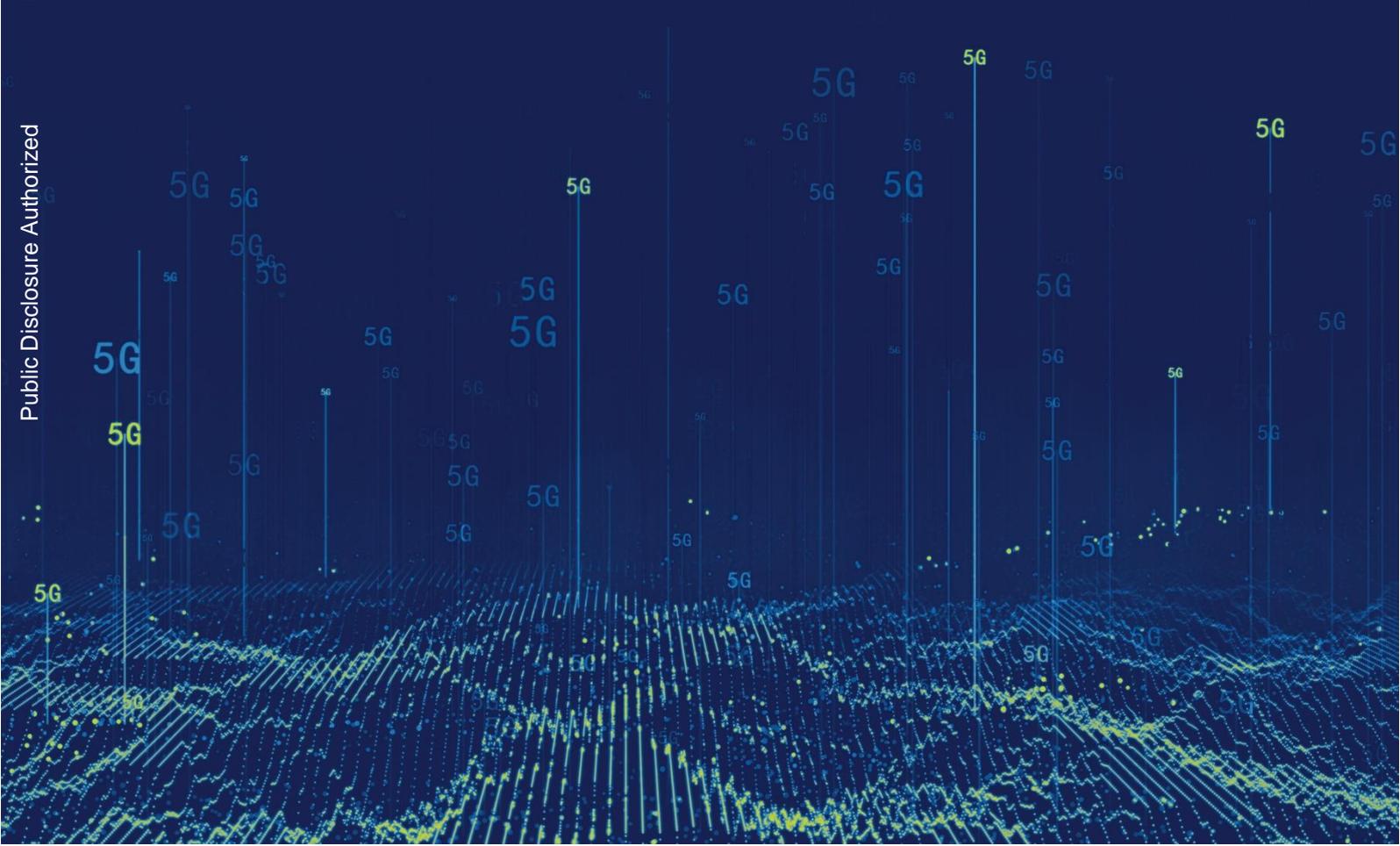




BACKGROUND NOTE

PRODUCTIVITY AND INNOVATION IN THE CZECH REPUBLIC: A FIRM-LEVEL PERSPECTIVE

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BACKGROUND NOTE

PRODUCTIVITY AND INNOVATION IN THE CZECH REPUBLIC: A FIRM-LEVEL PERSPECTIVE

October 2019

Elwyn Davies, Mariana Iovtsova & Jan Zouhar

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BACKGROUND

Convergence of productivity of Czech firms towards peer countries is slow, especially for smaller firms. Czech labor productivity was 68.3 of that in Germany and the productivity gap is in particular large for micro, small and medium enterprises (MSMEs). MSMEs (defined as having less than 250 employees) form the backbone of the Czech economy, accounting for 67.3% of total employment and 55.2% of value added (at factor cost), but face weak innovation demand and an unfavorable position in global value chains.

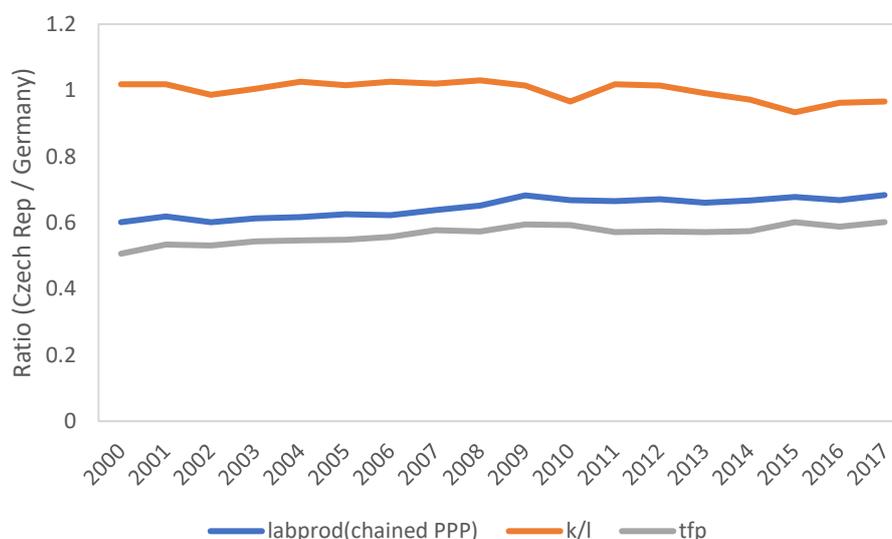
The Czech Ministry of Industry and Trade (MIT) is developing a new Small and Medium Enterprise (SME) Strategy and Implementation Plan for the period 2021-2027 to boost firm productivity and competitiveness of domestic SMEs. MIT has requested support from the European Commission under Regulation (EU) 2017/825 on the establishment of the Structural Reform Support Programme ("SRSP Regulation"). The request has been analyzed by the European Commission in accordance with the criteria and principles referred to in Article 7(2) of the SRSP Regulation, following which the European Commission has agreed to provide technical support to the Czech Republic, together with the World Bank, to conduct analytical work on the status of SMEs.

In support of the World Bank's technical assistance to the Czech SME Support Strategy 2021+, this background note analyzes productivity and innovation activities of Czech firms using firm-level data collected by the Czech Statistical Office (CZSO). This analysis has been conducted in close cooperation with the CZSO. The data sources used include the Structural Business Survey (SBS), an annual survey which covers about 265,000 firms, supplemented by innovation data from the RAD and TI surveys. This note is a background paper for the Czech Republic Assessment of the SME Policy Mix report (World Bank 2019), which assesses the Czech policy mix towards SMEs. A summary of the findings of this paper are included in the full report "Czech Republic: Assessment of the SME Policy Mix".

