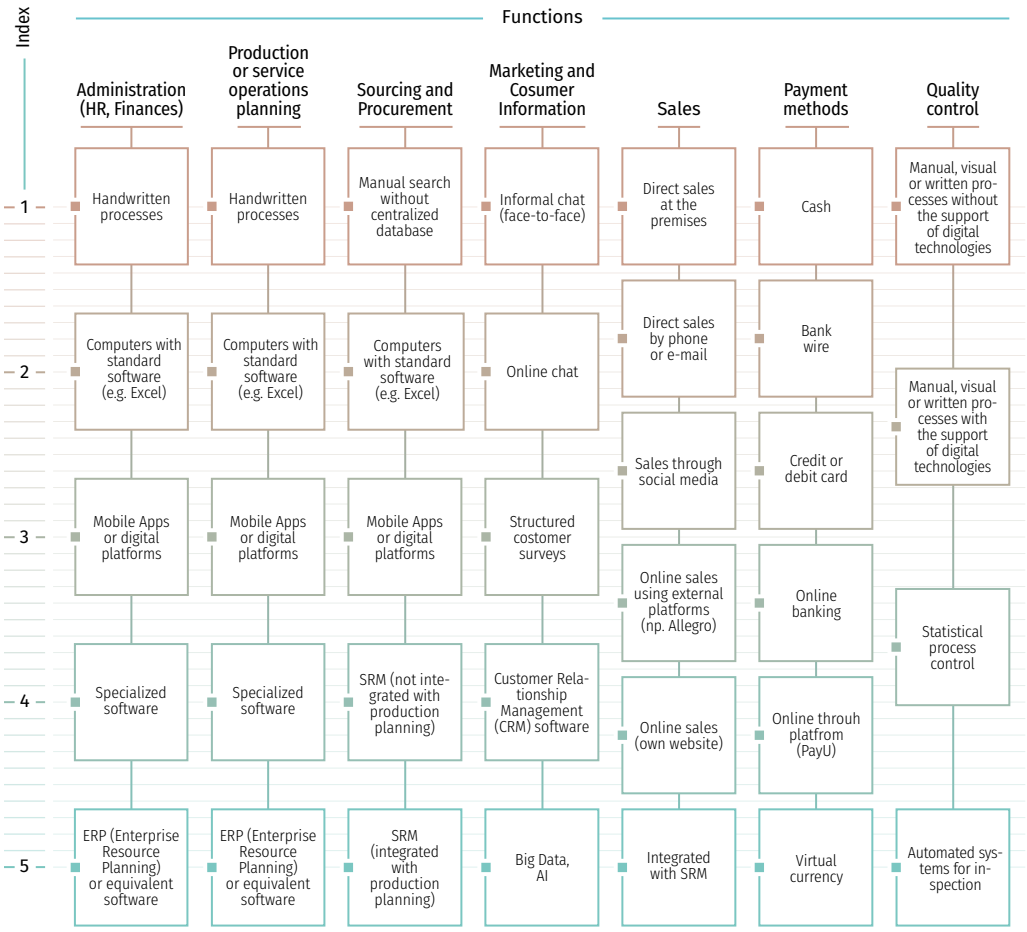
OECD. 2019. Indicators of Product Market Regulation. Organisation for Economic Co-operation and Development, Paris.

World Bank. 2017. *Lessons from Poland, Insights for Poland: A Sustainable and Inclusive Transition to High Income Status.* Washington, DC: World Bank.

World Bank. 2021. *Paths of Productivity Growth in Poland: A Firm-Level Perspective.* Washington, DC: World Bank.

APPENDIX

FIGURE A.1 General Business Functions (GBFs) and Technologies.



Source: Adopted from Cirera et al. 2022.

ACKNOWLEDGMENTS

The document serves as a summary of the project Technological Readiness and Management Skills — Productivity Growth Drivers in Poland" executed by the team led by Łukasz Marć (Task Team Leader, Senior Economist) and co-led by Magda Malec (Consultant) from the Finance, Competitiveness, and Innovation Global Practice of the World Bank Group (WBG). The team was joined by Umut Kilinc (Economist) and Bartłomiej Skowron (Consultant) for the work on productivity decomposition in Poland, and Damian Iwanowski (Extended Term Consultant), Caroline Schimanski (Consultant), and Adrianna Wrona (Consultant) for the work on the Technology Adoption Survey. The project benefited from other inputs provided by Bartłomiej Skowron, Maciej Sychowiec, Izabela Sobiech, Monika Woźniak, Daniel Querejazu, and Jerzy Toborowicz. The project was conducted in collaboration with the European Commission (EC) Directorate-General for Structural Reform Support (DG REFORM) aiming to support Poland's Ministry of Economic Development and Technology to enhance the effectiveness of firms' support systems by providing evidence based on firms' capabilities, context, and barriers to productivity growth.

