PATHS OF PRODUCTIVITY GROWTH IN POLAND

A FIRM-LEVEL PERSPECTIVE

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

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ABBREVIATIONS AND ACRONYMS

BPS	Business Pulse Survey
DESI	Digital Economy and Society Index
DG REFORM	Directorate-General for Structural Reform Support
EC	European Commission
EU	European Union
FDI	foreign direct investment
FOE	foreign-owned enterprise
GDP	gross domestic product
GVA	gross value added
GVC	global value chain
HHI	Hirschman-Herfindahl index
ICT	information and communications technology
LP	labor productivity
NACE	Statistical Classification of Economic Activities in the European Union
NIK	Polish Supreme Audit Office
OECD	Organisation for Economic Co-operation and Development
PDE	private domestic enterprise
PNT	questionnaire on research and experimental development
R&D	research and development
REGON	National Business Registry Number
SMEs	small and medium enterprises
SOE	state-owned enterprise
SP	Annual Enterprise Survey
TFP	total factor productivity
TFPQ	quantity-based total factor productivity
TFPR	revenue-based total factor productivity
UEFA	Union of European Football Associations
WBG	World Bank Group

EXECUTIVE SUMMARY

After a long period of economic transformation that included introducing a series of market-oriented reforms and joining the European Union (EU), Poland was one of the fastest-growing economies in the world by 2020. The Polish gross domestic product (GDP) per capita increased by 300 percent 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 its income per capita currently at two-thirds of the EU15 average. Factors delaying the catch-up with advanced economies include weak innovation performance, insufficient technology adoption, and labor force digital skills that are below the EU average. Because the post-transition (capital-driven) development model might be reaching its limits, the policy focus needs to shift toward different growth engines, such as productivity. With low levels of investment and a shrinking labor force due to population aging, Poland will increasingly depend for long-term growth on productivity advances, likely more so than in other advanced economies.

We employ firm-level data from Statistics Poland covering small, medium, and large enterprises between 2009 and 2019 to evaluate productivity performance in Polish manufacturing, construction, and non-financial services. Productivity as the technical efficiency in production can be quantified through two main indices — labor productivity and total factor productivity (TFP). Labor productivity indicates how much value each employee adds. Labor productivity growth has two sources — increase in the capital used per worker and TFP growth. TFP captures the efficiency of transforming inputs (such as capital and labor) into outputs. We use both measures and employ a firm-level approach, which allows identifying both the aggregate productivity drivers and the underlying heterogeneity. Aggregate productivity performance can grow through three main channels. First, productivity can rise due to efficiency improvements within firms — by adopting better technology, increasing managerial skills, or innovation (the "within" component). Second, more productive firms can increase their market share within the industry, meaning that factors of production — workers and capital — are allocated to more efficient companies ("between" component). Third, high-productivity firms can enter the market ("upscaling" component), and less successful establishments can exit ("downscaling" component); together, these form the "net entry" component.

This report investigates differences in productivity dynamics across economic segments and attempts to derive policy recommendations to improve the Polish economy's productivity performance. First, we estimate firm-level TFP, compute labor productivity indices, and analyze the main productivity patterns between 2009 and 2019. Second, we decompose aggregate productivity performance into the within, between, and net entry components using the Melitz-Polanec decomposition method to understand the underlying response behind the observed productivity growth in Polish sectors and industries. Even when there is no innovation or adoption of better technology that would increase individual firm productivity, reallocating production factors such as capital and labor from less to more productive establishments increases economy-wide productivity. Therefore, barriers to this reallocation would suppress the productivity performance of a given industry and hence, the aggregate productivity growth. However, significant productivity improvements require progress on every front. Even if the business environment is crystalline, there will be no growth if entrepreneurs do not have the necessary human capital to take advantage of it. To support productivity, Poland needs to design and adopt an effective mix of policies to improve market functioning, create an efficient business environment, and provide incentives for entrepreneurship and firm upgrading.

Despite Poland's remarkable economic growth, productivity growth has stagnated in the Polish manufacturing sector since 2012 and is significantly lower than in services and construction. The empirical analysis based on small, medium, and large Polish enterprises indicates that economy-wide TFP grew on average by 3 percent between 2009 and 2019. However, manufacturing, construction, and services follow distinctively different productivity trends. There are no significant TFP improvements in manufacturing after 2012 (1 percent growth between 2012 and 2019). At the same time, the construction and service sectors demonstrate continuous modest TFP growth of 3 percent per year. 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 increasing capital intensity of production methods between 2009 and 2019. In other words, to a large extent, firms expanded their production by using more machines per employee rather than by improving production efficiency.

In Poland, firms within narrowly defined industries are highly heterogenous in their productivity performance. This heterogeneity is partially driven by observable industry and firm characteristics such as firm size, age, and ownership status but also depends on firm-level decisions such as research and development (R&D) investments. Industries lagging the aggregate productivity growth include manufacturing of papers, food and beverages, metals, and utility services. The best productivity growth performers are the construction sector, manufacturing of computers and electronics, telecommunications, and accommodation. Because some industries and groups of firms perform distinctly worse than others, we highlight selected areas for further policy consideration.[1] However, addressing poor productivity performance in specific industries is not straightforward. It might result from natural market failures or inefficiencies that require policy attention. It might also be a consequence of poorly designed policies or excessive regulations that generate market imperfections. Furthermore, the economic performance of an industry is subject to changing outside conditions due to, for instance, the evolution of global value chains (GVCs) or production techniques that may provide new advantages to specific industries and disadvantages to others. Policies aiming to accelerate creative destruction can facilitate the reallocation of production factors toward more efficient uses and, in turn, lead to aggregate productivity improvements.

The efficiency of resource allocation (measured by the between effect) worsened over time in manufacturing and was responsible for the sector's productivity slowdown while allocative efficiency gains improved productivity performance in construction and services. Large low-productivity producers in the two biggest manufacturing industries (food and beverages and metals) increase their market share over time at the cost of more productive firms within their industries, reducing the manufacturing sector's aggregate productivity performance. Simultaneously, allocative efficiency improved in some manufacturing industries, demonstrating significant differences in productivity patterns across industries within the same sector. The deterioration in allocative efficiency calls for policy attention especially because the worsening allocative efficiency in manufacturing exemplifies a break in the long-lasting trend of between component driving the aggregate productivity growth in Poland. 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 benefit from supporting companies with high potential to innovate or grow rather than helping inefficient establishments survive.

1. The Technology Adoption Survey (Phase 2 of the project "Technological Readiness and Management Skill — Productivity Growth Drivers") will further study one of the low productivity growth industries, namely the manufacturing of food. The Technology Adoption Survey will also investigate, among other industries, manufacturing of textiles, vehicles, wholesale and retail trade, and accommodation.

Productivity growth accelerated in 2017 in all sectors, mainly driven by within-firm productivity improvements. The Polish service sector exhibited continuous growth in TFP during the sample period that was on average higher than in the manufacturing sector. Starting from 2017, productivity growth accelerated in all sectors simultaneously, such that the within component drove most of the recent productivity improvements. A more disaggregated sector classification shows that not all industries had positive within-firm productivity growth throughout the sample period. In industries such as the manufacturing of paper and paper products, chemicals, civil engineering, and construction of buildings, the within component was negative, which underlines the need for strengthening firm-specific productivity performance in these industries.

Small and medium-sized companies are the engines of productivity growth in Poland. The empirical evidence shows that small and medium firms are more likely to exhibit significantly higher productivity growth than large Polish firms. Large firms, however, do not lose their market shares in some sectors, indicating inefficient reallocation of market shares. These results have three main policy implications. First, empirical findings suggest that there is a need for policy intervention to intensify the competition in Polish industries. Second, removing barriers to growth for smaller firms, especially in manufacturing, seems to be key to accelerating aggregate productivity growth. Enhancing the growth of high-productivity smaller firms can be achieved, for instance, through facilitating their access to finance, promoting financial market deepening, and supporting the development of the innovation supply side (for instance, dedicated software) for small and medium enterprises (SMEs). Third, large firms should be incentivized (however, not financially) to improve their within-firm productivity performance and further investigation is needed to understand their barriers to productivity enhancement.

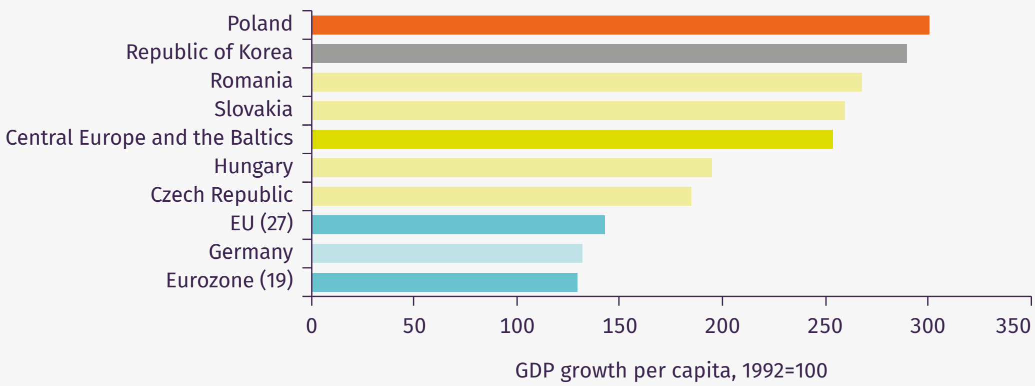
The results on the relationship between ownership status and productivity growth are inconclusive. There is some weak empirical evidence that in terms of productivity improvements, the most successful ownership type is foreign ownership. This result, however, should not be interpreted directly as the foreign-owned firms are better and more efficiently managed. It may also be the case that the most productive firms may be the ones that are taken over by multinational enterprises. The empirical analysis also suggests that firms in expanding industries exhibit better productivity performance than establishments in other industries. Because rising demand can motivate firms to be more productive, facilitating access to global markets might increase the demand for an industry's products and hence the productivity growth. The empirical findings justify policies to strengthen the linkages between Polish firms (especially SMEs) and foreign firms. Programs supporting export promotion should also be considered. R&D incentives are also justified because, in manufacturing, we find evidence that R&D has positive effects on productivity performance.

To boost Polish productivity, the empirical evidence provided in the report indicates certain areas for policy actions as well as a few directions for necessary further investigation. First, Polish firms need incentives to improve their capabilities through digitization, building innovation capacity, and increasing managerial skills. Second, the productivity-enhancing programs should focus on small and medium firms because they are the engines of productivity growth and exhibit higher productivity potential than large firms. Third, manufacturing calls for policy attention because the sector's productivity has stagnated since 2012. The reason behind poor productivity performance in manufacturing is worsening allocative efficiency in the largest industries within manufacturing, namely food and beverages and metals. The productivity in those industries requires further investigation. Moreover, because delivering the most effective policy recommendations requires an evidence-based approach, it is necessary to improve firm-level data accessibility.

INTRODUCTION: GROWTH AND PRODUCTIVITY — WHERE DOES POLAND STAND?

Poland was one of the fastest-growing economies in the world in recent decades, reaching high-income status in 2009. With GDP per capita tripling between 1992 and 2020, Polish economic growth surpassed that of all peer countries (Figure 1). Moreover, during that time, Poland was developing twice as fast as the EU average. Certainly, part of Poland's remarkable growth stems from its very low initial income level. In 1992, Poland's GDP per capita in purchasing power parity (PPP) was 52 percent of the Czech Republic's, 67 percent of Hungary's, and 28 percent of Germany's. Nonetheless, Poland (like other countries in Central and Eastern Europe) offered attractive conditions for foreign investors due to its geographical and cultural proximity to Western economies. These conditions drove foreign direct investment (FDI) and hence boosted economic growth

FIGURE 1 Growth of GDP Per Capita PPP (Constant 2017 International $), 1992–2020

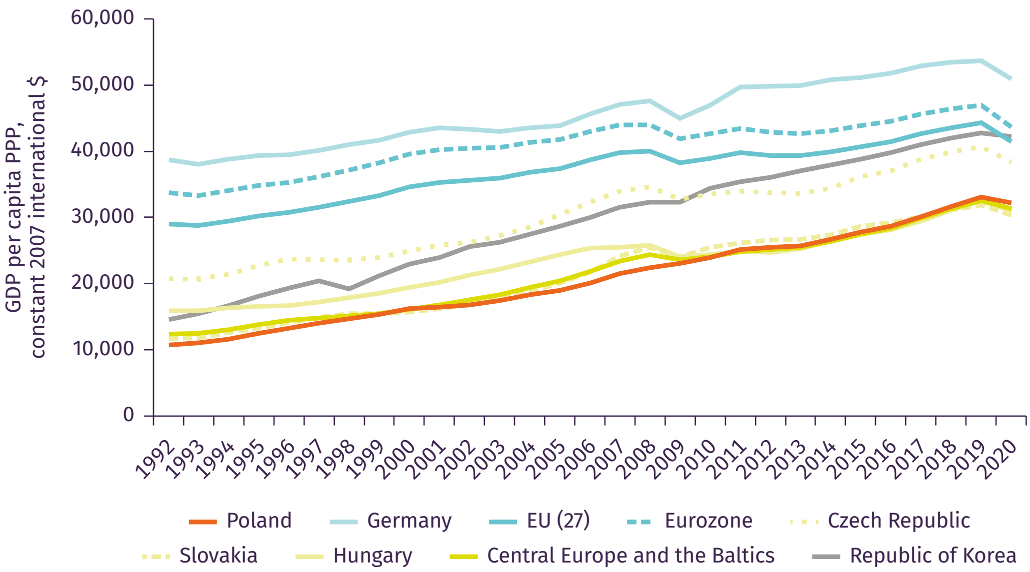


Source: Elaboration based on World Development Indicators.

(Grela et al., 2017). The process was further accelerated by Poland's accession to the EU in 2004, which increased trade openness, linked Poland to GVCs, and supported pro-growth reforms.

Despite Poland's outstanding growth performance for about three decades, its economy still lags those of many European countries. As depicted in Figure 2, Poland reached the same GDP per capita in PPP as Hungary in 2011, and Poland's GDP per capita in PPP surpassed Slovakia's in 2018. Nevertheless, in 2020, Poland's GDP per capita PPP was still equivalent to only 63 percent of Germany's and 84 percent of the Czech Republic's, and it was 28 percent below the EU average. Moreover, Poland's convergence has slowed in recent years. Between 1992 and 2008, Poland went from 28 percent to 47 percent of Germany's GDP per capita in PPP. In this period, average annual growth in Poland was 4.5 times faster than growth in Germany. After the global financial crisis, however, Poland's GDP per capita in PPP increased by only 12 percentage points. In this period, average annual growth in Poland was 3 times faster than growth in Germany.

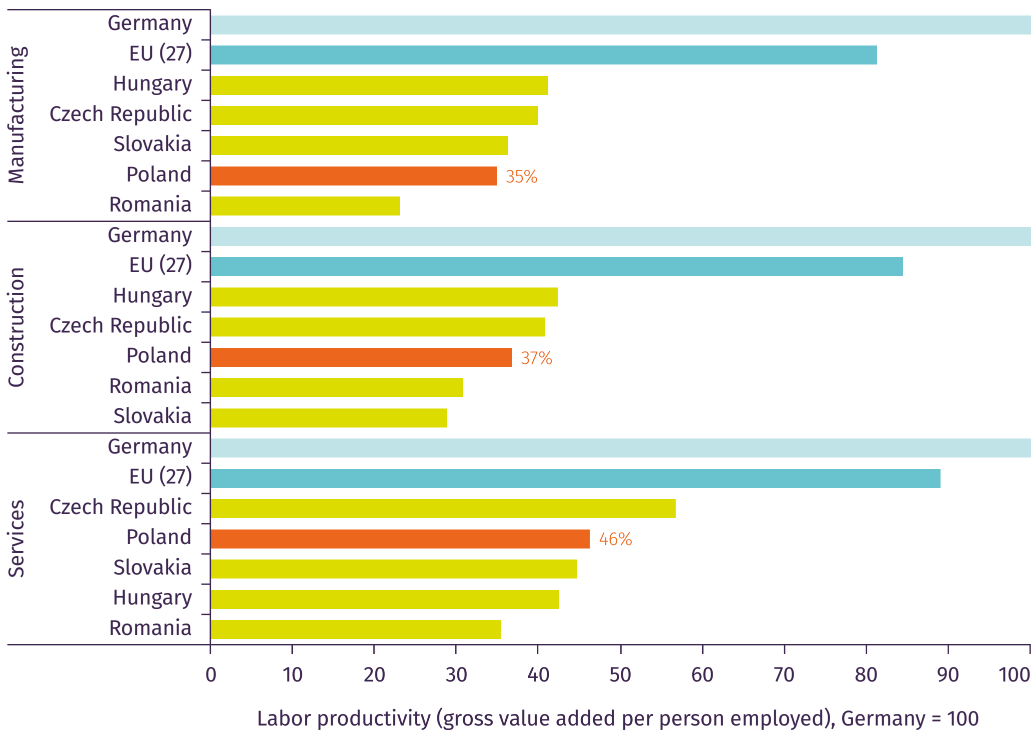
FIGURE 2 GDP Per Capita, 1992–2020



Source: Elaboration based on World Development Indicators.

A manufacturer in Poland needs almost three times as many employees to produce the same output as an average German firm. In 2018, gross value-added per person employed in a manufacturing firm in Poland, a measure of labor productivity, was only 35 percent of the German average and slightly lower than in Hungary or the Czech Republic (Figure 3). It was 37 percent for construction and 46 percent for services. The labor productivity across all sectors in Poland is substantially lower than in the EU, meaning that an average firm in Poland needs more than twice as many workers to produce the same output as an average EU firm. The gross value-added generated by each sector does not significantly vary across countries, but the structure of firm sizes is distinctly different (Eurostat 2021). For instance, in Poland, most employees work in the micro companies (34% of the labor force), while in Germany, only 19% of the workers are employed in the micro firms. Most of the German labor force (41%) is engaged in the largest companies (with more than 250 employees). However, the aggregated value added by firms in each size class is similar between Poland and Germany.

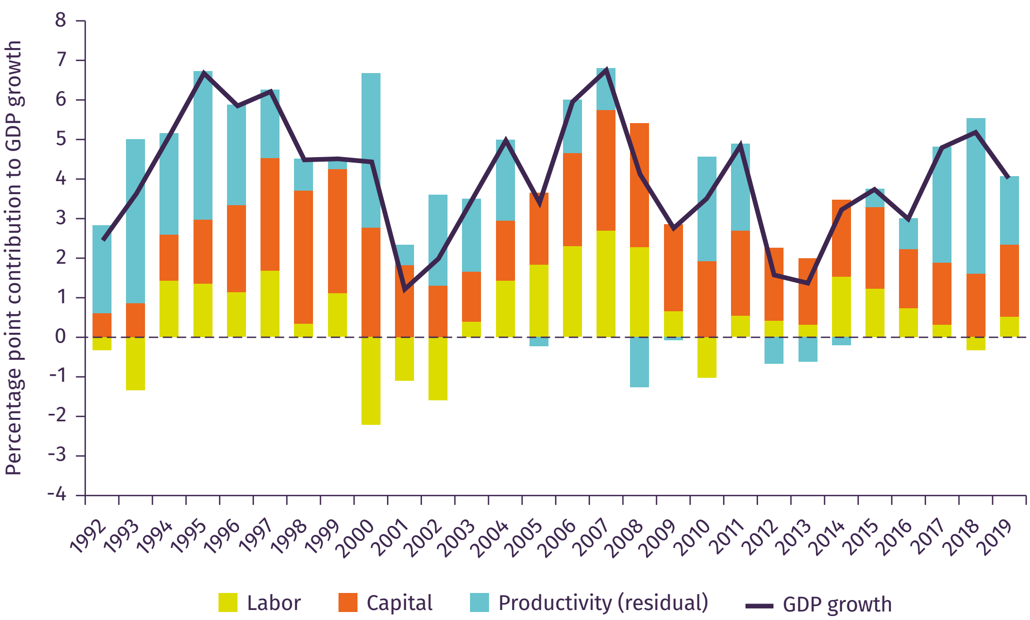
FIGURE 3 Labor Productivity as % of Germany's, 2018



Source: Elaboration based on Structural Business Survey (Eurostat 2021).
Note: Latest available data is for 2018.

Poland's post-transition growth model based mainly on capital inflows will not be sufficient to secure convergence to its main aspirational peers from Western Europe. The growth of Poland's economy after economic transformation was driven by capital accumulation (49 percent contribution to GDP growth) and improving production efficiency (37 percent contribution to GDP growth), with the remaining 14 percent associated with an increase in the size of the labor force (Figure 4). It is an upcoming challenge to maintain a strong pace of development while the capital-driven growth model is reaching its limits (Grela et al., 2017). Due to diminishing returns (for example, from education and capital), it will not be possible to maintain equally strong physical and human capital growth. Grela et al. (2017) argue that the new factors contributing the most to growth are related to structural competitiveness, innovation activity, and institutional environment. These are productivity components. Additionally, it is expected that exports will remain a significant growth driver for direct value added as they were in the past (Szpunar and Hagemejer, 2018). Building on these engines of growth will be crucial to counteract a substantial demographic challenge in the years to come caused by low fertility rates. The European Commission (2020) projects that Poland will reach the EU27 average old-age dependency ratio (52 people aged over 64 years for each 100 aged 15 to 64) in 2050 and will have the worst effective economic old-age dependency ratio in the EU in 2070 (92 versus 70 in the EU27).