MACRO-LEVEL INDICATORS SUGGEST A SLOW CONVERGENCE OF PRODUCTIVITY

At the macro level, labor productivity in the Czech Republic has been on a very slow path of convergence towards German levels. The speed of convergence of labor productivity growth performance in the Czech Republic towards Germany levels has been quite low: as of 2017, the Czech labor productivity level was 68.3 percent of the German, only 8 percentage points higher than in 2000 (Figure 1). In this period, capital labor ratio and TFP growth – the key components of labor productivity expansion¹ – have been experiencing different patterns. TFP has been growing relative to German levels – with the compound average growth rate (CAGR) growing at 0.1 percent from 2000 to 2017 – while the CAGR of capital labor ratio contracted 0.3 percent in the same period. Looking forward, with such a high level of capital labor intensity – at 97 percent of the level of Germany in 2017 – any increase of additional output per worker seems to depend more on technical efficiency and less on capital deepening.

Figure 1. Convergence of labor productivity has been slow compared to Germany
(Labor productivity in Czech Republic relative to Germany, 2000–17)



Source: authors' elaboration based on Penn Table 9.0 data

Note: Labor productivity is defined as output-side real GDP at chained PPP (in millions of 2011 US\$), divided by the number of persons engaged (in millions); capital: labor ratio is defined as capital stock at chained PPPs (in millions of 2011 US\$) divided by the number of persons engaged (in millions); TFP is reported as TFP level at current PPPs (USA=1).

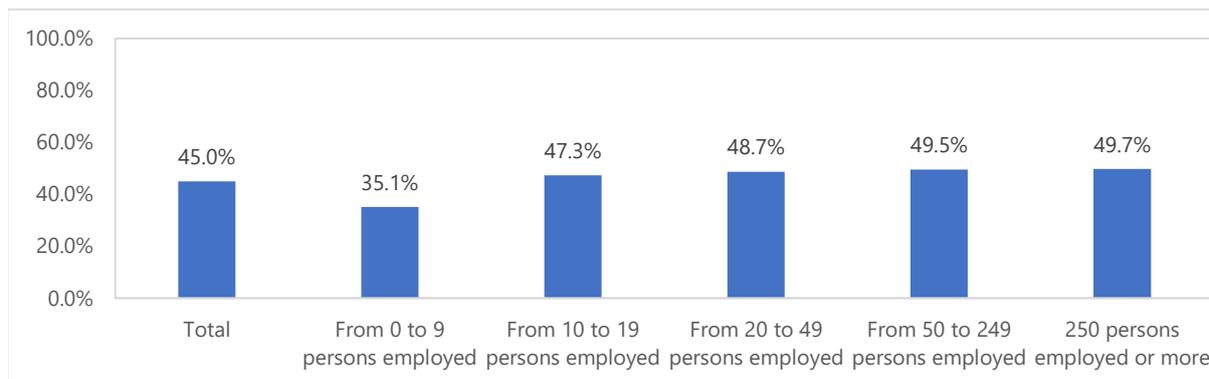
Data reveals that labor productivity gap relative to Germany is larger for smaller firms. When breaking down differences in labor productivity – measured as value added per worker

¹ Growth in output per worker (labor productivity) can be decomposed in terms of capital deepening – capturing the increase in the amount of capital used by workers – and growth in TFP – a traditional measure of efficiency, capturing the portion of output not explained by intermediate inputs capital and labor.

in euro – between the Czech Republic and Germany across different firm size groups, data shows that the gap is more pronounced for smaller firms. Indeed, average labor productivity of firms with 0 to 9 employees in the Czech Republic is 35% of Germany for same size firms. When comparing firms with more than 250 employees, the gap is smaller: average labor productivity of Czech Republic firms is 49.7% of the German level (Figure 2).

Figure 2. The productivity gap is larger for smaller firms

(Labor productivity in the Czech Republic, 2016, as a proportion of Germany)



Source: authors' elaboration based on Eurostat data

Note: tabulations extracted from "Annual enterprise statistics by size class for special aggregates of activities (NACE Rev. 2) [sbs_sc_sca_r2]". Data refer to total business economy; repair of computers, personal and household goods; except financial and insurance activities.

The negative correlation between labor productivity performance and firm size in the Czech Republic is particularly worrisome as micro, small and medium sized enterprises (MSMEs) account for the largest proportion of employment and value added in the country. According to Eurostat latest data, MSMEs account for 67.3% of total employment and 55.2% of value added (at factor cost) in the Czech Republic. Going forward, convergence to higher income levels will depend on the productivity performance of this group of firms.

Because aggregate data masks a lot of heterogeneity, it is key to go beyond the macro-level and disentangle the drivers of productivity growth in the Czech Republic, shedding special light on SMEs. Because of their intrinsic characteristics, firms are different from each other and they also differ in terms of performance, even within very narrowly defined industries (Syverson, 2004). It is then important to go beyond the aggregate data to assess the underlying drivers and nuances of productivity growth process in the country. Against this backdrop, this note aims at running a firm level productivity analysis to explore firm heterogeneity while answering three key questions: i) How have firms performed until so far; ii) what are the drivers behind SME productivity expansion, in particular the role of within and between components and which policy drivers might be influencing these results; and iii) How does innovation contribute to SME productivity growth.

PRODUCTIVITY GROWTH OF SMALL FIRMS LAGS BEHIND

This analysis uses firm-level data from the Structural Business Survey, with additional data from innovation surveys and administrative sources. These datasets are maintained by the Czech Statistical Office (CZSO). The Structural Business Survey (SBS) is an annual survey which covers about 265,000 firms (in 2016) and covers a wide range of sectors (accommodation, food services, agriculture, commerce, construction, ICT, manufacturing, mining, other services, transport and utilities).² This data is supplemented by administrative firm-level data as well as innovation data based on the Technological Innovation (TI) survey and the Annual Survey of Research and Development (RAD), also administered by the CZSO. The TI survey covers around 3800 firms and is conducted every two years, while the RAD survey covers 1700-1800 firms and is conducted every year. These surveys provide information of the innovativeness of sectors by type of enterprises, on the different types of innovation and on various aspects of the development of an innovation. The TI and RAD data are matched with the SBS data (see Box 1 for further information).

Box 1. Data sources

Firm-level data from years 2010, 2012, 2014 and 2016 are included in the analysis, coming from three separate business surveys administered by the Czech Statistical Office (CZSO): the Structural Business Statistics (SBS) survey (with additional administrative data), the Technological Innovation (TI) survey and the Annual Survey of Research and Development (RAD). Table 1 presents the sample sizes of these surveys in individual years. Even though many firms are followed repeatedly over time within the surveys, no common identifier was made available to allow for analysis of the panel dimension; therefore, data analysis of this paper is based on a repeated cross-section.

This analysis is based on the Structural Business Statistics (SBS) survey complemented with administrative data for active firms not included in the SBS. The Structural Business Statistics (SBS) survey is the largest business statistics survey in the Czech Republic, carried out annually. The target population of the SBS survey covers all active non-financial enterprises, natural persons including own-account workers and selected financial enterprises classified in the Sections B to S + Divisions 02, 03 of the NACE Rev. 2 activity classification. In 2016, the Czech Business Register contained approximately 2.57 million entities, of which 1.16 million were active. This analysis only includes active legal persons (i.e., natural persons are excluded), corresponding to 264,980 entities in 2016. The survey combines questionnaire data from the SBS with administrative firm-level data provided by the Ministry of Finance and by the Czech Social Security Administration to provide a comprehensive coverage of firms.