The team benefited greatly from the support and comments of the authors of the Technology Adoption Survey, Xavier Cirera and Marcio Cruz, as well as regular on-time support in the implementation and global data analysis from Kyung Min Lee. We are very grateful for the peer-review comments received from Gaurav Nayyar (Lead Economist), Elwyn Davies (Senior Economist), Andrzej Halesiak (Extended Term Consultant), Jan Hagemajer (Professor, Warsaw University) and Juan Rogers (Professor, Georgia Tech University), as well as suggestions received from Natasha Kapil, Leonardo Iacovone, and Antonio Soares Martins Neto.

The report was prepared under the leadership and guidance of Gallina Andronova Vincelette, Marcus Heinz, Ilias Skamnelos, and Reena Badiani-Magnusson. We are also grateful to Barbara Skwarczyńska, Agnieszka Boratyńska, and Małgorzata Bargilewicz for their excellent organizational support, Filip Kochan for support in dissemination, and Natasha Kapil for leadership and support during the project setup. The project was financed by the European Commission (EC) Directorate-General for Structural Reform Support (DG REFORM). Special thanks go to Kaspar Richter, Dobromiła Pałucha, Iulia-Mirela Serban, Valentin Ariton, Enrico Pesaresi, and Edward Tersmette (DG REFORM) for their cooperation, support, and feedback. The team would like to thank the government of Poland — especially Beata Lubos, Agata Wancio, and Marcin Łata from the Ministry of

Economic Development and Technology — for their support, feedback, and suggestions on research questions. We are also very grateful to Paulina Zadura, Jacek Pokorski, and Jacek Szut from the Polish Agency of Entrepreneurship and Development for lively brainstorming discussions on preliminary results. Special thanks go to Statistics Poland, including Dominik Rozkrut, Alicja Koszela, Magdalena Wegner, Katarzyna Szporek-Lutka, Joanna Dziekańska, Magdalena Orczykowska, Beata Idzikowska, Mateusz Gumiński, Michał Huet, and Bartosz Grancow, who partnered with the WBG on the demanding data collection (for the Technology Adoption Survey), and Mirosław Błażej, Mariusz Górajski, Emilia Gosińska, Dariusz Kotlewski, and Magdalena Ulrichs, who partnered with the WBG on the data preparation and production functions estimation regarding the productivity growth decomposition (for the report "Paths of Productivity Growth in Poland: A Firm-Level Perspective").

Details on the findings presented in the summary as well as graph descriptions and data sources could be found in the "Drivers of Productivity Growth in Poland: A Firm-Level Perspective on Technology Adoption and Firm Capabilities" and "Sectoral Approach to the Drivers of Productivity Growth in Poland: A Firm-Level Perspective on Technology Adoption and Firm Capabilities."

CONTENTS

Key Findings 3
Key Recommendations 5

Executive Summary 7
- Why is productivity important? 7
- How to improve aggregate productivity 9
- Two-speed productivity growth in Poland 11
- Significant productivity differences between industries in Poland 12
- Positive productivity shock starting from 2016 13
- How technologically advanced are firms in Poland? 16
- What are the factors associated with technology adoption? 18
- Where does Poland stand compared to the Republic of Korea? 19
- How does technology adoption vary across Polish sectors? 21
- Does technology sophistication matter for productivity? 21
- What inhibits and enables technology adoption? 22
- What does support for technology adoption look like in Poland? 23
- What should be done to increase productivity through technology adoption? 24
- What is the summary based on? 26

Abbreviations and Acronyms 28
References 29

Appendix 30

Acknowledgments 31

BOXES

Box 1 What is productivity? 9
Box 2 How to boost productivity 10
Box 3 What is the Technology Adoption Survey? 17
Box 4 Korea — A benchmark country for Poland 20

FIGURES

Figure 1 GDP per Capita, 1992–2020 7
Figure 2 Labor Productivity as Share of Germany's, 2019 8
Figure 3 Manufacturing Sector Productivity Growth Decomposition between 2009 and 2019 11
Figure 4 Service Sector Productivity Growth Decomposition between 2009 and 2019 11
Figure 5 Productivity Growth Decomposition in Manufacturing Industries between 2009 and 2019 13
Figure 6 Productivity Growth Decomposition in Service Industries between 2009 and 2019 13
Figure 7 Manufacturing Sector Productivity Growth Decomposition between 2016 and 2019 14
Figure 8 Productivity Growth from the Within Component vs. Between Component in Manufacturing Industries between 2016 and 2019 14
Figure 8 Service Sector Productivity Growth Decomposition between 2016 and 2019 15
Figure 9 Productivity Growth from the Within Component vs. Between Component in Service Industries between 2016 and 2019 16
Figure A.1 General Business Functions (GBFs) and Technologies. 30