FIGURE 4 Contributions to GDP Growth in Poland (1992–2019), Based on Macroeconomic Aggregates



Source: Elaboration based on the Conference Board Total Economy Database (Conference Board 2021).

Note: The presented values are a rough estimation of actual GDP growth constituent parts. Contributions to GDP growth are calculated by weighting the growth of the input by their respective share in income, the labor income share for labor inputs, and (1 – labor income share) for capital inputs. The productivity is a residual of GDP growth minus the input contributions (labor and capital) and not the production function estimation result. The numbers might not correspond to the firm-level productivity estimation presented in the report.

With its income at two-thirds of the EU15 level and the capital-driven development model weakening, Poland needs to realize substantial economic growth based on productivity improvements. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its productivity (Krugman, 1994). A global review by ILO (2013) finds that an increase in individual firm productivity (the within component) is the most critical factor contributing to economic growth. Such within-firm performance can be complemented by the reallocation of resources between firms and sectors (the between component), the entrance of high-productivity firms, and the exit of low-productivity firms. As a matter of fact, the advances in the between component were the main driver of the TFP growth in Poland between 1997 and 2013 (World Bank, 2017). Putting productivity at the center of Poland's growth agenda means focusing on monitoring and developing programs that support productivity growth (while not disturbing unnecessarily the functioning of the market), with particular attention to strengthening firms' productivity — innovation or adoption of better technologies, digitization, managerial and organizational talent, and human capital skills.

Innovation and R&D positively influence technological progress, contributing to productivity increases and, hence, economic growth. Because productivity is becoming the essence of economic growth, its determinants are also the center of research attention (Doraszelski and Jaumandreu, 2013). Nekrep et al. (2018) argue that there is a causal link between R&D expenditures and subsequent productivity growth in the EU countries between 1995 and 2013. Pop Silaghi et al. (2014) differentiate between the impact of private and public R&D spending. They find that only market R&D expenditures positively influenced growth in ten new member states between 1998 and 2008, whereas public R&D spending had a negligible effect. Additionally, Verspagen (1995) suggests that finding a significant link between R&D and productivity strongly depends on the empirical methodology and that R&D has a positive impact on productivity only in high-tech sectors. These contradictory findings imply that simple implementation of the best policy practices is not enough to enhance growth. A custom productivity-enhancing policy formula must be based on country-specific factors, like a country's economic structure and its institutional and regulatory environment.

Poland's innovation system is one of the least developed in Europe. Poland lags most countries on the European innovation scoreboard (European Commission 2021), surpassing only Romania, Bulgaria, and Latvia. The poor innovation ecosystem in Poland results from a low number of SMEs introducing product and business process innovations, small employment in knowledge-intensive sectors and innovative enterprises, and a maladjusted academic research system. The Community Innovation Survey 2018[2] found that only 22 percent of non-micro companies in Poland were innovative, the second-lowest result in the EU. The share of the population with tertiary education, the number of design applications, and environment-related technologies are the most positive aspects of Poland's innovation ecosystem. Overall innovation performance is also related to R&D expenditures (Mohnen and Hall, 2013), which amounted to 1.32 percent of Poland's GDP in 2019 compared to the European average of 2.19 percent.

The weak innovation performance of Poland's businesses is partially caused by insufficient technology adoption coupled with inadequate digital skills among the labor force. The Digital Economy and Society Index (DESI) is a tool used by the European Commission to monitor the digital progress of member states in five categories: broadband connectivity, human capital, use of internet services, integration of digital technology, and digital public services. In 2020, Poland ranked 23rd of 28 EU member states in DESI. The category that drags down Poland's rank the most is the integration of digital technologies, which considers the use of technologies such as electronic information sharing, big data, the cloud, and the degree of e-commerce utilization. Moreover, Poland needs to increase the digital skills of its labor force, which are currently below the EU average. Improving digital skills requires not only providing basic (or better) digital skills to the whole population but also training information and telecommunications technology (ICT) specialists and equipping them with the most advanced skills.

The general attitude of Poland's companies to training and digitization and the slow evolution of managerial practices indicates that state intervention can significantly accelerate the digital transformation of the economy. The World Bank's (2021) Business Pulse Survey (BPS) 4 shows that 50 percent of enterprises in Poland are convinced they do not need further digitization. What is more, over half of the firms did not train their employees in 2020, and among those that did not, as many as two-thirds think their employees' skills are adequate.[3] BPS 4 findings also point out the slow adoption of good managerial practices. The lack of knowledge is often a greater barrier to technology adoption than access to the technology itself (see Arendt, 2008; Bartel et al., 2007; Martin et al., 2013). Not knowing one's shortcomings, accompanied by a visible technological

2. https://ec.europa.eu/eurostat/web/science-technology-innovation/data/database?node_code=inn_cis11

3. Likely, the stand applies not only to the skills but to the productivity as well. In the UK, 79 percent of leaders believe that they are at least as productive as their peers (Wu and Broughton, 2019).

gap between Poland and peer countries, creates a rationale for public intervention. However, interventions that focus on just financing (with loans or subsidies for capital equipment) and ignore managerial capabilities and the human factor do not yield the full benefits of digital technology adoption (Matteucci et al., 2005). Embracing the full benefits of digital technology requires complementary firm-level capabilities — technical, managerial, and organizational (OECD, 2019).

Effective policy design aiming to boost productivity requires not only identifying aggregate productivity trends but also determining micro productivity drivers. To investigate productivity dynamics across economic segments and to derive policy recommendations to improve the productivity performance of Poland's economy, one needs to build the analysis on firm-level data. Each industry faces unique market conditions and is endowed with distinct technologies and skills. Without comprehensive knowledge about the nature of this heterogeneity, it is difficult to design a productivity-enhancing system of incentives successfully and cost-effectively. Employing firm-level data enables determining both the aggregate productivity trends and the underlying heterogeneity across sectors and industries. Moreover, it allows decomposing the productivity growth using the Melitz-Polanec method into four components — within, between, upscaling, and downscaling — that represent different drivers of productivity growth (Melitz and Polanec, 2015). Furthermore, it helps to determine whether the potential drivers of productivity growth that are well-known in the literature (investing in R&D and strengthening competition) are also effective in influencing the performance of firms in a particular country.

After economic transformation, the productivity growth in Poland was historically driven by improvements in allocative efficiency and growth of productive firms. The most recent study decomposing productivity growth using the Melitz-Polanec method investigated firm-level data in Poland between 1997 and 2013 (Albinowski et al., 2015; World Bank, 2017) focused on the manufacturing sector. The TFP growth in manufacturing between 1997 and 2013 was impressively fast, mainly driven by a reallocation of resources from less to more productive firms (the between component accounted for three-fourths of aggregate TFP growth). In fact, a further empirical investigation indicated that many small firms were forced to exit or downsize at that time, but a few grew fast and created enough new jobs to accommodate laid-off workers. Moreover, the report found that foreign-owned firms were on levels more productive than domestic firms, but domestic firms experienced faster TFP growth. To the best of the authors' knowledge, the decomposition was never applied to post-2013 data (most likely due to restricted access to firm-level data in Poland) and construction and service sectors. The following study aims to fill this research gap.

This report investigates the aggregate patterns and underlying heterogeneity in productivity growth in Poland across three sectors — manufacturing, construction, and services — and industries within these sectors between 2009 and 2019 and formulates policy recommendations aiming to enhance the economy's productivity performance. The remainder of the report is structured as follows. Chapter 2 provides a detailed description of the firm-level dataset used in the study and reports productivity growth patterns at the aggregate, sectoral (manufacturing, construction, non-financial services), and further disaggregated industrial levels. The chapter also describes the methodology of labor productivity computation and TFP estimation. Chapter 3 documents the productivity growth channels by presenting the sectoral results of a dynamic Melitz-Polanec productivity growth decomposition. Chapter 4 provides in-depth empirical analysis by identifying the underlying productivity heterogeneity across different firm groups. It also investigates the well-established productivity growth determinants (R&D investments and competition). The report concludes with a policy recommendations chapter.

This study is part of a project "Technological readiness and management skills — Productivity growth drivers in Poland" conducted in collaboration with DG REFORM. The project aims to support the Ministry of Economic Development and Technology in enhancing the effectiveness of firms' support systems in Poland by providing evidence based on firms' capabilities, context, and barriers to productivity growth. The project consists of three phases. Phase 1 focuses on understanding firm-level productivity dynamics and analyzing instruments supporting managerial skills and technology adoption. Phase 2 provides evidence based on Polish firms' capabilities by implementing and analyzing a Technology Adoption Survey (following Cirera et al., 2021). Phase 3 aims to build capacity and support in the redesign of instruments to build firms' capabilities. The following report is the main output of Phase 1 and provides information necessary for successfully conducting Phases 2 and 3.

II

PROPERTIES OF THE FIRM-LEVEL SAMPLE AND PRODUCTIVITY GROWTH IN POLAND

1 We employ a firm-level panel dataset covering small, medium, and large companies between 2009 and 2019 to evaluate the productivity performance in Polish manufacturing, construction, and private non-financial services. The analysis of the productivity dynamics of Polish enterprises relies on two measures: gross value added per worker (labor productivity) and TFP.

2 Labor productivity and TFP grew during the analysis period on average by 4% and 3% per year respectively. However, the manufacturing, construction, and services sectors followed distinctively different productivity trends: growing productivity in construction and services and stagnating productivity in manufacturing. Moreover, there was significant heterogeneity in firm performances not only across the main three sectors, but also within the sectors, across industries.

3 The manufacturing sector calls for particular attention because TFP in the sector has stagnated since 2012. The largest industries of the sector, namely the manufacturing of food, metals, and chemicals, are dragging down overall productivity growth. Moreover, labor productivity growth that significantly outpaces TFP growth indicates that the expansion of the manufacturing industry comes primarily from increasing capital intensity rather than improvement in technical efficiency.

Characteristics of the Firm-Level Dataset

The analysis uses a firm-level panel dataset covering small, medium, and large Polish companies in the manufacturing, construction, and service sectors from 2009 to 2019.[4] The data originates from the Statistics Poland annual economic activity surveys of non-financial enterprises. All firms with more than nine employees operating in Poland are obliged to fill out the survey. To create a consistent firm-level dataset for the study, one needs to combine micro-data surveys, remove outliers, and deal with missing values (Box 1). One-third of all observations were dropped in the procedure. The final dataset comprises almost 140,000 firms and 700,000 observations reported during an 11-year-period (Table 1).[5] Unfortunately, the universal reporting obligation does not apply to micro firms[6], which play a substantial role in the Polish business environment, employing 40 percent of the labor force and generating 30 percent of total value added. Five percent of micro firms are appointed to fill out the economic activity survey every year, and only a small portion answer the survey in consecutive years. Because the database for micro firms does not have a sufficient panel structure, the study excludes micro firms.

BOX 1 Firm-Level Dataset—Sources and Preparation

The 2009–19 firm-level panel dataset used in this study is based on the *Annual Enterprise Survey (SP)*, maintained by Statistics Poland. The firm-level sample covers all non-financial enterprises operating in Poland with more than nine employees. First, yearly surveys were merged to form a panel dataset based on the National Business Registry Number (REGON) identifier. Second, the dataset was cleared of outlier observations. Third, the dataset was further edited to remove all observations with zero or negative gross value added (the difference between deflated output and intermediate consumption) and capital. Lastly, every observation reporting non-positive intermediate inputs (sum of energy and material costs) was dropped. The production function estimation method employs intermediate inputs as proxies for unobserved productivity. The missing data on gross value added, capital and costs sum to 33 percent of all observations. The detailed dataset preparation and a description of endogenous and explanatory variables are reported in Appendix A.1

The nominal variables in the dataset (gross value added, capital, and investments) were transformed into real values using industry-level price indices (published yearly by Statistics Poland as *Prices*

4. Throughout the report, the word "sector" applies to the three major economy parts—manufacturing, construction, and services. The division follows the statistical classification of economic activities used in the European Union (NACE Rev. 2). We disaggregate the sectors further into industries (level 2 of NACE), such as the manufacture of textiles, construction of buildings, or telecommunications.

5. Because the firm-level data is strictly confidential, Statistics Poland performed the data cleaning process, calculated the variables, and aggregated them to the NACE 2 level.

6. Micro firm employs up to 9 full-time workers.

in the national economy) with the base year of 2010 (constant prices). The industrial deflators are defined at the level of the 2-digit NACE Rev. 2 *(The Statistical Classification of Economic Activities in the European Union)*. As explained in Box 3, because firm-level prices or quantities are not available, we do not use a quantity-based productivity indicator.

The study analyses the economic activity of enterprises classified at the 2-digit NACE level from divisions 10 to 88. It covers a wide range of industries — manufacturing, construction, and services (for example, trade, transport, and ICT). Due to the highly regulated business environment in divisions 12 (tobacco) and 19 (coke and refined petroleum products), we excluded those industries from the sample. Following the literature, we also left out the financial and insurance companies (divisions 65 – 66) because, among other reasons, their balance sheets differ significantly from the non-financial firms. Because the number of observations in some divisions (for example, manufacturing of beverages or veterinary activities), is too low for the production function estimation, we grouped them following guidelines from the statistical office of the EU (Eurostat). The details of merging selected industries and their economic properties are given in Appendix A.2.

The sample comprises about 140,000 small, medium, and large companies in an 11-year-period. As expected, the panel is unbalanced, with an average of about five observations per firm. Table 1 reports the number of firms and their market share in terms of gross value added and employment by sector.

In the firm-level dataset used in this study, the real gross value added and total employment in the Polish manufacturing and service sectors experienced almost uninterrupted growth between 2009 and 2019. The real gross value added of manufacturing and services companies increased by 51 percent and 53 percent, respectively, accompanied by a 12 percent and 16 percent rise in the total employment (Table 2). The only exception was the aftermath of the global financial crisis, which resulted in a mild drop in values of both indices until 2013. (See Appendix Figure A2.2) The growth patterns of the performance indicators in the manufacturing and services followed each other closely over the sample period except for a slight fall in the total employment within services in 2013. What is more, there was a universal increase in real wages across sectors: 60 percent on average in the firm-level dataset between 2009 and 2019. The real average wage growth is higher than observed in the national economy — which equaled 35 percent between 2009 and 2019 according to Statistics Poland — because micro firms, the agriculture sector, and civil services are excluded from the sample.

TABLE 1 Firm-Level Sample Description of the 2009 – 19 dataset.

Sector	Firms (no.)	Labor share (%)	GVA share (%)
Manufacturing	39,341	40	37
Construction	19,807	7	7
Services	77,505	53	56

Source: Elaboration based on Statistics Poland data.
Note: GVA = gross value added.

TABLE 2 Sector-Specific Growth over the Entire Sample Period (2009–19)

Sector	Δ TFP (%)	Δ LP (%)	Δ GVA (%)	Δ Employment (%)	Δ Wages (%)	Δ Revenues (%)
Manufacturing	22	56	51	12	68	60
Construction	39	44	11	−27	59	23
Services	38	35	53	16	55	56
Sample	31	44	49	11	60	54

Source: Elaboration based on Statistics Poland calculations.
Note: Detailed sector-specific growth, divided into industries, is given in Appendix A.2. Δ = delta (change), GVA = gross value added, LP = labor productivity, TFP = total factor productivity.

The volatility of total employment in the construction sector is rather high, mostly because micro companies were not analyzed in this study. The total employment dropped by 27 percent between 2009 and 2019 among small, medium and large firms in the dataset and by 25 percent in the same group according to Poland's labor force survey, which covers the whole economy (Statistics Poland, 2021). At the same time, employment in micro firms rose by 29 percent according to the labor force survey. In other words, the labor force outflowed to the micro firms that are unobserved in the firm-level dataset, which explains the detected volatility. This feature corresponds with the change in the number of construction companies in the economy over the sample period. According to the *Activity of non-financial enterprises reports* published by Statistics Poland, the number of micro firms in the economy rose by 47 percent between 2009 and 2019, accompanied by a drop in the number of larger firms. The growth of the number of micro firms within the sector is likely a result of construction business practices in Poland. Namely, as a bankruptcy precaution, real estate developers tend to establish a new entity for every construction project (Szreder, 2018; Office of Competition and Consumer Protection, 2021). The decrease in employment in the construction sector was accompanied by a far slower growth in the real gross value added and revenues — of 11 percent and 23 percent, respectively — than for the other two sectors. Moreover, the construction of buildings was the only industry in any sector that experienced a fall in the real gross value-added: 3 percent between 2009 and 2019. (See Appendix A.2.)

The construction sector experienced a massive disruption in 2011–2013 due to a demand boom following public investments for the UEFA Euro 2012 and EU structural funds co-financed projects. Between 2011 and 2012, construction companies experienced a drop of more than 10 percent in real gross value-added. (See Appendix Figure A2.2) The highly volatile performance of firms within the sector corresponds to the wave of bankruptcies and liquidity problems of the construction companies in that period that is being attributed to the issues in the payment system developed by the General Directorate for National Roads and Motorways for railways and football infrastructure buildings (Supreme Audit Office, 2018).[7] During 2012, about 10 percent of all construction companies declared bankruptcy, which accounted for over a quarter of all collapsed firms, 80 percent more than a year earlier and four times more than in 2008. The road system in Poland had never been worse than before the EU accession, and from 2004 onward, the country landscape changed into a construction site. The bankrupted companies engaged in the most significant infrastructure projects financed by the EU funds. The construction sector also experienced an enormous drop in real investments,[8] namely 80 percent in the firm-level data, between 2011 and 2012. First, the sharp fall in the investment rate was primarily caused by a decline in public investment, as the large construction projects connected to preparations for the Euro 2012 were ending. Second, following the global trend, due to policy uncertainty for investors and elevated geopolitical risks, there was a slowdown of the net inflow of FDI to Poland. (See Appendix Figure A7.1). Moreover, the scale of capital in transit (meaning the transactions of special purpose entities that transfer funds at the mother company's request for the purposes of tax optimization) severely influenced the value of global FDI in Poland.[9]

7. Poland co-hosted the UEFA Euro 2012 with Ukraine. Hosting the event set in motion a massive stimulus for public infrastructure investments. Due to increased demand for building materials, their price increased substantially; for example, the price of tarmac rose by 25 percent in 2011 (Supreme Audit Office, 2018). However, the public tenders didn't contain an indexation clause. The construction companies didn't forecast high material costs and were forced to operate with negative returns or declare bankruptcy. Moreover, the large construction consortia were not paying their subcontractors on time (or at all), which disturbed their financial liquidity and brought them to default. According to the report prepared by the Polish Supreme Audit Office (Supreme Audit Office, 2018), the public tenders were settled mainly based on the lowest price criterion. There were several problems. First, severe competition on the market led to tendering below the real construction costs. Second, the General Directorate did not always verify the contractor's financial condition and signed contracts with unreliable construction companies. Third, the public tenders did not give the General Directorate the authority to monitor the payments to subcontractors.

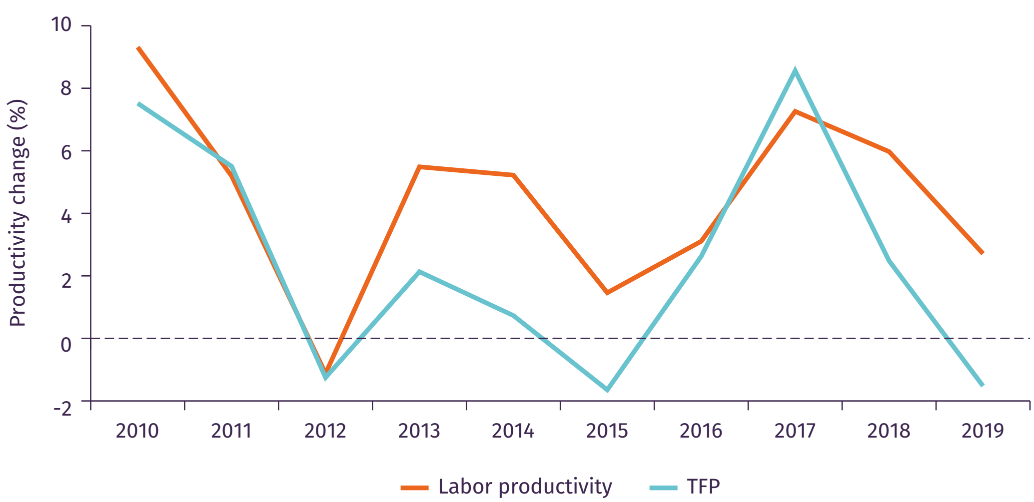
8. Real investments are calculated as a log of outlays on tangible and intangible assets (reported in *SP surveys*), deflated with the investment price deflators at 2-digit NACE Rev. 2 (published yearly by Statistics Poland as *Prices in the national economy*).