The Annual Survey of Research and Development (RAD) survey is an annual survey that aims at obtaining an exhaustive sample (i.e., a census) of all ventures involved in R&D activities as their primary or secondary

² The data analysis of this paper is based on a repeated cross-section of the SBS data, as no common identifier was made available to allow for analysis of the panel dimension.

economic activity. The CSZO uses all available information to identify such ventures and includes them in the survey, with the response rate being over 80% (CZSO, 2018b). Table 1 shows the sample sizes restricted to firms also contained in the analyzed dataset. According to (CZSO, 2018b), the RAD survey is fully compatible with the Frascati manual (OECD, 2015), making the results internationally comparable.

The Technological Innovation (TI) survey is conducted every two years and targets firms with 10+ employees. It covers Sections B, C, D, E, G46, H, J, K, and M71-73 of CZ-NACE. The survey combines exhaustive sampling (for all firms with 250+ employees) and random sampling (for firms with less than 250 employees). In the observed years, over 25 percent of the underlying population was contacted within the survey each year, with the response rate being around 80% (CZSO, 2018a, Table 2.3). Table 1 shows the sample sizes restricted to firms also contained in the analyzed dataset. According to (CZSO, 2018a), the methodology of the TI survey follows the Oslo Manual (OECD/Eurostat, 2018).

Table 1. Sample sizes in CZSO business surveys

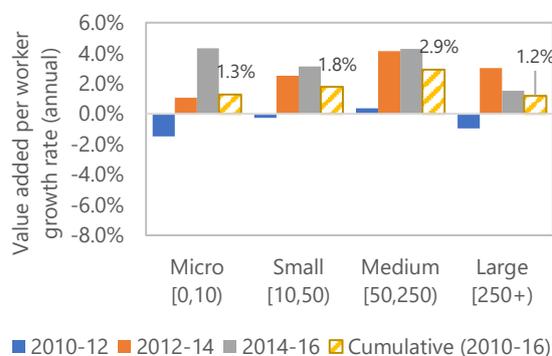
| Year | Firm-level data (SBS and administrative sources) | Technological Innovation (TI) | Annual Survey of Research and Development (RAD) |
|------|--------------------------------------------------|-------------------------------|-------------------------------------------------|
| 2010 | 254,358 | 3,490 | 1,618 |
| 2012 | 225,741 | 3,730 | 1,758 |
| 2014 | 244,873 | 3,539 | 1,784 |
| 2016 | 264,980 | 3,800 | 1,736 |

Source: Staff calculations based on CZSO data.

The firm-level data shows that productivity grew for almost all size groups of firms between 2010 and 2016. The productivity growth rates – as measured by value added per worker (Figure 3) and total factor productivity (Figure 4) – were positive between 2012 and 2016 for most size groups of firms, after mostly negative growth rates between 2010 and 2012. For most groups of firms, productivity growth accelerated in the last two years of the survey (2014-16).

Figure 3. Value added per worker increased for all size groups of firms between 2012 and 2016.

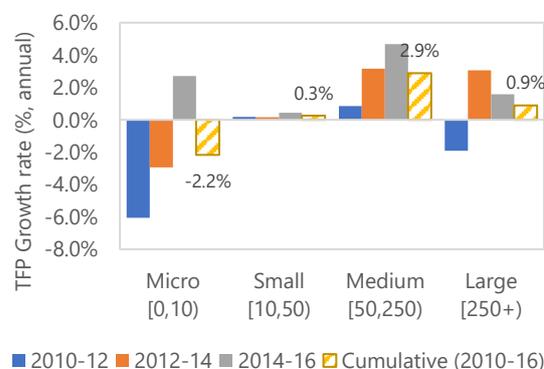
(Value added per worker growth, 2010-2016)



Source: authors' calculations based on the CZSO Structural Business Survey (SBS)

Figure 4. Increases in total factor productivity were low for small firms (10-49 workers)

(Total factor productivity growth, 2010-16)



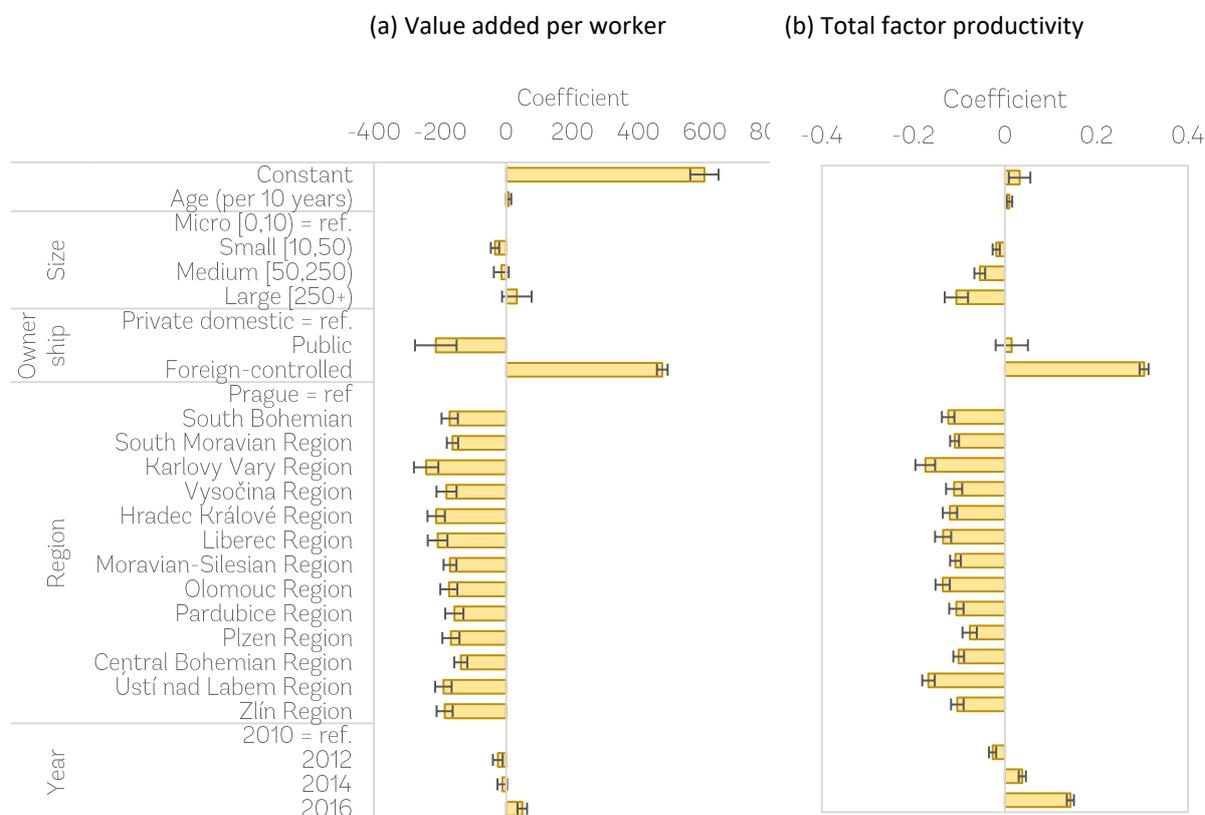
Source: authors' calculations based on the CZSO Structural Business Survey (SBS)

Small firms (with 10-49 workers) and large firms (with more than 250 workers) saw the lowest productivity growth rates. Especially total factor productivity growth of small firms was low between 2012 and 2016, with growth rates of 0.3 percent between 2012-2014 and 0.9 percent between 2014 and 2016, while other groups of firms saw higher rates. Also, large firms (with more than 250 workers) saw lower productivity growth rates. Value added per worker grew by only 1.5 percent between 2014 and 2016 and total factor productivity growth – even though positive at 3.2 percent – lagged behind the growth rates of micro and medium firms.