9. More on the global FDI transfers can be found in World Investment Reports (UNCTAD 2013, 2014, 2015).

Productivity Growth Patterns at the Sectoral Level

Establishments in Poland's manufacturing, construction, and services had predominantly positive productivity growth between 2009 and 2019, but the growth rates fluctuated considerably over time. The evaluation of the efficiency performances of Poland's enterprises relies on two measures of productivity: gross value added per worker (labor productivity) and TFP. Labor productivity growth has two sources: capital deepening (increases in the capital used by workers) and change in TFP. The latter is the traditional measure of efficiency that captures output not explained by intermediate inputs, labor, and capital. (See Box 2 and Box 3 for details.) Over a decade, labor productivity — resulting from the growth of capital used by each worker and TFP growth — improved by 44 percent, while TFP increased by 31 percent, translating to average annual growth of 4 and 3 percent respectively. Labor productivity and TFP followed a similar trend over the sample period (Figure 5). In 2009 – 11, companies displayed on average fast productivity growth that can be considered the economic rebound from the global financial crisis. From 2012 until 2015, productivity growth fluctuated around zero for TFP and around 2 percent for labor productivity. Starting in 2015, productivity growth recovered, reaching its peak in 2017. There is an apparent slowdown in productivity for the last two years in the sample, with TFP even slightly decreasing between 2018 and 2019. Faster labor productivity growth compared to TFP suggests that firms were using increasingly more capital relative to labor in production between 2009 and 2019.

FIGURE 5 **Productivity Growth (2009 – 19)**



Source: Elaboration based on Statistics Poland calculations.

BOX 2 How to Measure Productivity

Productivity as the technical efficiency in production can be quantified through two main indices—**labor productivity** and **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 in the production process. Consider two hypothetical textile manufacturers. The first one produces handcrafted shirts. The second one uses high-tech equipment to produce shirts of similar quality. The equipment only requires one machine operator rather than several sewers. We can measure labor productivity in this case as the ratio of one shirt to the number of workers employed to produce it. It would be lower for the producer that handcrafts shirts, even though both producers make shirts of the same quality. Labor productivity is easily measured and comparable between countries, keeping in mind the limitation that it depends on capital intensity in the production process.

TFP captures how efficiently firms transform inputs (in our case, capital and labor) into outputs. Thus, it captures the increase in output that is not attributed to a change in the quantity of factors of production. The higher the TFP, the less input 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. TFP is not observable from the data directly but can be obtained as a residual of the production function.

TFP can be computed using both macro and micro data. Micro-level TFP, however, has some advantages. First, it enables a more in-depth analysis by identifying the underlying productivity heterogeneity across different firm groups and industries. Second, it allows employing decomposition methods to indicate the channels of productivity change. Third, it addresses the endogeneity issues that can contaminate the causal link between TFP and usage of factors of production. The methodological details of calculating TFP are described in Appendix A.3.

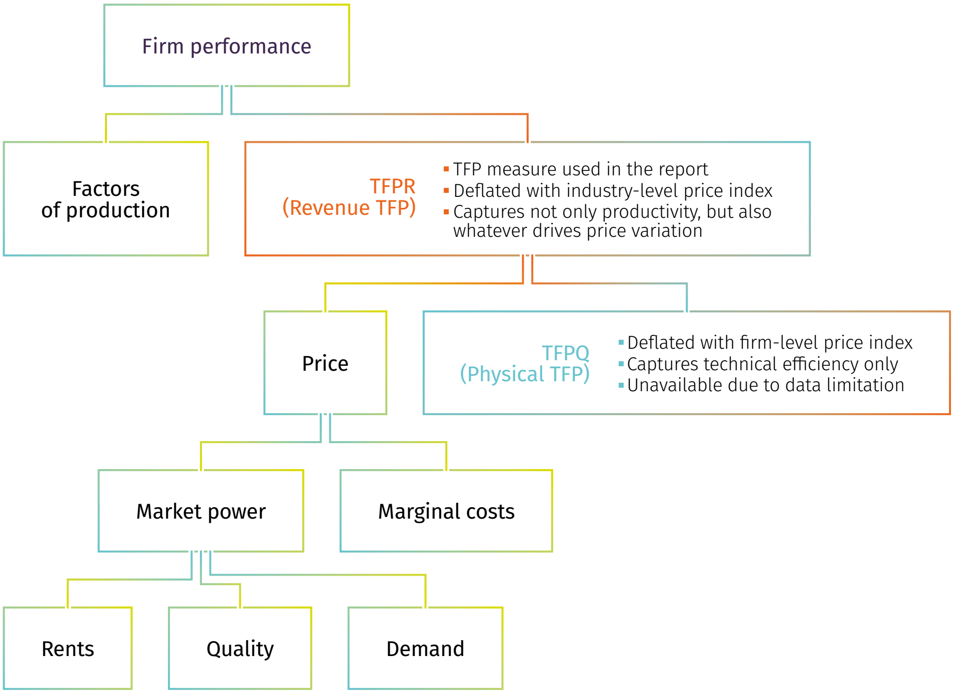
Labor productivity is computed as a log of the ratio of gross value added to the log number of full-time employees. In this study, we use firms' employment shares as the weights in aggregating firm-level productivity to reach the economy-wide averages. The complete definitions of the variables are provided in Appendix A.1.

This study focuses on the dynamic aspects of productivity growth, namely how productivity evolves over time, rather than the levels. Applying different weights to calculate the economy average or sectoral averages affects the productivity value, but the dynamic analysis is free of such influence.

BOX 3 What Does TFP Represent?

TFP can be interpreted as the part of firm-level value added that cannot be explained by the quantity of traditional inputs (in our case, capital and labor) used in production (Figure 8). To draw a comparable TFP index, one needs to deflate nominal firm-level variables to adjust, for example, firm sales for inflation and express time-series data in one comparable measure ("constant" prices comparable across years). We deflated nominal firm-level variables using industry-level price indices. Using industry-level prices in the computation of firm-level TFP causes the productivity to reflect firm-specific variation in the prices, so the TFP index used in this study embodies demand-side effects to some degree. Quantity-based TFP would be ideal to avoid this shortcoming, but its consistent computation requires observing quantities of outputs and inputs or their prices at the firm level, and this information is not available in our dataset. Nevertheless, in this study, a large portion of the results are reported at an industry level that is either the same as or more aggregated than the level of price indices, which mitigates the bias due to unobserved firm-specific price issues.

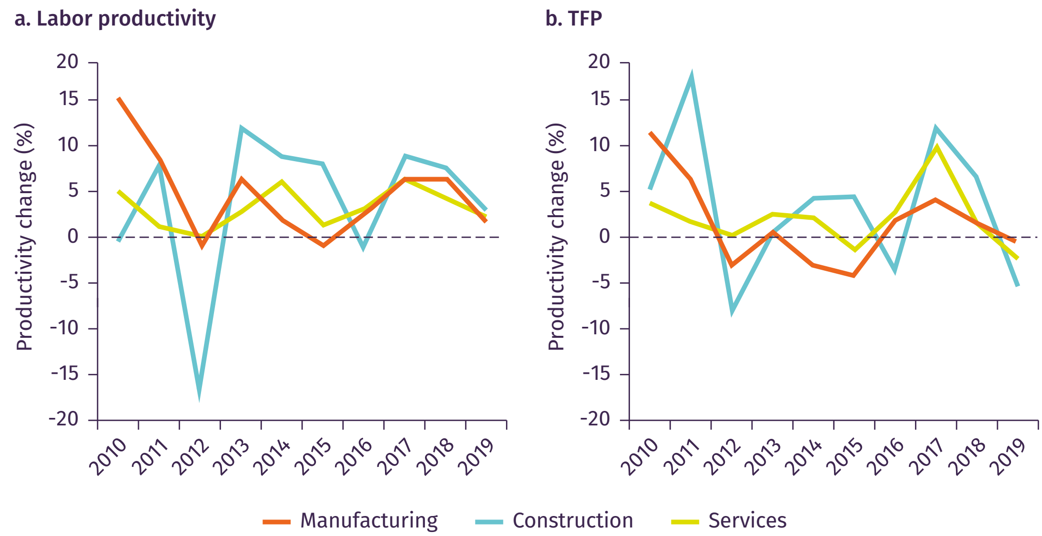
FIGURE B3.1 What Influences Firm Performance?



Given the substantial differences across sectors due to characteristics of production, market structure or surrounding business environment, the productivity patterns were analyzed separately for manufacturing, construction, and services. This was done using disaggregated data and by breaking down the economic performance indicators at a level of aggregation that would not hide the heterogeneity across different segments of the economy. Furthermore, given the differences in the data structure and coverage across sectors (significant variation of the data characteristics for construction services as compared to manufacturing and services), it was necessary to go beyond sector-level aggregation and analyze productivity at a more disaggregated level, for instance, for each 2-digit industry.

Except for the initial two years in the sample, the TFP in Polish manufacturing stagnated, while labor productivity followed an overall increasing trend. (See Figure 6) Even though the difference in the TFP levels between 2009 and 2019 amounted to 22 percent in total, as much as 20 percentage points of the growth was realized between 2009 and 2011. Afterwards, there were no significant productivity gains in Polish manufacturing — the difference between TFP levels in 2012 and 2019 amounts to only 1 percent. Labor productivity increased by 56 percent between 2009 and 2019, and again, the fastest pace was between 2009 and 2010, with a growth of 26 percent. In the next nine years, labor productivity increased by 30 percent. While the labor productivity growth in manufacturing and services followed similar upward trends, the TFP growth path in manufacturing coincided neither with that in construction nor that in services and fluctuated around zero most of the time (Figure 6). One possible reason for the discrepancy in the growth rates between the labor productivity and TFP indices is that the manufacturing sector adopted more capital- and technology-intensive production methods over time. Labor productivity may have increased as a result of capital deepening, meaning using capital more intensively in production. As a result, the amount of labor used in the production of one additional unit would decrease as time passes. However, TFP levels are not necessarily affected by this transformation in the production method, because TFP accounts for the increase in the intensity of capital used in production.

FIGURE 6 Productivity Growth by Sectors (2009–19)



Source: Elaboration based on Statistics Poland calculations.

In Polish services, both labor productivity and TFP improved between 2009 and 2019 at a modest but positive rate of 4 percent per year — significantly faster than in manufacturing. TFP was more variable than labor productivity, rising nearly 10 percent between 2016 and 2017 after five years of modest 2 percent annual growth. Overall, there was a noticeable acceleration in the TFP growth in all sectors between 2015 and 2018. Yet, compared to manufacturing and construction, services experienced the most stable upward trend over the entire sample period. Nevertheless, the evolution of other sectoral outcomes — such as the growth paths of gross value added and labor (except for exports) — was comparable between services and manufacturing. (See Appendix Figure A2.2)

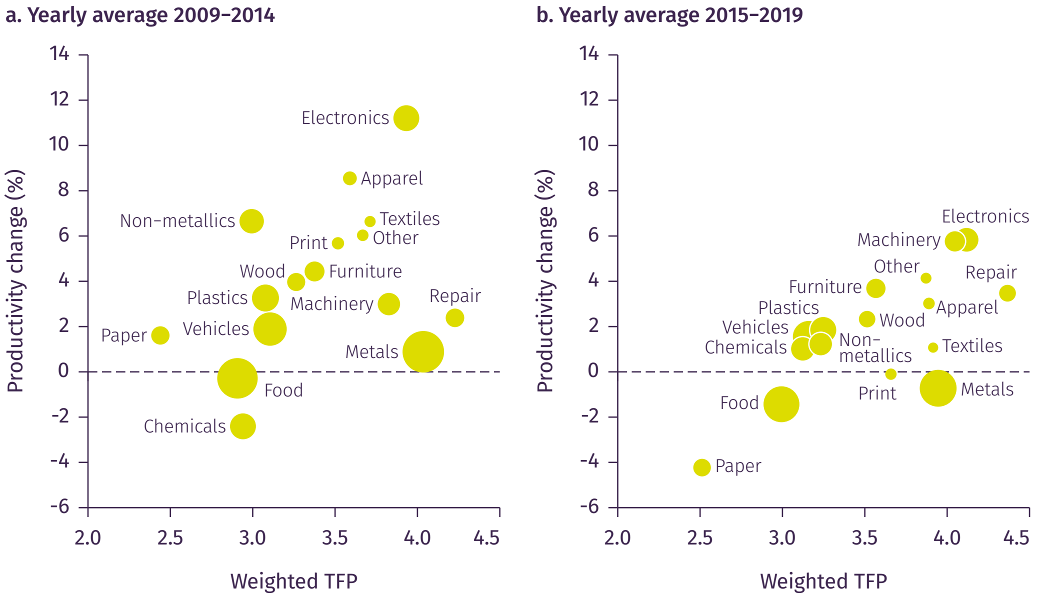
The construction sector displayed the highest productivity variability, resulting in a net moderate increase of both productivity indices between 2009 and 2019. The construction sector consists of only three industries: construction of buildings, civil engineering, and specialized construction activities. They are of roughly similar size. (See Appendix Table A2.1) Due to the previously described sectoral disruption, there was a significant drop in labor productivity and TFP between 2011 and 2012 that amounted to 16 percent and 8 percent respectively (Figure 6). This decline was led by the construction of buildings, which experienced more than a 40 percent decrease in labor productivity between 2011 and 2012. (See Appendix Figure A5.1) However, the labor productivity change is likely not a reflection of the actual sectoral situation but rather a statistical artifact because the exit rates of enterprises in the dataset during 2011 – 13 are unprecedently high.[10] There was a significant drop in the FDI inflows at the same time, which negatively affected the investments and gross value added. Both industrial and sectoral labor productivity grew considerably in 2013. The labor productivity in construction caught up with the values before the downturn in just two years. The volatility in TFP originated mainly from the civil engineering industry, which consists of firms involved in building roads, railways, bridges, tunnels, or city infrastructure. The civil engineering industry was predominantly affected by the market disruption following the increased construction demand due to the UEFA Euro 2012 infrastructure investments, as previously mentioned. In civil engineering, there was an almost 25 percent increase in TFP followed by a more than 30 percent drop between 2010 and 2013. (See Appendix Figure A5.1) Despite the volatility and possible sectoral disruption during 2011 – 13, the productivity in the entire construction sector, in terms of both gross value added per worker and TFP, began increasing again starting in 2013. The time paths of the two productivity indices coincide closely with each other, with the construction sector having total labor productivity growth of 44 percent and total TFP growth of 39 percent between 2009 and 2019, both corresponding to an annual average 4 percent increase.

10. The mean exit rate measured as an exit of an individual firm amounts to as high as 20 percent between 2011 and 2013.

Productivity Growth Patterns at the Industry Level

The largest Polish manufacturing industries — manufacturing of food and beverages and manufacturing of basic metals and fabricated metal products — experienced a drop in TFP between 2009 and 2019. The poor productivity performance of manufacturing was driven by the largest industries dragging down the sectoral TFP. As depicted in Figure 7, the manufacturing of food and beverages industry and the manufacturing of basic and fabricated metals industry, which jointly produce 34 percent of gross value added and employ 33 percent of the sectoral labor force, experienced negative TFP growth. Two other manufacturing industries also had negative productivity performance: manufacturing of paper and paper products and manufacturing of chemicals and pharmaceuticals. These two industries account for an additional 11 percent of gross value added in manufacturing.

FIGURE 7 TFP Growth versus TFP Levels in the Manufacturing Sector, 2009 – 14 and 2015 – 19



Source: Elaboration based on Statistics Poland calculations.
Note: An industry's relative size represents the percentage of gross value added generated in that industry.

In manufacturing industries, productivity trends differed considerably between 2009 – 14 and 2015 – 19. As shown on the left-hand side of Figure 7, in the earlier period, some industries displayed outstanding productivity performance with an average yearly productivity growth close to 10 percent: manufacturing of computers and electronics and manufacturing of wearing apparel and leather.

The latter industry was undergoing microeconomic restructuring,[11] also associated with a drop in employment amounting to 42 percent over the entire sample period. The TFP increase in manufacturing of computers and electronics reflects the fast-developing global IT technology sector. This industry experienced a remarkable real gross value added growth, amounting to more than 200 percent during the 11 years from 2009 to 2019, probably driven by the upsurge in demand for electronics (and the productivity advantages within companies; see Appendix Figure A5.2).[12] However, between 2015 and 2019, high-performing industries converged to the manufacturing average.

Productivity stagnated in some service industries (such as IT[13] and consulting services[14]) and in utilities,[15] where state ownership is prevalent. Those stagnant industries (Figure 8) represent 25 percent of sectoral gross value added and accommodate one-fifth of the services labor force. Among all the service industries, only scientific research, advertising, market research, and veterinary[16] had negative TFP growth between 2009 and 2019, with a striking 39 percent drop in TFP between 2015 and 2016. The drop in the productivity of research, advertising, and veterinary was most likely caused by the unprecedently high rate of low-productivity firms entering the sample. (See Appendix Figure A5.2) The number of observations increased by 37 percent, and the industrial labor force doubled. One possible reason for the expanded coverage of the firm-level data in the research industry is the introduction of R&D tax relief from 2016 onwards (Laplante et al., 2019). Almost 40 percent of companies in the research industry report R&D expenditures, and the number of companies performing R&D doubled between 2015 and 2016.

While a nearly all service industries exhibited similar productivity growth, telecommunications was different. In telecommunications — a highly regulated industry including, for instance, Internet providers and mobile network operators — TFP increased by 86 percent in 11 years, a far higher growth than the sectoral average. (See Table 2 and Appendix Table A2.1) In addition, labor

11. Since the economic transformation, there has been a systematic decline of employment in the Polish wearing apparel industry (Lewandowski and Magda, 2014). Firms transformed their production process toward less labor-intensive methods, and the high-productivity establishments increased their market share.

12. For more on the relations between demand shocks and productivity, see Mayer, Melitz, and Ottaviano (2014, 2016) and Cusolito, Fernandes, and Maemir (2018).

13. Computer programming, information service activities, consultancy, and related activities

14. Legal and accounting activities, management, architectural and engineering

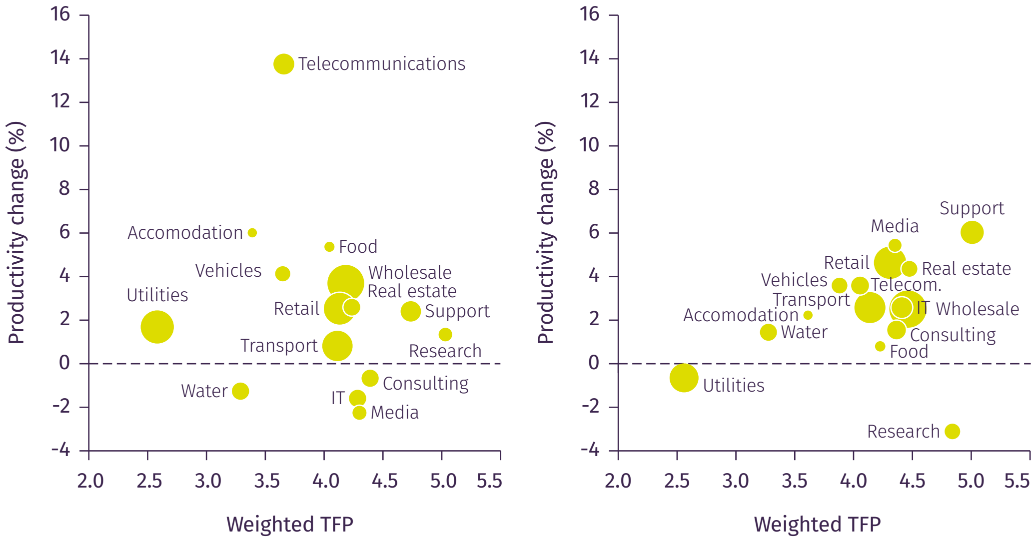
15. Electricity, gas, water, sewerage, waste, etc.

16. Section M of NACE Rev. 2

FIGURE 8 TFP Growth versus TFP Levels in the Services Sector, 2009–14 and 2015–19

a. Yearly average 2009–2014

b. Yearly average 2015–2019

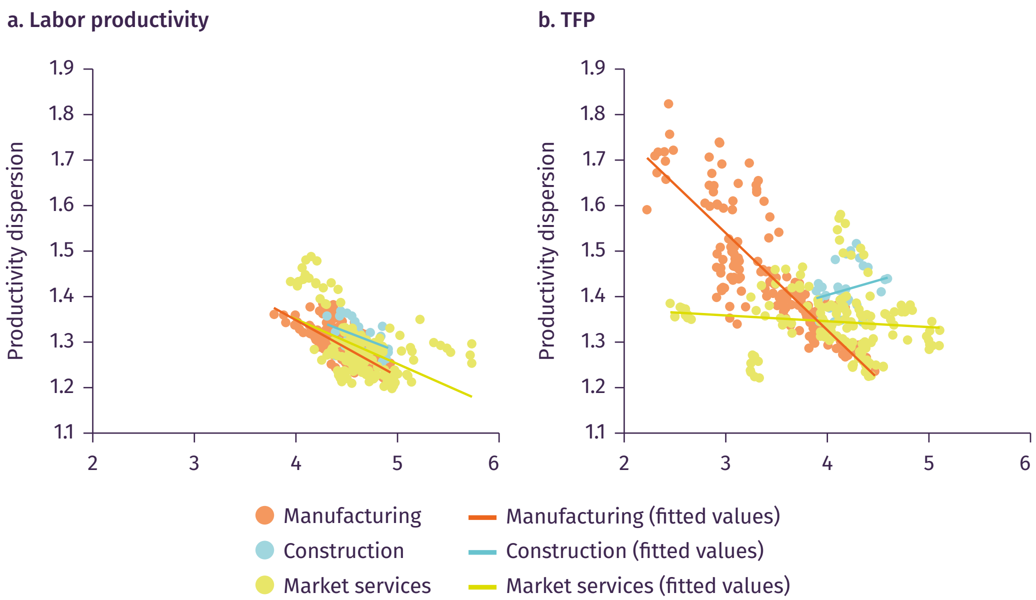


Source: Elaboration based on Statistics Poland calculations.
Note: An industry's relative size represents the percentage of gross value added generated in that industry.

productivity growth was 91 percent in the telecommunications industry. These productivity performance increases were associated with a 24 percent drop in employment and an 81 percent increase in gross value added. A further empirical investigation of the industry (details provided in Chapter 3) reveals that most of the productivity growth in telecommunications came from firms improving their capabilities, for instance through successful digitalization and innovation. (See Appendix Figure A5.2, Panel c.) At the same time, more productive telecommunications companies increased their market share within the industry. This provides some evidence that less productive establishments in telecommunications decreased their number of employees (possibly, for instance, due to lack of digitalization in some companies) so that high-productivity growth occurred simultaneously with shrinking industry employment.

Manufacturing had higher TFP dispersion than construction or services, and industries with high dispersion tended to have low TFP. An industry may exhibit high productivity dispersion when, for instance, low-productivity companies (firms that lag the industry and sectoral TFP) have a considerable share in the industry. Such dominance of inefficient firms might be a result of barriers to firm entry and exit or a rigid labor market, either of which would hinder resource allocation toward more productive firms. Firms being unable to adjust their workforces easily (due to regulations or labor market conditions) will inevitably lead to higher dispersion. Another cause of high TFP dispersion can be highly productive firms that are in the process of technology adoption or are undergoing risky R&D activities and innovations. These firms would contribute to the growth in aggregate outcomes (Doraszelski and Jaumandreu, 2013). Moreover, due to data limitations, the TFP measure employed in the study captures not only efficiency in production but also price and quality effect. (See Box 3 for more details.) High dispersion might signify substantial price and quality differences between firms. Figure 9 exhibits the productivity dispersion (calculated as the ratio of the 80th percentile of productivity to the 20th percentile of productivity) for industries in the manufacturing, services, and construction sectors during 2009 – 19. The figure demonstrates that there was a negative link between productivity dispersion and TFP in manufacturing. (That is, the higher the productivity dispersion within a manufacturing industry, the lower the TFP levels in that industry tended to be.) This association provides some evidence for the presence of a significant number of inefficient firms in the high-dispersion industries. Therefore, the following sections pay particular attention to how market shares are allocated across producers with different productivity levels and further analyze the patterns in resource allocation by decomposing productivity.

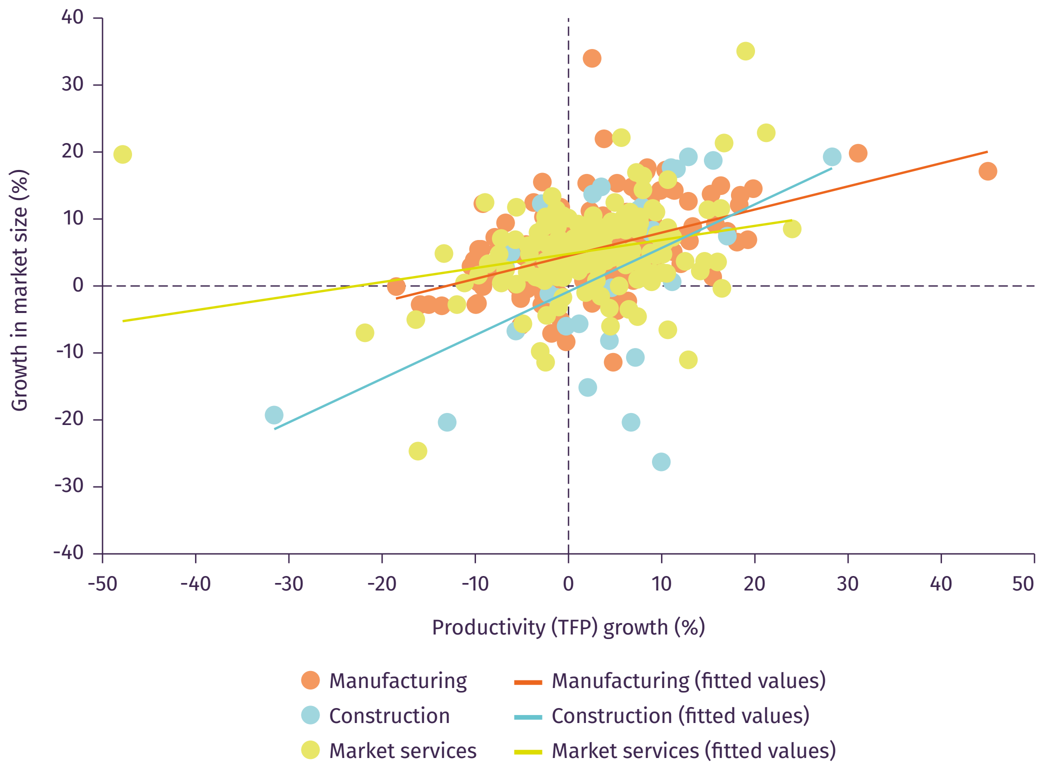
FIGURE 9 Firm-Level Productivity Dispersion by Sector, 2009 – 19



Source: Elaboration based on Statistics Poland calculations.
Note: Dispersion is calculated as the ratio of weighted productivity in the 80th percentile to weighted productivity in the 20th percentile within an industry (as in the TFP estimation). The dots represent the result for each industry in each year.

Sectors that have higher revenue growth also had higher TFP growth on average. Figure 10 compares the TFP of industries in a given year and the annual real growth rates of their revenues in that year. For each sector, there was a positive correlation between real revenue growth and TFP growth. This positive correlation implies that industries that expanded (in terms of total revenues) tended to have higher TFP growth. Conversely, industries with decreasing total revenues tended to experience productivity declines. Figure 10 provides a dynamic perspective, meaning that it depicts the relationship between growth in market size and TFP growth levels across years. Some large industries had negative TFP growth rates in earlier years, and their size contracted over subsequent years. Such industries underly the positive correlation between the growth rates of TFP and market size. In Poland, some of the large traditional sectors (for example, manufacturing of food and beverages or utility services) were shrinking while more productive industries were growing in size, indicating that microeconomic restructuring has been occurring in a productivity-enhancing way.

FIGURE 10 **Growth in Market Size versus TFP Growth**



Source: Elaboration based on Statistics Poland calculations.
Note: Each dot represents the combination of TFP and annual real revenue growth rates for a specific industry and year.

III

WHAT DRIVES POLISH FIRM-LEVEL PRODUCTIVITY GROWTH?

1 To understand the underlying response behind the observed productivity growth in Polish sectors and industries, we decompose aggregate productivity growth using the Melitz-Polanec decomposition method into four components: within (innovation or adaptation), between (more efficient resource allocation), upscaling (entry of more productive producers), and downscaling (exit of less successful establishments).

2 The manufacturing sector's productivity stagnation between 2012 and 2019 resulted mainly from a deterioration in the allocative efficiency in the largest manufacturing industries: metals and food and beverages. During that period, the low-productivity firms in these industries grew and expanded their market share at the cost of more productive firms. Consequently, the between component negatively contributed to productivity performance and pulled down the aggregate productivity of the entire manufacturing sector. This negative pattern changed the long-observed (since 1997) trend of the between component driving the TFP growth in Poland's manufacturing.

3 Poland's private non-financial service sector exhibited continuous growth in TFP during the sample period that was on average higher than that in manufacturing. In services, resource allocation also improved continuously and dominated the within contribution during 2012–16. In the later period of the sample, the within component rose above the between component and became the main driver of productivity growth in services, much like in manufacturing and construction after 2017.

4 Only two industries substantially contributed to sectoral productivity growth: telecommunications and manufacturing of computers and electronics. These two industries can attribute their outstanding productivity performance to the within component: advances in firm capabilities, such as through innovation, technology adoption, increasing managerial and organizational practices, or improvements in human capital skills.

Decomposition Methodology

Aggregate productivity can grow as a result of firms increasing their capabilities (within-firm productivity growth), allocating resources in more productive firms and facilitating high-productivity firms to increase their market share (between-firm productivity growth) as well as productive firm entry and exit. Employing firm-level panel data enables breaking down the productivity growth into four components, each representing a different source of productivity. This method is called Melitz-Polanec decomposition (Melitz and Polanec, 2015). Tracking the performance of an individual firm over time allows analyzing not only the within-firm productivity improvements but also the pattern of market share reallocations across firms and its consequences for aggregate productivity. Box 4 and Box 5 provide methodological details and linkages between decomposition components and relevant policy responses.

BOX 4 How to Decompose Productivity

Productivity measured with firm-level panel data can be broken down into four components, each representing a different source of productivity. To distinguish sources of Polish productivity growth during 2009–2019, we employ the dynamic Olley-Pakes decomposition, also known as Melitz-Polanec decomposition (Melitz and Polanec, 2015). The method relies on tracking the performance of individual firms over time to analyse the pattern of market share reallocations across firms and its consequences for aggregate productivity. Let's define the aggregate productivity (θ) in two successive periods ($\theta 1$ and $\theta 2$) with:

$$\theta_1 = S_{S1}\theta_{S1} + S_{X1}\theta_{X1} = \theta_{S1} + S_{X1}(\theta_{X1} - \theta_{S1})$$

$$\theta_2 = S_{S2}\theta_{S2} + S_{E2}\theta_{E2} = \theta_{S2} + S_{E2}(\theta_{E2} - \theta_{S2}),$$

where S is the market share of: firms surviving between periods (survivors, $SS1$ $SS2$), firms exiting the sample or downscaling (exiters, $SX1$), and firms entering the sample or upscaling (entrants, $SE2$). The difference in productivity between two periods is then:

$$\Delta\theta = \underbrace{(\theta_{S2} - \theta_{S1})}_{\text{survivors}} + \underbrace{S_{E2}(\theta_{E2} - \theta_{S2})}_{\text{entrants}} + \underbrace{S_{X1}(\theta_{S1} - \theta_{X1})}_{\text{exiters}}$$

Hence, the productivity is decomposed into contributions from three groups of firms: survivors, entrants and exiters. The survivor's contribution is further separated using Olley-Pakes (Olley and Pakes, 1996) into two: 1) the unweighted mean change in the productivity of survivors and 2) the covariance change between market share and productivity for survivors. Finally, the productivity change can be expressed as:

$$\Delta\theta = \underbrace{\Delta\bar{\theta}_S}_{within} + \underbrace{\Delta cov(\theta,s)}_{covariance} + \underbrace{S_{E2}\,(\theta_{E2,} - \theta_{S2})}_{entry} + \underbrace{S_{X1}\,(\theta_{S1} - \theta_{X1})}_{exit}$$

The aggregate productivity is decomposed into four components: (1) the change in the mean (within component), (2) the change in the covariance (between component), (3) entry or upscaling, and (4) exit or downscaling. The within component measures the gains from firms' own productivity performance. It represents a shift in the distribution of firm productivity. **The between component** represents the productivity growth coming from the reallocation of resources across producers. **The upscaling and downscaling components** measure productivity gains from entering and exiting firms. If a firm enters a market any time in the period between *t* and *t+1* and displays a productivity performance above the industry average as of time *t*, this is reflected as a positive contribution to the aggregate productivity growth. Similarly, if a firm whose productivity is lower than the industry average at time *t* exits a market until time *t+1*, this is reflected as a positive productivity contribution. However, capturing the contributions of firm entry and exit robustly depends heavily on the quality of the data, particularly the reliability of the panel structure. In the Melitz-Polanec decomposition, the entry and exit components must be computed based on the absence or presence of data rather than the actual information on firm entry and exit. Moreover, given that we observe only companies with more than nine employees, if a firm in a specific year drops to fewer than ten employees, that company will be detected as an exiter, while in fact it still operates in the market. That is why we call the dynamic components **upscaling and downscaling**. Consequently, if micro firms are not included, the significant entry/exit productivity contribution reflects to a larger extent changes of firm size around the threshold rather than actual establishment of new firms and closures of existing companies.

BOX 5 Productivity-boosting policies

Boosting productivity requires policy actions addressing all components of productivity growth. The figure below presents an exemplary set of policy interventions and programs broken down into the three productivity growth components with which they are typically associated. (For these purposes, the upscaling and downscaling components are combined into a single "dynamic" component.) It is important to recognize that, although conceptually distinct and driven by different types of firm dynamics, these three components are closely interlinked. For instance, barriers to reallocation that dampen the between component (market distortions such as poorly designed institutions, excessive regulation, or the disproportionate presence of state-owned enterprises) can also discourage investment in innovation (within component) or disincentivize low-productivity firms from exiting (dynamic component). At the same time, without innovation and technology adoption (within component), there would be limited space for reallocation (between component) or selection (dynamic component).

TFP growth

Within growth

Increasing firm capabilities

Promoting innovation through incentivizing R&D investments (matching grants or fiscal incentives such as loans).

Enhancing technology adoption not only by financial incentives but also by strengthening managerial capabilities and the human factor (filling the knowledge gap, working on peer networks, outsourcing technology adoption consultants, accounting for loss aversion associated with new technology adoption).

Upgrading organizational and management practices in firms by improving education quality, supplying digital and technical skills (hiring professional managers).

Between growth

Allocating resources to more productive firms

Allowing markets to work efficiently, reducing distortions and disincentives to grow for more productive firms, targeting the elimination of labor market frictions, removing industrial protection, addressing market failures such as information asymmetries or moral hazard (financial market deepening).

Strengthening competition, improving investment climate and business environment.

Strengthening linkages with foreign markets, reducing transaction costs for firms to integrate with larger markets (trade facilitation, certifying products for sophisticated export markets, matchmaking).

Dynamic growth

Entry of high-productivity firms and exit of low-productivity firms

Removing barriers to entry and experimentation, reducing the risk of failure by making exit and re-entry low cost (digitalization and simplification of requirements for starting up businesses, simplifing licensing, imposing limited bureaucratic burden on low-risk activities, simplifing regimes of bankruptcy or restructuring.

Lowering risks of innovative products or the market risk associated with novel business models (including fiscal or monetary policies, financial sector policies, protection of property rights, etc.).

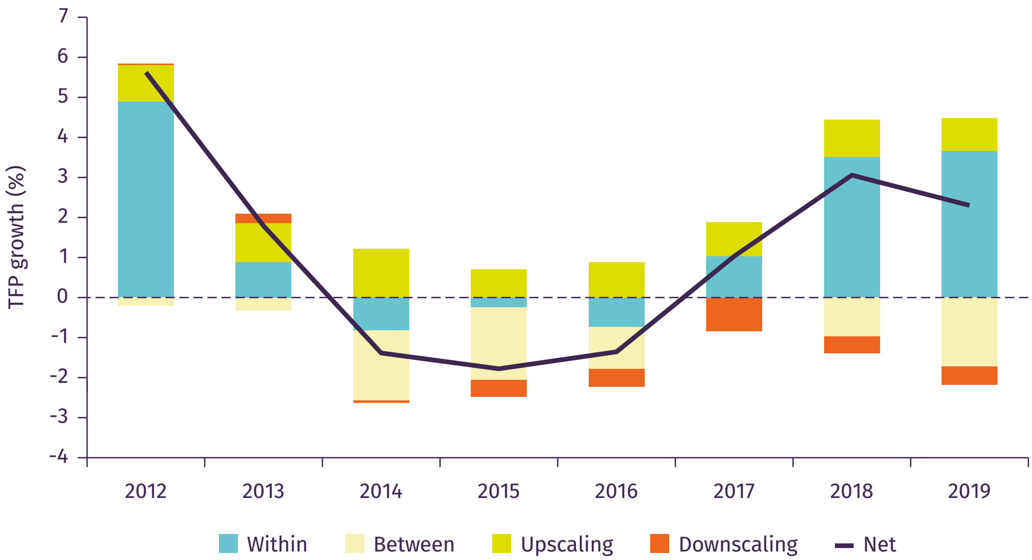
Encouraging entrepreneurship (entrepreneurial training).

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

Productivity Growth Decomposition in Manufacturing

In manufacturing, the efficiency of resource allocation across firms worsened over time, which slowed the sector's productivity growth. The between component that represents the productivity growth from the reallocation of production factors across manufacturers within industries was negative for most years, especially from 2014 until 2019 (Figure 11). Decomposition at the industry level reveals that large low-productivity manufacturers of food, beverages, metals, and rubber increased their market share over time at the cost of more productive companies, negatively contributing to the manufacturing sector's aggregate productivity performance. (See Appendix Figure A5.2 and Box 6) At the same time, manufacturing displayed growth in terms of gross value added as well as labor. (See Appendix Figure A2.2) The fact that this high-growth period of value added and labor corresponds to substantial drops in the between component provides some evidence that fast-growing manufacturing firms had low TFP levels initially. This stems from the fact that the between component reflects the part of the increase in the sector's size that comes from the expansion of incumbents but not the part that comes from the entry of new firms (which is reflected in the upscaling component).

FIGURE 11 **Manufacturing Sector Productivity Growth Decomposition**



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

Worsening efficiency of resource allocation in manufacturing means breaking the long-observed trend of between component driving the TFP improvements in Poland. The fast TFP growth between 1997 and 2013 was a result of more productive firms gaining market share at the expense of less productive firms shrinking (World Bank, 2017). However, as noted in the World Bank's report, in 2012 the selection mechanism was interrupted and the between component turned negative. This was primarily driven by relatively more productive firms in the electronics, metals and beverages industries losing their market share. The decomposition results applied to 2009 – 19 data confirmed that worrying shift in trend. Moreover, our study also detected the efficiency deterioration in resource allocation in the biggest manufacturing industries in Poland — metals, food, and beverages. (See Box 6.) It means that as the years go by, the situation in those industries hasn't improved for almost a decade, and still, more productive firms are losing their market share.

BOX 6 Evidence from Poland's Food Industry

Since 2012 the efficiency of resource allocation in Poland's food industry worsened over time, which significantly slowed the manufacturing's productivity growth. (See Appendix Figure 18 and Appendix Table 8.) The food industry is one of the biggest parts of Poland's economy, employing in 2019 18% of the manufacturing's labor force and generating 16% of the sectoral gross value added. Worsening resource allocation in the industry means that since 2012 more productive food producers have been losing their market share and at the same time, less productive establishments were growing. World Bank's report *Poland Catching-Up Regions 2: Safer Food, Better Business in Podkarpackie and Lubelskie* (World Bank, 2018) indicates that one of the potential reasons behind that is the enforcement of food-related requirements that could be excessively burdensome to firms, hamper entry, limit competition and stall growth (typical factors negatively contributing to the between component of productivity growth, see Box 5).

Firms in the food industry need to comply with demanding EU- and nation-wide requirements. These requirements help to minimize negative externalities, such as the spread of food-borne illnesses. They are enforced mainly through business inspections carried out by five inspectorates responsible for food control in Poland. However, firms struggle to understand requirements and perceive inspections mainly as a burden. Poland's authorities have many institutional practices in place to reduce the inspection burden and improve compliance with regulations in the country's southeast. The fragmentation of inspections is partly addressed through multi-annual control plans and inter-institutional cooperation agreements. Risk assessment methodologies are used to determine how frequently businesses should be inspected. Inspectorates use checklists to harmonize inspections and occasionally provide guidance to businesses. However, Poland's authorities can still learn from international best practices in regulatory enforcement to reduce administrative burden and provide firms with more information about requirements. Improvements should focus on strengthening coordination between inspectorates, refining and fully implementing risk assessment, and scaling up compliance promotion.