Older, foreign-owned firms and firms headquartered in Prague are more productive. A regression of productivity on firm characteristic show that firm characteristics are strongly correlated with productivity (Figure 5). Older firms, those that are foreign-owned and firms headquartered in Prague are more productive, while firms that are publicly owned have lower value added per worker than private firms. For firm size, the relationship with productivity depends on the productivity measure: it is positive for value added per worker, but negative for total factor productivity. A possible explanation for this is that larger firms are more capital intensive than smaller firms, but do not necessarily use their capital more efficiently.

Figure 5. Older firms, foreign enterprises and firms headquartered in Prague are more productive.

(Regression of productivity on firm characteristics and year, 2010-2016)



Source: authors' calculations based on the CZSO Structural Business Survey (SBS). The error bars indicate the 95% confidence interval.

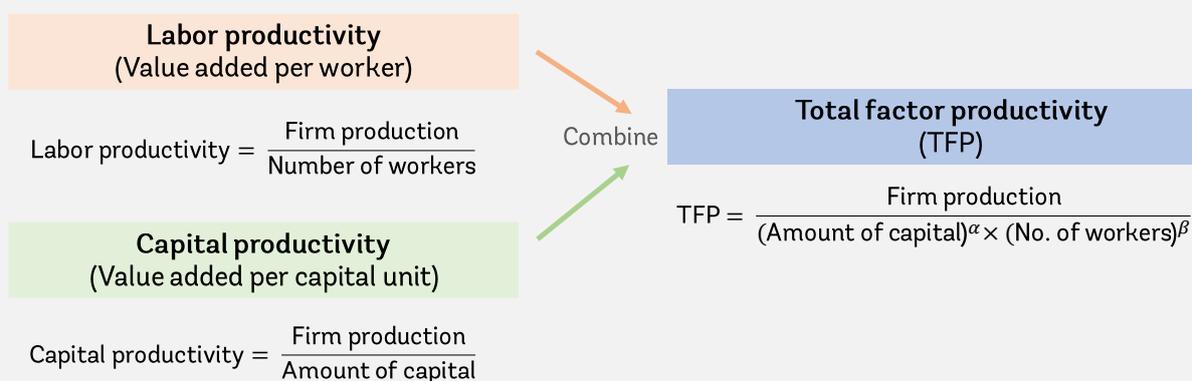
Box 2. Measuring productivity

Productivity is the efficiency of how the economy transforms the factors of production (capital and labor) to production output. Productivity is an important driver of growth: cross-country studies have shown that productivity growth may account for up to 60 percent of economic growth.³

This analysis relies on two measures of productivity, value added per worker and total factor productivity. **Value added per worker** is a measure of labor productivity and is calculated by dividing the value of firm production – measured by revenue or value added – by the number of employees (both permanent and temporary). In capital-intensive firms, labor productivity is expected to be high, because employees have more capital at their disposal. The advantage of value added per worker is that it can be easily compared across sectors and countries.

While labor productivity only measures the productivity of one factor of production, **total factor productivity (TFP)** measures how efficiently multiple factors of production are employed. TFP is estimated by calculating the share of output that is not explained by the quantity of factors of production used the production (the “residual”). In a production function $Y = A K^\alpha L^\beta$, in which Y is output, K is the amount of capital and L the amount of labor, TFP is equal to A .⁴

Figure 6. Total factor productivity estimates the efficiency of use of multiple factors of production, while labor productivity and capital productivity only measure the efficiency of use of one factor.



For this analysis, no physical output quantity or price data was available and therefore the used measure of TFP is **revenue TFP (TFPR)**. This measure does not only reflect efficiency but also the price-setting power of firms.⁵

³ Easterly & Levine (2001), Hall & Jones (1999).

⁴ TFP is calculated by taking the residual of an ordinary least squares (OLS) regression. Due to unavailability of a common identifier for firms across time, estimation methods that rely on the panel dimension to reduce simultaneity or endogeneity biases could not be used.

⁵ Cusolito & Maloney (2018) estimate that in certain cases up to half of observed productivity differences could be attributed to issues related to market power.

A LACK OF GROWTH OF MORE PRODUCTIVE FIRMS DRAGS DOWN AGGREGATE PRODUCTIVITY

Productivity can grow by firms upgrading, improving the allocation of the factors of production as well as productive entry and exit. Firms can improve their productivity by innovating, adopting better technologies and implementing better managerial practices (“within-firm” productivity growth). Productivity can also improve if labor and capital move from less-efficient to more-efficient firms (“between-firm” productivity growth, associated with improved allocation of resources), either through firm growth and decline or through entry and exit (“dynamic” productivity growth).⁶ Table 2 summarizes these three components and their links with policy. Most policies are not exclusively associated with only component: for example, reforming business regulations can both facilitate entry of new firms (“dynamic”) as well as facilitate the growth of firms that were previously restricted (“between”).

Table 2. The sources of growth and links with policy

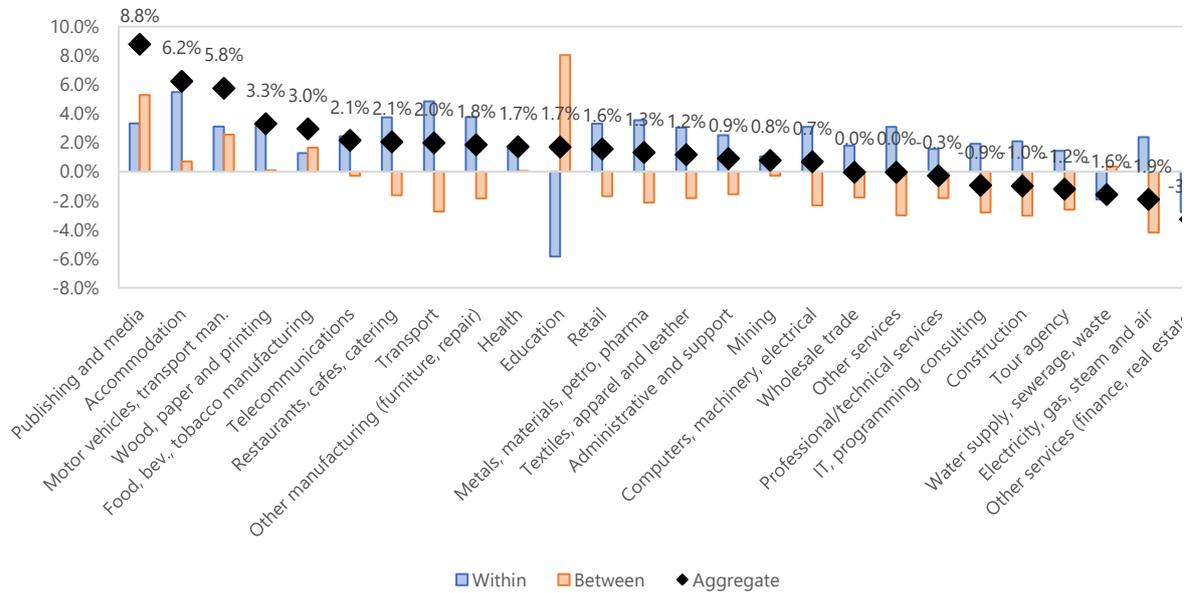
| <u>“Within”</u> | <u>“Between”</u> | <u>“Dynamic”⁷</u> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Firms increasing their capabilities | Allocating resources to more productive firms | Entry of productive and exit of unproductive firms |
| Internal firm capabilities include: human capital skills, management and organizational practices, the use and adoption of technology, firm innovation. | Misallocation of resources indicate barriers that prevent the movement of capital, labor and other production factors to the most productive firms in the economy. | Entry of highly productive, fast-growing firms (<i>gazelles</i>) and the exit of less productive firms that are not growing (<i>laggards</i>) |
| Relevant Policy Responses | | |
| improve quality of education, supply of technical (& digital) skills, encourage entrepreneurship, technology adoption and innovation, ease regulatory constraints to firm growth, build innovation complementarities (intermediaries, etc.)? | Address product market regulations, distortions in access to financing / SME financing, risk finance, labor market frictions, remove protections of certain industries | Remove barriers to entry of new firms (e.g., costly licensing), enforce competition policy, encourage entrepreneurship |

Source: adapted from Davies (2019).