The manufacturing industries with the fastest TFP growth can credit their productivity performance to the within component, reflecting firms' own productivity improvements, for instance, through innovation, better managerial practices, or adopting new technologies. Manufacturing of machinery and equipment, computers and electronics, wearing apparel and leather, and furniture exhibited fast TFP growth in Poland. (See Appendix Table A2.1) The decomposition indicates that this growth performance was primarily driven by the within component reflecting firms' increasing performance capabilities (Figure A5.2, panel a). This component was on average positive in all but one industry: paper and paper products. However, the productivity gains in the other industries were insufficient to offset the misallocation of productive resources (the between component — that is, increasing market share of low-productive firms in the industry) that caused the productivity in manufacturing to stagnate from 2013 to 2017. Starting in 2017, TFP growth was positive due to the upscaling and within components. This means not only that existing firms were getting more productive but also that new firms with high productivity were entering the dataset (upscaling from micro to at least small-sized).

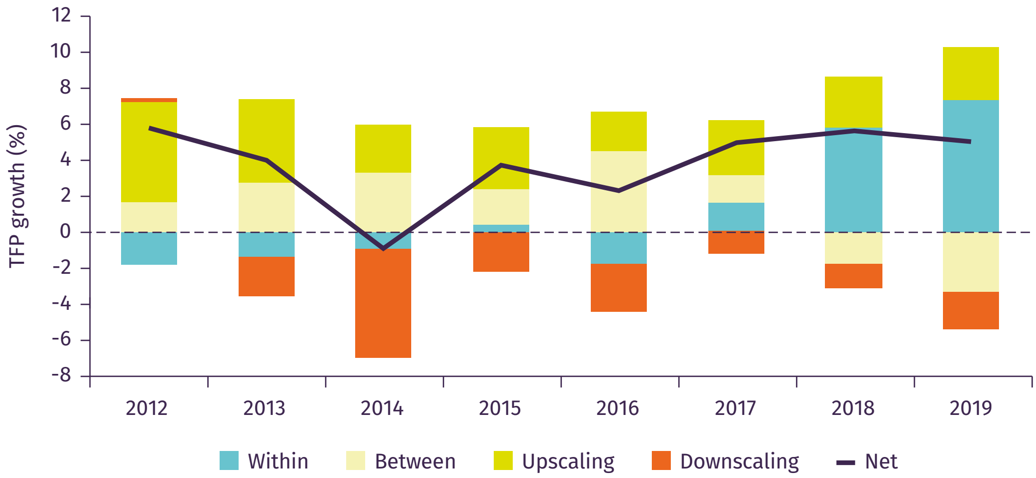
There was no significant productivity contribution from the net of upscaling and downscaling components in the manufacturing sector.[17] As shown in Figure 11, the upscaling contribution was positive and slightly larger than the downscaling component, which was negative. One possible reason for the small contribution of upscaling is that manufacturing entrants tend to have larger sunk investments and other fixed start-up costs, which causes their post-entry performance to be slower than that of the firms in other sectors (Brouthers and Brouthers, 2003). Given our sample, we cannot determine whether the net entry effect resulted from the exit of unproductive firms from the market or firms lowering headcount and dropping out of the SP survey. (As mentioned earlier, the decomposition method relies on the absence of the data to detect the exit of a firm, and micro firms are not obliged to fill out the SP survey.) Therefore, the available evidence is insufficient to determine whether the market selection process has been functioning effectively in manufacturing.

Productivity Growth Decomposition in Construction

Until 2018, Poland's construction industry profited from more efficient allocation of resources between firms, but afterward, its TFP growth was primarily driven by productivity improvements within firms. The within and between productivity components in construction followed divergent paths (Figure 12). The between component was positive and relatively high until 2018, while the within was generally negative. Starting from 2017, the situation reversed: the within component remained positive, while the between component was negative for the last two years. This suggests that Polish construction received a positive productivity shock in 2017 that increased the within component and the aggregate productivity growth performance of the sector. Firms that benefited from this positive shock, however, did not necessarily have large market shares, so the between component decreased by the end of the sample.

17. This study implements Melitz-Polanec decomposition from a 3-year window, but the decomposition can be applied to annual productivity growth rates, which may result in negligibly small or negative entry contributions. Even equipped with the latest technology and skills, entrant firms generally need a start-up period to learn the market demand, advertise their products, and exploit their productivity advantage. This start-up period is usually longer than one year, so decomposing annual growth may not capture the real contribution of entrants in the longer term. Therefore, in the study, the Melitz-Polanec decomposition is applied to 3-year productivity growth rates (to capture entrants' productivity contribution after their first year in the market) and then divided by three (to represent the annual dynamics). Melitz-Polanec decomposition was also applied to 5-year productivity growth rates. The results based on the 5-year differencing do not differ significantly from those based on 3-year differencing.

FIGURE 12 Construction Sector Productivity Growth Decomposition



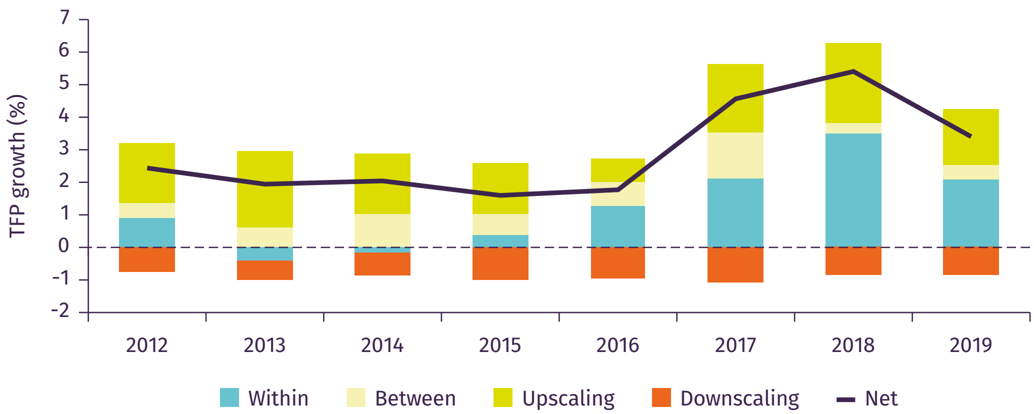
Source: Elaboration based on Statistics Poland calculations.
Note: The figure shows the results of decomposing 3-year productivity growth rates using the Melitz-Polanec method, smoothed to represent an annual change.

The construction industry in Poland has a very dynamic structure with high rates of firm entry and exit from the dataset. As mentioned previously, these entry and exit rates do not necessarily reflect newborn or dying firms. Rather, they may reflect project-specific reorganization of the companies that generates gaps in the panel structure of the dataset, which does not capture micro firms. Accounting for allocative efficiency gains, however, is not straightforward with an unbalanced panel structure, and unrealistically large fluctuations may occur as a result. Nevertheless, as mentioned previously, the construction sector experienced a disruption in 2010 – 13 due to an unprecedented demand boom related to the UEFA Euro 2012 and projects co-financed by EU structural funds. The large negative downscaling contribution in 2014 that is depicted in Figure A2.1 might reflect this negative shock and the bankruptcy wave that followed. It is also likely connected to Poland's lower net inflow of FDI. (See Appendix Figure A7.1)

Productivity Growth Decomposition in Services

As in manufacturing and construction, the within component in services contributed substantially to aggregate productivity growth, especially for the later period in the sample (2016 – 2019), but unlike in other sectors, the efficiency of resource allocation improved continuously 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 13). In the earlier years, much of the growth came from the entry of new producers to the dataset (upscaling component) and efficiency in resource allocation (between component). After 2016, however, firms' own productivity performance (within component) was the main driver of the accelerated productivity performance. The only negative productivity contribution came from the downscaling component, indicating that some high-productivity firms exited the dataset, if not the market. The negative exit contribution, however, may be due to gaps in the data for some high-productivity firms. When a data point is missing for such a high-productivity firm, there are two consequences. First, its absence in a given year will be reflected as a negative contribution to the downscaling component for that year. Second, the upscaling component will rise in the next year, when the missing firm is observed again in the sample. Thus, the simultaneously negative downscaling and positive upscaling components in the service sector's productivity decomposition may be mainly due to the unbalanced structure of the sample rather than to actual firm entries and exits.

FIGURE 13 Services Sector Productivity Growth Decomposition



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

The Polish services industries with the fastest-growing TFP owed their productivity performance to the within component. Among services industries in Poland, telecommunications had by far the fastest-growing TFP. (See Appendix Table A2.1) Although its outstanding growth performance was primarily driven by the within component, the allocative efficiency also improved considerably. (See Annex Figure A5.2). The within component was on average positive in almost all services industries. The best-performing industries in the sector — accommodation, trade, real estate, and administration[18] — can credit their productivity performance to within-firm improvements and more efficient factor allocation. Among all the service industries in the firm-level sample, only professional, scientific, and technical activities[19] had, on average, negative TFP growth between 2009 and 2019.

The services industries with the largest shares of state-owned enterprises had below-average between components. That is, they experienced worse than sectoral average allocation of the factors of production. Utilities[20] and publishing[21] had the largest shares of firms in the dataset with a majority of public capital: over 60 percent in utilities such as electricity, gas, and steam, 55 percent in water utilities, and 8 percent in publishing. The efficiency in the allocation of resources in those industries was the worst among all services. Moreover, the productivity performances of utilities and publishing did not change significantly over the entire 11-year period. It is worth mentioning that, apart from utilities and publishing, the share of state-owned enterprises in most industries in the service sector is less than 2 percent. In the entire firm-level dataset, the firms controlled by the state amounted to 5 percent.

18. Rental, leasing, employment activities, travel agencies, office administration, office supporting activities, and security.

19. Section M of NACE Rev. 2

20. Electricity, gas, water, sewerage, waste, etc.

21. Publishing activities, television production, programming, and broadcasting activities.

IV

HETEROGENEITY IN PRODUCTIVITY PERFORMANCE AND ITS DETERMINANTS

1 In the last decade, small and medium Polish enterprises were the engines of productivity growth in Poland, displaying faster productivity performance than large firms. Moreover, there is some weak evidence that companies with foreign ownership status were more successful in terms of productivity growth than establishments with domestic or state ownership status.

2 Firms operating in expanding industries, such as the manufacturing of computers and electronics, vehicles and equipment, as well as IT services, had better productivity performance than other establishments over time. While this can be interpreted as better-performing firms driving size growth in the industry, increasing demand for an industry's products can also motivate firms to be more productive.

3 Performing R&D activities improved firms' market share within the industry (between component), but there is no evidence that it also led to firms' own productivity improvements (within component). This may imply that R&D investments help more productive firms to capture larger market shares, which in turn improves allocative efficiency. Also, R&D's explanatory power with respect to productivity growth differs between sectors: R&D had a positive impact on TFP in the manufacturing sector but was insignificant in services and construction.

Regression Approach

Because different sectors have different characteristics, analyzing the heterogeneity of productivity growth is needed to understand the paths it can take. As shown in Table 3, the firm-level sample used in this analysis includes firms from every size (except for micro), owner, and age group. Even though large firms constitute only 5 percent of the companies in the sample, they hire more than half of the entire labor force (which corresponds to the shares observed in the aggregate economy). Small, medium, and large enterprises account for an equal share of the labor force in the construction sector, while large companies account for over 50 percent of employment in the manufacturing and services sectors. Even though small firms are universally prevalent in each sector, they employ less than one-fifth of the labor force. Sixty-one percent of the construction companies are owned by Polish entities, while foreign ownership is most common in manufacturing, having 38 percent of all manufacturing workers. Over two-thirds of companies in the dataset are well-established entities, operating for more than a decade on the market and firms' maturity patterns are similar across sectors.

TABLE 3 Firm Characteristics by Sector, Average for 2009–19

	Firm share by sector (%)				Labor share by sector (%)			
	Sample	Manufacturing	Construction	Services	Sample	Manufacturing	Construction	Services
Size classes[a]								
Small (10–49)	74	65	81	78	19	14	36	21
Medium (50–249)	21	28	17	18	29	32	37	26
Large (250+)	5	7	2	4	51	54	28	53
Ownership classes[b]								
Private domestic (PDE)	44	41	48	44	41	44	56	37
State-owned (SOE)[c]	4	1	2	5	10	2	5	16
Foreign-owned (FOE)[d]	10	13	3	10	31	38	14	28
Dispersed capital[e]	<1	<1	<1	<1	2	2	1	2
Undefined[f]	42	45	47	40	17	14	24	18

	Firm share by sector (%)				Labor share by sector (%)			
	Sample	Manufacturing	Construction	Services	Sample	Manufacturing	Construction	Services
Age classes								
Less than 3 years	9	8	10	9	9	8	9	9
From 4 to 9 years	22	21	22	23	24	23	25	25
Older than 10 years	69	71	68	68	67	69	66	66

Source: Elaboration based on Statistics Poland data.

Note: Percentages sum to 100 within firm classes and sectors. FOE = foreign-owned enterprise; PDE = private domestic enterprise; SOE = state-owned enterprise.

a. Three categories based on the annual average number of employees in full-time equivalents.

b. Five categories based on the source of the largest share in core capital. The classification is contingent on data availability in Statistics Poland but largely follows Eurostat's guidelines.[22]

c. State-owned enterprise, SOE = enterprise with a state as the largest shareholder.[23]

d. Foreign-owned enterprise, FOE = enterprise with a foreign entity as the majority shareholder.

e. Enterprise in which dispersed capital constitutes the majority.

f. Enterprise not reporting ownership.[24]

Productivity levels and their dynamics are expected to differ across firm sizes, ownership status, and years on the market. We employ fixed-effects regressions to derive implications for the relationship between firm groups, competition, and firm productivity performance. In the fixed-effects model, every variable is transformed by subtracting the variable's mean, and the estimation is done on so-called time-demeaned data. In our case, we investigate the effect of firms' features (size, age, ownership) and competition on TFP growth rates. The first lags of the size dummies are introduced into the firm performance regressions along with 2-digit industry, year, and region fixed effects. In this setup, controlling for

22. https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/ks-ra-12-016.

23. The state-owned enterprises constitute 4 percent of firms in our sample, and they are mostly concentrated in utilities (60 percent of firms in the industry are state-owned) and real-estate activities (14 percent of firms in the industry are state-owned). They generate 6 percent of aggregate revenue and employ 10 percent of the labor force (16 percent in services).

24. Due to poor reporting, more than 40 percent of companies in the dataset prepared by Statistics Poland do not disclose their ownership. Those companies are mostly small entities (76 percent of those firms hire between 10 and 49 employees, 13 percent firms are micro firms, and the remaining 11 percent are medium firms) engaged in manufacturing (34 percent of firms with undefined ownership are manufacturers), construction (14 percent), and retail and trade activities (32 percent). Even though firms with undefined ownership constitute more than 42 percent of all firms in the sample, they hire only 17 percent of the labor force and generate 12 percent of aggregate revenue.

industry fixed effects is particularly important due to the unobserved differences in industry-level conditions (e.g., Cohen and Klepper, 1996). The small, young, and domestic companies are set as the benchmarks so that the corresponding size dummies are omitted in the regressions. However, due to poor ownership reporting (40 percent of companies do not disclose their ownership status), the analysis of the relationship between firms' ownership and TFP growth is not straightforward, so we employ two regression strategies. First, we divide all companies into two categories: foreign (enterprise with a foreign entity as the majority shareholder) and the rest. The results are given separately for manufacturing (Table 4) and construction and services (Table 5). The second approach assumes running regressions with ownership dummies, as they were defined in the firm-level dataset: private-owned domestic, state-owned, foreign-owned, dispersed capital and undefined (see Table 3 for details on size classes and Appendix Table A6.1, Panel b and Table A6.2, Panel b for regression results). Moreover, since the size dummy might capture all the productivity variation of the state-owned and foreign-owned companies, we present additional two sets of the results with ownership and size dummies introduced one at a time.[25] Those estimation results are given in the Appendix. (See Table A6.1 for manufacturing and Table A6.2 for construction and services.) The regression results investigating the link between firm's age and productivity performance are also given separately and for manufacturing (Table A63, Panel a) and construction and services (TableA63, Panel b).

TABLE 4 Fixed-Effects Regression of TFP on Competition Indicators by Characteristics of Firms in the Manufacturing Industry, 2009–19

Dependent variables	TFP		
Specifications	(1)	(2)	(3)
Competition			
Number of firms (log)		0.0615*** (0.0222)	0.0718*** (0.0217)
Industry-level profit margin			0.657*** (0.0886)
Concentration Index	2.930*** (0.287)	3.071*** (0.289)	3.152*** (0.281)

25. Because, for instance, state-owned and foreign-owned enterprises are usually also large, introducing size and ownership dummies at the same time might make the results hard to interpret. Even though the majority of results do not considerably differ when the dummies are introduced simultaneously or one at a time, the link between foreign-owned firms and productivity growth is universally positive and statistically significant across sectors when the ownership dummies are introduced separately and for more detailed size classes' definition (See Appendix Table A6.1 and Table A6.2). Hence, we find a weak positive relationship between foreign ownership status and TFP growth.

Dependent variables	TFP		
Specifications	**(1)**	**(2)**	**(3)**
Firm size (reference group: small firms)			
Micro-small[a]	0.0635*** (0.009)	0.0638*** (0.009)	0.0628*** (0.009)
Medium [50–250)	-0.0934*** (0.008)	-0.0941*** (0.008)	-0.0935*** (0.008)
Large [250+)	-0.134*** (0.0135)	-0.135*** (0.0136)	-0.135*** (0.0133)
Ownership (reference group: all except foreign-owned)[b]			
Foreign-owned (FOE)	-0.0171 (0.0248)	-0.0172 (0.0248)	-0.00774 (0.0229)
Constant	2.547*** (0.154)	2.033*** (0.239)	1.933*** (0.234)
Observations	168,162	168,162	168,162
R-squared	0.059	0.059	0.107
2-Digit industry FE	yes	yes	yes
Year FE	yes	yes	yes
Region FE	yes	yes	yes

Source: Statistics Poland calculations.

Note: Small firms and private domestic firms are considered the reference groups in their categories.

Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.10.

a. Recall that micro firms are excluded from the sample. However, the dataset prepared by Statistics Poland (based on the *SP surveys*) includes several companies employing more than nine people not working full-time. Firm sizes are defined by full-time employment. Hence, when recalculating for full-time engagement, there appears a small group of micro firms in the dataset, namely 7 percent of all observations (1 percent of the labor force), employing most often 7–9 full-time workers. In the economy, the percentage of micro firms approaches 97 percent. In the production function estimation and productivity analysis, those special-case micro firms were classified as small firms. Those companies appear to be the most productive in the sample (universally in all sectors), which is likely a statistical artifact.

b. The regression's results with ownership dummies as defined in the *SP survey* are given in Appendix Table 11, Panel b.

TABLE 5 Fixed-Effects Regression of TFP on Competition Indicators by Characteristics of Firms in the Construction and Services Industries, 2009–19

Dependent variables	TFP		
Specifications	**(1)**	**(2)**	**(3)**
Competition			
Number of firms (log)		-0.0230** (0.0104)	-0.0231** (0.0104)
Industry-level profit margin			0.000807 (0.00114)
Concentration Index	-0.0776* (0.0456)	-0.0814* (0.0456)	-0.0813* (0.0456)

Dependent variables	TFP		
Specifications	**(1)**	**(2)**	**(3)**
Firm size (reference group: small firms)			
Micro-small[a]	0.0807*** (0.00648)	0.0807*** (0.00648)	0.0807*** (0.00648)
Medium [50–250]	-0.0740*** (0.00572)	-0.0737*** (0.00572)	-0.0737*** (0.00572)
Large [250+)	-0.126*** (0.0135)	-0.126*** (0.0135)	-0.126*** (0.0135)
Ownership (reference group: all except foreign-owned)[b]			
Foreign-owned (FOE)	0.0239 (0.0179)	0.0237 (0.0179)	0.0237 (0.0179)
Constant	2.323*** (0.0719)	2.479*** (0.100)	2.479*** (0.100)
Observations	353,276	353,276	353,276
R-squared	0.069	0.069	0.069
2-Digit industry FE	yes	yes	yes
Year FE	yes	yes	yes
Region FE	yes	yes	yes

Source: Statistics Poland calculations.

Note: Small firms and private domestic firms are considered the reference groups in their categories. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.10.

a. Recall that micro firms are excluded from the sample. However, the dataset prepared by Statistics Poland (based on the *SP surveys*) includes several companies employing more than nine people not working full-time. Firm sizes are defined by full-time employment. Hence, when recalculating for full-time engagement, there appears a small group of micro firms in the dataset, namely 7 percent of all observations (1 percent of the labor force), employing most often 7–9 full-time workers. In the economy, the percentage of micro firms approaches 97 percent. In the production function estimation and productivity analysis, those special-case micro firms were classified as small firms. Those companies appear to be the most productive in the sample (universally in all sectors), which is likely a statistical artifact.

b. The regression's results with ownership dummies as defined in the *SP survey* are given in Appendix Table 12, Panel b.

There is a strong body of empirical evidence that competition drives productivity — by motivating firms to innovate and develop better products, ensuring that more productive firms increase their market share, and by placing pressure on the managers to become more efficient.[26] To capture the link between competition and TFP for Polish enterprises, we introduce an index of market concentration into the analysis. The Hirschman-Herfindahl index (HHI) is a standard measure of market concentration. The index ranges from 0 to 1, so that the higher the market's concentration (HHI closer to 1), the lower the competition within the industry. The index is calculated for each year and industry (grouped

26. On the link between competition and productivity, see Ahn (2002), Holmes and Schmitz. (2010), and Buccirossi et al. (2013).

as in the production function estimations). The coefficient on the HHI variable is expected to be negative, indicating that more intense competition is positively associated with firms' TFP performances. Furthermore, we employ different variables that can be correlated with competition, such as the industry-level average profit margin, the log number of firms in an industry, as well as variables representing aggregate demand conditions, such as the log industry size calculated based on total sales. Moreover, to derive implications for the relation between competition (as well as R&D expenditures) and separate components of firm performance, we regressed the productivity indicators (growth, within and between components) on the concentration index, profit margin, and R&D intensity (calculated as R&D expenditures to sales ratio). The second lag of each regressor is used because the dependent variable covers the years t and t-1 (we employ 1-year average growth). We control for industry and year fixed effects in each regression. The industries are grouped as for the production function estimation. In addition, to identify the link between R&D and productivity performance, we employed two regression approaches: on the firm-level sample and industry-level data. First, we utilized the firm fixed-effects approach controlling for 2-digit industry, year, and region effects. We used the first lag of each regressor in two separate specifications: taking the log of total R&D expenditures and the log of each R&D expenditure separately (internal, external, and equipment; see Box 7 and Table A4.1 for details on the data description). The results are given in Table 6.

Firm and Sector Characteristics and Productivity Growth

Small and medium-sized firms constitute the engine of productivity growth in Poland. The results in Table 4 and Table 5 show that small and medium companies in each sector have significantly higher productivity growth than large companies in Poland. Moreover, a peculiar subset of micro firms in the firm-level sample (henceforth called "micro-small") — having fewer than 10 full-time employees, but at least 10 people engaged and accounting for 7 percent of the sample — are improving their productivity the fastest over time across all firms and sectors. The large companies have the least dynamic productivity growth. SMEs exhibit the highest productivity performance potential, which implies that targeting smaller firms with public incentive programs will more likely increase economy-wide productivity further and, in turn, lead to higher growth.

The characteristics of the industry that a company operates in matter for its individual productivity performance — in expanding industries, firms tend to improve productivity performance over time. The change in the relative size of the industry, measured based on the industry's total sales, has significant explanatory power on firm-level productivity performance. This result is valid for all three sectors and has several implications (Appendix Table A6.1 and Table A6.2). First, higher sales indicate the relative size of the sector and potentially higher competition. Second, productivity often rises as a result of positive demand shocks (Mayer, Melitz, Ottaviano, 2014 and 2016). Increased demand leads producers to shift their production toward their best-performing products or raise prices, both of which lead to increases in labor productivity and TFP. Third, more sizable sectors can generate higher demand for productivity-enhancing technologies because their market is larger (from the perspective of technology providers). We found a positive link between number of competitors in a given industry as well as an industry-level profit margin and productivity growth for manufacturing (see Table 4). What is more, the concentration index for the construction and services industries indicates that high competition in expanding sectors leads to higher TFP.

While competition positively influences aggregate economic outcomes, more intense competition is not always associated with better firm performance at the micro level. The relationship between competition and productivity at the firm level depends on various factors related to the industry's structure and the initial level of competition. Contrary to what might be expected, the link is not always positive. Furthermore, innovation — the major component of firm-specific productivity performance, has an inverted-U shape relationship with product market competition (Aghion et al., 2005). Thus, when competition is already intense and firms differ significantly in performance, more intense competition may discourage laggard firms from innovating. In this case, one can find a negative link between productivity and competition. Conversely, when the level of competition is moderate initially and there is neck-to-neck competition, one can expect that firms tend to be more productive to escape from competitors. In order to assess the link between competition and firm performance, this study introduces four indicators that can be correlated with the product market competition: the number of competitors, the industry size calculated based on total sales, the industry-level profit margin, and market concentration (HHI Index). However, having a relatively large number of competitors in a very large market may not necessarily imply more intense competition. The changes in the market size, therefore, are introduced as a control variable into the estimations (results with log industry size calculated based on total sales dummy are given in Appendix Table A6.1 and Table A6.2).

In manufacturing, intense competition measured by the number of competitors positively influences productivity performance, while in services and construction, decreases in the market concentration are associated with higher productivity. Table 4 displays that the number of competitors in manufacturing has a significantly positive coefficient estimate regardless of the industry size introduced as a control (Appendix TableA6.1). This indicates that manufacturing firms tend to exhibit faster productivity performance in sectors where there is an increase in the number of competitors. Moreover, product market concentration measured by the Herfindahl-Hirschman index has a positive coefficient estimate indicating a positive association between productivity growth and increases in the market concentration. Also, firms operating in industries with an increasing average profit margin perform better in terms of productivity. One possible explanation for this is that in manufacturing, firms that exhibit improvements in their productivity performance tend to occupy more of the market, which leads to a joint increase in productivity and concentration in the industry. This, however, more likely occurs in the industries where concentration is initially low, since in the latter part of this study, we also find evidence to a negative link between the level of concentration and productivity obtained at the industry-level (Table 7). Unlike in manufacturing, decreases in the market concentration are associated with higher productivity growth performance in services and construction (see Table 5). Moreover, the industry-level profit margin does not have any significant influence on firm performance. These results jointly indicate that higher competition leads to better productivity performance in construction and services. This variation in the relationship between competition and productivity in the two main sector groups is most likely due to the differences in the initial level of competition and concentration observed in the market. Further investigation is needed to understand so distinctively opposite results on the link between competition and productivity performance between manufacturing and construction and services.

Ownership status matters for productivity growth, but the empirical results on the relationship are mixed. Due to the structure of the SP survey regarding ownership, we had to employ two regression strategies to investigate the relationship between ownership status and TFP growth. When we introduce the foreign ownership dummy alone, the coefficient turns out to be insignificant, indicating no distinctive productivity performance for foreign-owned establishments (Table 4 for manufacturing and Table 5 for construction and services). In our sample, however, there is a large group of firms whose ownership status is unknown (42 percent of all companies), but they have distinctively better productivity performance. When we control for this undefined ownership category, the coefficient of foreign-owned firms turns out to be significantly positive (Appendix Table A6.1 for manufacturing and Table A6.2 for construction and services). This implies that apart from the undefined category, foreign-owned firms perform much better than others that reported domestic ownership in Poland. The positive relationship between foreign ownership and productivity performance is likely driven by the transfer of technologies and best management practices from abroad and easier access to foreign markets (export-led productivity growth[27]). There is empirical evidence that the transfer of knowledge occurs only if the gap between host (Polish firms) and source (foreign entities) is sufficiently pronounced (Benfratello and Sembenelli, 2006). However, it is challenging to determine the causal effect of ownership on productivity performance explicitly. With takeovers being a predominant mode of entry by foreign entities, higher productivity at foreign-owned establishments might reflect the selection (so-called "cherry-picking") of high-productivity firms for takeover (Griffith et al., 2004; Benfratello and Sembenelli, 2006).

Young firms in Poland exhibit faster productivity growth than older establishments. The relationship between the ages that a firm operates on the market and productivity growth suggests that younger firms experience the fastest productivity growth among all companies (see Appendix Table A6.3). Even though new firms entering the market in manufacturing might begin with low levels of productivity (see Figure 11 and Chapter III for details), they grow much faster than older establishments in the sector. Also, the micro firms (described as micro-small) with an exceptional productivity performance that we observe in the dataset might also be the youngest among all companies, which makes the result consistent. In this regard, facilitating market entry conditions might foster aggregate productivity growth.

R&D and Productivity Growth

Firms of various characteristics invest in R&D differently. R&D expenditures vary significantly across firm size, ownership status, and leading industry of activity. (See Box 7 for details on the R&D dataset.) First, large firms are more

27 See, for instance, Lederman et al. (2018), Atkin et al. (2017), and De Loecker (2013).

likely to incur R&D expenditures than other establishments — 20 percent of large firms in the sample perform R&D, compared to only 7 percent of medium firms and 1 percent of small firms. Second, foreign-owned companies report investments in R&D (7 percent of foreign-owned firms in the sample) more often than state-owned (5 percent), sole domestic (4 percent), and foreign-domestic establishments (4 percent). Third, the older the company, the more likely it is to incur R&D expenditures. Seven percent of companies in the sample operating on the market longer than 20 years perform R&D, compared to 1 percent of young firms (less than 3 years on the market) and 3 percent of established firms (between 4 and 19 years on the market). Lastly, firms operating in medium-high–technology manufacturing industries and knowledge-intensive service industries are not only more likely to report R&D activities but also spend more on those investments. (See Appendix Table A4.1 for details on R&D expenditures across industries and sectors.) However, across firm groups, R&D expenditures are usually performed in the reporting unit (around 83 percent) rather than purchased from other contractors and subcontractors.

BOX 7 R&D Data Sources

To evaluate the link between R&D and Polish enterprises' performance, we use firm-level data covering R&D expenditures incurred by the companies from 2009 to 2019. The data on R&D activities comes from the annual *Questionnaire on research and experimental development (PNT-01)*, maintained by Statistics Poland. All firms (regardless of size) operating in Poland, conducting or commissioning R&D activities (continuous or ad hoc), and allocating funds for such works are legally obliged to submit the form. Even though the firms are additionally incentivized to fill out the questionnaire (including the requirement of providing proof of R&D activities in the form of *PNT-01* when applying for publicly-operated funds), the number of observations in the dataset is very low. Data confidentiality decreases the number of observations further. When there are fewer than three companies or the share of one firm is greater than three-quarters of the total in a given aggregation (year and industry in the study), the data cannot be shared (the Law of 29 June 1995 on official statistics, Journal of Laws No 88, item 439 as amended).

There are 8,000 enterprises of all sizes (micro firms included) reporting R&D expenditures in the manufacturing, construction and service sectors between 2009 and 2019. Furthermore, after excluding micro firms and merging the R&D dataset with the estimated TFP index that is based on the enterprise survey productivity dataset (we need to employ the same companies as for the production function estimations), we are left with 17,000 observations and about 5,000 companies during an 11-year-period. Thus, only 3.5 percent of the firms observed in the productivity dataset are disclosing R&D expenditures, with an average of about three observations per firm. The details of the dataset are given in Appendix A.4. Due to the low number of observations and the highly unbalanced structure of the R&D dataset, the analysis results must be interpreted with caution. The R&D analysis investigates a correlation with different firm groups and productivity rather than causal link and capturing the causal relationship between R&D and productivity requires further empirical work.

There is a positive link between R&D expenditures and productivity performance in the manufacturing sector, but not in the construction and services sectors. The regression results on R&D and firm performance are mixed (Table 6). We do not find any significant effect of firm-level expenditures on R&D on TFP growth in the services and construction industries. However, R&D is significantly and positively associated with firms' productivity growth in manufacturing.[28] The fact that R&D expenditures and productivity are positively correlated in manufacturing may imply potential positive returns from R&D incentives. One possible reason for inconclusive results regarding the link between R&D expenditures and productivity growth might be the low number of companies reporting R&D expenditures in the panel dataset, especially until 2016. Second, productivity advances in services often happen through investments in intangible assets, however, their reliable measurement is still a challenge (Demmou et al. 2019).

TABLE 6 Fixed-Effects Regression of TFP on R&D Variables, 2009–19

Dependent variable	TFP			
Specifications	(1)	(2)	(1)	(2)
	Manufacturing		Construction & services	
R&D internal (log)		0.0024*** (0.0005)		0.0002 (0.0007)
R&D external (log)		-0.0006 (0.0005)		-0.0003 (0.0009)
R&D equipment (log)		0.0001 (0.000567)		-0.0001 (0.001)
R&D total (log)	0.0019*** (0.0004)		0.0001 (0.0006)	
Constant	3.309*** (0.004)	3.309*** (0.0076)	3.776*** (0.007)	3.774*** (0.014)
Observations	168,162	168,162	353,276	353,276
R-squared	0.000	0.000	0.000	0.000
2-Digit industry FE	yes	yes	yes	yes
Year FE	yes	yes	yes	yes
Region FE	yes	yes	yes	yes

Source: Statistics Poland calculations.
Note: Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.10.

28. The literature finds similar results, see Doraszelski and Jaumandreau (2013), Hall et al. (2010), Bloom et al. (2017).

R&D expenditures lead to more efficient resource allocation (impact on the between component) but not to improved firm productivity performance (the within component). Firms can make R&D investments to create innovative new products, production methods, or organizational structures or adopt them from others, which would increase the R&D-making firms' individual productivity performance. In some cases, however, firms can do R&D to understand market demand and trends to better advertise products, learn consumer preferences, and test demand conditions (for instance, on foreign markets), in which case the firm benefits from the R&D investment by expanding its market share. As Table 7 shows, there is a positive link between R&D expenditures and the between component. This implies that firms that are more productive invest in R&D and expand their market shares rather than improving their innovation performance. The R&D effect on the industry-specific within component measuring overall growth from innovation or adaptation performance, however, is not significant.

TABLE 7 Linear Regression of TFP Growth and Its Components on Selected Productivity Determinants, 2009–2019

Dependent Variables	(1) Productivity Growth	(2) Within	(3) Between
Concentration Index	-1.823*** (0.596)	-0.303 (0.459)	-1.52*** (0.478)
Profit Margin	-0.0601** (0.0299)	0.0006 (0.0115)	-0.0607*** (0.0217)
R&D Intensity	1.048 (0.688)	-0.0426 (0.354)	1.091** (0.517)
Constant	0.0931*** (0.027)	0.0506* (0.0289)	0.0425* (0.0221)
Observations	242	242	242
R-squared	0.319	0.405	0.224
2-Digit Industry FE	yes	yes	yes
Year FE	yes	yes	yes

Source: Elaboration based on Statistics Poland calculations.
Note: Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.10.

V

AREAS FOR POLICY ACTION

Based on the key findings from the analysis, this section aims to provide insights on where and how regulations and support mechanisms could be adjusted to improve the productivity performance of firms. It also offers some considerations for areas for further research.

Enhancing firms' capabilities. Poland's aggregate productivity growth accelerated in all sectors from 2017 onwards and was mainly driven by within-firm productivity improvements. However, not all industries saw their firms' capabilities increase. Moreover, Polish companies lag in terms of digitalization and innovation capabilities. (Poland ranks 23rd in the Digital Economy and Society Index and 24th on the Innovation Scoreboard out of 27 EU member states.) About half of Polish firms do not use even basic techniques that improve management (World Bank, 2021), and relatively few current instruments are dedicated to improving management practices (World Bank, 2019). Strengthening within-firm productivity growth is critical for sustaining long-term economic growth, and it remains a priority on the productivity-enhancing policy agenda. Improving within-firm performance means increasing the amount of output firms produce with a constant quantity of inputs (such as labor, capital, and intermediate inputs) by, for instance, strengthening managerial skills, workforce skills, innovation capacity, and technology absorption capability. In this respect, human capital–related abilities such as digital literacy and leadership skills are as important as technology itself. Policy interventions aiming to improve within-firm performance include, for instance, providing business advisory (outsourcing consultants) and technology extension services, facilitating entrepreneurial networks and clusters, offering vouchers for training, and improving employees' digital skills.

Supporting small and medium firms because they are the engine of productivity growth in Poland. The empirical results indicate a need to intensify competition in Polish industries and allow smaller establishments to exert competitive pressure on their larger counterparts. Besides reducing barriers to competition by detecting and removing regulations that provide advantages asymmetrically to large firms, eliminating barriers to growth for smaller firms, especially in manufacturing, is critical for economic growth. Improving SMEs' ability to grow means, for instance, facilitating their access to finance, promoting financial market deepening, and supporting the development of their innovation supply side. Besides financial constraints, barriers to adoption may also include information gaps (such as the mistaken belief that digitalization is not suitable for SMEs), lack of awareness of technology benefits, managers' loss aversion, and overestimation of firm's productivity (Martin et al., 2013; Bloom et al., 2012; Dincă et al., 2019). There is evidence that digital adoption more often takes place in larger establishments (World Bank, 2021). Policy interventions need to address potential barriers to SMEs' technology adoption because their gains from adoption are possibly more significant than for larger establishments.

Improving allocative efficiency in manufacturing. Deterioration in allocative efficiency in manufacturing calls for attention in the structure and targeting of existing incentive programs in the form of tax reliefs, subsidized credits, grants, and other types of firm-specific interventions. For instance, taxes that depend on the size of a company may incentivize firms to remain below a certain threshold and limit their growth. Poland's growth would benefit from supporting companies with high potential to innovate or grow rather than help inefficient establishments survive in the market. Supporting potentially high-productivity producers should not be limited to subsidizing selected growth-enhancing investments, but also facilitating their conditions to do business and access finance. For example, an economic policy that would mitigate market imperfections such as lack of developed second-hand markets for capital goods or improving information asymmetries by developing efficient employment agencies would facilitate labor flow to more productive firms. These types of supportive interventions will work in favor of more efficient factor allocation and accelerate the creative destruction necessary for restructuring of poor-performing industries.

Investigating barriers for growth for large Polish firms. Even though large establishments constitute only 5 percent of all firms in Poland, they employ more than half of the labor force. Their productivity performance is essential for the aggregate outcomes. In terms of productivity-enhancing investments, compared to smaller entities, large enterprises are usually not financially constrained. However, the empirical evidence suggests that their productivity performance is substantially worse than the performance of smaller establishments.

Since the financial nudges to improve productivity are not the most effective policy option for large enterprises, the policy makers could further investigate what barriers firms face when innovating or adopting new technologies. One possible reason for large firms' poor performance is that they are frequently exposed to many policy interventions, such as industrial regulations or taxes. Revising the existing large firms' business environment, especially in the food, beverages, metals and rubber industries and targeting elimination of industrial protection might be the best policy option to improve the performance of larger establishments.

Strengthening linkages between Polish and foreign firms. The empirical evidence indicates that firms in expanding industries exhibit better productivity performance than establishments in other industries. In addition, there is some weak empirical evidence, that firms that reported foreign ownership experience faster productivity growth than those that reported domestic and state ownership. Also, following the results from "Return on Investment of Public Support to SMEs and Innovation in Poland", these findings can lead to the conclusion that firms in the Polish economy generally benefit from lower barriers to international trade (World Bank, 2019). Policy makers could consider interventions to establish or strengthen the linkages between Polish firms (especially SMEs) and foreign firms through, for instance, supplier development programs and matchmaking that would facilitate the integration of domestic producers with GVCs. Promoting exports also involves facilitating domestic infrastructure for testing and certification, without which the sunk costs of exporting are high. However, a tailored set of skills (linkage capabilities) and managerial processes are required to fully benefit from exposure to international markets. Tacit knowledge about foreign markets is best transferred by interacting with the business community of the export market.

Enhancing the industry-specific and tailored approach to policy design. Polish firms exhibit a high degree of heterogeneity in their productivity performance within narrowly defined industries and across sectors. Consequently, an industry-specific perspective is a necessity in policy design. Carefully targeted programs lower the financial costs of policy implementation. Even though the drivers of productivity are distinct, they are also interlinked, and a well-designed system of incentives accounts for complementarity in policy interventions. Poland needs a mix of policies that include improving the functioning of markets and business operating environments (between component), as well as policies that support firm upgrading (within component). While firms differentiate by their capabilities, especially across sizes, and face various market conditions, effective policy design accounts for those differences. Given the high productivity growth potential in Polish SMEs, it is crucial to revise and adjust existing policies to increase the share of smaller establishments investing in digitalization and technology adoption.

Employing the new wave of productivity diagnostics and analytics. Due to the lack of variables reflecting firm-level prices and quantities of outputs and inputs in the dataset prepared by Statistics Poland, the computation of TFP in the study employs industry-level price indices (Box 3). Using industry-level prices in the estimation of firm-level TFP causes the estimated productivity of individual firms to reflect not only efficiency in production but also factors driving firm-level price variation (general firm performance). In turn, the TFP value grows not only as a result of production efficiency improvements but also due to higher prices following better product quality, advertising, marketing, or product market competition. Distinguishing production efficiency and firm performance is crucial because otherwise improvements in productivity driven by market power and markups are confused with improvements in real efficiency. Even though both efficiency and firm performance are important for an overall growth strategy, providing precise policy recommendations requires a comprehensive understanding of drivers and barriers to productivity growth. Therefore, employing the new wave of productivity diagnostics is necessary to quantify the importance of different market failures or distortions and define appropriate priorities. These approaches require detailed firm-level data on prices, marginal costs, intangible assets, quality, and management. Consequently, the institutional capacity building of national statistical offices is essential for evidence-based policy design.