⁶ The data as analyzed for this report does not allow for a separate identification of the dynamic component, due to a lack of the panel dimension.

Figure 8. Most sectors have seen a negative contribution of the “between” component, indicating a lack of growth of more productive enterprises.

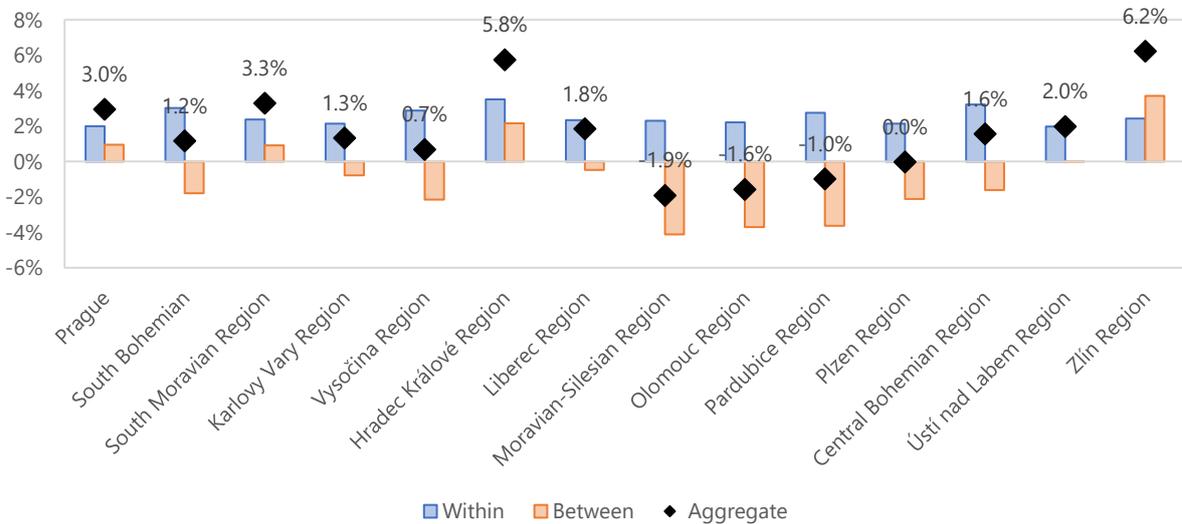
(Dynamic Olley-Pakes decomposition of productivity growth by sector, 2010-2016)



Source: authors' calculations based on the CZSO Structural Business Survey (SBS)

Figure 9. While “within” productivity growth is similar across most regions, “between” productivity growth varies and drives most of the observed differences in productivity growth.

(Dynamic Olley-Pakes decomposition of productivity growth by region, 2010-2016)



Source: authors' calculations based on the CZSO Structural Business Survey (SBS)

These results suggest a lack of growth of productive firms, potentially driven by a suboptimal allocation of resources. Two sources of misallocation can be identified that underpin this lack of resource allocation: barriers against doing business and barriers against competition.

First, barriers against doing business limit productive growth. Resource misallocation often results from inappropriate policy interventions and/or market imperfections that prevent efficient firms from expanding their activities and promote the survival of inefficient ones. In this regard, Restuccia and Rogerson (2017) provide a compelling discussion about resource misallocation and emphasize three general categories of misallocation sources: statutory provisions that vary with firm characteristics,⁸ discretionary provisions favoring specific firms⁹ and market frictions.¹⁰ Against this backdrop, one of the factors to explain the weak performance of between component of productivity growth in the Czech Republic is barriers against doing business. In principle, costs of doing business tend to impose higher burden on entry of new firms, SMEs and/or innovation disruptors that could be potentially more efficient than incumbents.¹¹

According to 2019 Doing Business data, the Czech Republic ranks 34th (out of 190 countries) in the overall ranking of doing business. This is slightly below OECD high income average country and traditional peers as Poland and Germany (Figure 10). The performance is worse when it comes to specific entry costs of doing business, such as starting a business¹² and dealing with construction permits. In both cases, the Czech Republic ranks in the bottom third of the Doing Business 2019 ranking (115th and 156th, respectively).

There are large regional differences in indicators related to doing business. The 2018 regional Doing Business indicators (World Bank 2018) suggest that there are large differences between cities in the Czech Republic. These subnational differences were larger than in the other European countries included in this study (Croatia, Portugal and Slovakia). Cities other than Prague¹³ are lagging behind the capital in most regulatory areas, including getting electricity and enforcing contracts. Especially access to electricity shows the largest differences between cities, often requiring a lengthy process in cities other than Brno and Prague (e.g., in Usti nad Labem, getting access to a medium-voltage network can take about

⁸ For example, provisions of the tax code that vary with firm size; employment protection measures; product market regulation limiting size or market access; and tariffs applied to specific categories of goods.

⁹ Discretionary provisions made by the government or other entities (such as banks) that favor or penalize specific firms; for instance, subsidies, tax breaks, low interest loans granted to specific firms.

¹⁰ For example, monopoly power, market frictions, and enforcement of property rights.

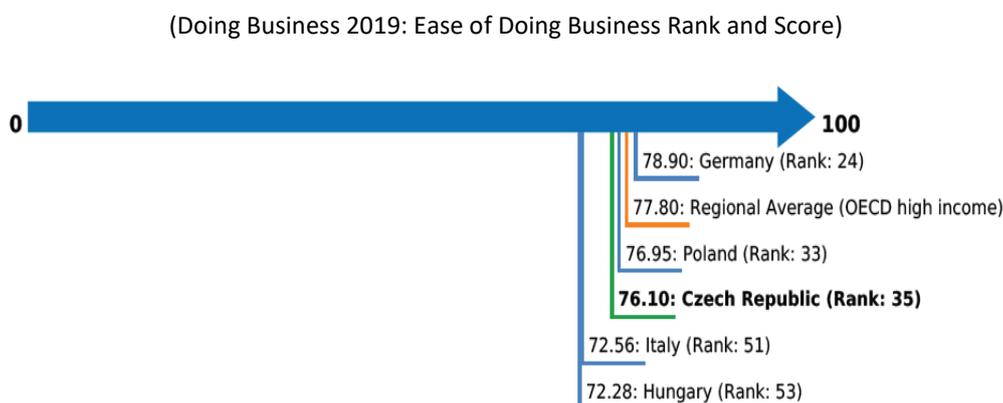
¹¹ Using a worldwide database, Klapper, Laeven and Rajan (2006) found that entry regulations have significant adverse effects on entrepreneurship and tend to mute the disciplining effect of competition by indiscriminately screening out small young firms that could be more productive than incumbents. Evidence presented in the analysis shows that the growth in labor productivity for firms older than two years is relatively lower in naturally high-entry industries when the industry is in a country with higher bureaucratic barriers to entry.