Improving data accessibility. Due to statistical confidentiality law, firm-level data on business activities in Poland are restricted and not easily accessible to researchers. Providing the results presented in this report was only possible through the World Bank's close cooperation with an experienced team at Statistics Poland. However, this type of cooperation is often time-consuming to establish and may result in delays and inefficiencies that would be resolved if the analysts were to have direct access to the firm-level data. In some countries, researchers can directly access data (for instance, using computers on the statistics agency's premises), with appropriate privacy controls preventing firm-identifying information from being made public (World Bank, 2019). Delivering high-quality research depends on government openness to share data. Given the importance of evidence-based research in effective policy design, one recommendation would be to establish an "Innovation and

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

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APPENDIX

A.1 Endogenous and Explanatory Variables

To calculate productivity, one must construct variables not explicitly reported in the *Annual Enterprise Survey* (SP). We express firm labor costs, intermediate consumption, and output as:

costsLabor = *wages* + *insurFees* + *costsBusTrip*,

intermConsump = *costsMatEnerg* + *costsExternalServ* + *costsOtherIC* − *costsBusTrip*,

output = *revNet* − *goodsChange* − *tax* − *valCM* + *goodsU2* − *goodsU1* + *goodsF2* − *goodsF1*,

revNet = *revNetP* + *goodsChange* + *costOwn* + *revNetCM*

with the SP variables summarized:

wages	remunerations (from the income statement)
insurFees	social security contribution
costsBusTrip	business travel costs
costsMatEnerg	use of raw materials and energy costs
costsExternalServ	outside services costs
costsOtherIC	other operating costs (includes business travel costs)
revNet	net revenues
revNetP	net revenues from the sale of products (goods and services)
costOwn	cost of producing products for own use
revNetCM	net revenues from sales of commodities and raw materials
goodsChange	change in stocks of finished goods and work in progress
tax	excise tax
valCM	the value of sold commodities and raw materials
goodsU(1/2)	semi-finished products and production in progress (the beginning and end of the year)
goodsF(1/2)	finished goods (the beginning and end of the year)
tangFixAss(1/2)	tangible fixed assets (the beginning and end of the year)
intangFixAss(1/2)	intangible fixed assets (the beginning and end of the year)

The define firm gross value-added and capital as:

$$gva = output - intermConsump,$$

$$capital = \frac{tangFixAss1 + tangFixAss2}{2} + \frac{intangFixAss1 + intangFixAss2}{2}$$

The relatively short sample period makes the Perpetual Inventory Method to construct capital unreliable. The final measurement of variables is calculated with the enterprise's real gross value added and real capital at constant average prices from 2010. For this purpose, we employ capital and gross value added price deflators at 2-digit NACE Rev. 2 (published yearly by Statistics Poland as *Prices in the national economy*).

A.2 Firm-Level Panel Dataset Characteristics

TABLE A2.1 The Growth of Selected Industrial Characteristics in the Sample by Sectors—Manufacturing, Construction and Services. Δ Represents the % Change of an Index Number between 2009 And 2019.

a. manufacturing

Divisions (NACE Rev. 2)	code	Δ TFP	Δ LP	Δ GVA	Sectoral GVA share in 2009	Sectoral GVA share in 2019	Δ Employ.	Sectoral labor share in 2009	Sectoral labor share in 2019	Δ Rev.
Low technology										
Food and beverages	10–11	-1%	34%	21%	21%	15%	-4%	18%	16%	57%
Textiles	13	40%	59%	63%	1%	1%	-4%	2%	2%	105%
Wearing apparel & leather	14–15	56%	67%	13%	2%	1%	-42%	5%	3%	22%
Wood, cork & straw	16	32%	56%	57%	4%	3%	-4%	4%	4%	58%
Paper	17	-11%	30%	47%	3%	3%	21%	2%	3%	100%
Printing	18	29%	42%	81%	1%	1%	25%	1%	2%	68%
Furniture	31	41%	62%	100%	4%	5%	14%	7%	7%	86%
Others	32	55%	86%	164%	1%	2%	22%	1%	2%	136%
Medium-low technology										
Rubber & plastics	22	24%	47%	109%	7%	9%	40%	7%	9%	115%
Non-metallic minerals	23	39%	77%	104%	6%	7%	8%	5%	5%	77%

Divisions (NACE Rev. 2)	code	Δ TFP	Δ LP	Δ GVA	Sectoral GVA share in 2009	Sectoral GVA share in 2019	Δ Employ.	Sectoral labor share in 2009	Sectoral labor share in 2019	Δ Rev.
Basic & fabricated metals	24–25	8%	52%	65%	15%	15%	16%	15%	15%	93%
Machinery repair & installation	33	25%	34%	61%	3%	3%	17%	3%	4%	116%
Medium-high technology										
Chemicals & pharmaceu-ticals	20–21	-5%	19%	28%	8%	6%	10%	5%	5%	58%
Computers & electronics	26–27	84%	111%	205%	5%	10%	15%	7%	8%	73%
Machinery & equipment	28	41%	70%	79%	6%	7%	-3%	6%	5%	68%
Vehicles & transport	29–30	19%	54%	93%	10%	11%	28%	10%	12%	85%

b. construction

Divisions (NACE Rev. 2)	code	Δ TFP	Δ LP	Δ GVA	Sectoral GVA share in 2009	Sectoral GVA share in 2019	Δ Employ.	Sectoral labor share in 2009	Sectoral labor share in 2019	ΔRev.
Buildings	41	45%	45%	-3%	41%	36%	-39%	39%	33%	32%
Civil engineering	42	27%	43%	16%	33%	34%	-21%	33%	36%	29%
Specialized activities	43	45%	45%	29%	26%	30%	-18%	28%	31%	28%

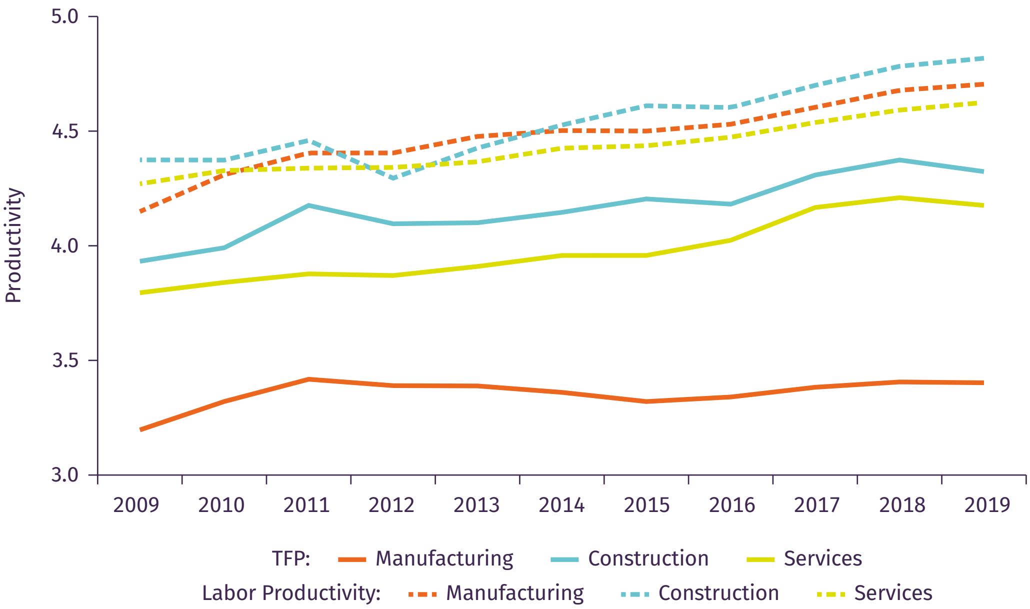
c. services

Divisions (NACE Rev. 2)	code	Δ TFP	Δ LP	Δ GVA	Sectoral GVA share in 2009	Sectoral GVA share in 2019	Δ Employ.	Sectoral labor share in 2009	Sectoral labor share in 2019	Δ Rev.
Electricity, gas & steam	35	7%	60%	18%	14%	10%	-27%	6%	4%	-5%
Water utilities	36–39	0%	10%	36%	4%	3%	24%	4%	4%	69%
Vehicles: wholesale, retail and repair	45	37%	43%	81%	3%	4%	13%	3%	3%	107%
Wholesale trade	46	31%	46%	61%	20%	19%	6%	18%	16%	65%
Retail trade	47	35%	42%	76%	13%	14%	18%	21%	21%	79%
Transport & storage	49–53	18%	25%	63%	13%	13%	13%	18%	17%	103%

Divisions (NACE Rev. 2)	code	Δ TFP	Δ LP	Δ GVA	Sectoral GVA share in 2009	Sectoral GVA share in 2019	Δ Employ.	Sectoral labor share in 2009	Sectoral labor share in 2019	Δ Rev.
Accommodation	55	40%	39%	45%	1%	1%	-2%	2%	1%	72%
Food & beverage activities	56	29%	38%	68%	1%	1%	15%	2%	2%	109%
Real estate	68	33%	38%	33%	4%	3%	-8%	4%	3%	32%
Knowledge-intensive										
Publishing & broadcasting	58–60	17%	43%	27%	3%	2%	-6%	2%	1%	21%
Telecommunications	61	86%	91%	81%	7%	8%	-24%	2%	2%	40%
IT	62–63	9%	18%	219%	3%	6%	180%	2%	5%	225%
Consulting	69–71	7%	24%	114%	4%	5%	82%	3%	5%	99%
Research	72–75	-8%	-25%	66%	3%	3%	95%	2%	3%	49%
Administration & support	77–82	46%	52%	125%	5%	7%	36%	11%	12%	220%

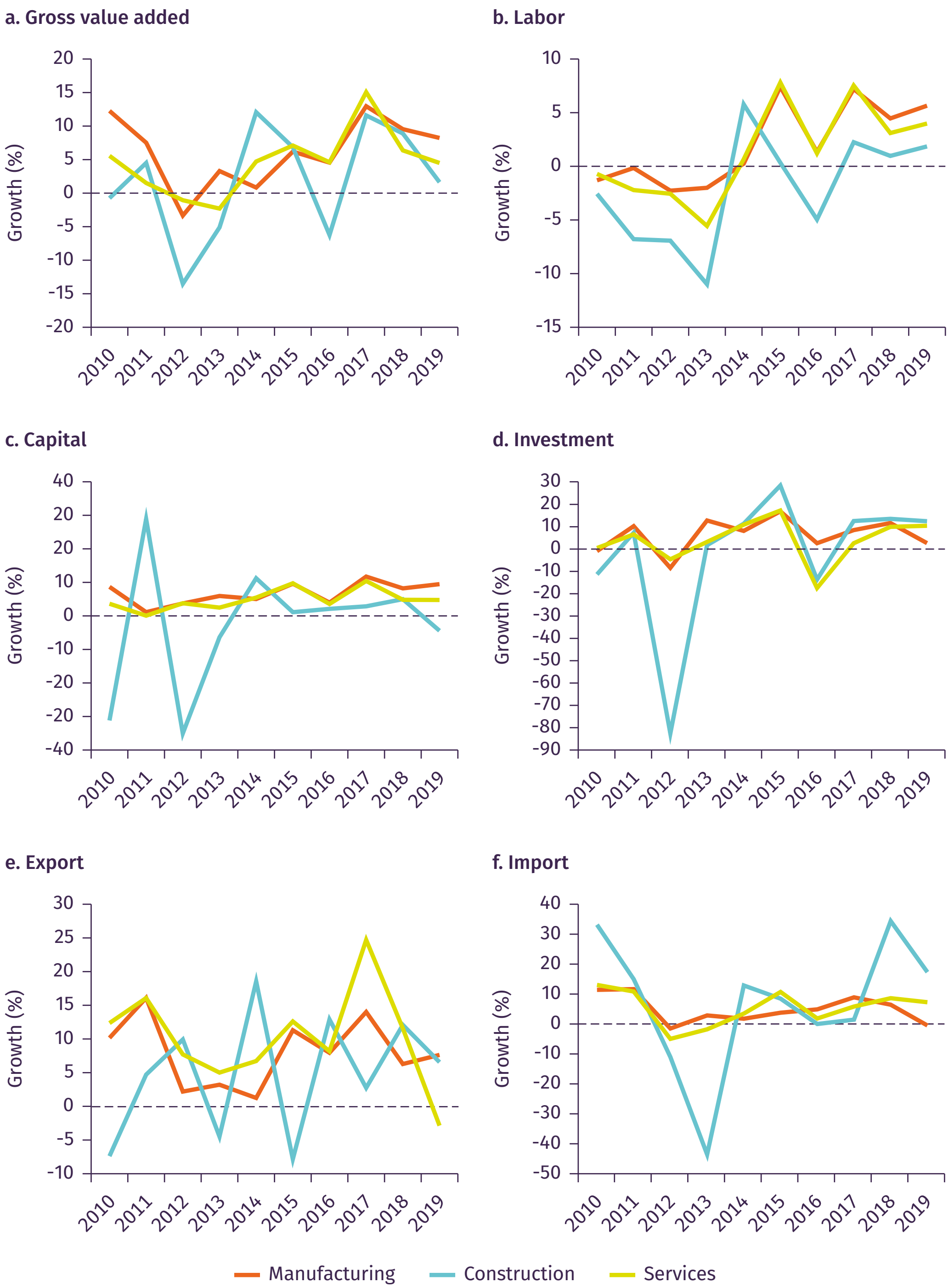
Source: Elaboration based on Statistics Poland calculations.
Note: Darker shades of green indicate stronger development characteristics relative to industries with lighter blue within sectors.

FIGURE A2.1 Levels of Productivity by Sector (2009–19)



Source: Elaboration based on Statistics Poland calculations.

FIGURE A2.2 **Growth in Performance Indicators by Sectors (2009–19)**



Source: Elaboration based on Statistics Poland calculations.

A.3 Production Function Estimation

TFP is calculated using the structural production function estimation approach by Ackerberg et al. (2015) that is implemented separately for every 2-digit NACE manufacturing, construction, and services industry. Due to lack of sufficient observations or data confidentiality, some of the 2-digit NACE industries were grouped in the production function estimations (e.g., Food&Beverages). The estimation sample covers the period from 2009 to 2019. Estimation results for the industry-level production functions and grouping of industries are given in Table A3.1.

The TFP estimation is based on the Cobb-Douglas production function in the following form:

$$Y_{it} = A_{it}^{\beta_k} K_{it} \; L_{it}^{\beta_l}, \tag{1}$$

In the above equation Y_{it}, L_{it}, K_{it} is, respectively, the real gross value-added, labor, and capital inputs of enterprise *i* in period *t*. A_{it} is an idiosyncratic Hicks technological level used in the production process. Y_{it}, K_{it} were measured by deflating gross value-added and physical capital to 2010 prices. The technology level used in the production process can be decomposed:

$$A_{it} = TFP_{it} \; U_{it} = e^{\beta_0 + dummies} \, V_{it} \; U_{it}. \tag{2}$$

A_{it} is the unobservable variable that can be expressed as the product of the constant term $e_0^{\beta + dummies}$, the volatility of individual productivity V_{it} and idiosyncratic white noise $U_{it} = e^{u_{it}}$. If y_{it}, l_{it}, k_{it}, v_{it} are logarithms of Y_{it}, L_{it}, K_{it}, V_{it}, then

$$\omega_{it} = \beta_0 + dummies + v_{it} \tag{3}$$

represents the logarithm of productivity of enterprise *i*. Production function can be presented in a log-linear form:

$$y_{it} = \omega_{it} + \beta_k k_{it} + \beta_l l_{it} + u_{it} \tag{4}$$

Coefficient ω_{it} is often interpreted as a state variable in the enterprise decision problem of selecting factor inputs, with the error term u_{it} correlated with measurement errors and represents so-called unpredictable productivity shock. Equation (4) is estimated to determine individual TFP. As a result, we obtain estimator of $logTFP$:

$$\hat{\omega}_{it} = y_{it} - \hat{\beta}_k k_{it} + \hat{\beta}_l l_{it}. \tag{5}$$

It follows that individual TFP is given by:

$$\widehat{TFP}_{it} = e^{\hat{\omega}_{it}} \tag{6}$$

To estimate the production function, we use the control function method (Levinsohn and Petrin, 2003). It helps address endogeneity problems (van Beveren, 2012) by employing variables that proxy for unobservable productivity shocks. It assumes that productivity can be proxied by outlays on materials and energy. The model is estimated in a 2-step procedure. In the first step, the estimates of unobserved productivity are calculated. In the second step, using generalized method of moments (GMM) and estimates from the previous stage, non-linear regression of gross value added of surviving firms is estimated to determine capital and labor elasticities.

TABLE A3.1 Production Function Estimation Results

a. Manufacturing

	Labor	Capital	#obs	#firms
Food & beverages	0.764*** -0.00233	0.296*** -0.0018	25,172	4,153
Textiles	0.780*** -0.00311	0.180*** -0.00535	3,561	645
Wearing apparel & leather	0.829*** -0.0043	0.164*** -0.00584	6,033	1,090
Wood, cork & straw	0.827*** -0.00497	0.228*** -0.00551	7,711	1,418
Paper	0.619*** -0.00646	0.399*** -0.00533	4,564	753
Printing	0.894*** -0.00867	0.171*** -0.00612	3,913	737
Chemicals & pharmaceuticals	0.709*** -0.00801	0.319*** -0.00674	5,988	994
Rubber & plastics	0.810*** -0.00261	0.241*** -0.00192	14,226	2,366
Non-metallic minerals	0.840*** -0.00713	0.255*** -0.00786	8,338	1,483
Basic & fabricated	0.860*** -0.00187	0.160*** -0.000865	27,911	5,031
Computers & electronics	0.815*** -0.00579	0.177*** -0.00561	8,220	1,369
Machinery & equipment	0.835*** -0.00296	0.175*** -0.00149	10,241	1,800
Vehicles & transport	0.811*** -0.00932	0.241*** -0.0124	6,367	1,074
Furniture	0.922*** -0.00479	0.140*** -0.00347	7,181	1,288
Others	0.776*** -0.0111	0.215*** -0.00852	2,943	570
Machinery repair & installation	0.865*** -0.00535	0.115*** -0.00629	8,229	1,819

b. Construction

	Labor	Capital	#obs	#firms
Buildings	0.803*** -0.00559	0.200*** -0.00478	20,755	4,997
Civil engineering	0.852*** -0.00296	0.179*** -0.0053	17,155	3,511
Specialized activities	0.931*** -0.00296	0.130*** -0.00374	19,354	4,686

c. Services

	Labor	Capital	#obs	#firms
Electricity, gas & steam	0.758*** -0.00698	0.332*** -0.00713	4,866	747
Water utilities	0.839*** -0.00109	0.198*** -0.00179	13,916	2,055
Vehicles - wholesale, retail, repair	0.904*** -0.000966	0.176*** -0.00154	15,781	2,825
Wholesale trade	0.846*** -0.000001	0.168*** -0.000001	95,548	18,980
Retail trade	0.796*** -0.000001	0.147*** -0.000001	64,801	13,285
Transport & storage	0.822*** -0.00159	0.148*** -0.00169	30,817	6,433
Accommodation	0.935*** -0.00458	0.144*** -0.00656	6,149	1,289
Food & beverage activities	0.848*** -0.00685	0.130*** -0.00742	5,359	1,441
Publishing & broadcasting	0.848*** -0.00658	0.191*** -0.0112	4,397	849
Telecommunications	0.803*** -0.0111	0.270*** -0.0182	1,942	484
IT	0.941*** -0.00383	0.119*** -0.00591	10,638	2,510
Real estate	0.794*** -0.00319	0.156*** -0.0039	21,918	3,579
Consulting	0.948*** -0.00307	0.105*** -0.00288	17,861	3,992
Research	0.911*** -0.00635	0.0595*** -0.00809	7,551	1,882
Administration & support	0.706*** -0.00211	0.167*** -0.00246	18,090	4,362

Source: Elaboration based on Statistics Poland calculations.
Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All equations include time dummies and 2-digit industry dummies if a group contains more than one 2-digit industry.