¹² According to the Doing Business methodology, starting a business indicator captures all procedures officially required, or commonly done in practice, for an entrepreneur to start up and formally operate an industrial or commercial business, as well as the time and cost to complete these procedures and the paid-in minimum capital requirement. These procedures include the processes entrepreneurs undergo when obtaining all necessary approvals, licenses, permits and completing any required notifications, verifications or inscriptions for the company and employees with relevant authorities.

¹³ The seven Czech cities considered include Brno, Liberec, Olomouc, Ostrava, Plzen, Prague, Usti nad Labem.

eight months due to the requirement of obtaining multiple municipal permits). The less conducive business environment seen outside Prague could contribute to the negative “between” productivity growth component (which corresponds to resource allocation) seen in many regions.

Figure 10. The Czech Republic ranks below the OECD high income average, Germany and Poland in its Doing Business score.



Source: Doing Business, 2019 (http://www.doingbusiness.org/en/data/exploreeconomies/czech-republic#DB_dwcp)

Note: The ease of doing business score captures the gap of each economy from the best regulatory performance observed on each of the indicators across all economies in the Doing Business sample since 2005. An economy’s ease of doing business score is reflected on a scale from 0 to 100, where 0 represents the lowest and 100 represents the best performance. The ease of doing business ranking ranges from 1 to 190.

Second, barriers against competition. Competition is a critical ingredient to foment allocative efficiency, allowing more efficient firms to enter and gain market share, at the expense of less efficient firms, boosting aggregate productivity.¹⁴ Several studies have attempted to quantify the importance of this market-sorting effect; see for instance Syverson (2004) and Arnold et al. (2011). While it is true that some critical input markets¹⁵ exhibit inherent features that reduce contestability and facilitate anti-competitive behavior, competition intensity is ultimately affected by government interventions. For instance, anticompetitive regulations distort the level playing field in key sectors and high direct government participation through SOES in markets where competition is viable without the necessary rules that could ensure competitive neutrality. In principle, governments intervene in product markets through regulatory policies, often motivated by legitimate reasons, as to address typical market failures such as asymmetric information, externalities, and monopoly conditions. However, if poorly designed, these product market regulations may affect the degree of competition between firms which in turn limit firm’s incentives to maximize efficiency, innovate, and

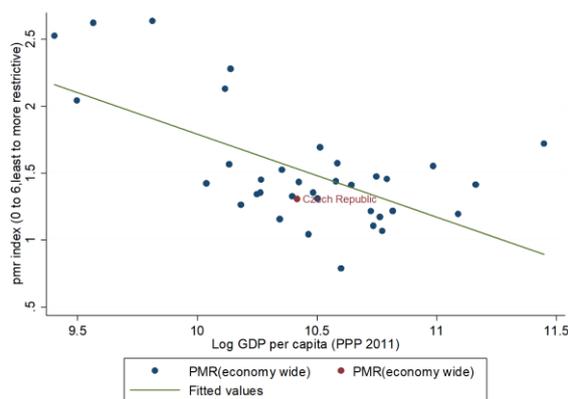
¹⁴ Competition is also relevant to push productivity growth in two complementary ways, by enhancing productive efficiency and boosting innovation. Competition leads to an improvement of *productive efficiency*; it acts as a disciplining device within firms, placing pressure on the managers of firms to become more efficient, which decreases ‘x-inefficiency’ – that is, the difference between the most efficient behavior that the firm is capable of and its observed behavior in practice (the so called the “within-firm” effect). In addition, competition pushes firms to innovate which increases dynamic efficiency through technological improvements of production processes, or the creation of new products and services.

¹⁵ Such as steel and cement production, as well as oil and gas extraction and distribution.

increase productivity. It is then not surprising to see that countries with higher income per capita have product market regulations that are less stringent to competition. A simple correlation analysis using the latest product market regulation (PMR)¹⁶ cross-section data available for 39 countries – collected by the OECD – suggests that GDP per capita is higher for countries with lower incidence of regulatory barriers that inhibit competition (Figure 11).

Figure 11. GDP per capita is higher for countries with a lower incidence of regulatory barriers inhibiting competition.

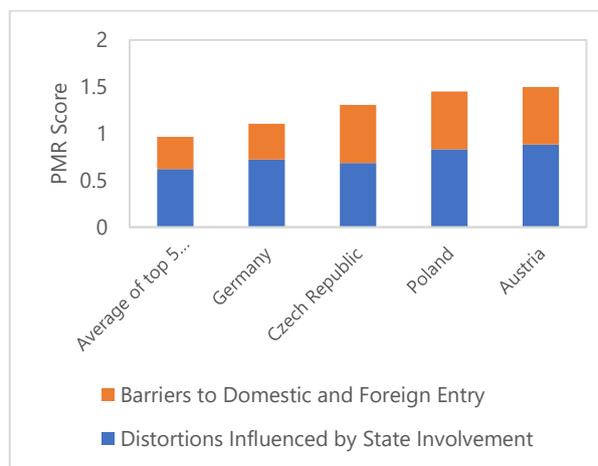
(GDP per capita, 2011 PPP adjusted, vs. economy wide PMR index)



Source: authors' elaboration based on OECD PMR data and WDI data

Figure 12. Product market regulations (PMR) in the Czech Republic are more restrictive to competition than Austria or Poland

(Economy-wide product market regulation scores: restrictiveness to competition; 0, least restrictive, to 6, more restrictive)



Source: authors' elaboration based on OECD PMR data

Recent data suggests that product market regulations in the Czech Republic are not conducive to competition. The 2018 PMR data shows that product market regulations are more restrictive to competition in the Czech Republic than in Germany or when compared to average top 5 OECD countries; however, the country performs better than Austria and Poland (Figure 12). These results are equally driven by distortions induced by state involvement (public ownership, involvement in business operations and simplification and evaluation of regulations) – accounting for 52.5% of the total PMR score – and barriers to domestic and foreign entry (administrative burden on startups, barriers in service/network sectors) – responding for the remaining for 47.5%.

¹⁶ PMR indicators form a comprehensive and internationally-comparable set of indicators. It measures the degree to which policies promote or inhibit competition in areas of the product market where competition is viable. Scores range from 0 to 6, whereby 6 reflects restrictive regulation or a regulatory framework least conducive to competition. It covers two main blocks of factors that can inhibit competition: i) distortions induced by state involvement (public ownership, involvement in business operations and simplification and evaluation of regulations); and ii) barriers to domestic and foreign entry (administrative burden on startups, barriers in service/network sectors).

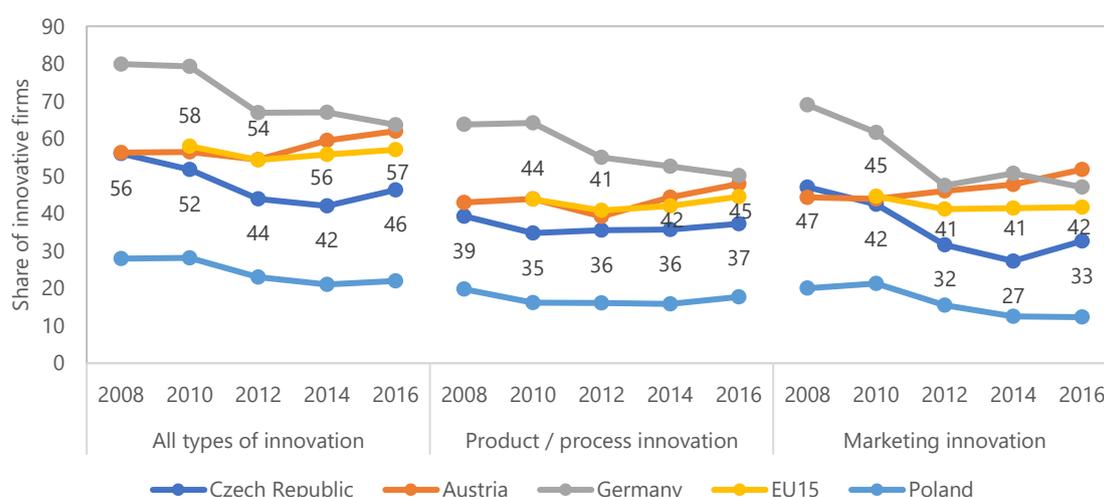
MORE PRODUCTIVE FIRMS INNOVATE MORE, BUT RETURNS DIFFER

Innovation is an important driver of firm-level productivity. The invention of new technologies as well as adoption of existing technologies allow firms to upgrade their production process and improve efficiency and productivity. Roughly half of productivity growth can be attributed to firms adopting new technologies, products and processes.¹⁷

Czech firms are lagging in innovation activities (Figure 13). Data from the Eurostat Community Innovation Survey, which is based on CZSO innovation survey data, suggests that Czech firms lag behind EU-15 companies both on product/process innovations and marketing innovations (but is higher than in many Central and Eastern European countries). The share of firms engaging in product/process innovations has remained constant – around 37% of firms. However, the share of firms engaging in marketing innovation has dropped since 2008, widening the gap with the EU-15.

Figure 13. The share of firms innovating is lower than in the EU-15.

(Share of firms engaging in innovative activities, 2008-2016)¹⁸



Source: Community Innovation Survey, Eurostat

Small and medium-sized enterprises (SMEs, with fewer than 250 employees) are less likely to spend on research and development compared to larger firms (Figure 14). Czech firms

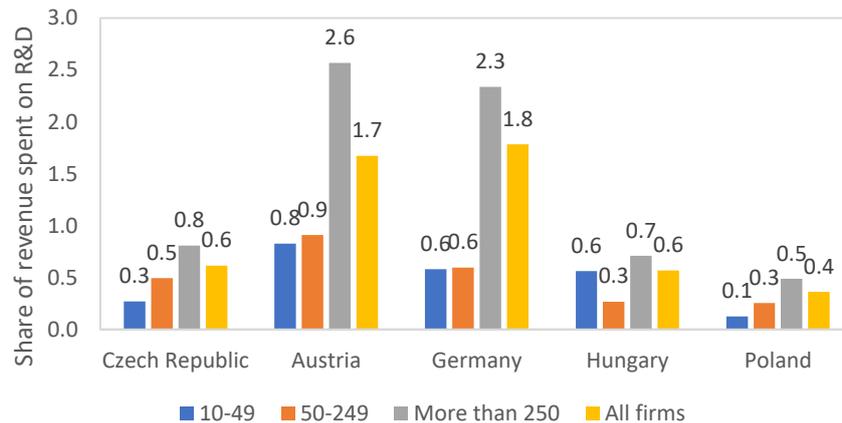
¹⁷ Cirera & Maloney (2018).

¹⁸ At the time of the analysis, 2014 was the latest year for which comprehensive data is available as part of the Community Innovation Survey. Data for 2016 has recently been made available.

spent about 0.6 percent of revenue on research and development (R&D), which is at similar levels as Hungary and higher than in Poland, but lower than in Austria or Germany. Just like in other European countries, larger firms are spending a higher share of their revenue (0.8 percent) than small (0.3 percent) and medium-sized enterprises (0.5 percent).

Figure 14. Small and medium-sized firms spend less on R&D than larger firms

(Share of revenue spent on R&D, all firms with more than 10 employees, 2016)

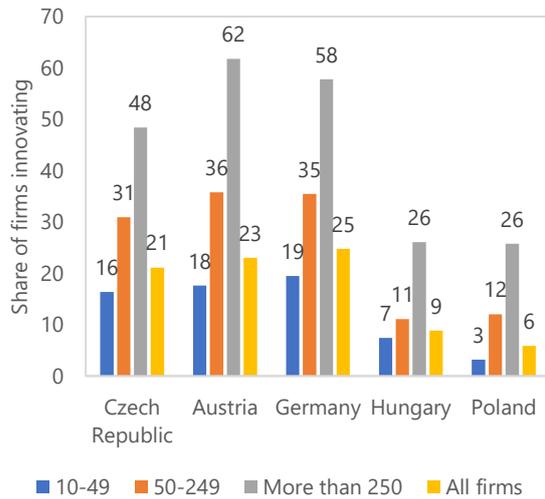


Source: Community Innovation Survey, 2016.

This difference is driven by SMEs being less likely to invest in R&D (the extensive margin) and not by SMEs spending lower amounts if they invest in R&D (the intensive margin). Only 16 percent of small firms (10-49 employees) and 31 percent of medium-sized enterprises (50-249 employees) invest in R&D, compared to 48 percent of large firms (Figure 14). However, the share of revenue that firms invest in R&D is similar across the firm size groups (around 1.0 percent; Figure 16), indicating that the difference in R&D investment between small and larger firms is mostly due to the lower share of SMEs investing in innovation (the extensive margin) than investment differences (the intensive margin).

Figure 15. SMEs are less likely to spend on R&D than large firms...

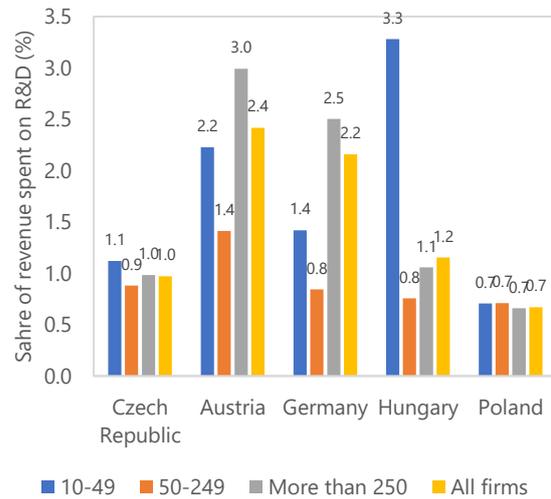
(Extensive margin – the share of firms with R&D expenditure, 2016)



Source: Community Innovation Survey, 2016.

Figure 16. ... but the SMEs with positive investments spend a similar share of their revenue on R&D as large firms.

(Intensive margin – the share of revenue spent on R&D by firms with R&D expenses, 2016)



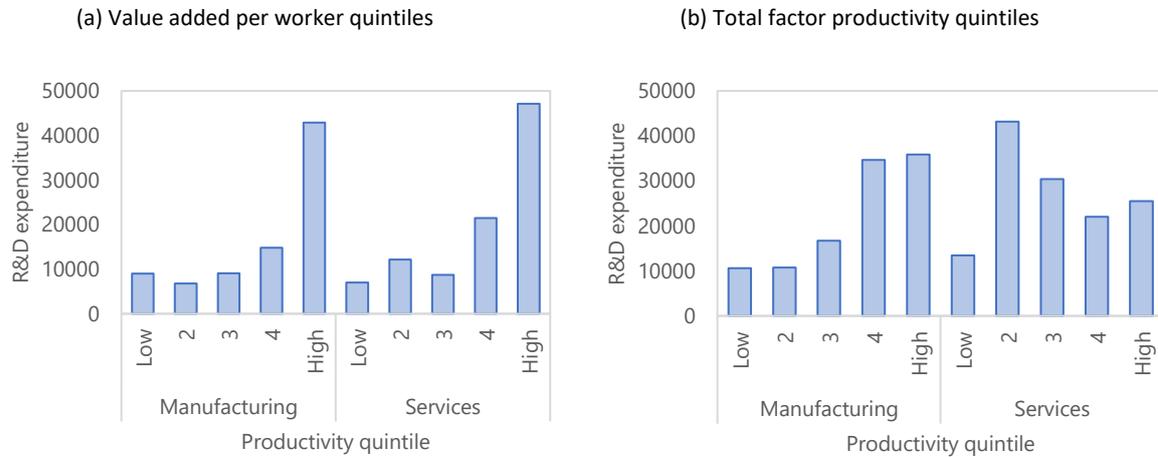
Source: Community Innovation Survey, 2016.