A.4 R&D Dataset Description

TABLE A4.1 The Descriptive Statistics, the Number of Observations, and Firms in the R&D Panel Dataset

a. Manufacturing

Divisions (NACE 2.)	code	No. observ.	No. Firms	R&D (thous. PLN)	R&D (by an employee)	R&D internal	R&D external	R&D equipment
Low technology								
Food and beverages	10–11	1,068	337	2,113	0.6	1,960	154	723
Textiles	13	259	71	2,443	1.6	2,305	138	453
Wearing apparel & leather	14–15	119	48	936	0.2	772	164	75
Wood, cork & straw	16	289	105	1,698	0.6	1,479	219	390
Paper	17	276	100	802	0.4	584	218	196
Printing	18	181	79	1,481	0.8	1,447	34	455
Furniture	31	358	117	1,968	0.5	1,803	165	466
Others	32	405	119	1,313	1.7	1,272	41	292
Medium-low technology								
Rubber & plastics	22	1,415	450	1,132	0.9	873	259	365
Non-metallic minerals	23	706	222	1,356	0.9	1,129	226	504
Basic & fabricated metals	24–25	2,533	775	1,999	1.6	1,579	421	423
Machinery repair & installation	33	408	160	2,054	1.1	1,805	249	151
Medium-high technology								
Chemicals & pharmaceuticals	20–21	1,876	401	2,729	5.4	2,206	523	378
Computers & electronics	26–27	2,224	563	3,863	5.6	3,563	300	708
Machinery & equipment	28	1,926	521	2,030	3.4	1,629	401	377
Vehicles & transport	29–30	1,185	284	10,545	5.5	6,932	3,613	1,169

b. Construction

Divisions (NACE 2.)	code	No. observ.	No. Firms	R&D (thous. PLN)	R&D (by an employee)	R&D internal	R&D external	R&D equipment
Buildings	41	141	67	1,281	0.1	1,156	125	74
Civil engineering	42	241	96	1,205	0.2	1,086	120	144
Specialized activities	43	319	126	1,378	0.4	904	474	198

c. Services

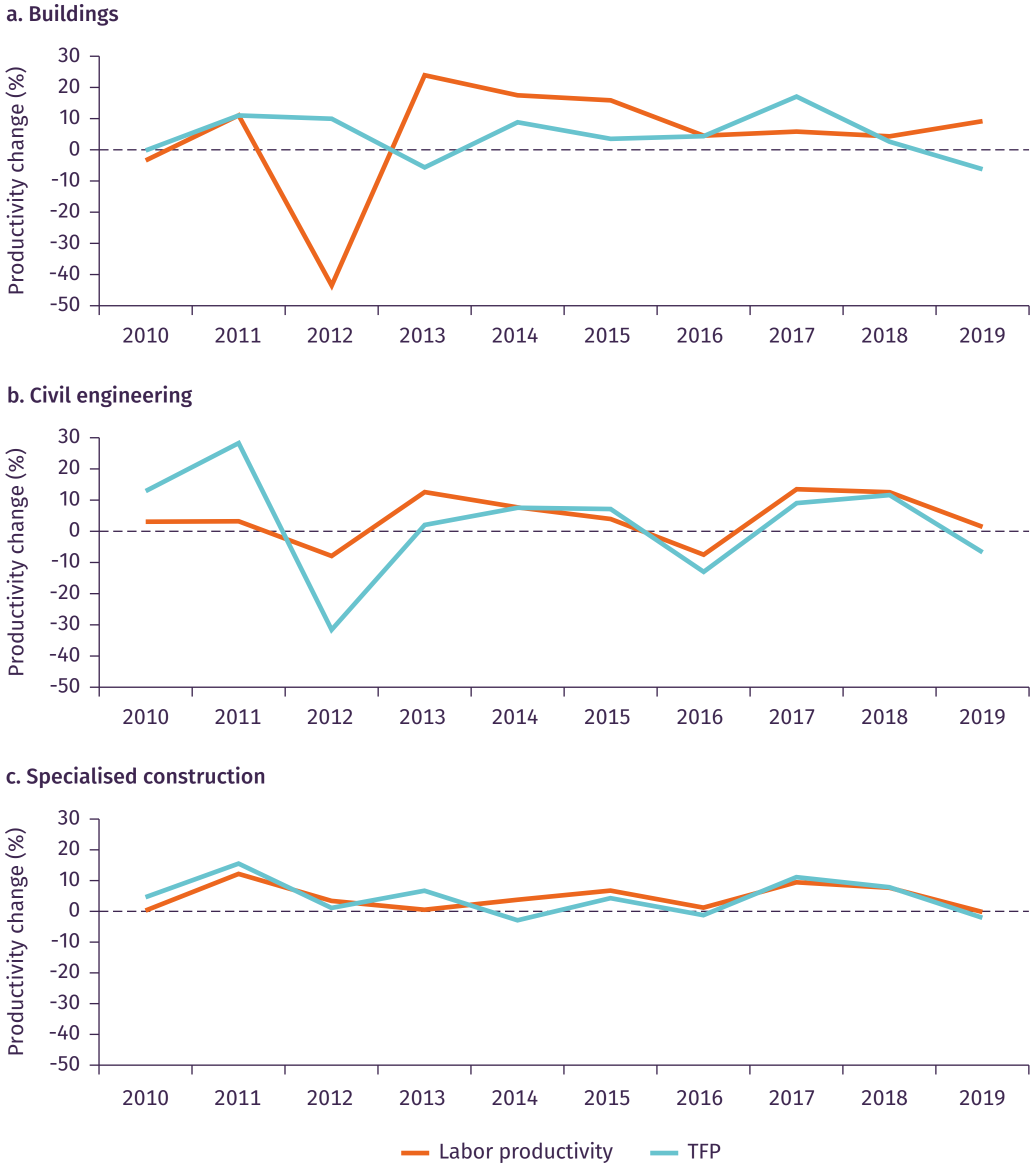
Divisions (NACE 2.)	code	No. observ.	No. Firms	R&D (thous. PLN)	R&D (by an employee)	R&D internal	R&D external	R&D equipment
Electricity, gas & steam	35	275	74	3,244	0.6	1,672	1,571	748
Water utilities	36–39	346	132	732	0.2	659	73	256
Vehicles—wholesale, retail, repair	45	102	39	3,632	0.4	3,485	147	393
Wholesale trade	46	1,944	780	4,097	1.7	3,032	1,066	319
Retail trade	47	289	157	1,006	0.0	920	87	118
Transport & storage	49–53	186	68	1,146	0.0	600	546	147
Accommodation	55	10	7	238	0.0	228	9	100
Food and beverage activities	56	10	6	474	0.0	311	164	178
Real estate	68	93	38	3,133	0.3	3,065	68	1,133
Knowledge-intensive								
Publishing & broadcasting	58–60	202	86	5,787	3.3	5,694	93	399
Telecommunications	61	161	67	62,285	20.8	59,124	3,161	5,950
IT	62–63	1,847	735	6,236	11.7	5,983	253	461
Consulting	69–71	626	250	4,702	2.5	4,256	446	754
Research	72–75	2,287	933	6,031	20.1	5,513	518	458
Administration & support	77–82	153	75	1,765	0.1	1,259	506	124

Source: Elaboration based on Statistics Poland calculations.

Note: The table reports the real mean firm-level expenditures of R&D (total, total divided by the number of employees in the industry, internal, external, and on equipment). The mean values are deflated with gross value-added deflators and expressed at 2010 constant prices, in thousands of Polish zloty (national currency). Variables' description: 1) R&D internal: R&D performed in the reporting unit, regardless of the source of funds; 2) R&D external: R&D works purchased from other contractors (subcontractors) domestic and foreign; 3) R&D equipment: machinery and technical equipment, software.

A.5 Sector- or Industry-Specific Results Based on Firm-Level Data

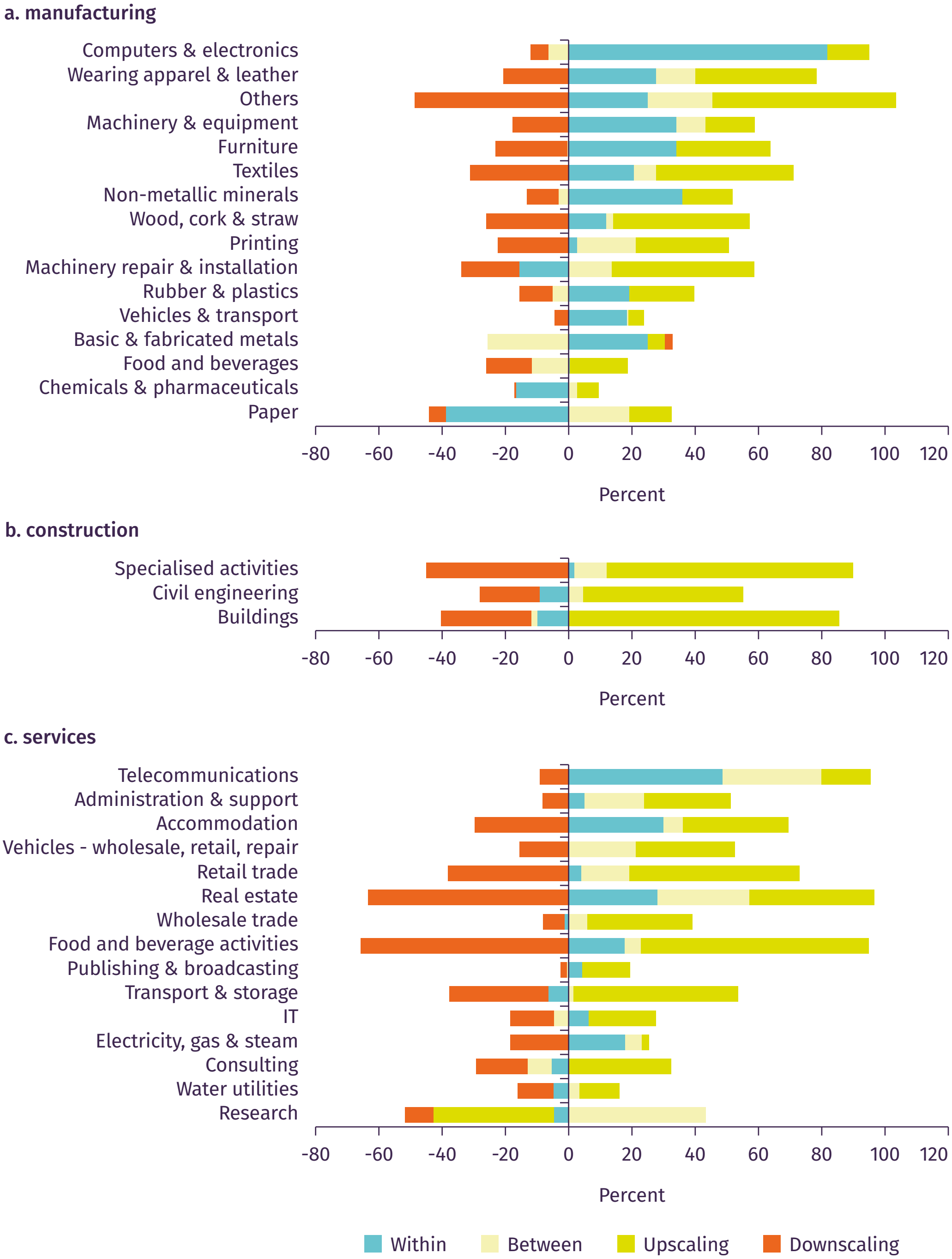
FIGURE A5.1 Disaggregation of Productivity Change on the Industrial Level—Construction Sector



Source: Elaboration based on Statistics Poland calculations.

Note: There are only three industries that constitute the whole construction sector: construction of buildings, civil engineering and special construction activities.

FIGURE A5.2 **Industry-Specific Time-Averaged Contributions to the Productivity: Melitz-Polanec Decomposition of the TFP Growth for the Entire Sample Period (2009–19).**



Source: Elaboration based on Statistics Poland calculations.

A.6 Other Regression Results Based on the Firm-Level Sample

TABLE A6.1 Fixed-Effects Regression of TFP on Competition Indicators by Firms' Characteristics (Introduced Separately) in Manufacturing (2009–19)

a. Firm Size

Dependent variables		TFP	
Specifications	**(1)**	**(2)**	**(3)**
Competition			
Number of firms (log)		0.0614*** -0.0222	0.0437* -0.0229
Industry size (log)			0.0384* -0.0204
Concentration Index	2.929*** -0.287	3.070*** -0.289	2.962*** -0.297
Firm size (reference group: small firms)			
Micro-small	0.0635*** -0.00879	0.0638*** -0.00878	0.0638*** -0.00878
Small [10–50) - ref.			
Medium [50–250)	-0.0934*** -0.0077	-0.0941*** -0.0077	-0.0943*** -0.0077
Large [250+)	-0.134*** -0.0135	-0.135*** -0.0136	-0.135*** -0.0136
Constant	2.543*** -0.154	2.029*** -0.239	1.460*** -0.407
Observations	168162	168162	168162
R-squared	0.059	0.059	0.059
2-Digit industry FE	yes	yes	yes
Year FE	yes	yes	yes
Region FE	yes	yes	yes

b. Ownership

Dependent variables		TFP	
Specifications	**(1)**	**(2)**	**(3)**
Competition			
Number of firms (log)		0.00735 -0.0202	0.0782*** -0.0215
Industry size (log)			-0.137*** -0.019
Concentration Index	1.938*** -0.255	1.954*** -0.257	2.367*** -0.268

Dependent variables	TFP		
Specifications	(1)	(2)	(3)
Ownership (reference group: private domestic)			
State-owned (SOE)	-0.0113 -0.0259	-0.0112 -0.0259	-0.0094 -0.0258
Foreign-owned (FOE)	0.0831*** -0.0234	0.0831*** -0.0234	0.0829*** -0.0235
Dispersed capital	-0.0215 -0.0487	-0.0214 -0.0487	-0.0231 -0.0489
Undefined[a]	0.733*** -0.0229	0.733*** -0.0229	0.733*** -0.0229
Constant	2.170*** -0.13	2.108*** -0.211	4.078*** -0.358
Observations	216,780	216,780	216,780
R-squared	0.093	0.093	0.094
2-Digit industry FE	yes	yes	yes
Year FE	yes	yes	yes
Region FE	yes	yes	**yes**

Source: Statistics Poland calculations.

Note: Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.10.

a. Less than 1 percent of firms with undefined ownership status are used for identification in the fixed-effects regressions, meaning that they are changing ownership status between years which is captured by the regressions. Those companies appear to be the most productive in the sample, but it is likely a statistical artifact. (See Table 3 for details).

TABLE A6.2 Fixed-Effects Regression of TFP on Competition Indicators by Firms' Characteristics (Introduced Separately) in Construction and Services (2009–19)

a. Firm Size

Dependent variables	TFP		
Specifications	(1)	(2)	(3)
Competition			
Number of firms (log)		-0.0231** (0.0104)	-0.0378*** (0.0106)
Industry size (log)			0.0563*** (0.0107)
Concentration Index	-0.0777* (0.0457)	-0.0815* (0.0457)	-0.238*** (0.0541)
Firm size (reference group: small firms)			
Micro-small	0.0807*** (0.0065)	0.0807*** (0.0065)	0.0806*** (0.0065)
Medium [50–250)	-0.0739*** (0.0057)	-0.0737*** (0.0057)	-0.0747*** (0.0057)
Large [250+)	-0.126*** (0.0135)	-0.125*** (0.0135)	-0.128*** (0.0135)
Constant	2.326*** (0.0719)	2.482*** (0.100)	1.527*** (0.211)

Dependent variables	TFP		
Specifications	**(1)**	**(2)**	**(3)**
Observations	353,276	353,276	353,276
R-squared	0.069	0.069	0.069
2-Digit industry FE	yes	yes	yes
Year FE	yes	yes	yes
Region FE	yes	yes	yes

b. Ownership

Dependent variables	TFP		
Specifications	**(1)**	**(2)**	**(3)**
Competition			
Number of firms (log)		-0.0067 (0.0098)	-0.0182* (0.01)
Industry size (log)			0.0327*** (0.0098)
Concentration Index	-0.133*** (0.0439)	-0.134*** (0.0439)	-0.226*** (0.0517)
Ownership (reference group: private domestic)			
State-owned (SOE)	0.0268* (0.0162)	0.0267* (0.0162)	0.0264 (0.0162)
Foreign-owned (FOE)	0.0708*** (0.0166)	0.0708*** (0.0166)	0.0704*** (0.0166)
Dispersed capital	0.0311 (0.0399)	0.0311 (0.0399)	0.0310 (0.0399)
Undefined[a]	0.715*** (0.0178)	0.715*** (0.0178)	0.715*** (0.0178)
Constant	2.132*** (0.0658)	2.177*** (0.0927)	1.643*** (0.190)
Observations	471,644	471,644	471,644
R-squared	0.077	0.077	0.077
2-Digit industry FE	yes	yes	yes
Year FE	yes	yes	yes
Region FE	yes	yes	yes

Source: Statistics Poland calculations.

Note: Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.10.

a. Less than 1 percent of firms with undefined ownership status are used for identification in the fixed-effects regressions, meaning that they are changing ownership status between years which is captured by the regressions. Those companies appear to be the most productive in the sample, but it is likely a statistical artifact. (See Table 3 for details).

TABLE A6.3 Fixed-Effects Regression of TFP on Competition Indicators by Firms' Characteristics (Age and Ownership) in Construction and Services (2009–19)

a. Manufacturing

Dependent variables		TFP	
Specifications	**(1)**	**(2)**	**(3)**
Competition			
Number of firms (log)		0.00396 (0.0206)	0.0102 (0.0203)
Industry-level profit margin			0.443*** (0.0956)
Concentration Index	1.895*** (0.264)	1.904*** (0.266)	1.982*** (0.261)
Ownership (reference group: all except foreign-owned)			
Foreign-owned (FOE)[a]	-0.0007 (0.0223)	-0.0007 (0.0223)	0.0025 (0.0214)
Firm age (reference group: young firms)			
Age (4–9 years)	-0.0482*** (0.0084)	-0.0482*** (0.0084)	-0.0527*** (0.0082)
Age (10–19 years)	-0.0624*** (0.0097)	-0.0624*** (0.0097)	-0.0661*** (0.0095)
Age (20+ years)	-0.0614*** (0.0106)	-0.0614*** (0.0106)	-0.0641*** (0.0105)
Constant	2.557*** (0.126)	2.524*** (0.211)	2.383*** (0.233)
Observations	216,780	216,780	216,780
R-squared	0.060	0.060	0.091
2-Digit industry FE	yes	yes	yes
Year FE	yes	yes	yes
Region FE	yes	yes	yes

b. Construction and Services

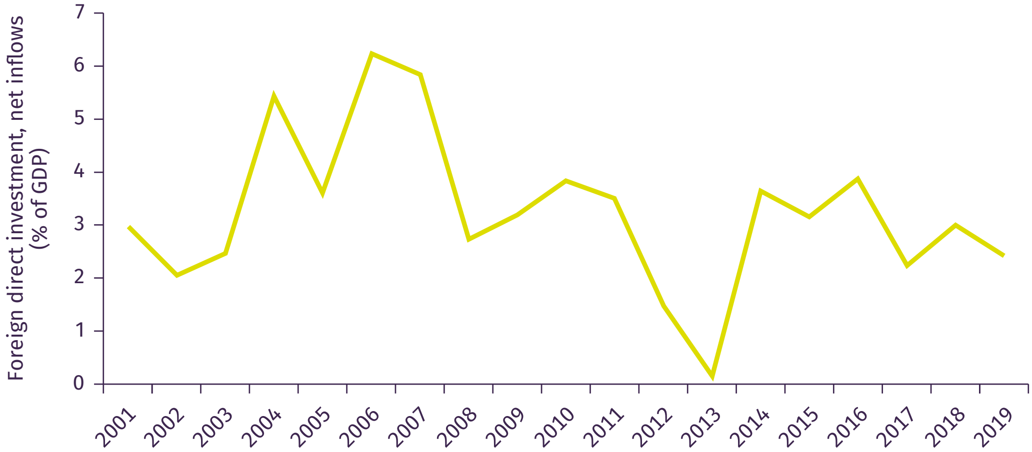
Dependent variables		TFP	
Specifications	**(1)**	**(2)**	**(3)**
Competition			
Number of firms (log)		-0.0083 (0.0098)	-0.0082 (0.0098)
Industry-level profit margin			-0.0003*** (0.0001)
Concentration Index	-0.120*** (0.0434)	-0.121*** (0.0434)	-0.121*** (0.0434)
Ownership (reference group: all except foreign-owned)			
Foreign-owned (FOE)[b]	-0.0087 (0.016)	-0.0087 (0.016)	-0.0087 (0.016)

Dependent variables	TFP		
Specifications	(1)	(2)	(3)
Firm age (reference group: young firms)			
Age (4–9 years)	-0.0393*** (0.006)	-0.0393*** (0.006)	-0.0391*** (0.006)
Age (10–19 years)	-0.0578*** (0.0069)	-0.0577*** (0.0069)	-0.0575*** (0.0069)
Age (20+ years)	-0.0544*** (0.008)	-0.0544*** (0.008)	-0.0542*** (0.008)
Constant	2.474*** (0.0663)	2.530*** (0.0932)	2.529*** (0.0932)
Observations	471,644	471,644	471,644
R-squared	0.052	0.052	0.052
2-Digit industry FE	yes	yes	yes
Year FE	yes	yes	yes
Region FE	yes	yes	yes

Source: Statistics Poland calculations.
Note: Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.10.
a. Introducing ownership and size dummies one at a time makes the relationship between foreign ownership and productivity growth statistically significant. (See Appendix Table A6.2, Panel b.)
b. Introducing ownership and size dummies one at a time makes the relationship between foreign ownership and productivity growth statistically significant. (See Appendix Table A6.2, Panel b.)

A.7 Selected Characteristics Based on the Aggregate Data

FIGURE A7.1 Foreign Direct Investment to Poland



Source: Elaboration based on World Development Indicators data.