There is a positive relationship between productivity and expenditure on R&D. The firm-level data shows that more productive firms spend more on R&D than less productive firms. A manufacturing firm in the top 20% of the productivity distribution spends 2-3 times as much on R&D than the median firm (Figure 17). Regressions confirm the positive relationship between productivity and R&D expenditure (Table 3).¹⁹ A one percent increase in R&D expenses is related to a 4.3 percent increase in TFP (Figure 18). A breakdown in different categories of R&D expenses shows that external R&D and internal R&D spending are the most strongly related with productivity increases (see column (2) and (4) of Table 3). External R&D expenses are associated with an increase of 1.5 percent, internal R&D expenses with an increase of 0.9 percent, while spending on equipment and software is not significantly related to an increase in R&D. This positive relationship can both be an indication that expenditure on R&D leads to higher productivity, but also that productive firms are more likely to see the need and have the resources to invest in R&D (selection effects).

¹⁹ This regression focuses on the intensive margin of R&D expenses (i.e., it only includes firms that invest in R&D). As Figure 15 shows, there is much variation on the extensive margin: a large firm is almost three times likely to spend on R&D than a small firm. Taking the extensive margin into account, the impact of R&D activities on productivity is likely larger.

Figure 17. Expenditure on R&D is higher for more productive firms.

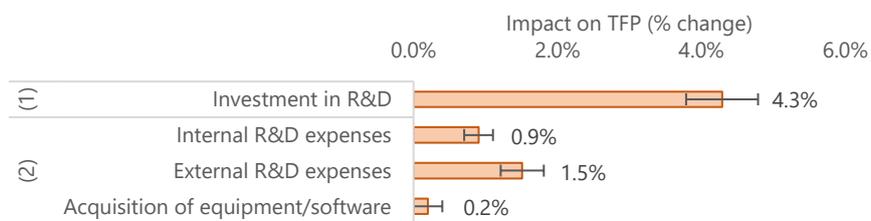
(Expenditure on R&D by productivity quintile, 2016)



Source: Authors' calculations based on the CZSO Structural Business Survey (SBS) and Technological Innovation (TI) surveys.

Figure 18. Investment in R&D is positively associated with TFP increases

(Coefficients of the regression of productivity on investment in R&D, 2010-2016)



Note: The reported coefficients are those of the regression of TFP on investment in R&D (regression (1)) and on internal R&D, external R&D and acquisition expenditures, pooling data from 2010, 2012, 2014 and 2016. The regressions control for size, ownership, region and year. The regression was run with log TFP as dependent variable, but the coefficients are reported as the percentage increase in TFP levels. The error bars indicate the 95% confidence interval.

Source: Authors' calculations based on the CZSO Structural Business Survey (SBS), Annual Survey of Research and Development (RAD; used for regression (1)) and Technological Innovation (TI, regression (2)) surveys.

Table 3. Linear regression of productivity on R&D variables (for firms with R&D expenses)

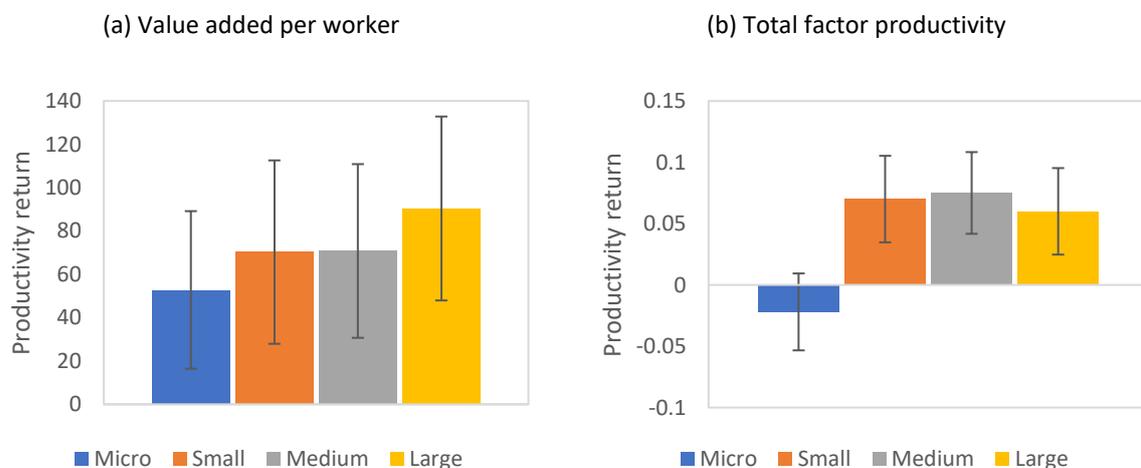
| Dependent variable | (1) Value added per worker | (2) Value added per worker | (3) Total factor productivity (log) | (4) Total factor productivity (log) |
|-----------------------------------------------------|----------------------------------|----------------------------------|-------------------------------------------|-------------------------------------------|
| Constant | 631.183 (70.650) ** | 1045.580 (175.607) ** | 0.313 (0.058) ** | 0.498 (0.062) ** |
| Age | -9.300 (1.418) ** | -15.093 (3.152) ** | -0.008 (0.001) ** | -0.004 (0.001) ** |
| R&D amount (log) | 73.915 (5.987) ** | | 0.042 (0.005) ** | |
| Internal R&D amount (log) | | 2.752 (6.556) | | 0.009 (0.002) ** |
| External R&D amount (log) | | 52.700 (7.203) ** | | 0.015 (0.003) ** |
| Acquisition of equipment/ software, amount (log) | | 0.235 (6.076) | | 0.002 (0.002) |
| Firm size | | | | |
| Micro [0,10) = ref. | | | | |
| Small [10,50) | -64.556 (28.115) * | 49.543 (145.280) | -0.122 (0.024) ** | -0.156 (0.052) ** |
| Medium [50,250) | -45.225 (29.998) | 68.679 (147.430) | -0.204 (0.025) ** | -0.294 (0.053) ** |
| Large [250+) | -95.370 (37.956) * | -1.544 (150.875) | -0.342 (0.032) ** | -0.400 (0.054) ** |
| Ownership | | | | |
| Private domestic = ref. | | | | |
| Public | 437.735 (68.728) ** | 103.045 (121.296) | 0.025 (0.056) | -0.112 (0.042) ** |
| Foreign-controlled | 220.186 (21.029) ** | 486.768 (45.483) ** | 0.220 (0.017) ** | 0.290 (0.016) ** |
| Region | | | | |
| Praha = ref. | | | | |
| Jihočeský kraj | -226.604 (47.301) ** | -435.612 (98.447) ** | -0.202 (0.039) ** | -0.268 (0.034) ** |
| Jihomoravský kraj | -119.168 (27.451) ** | -334.654 (76.460) ** | -0.114 (0.023) ** | -0.223 (0.027) ** |
| Karlovarský kraj | -308.580 (87.116) ** | -561.648 (144.614) ** | -0.353 (0.072) ** | -0.378 (0.050) ** |
| Kraj Vysočina | -227.955 (48.020) ** | -412.949 (108.391) ** | -0.238 (0.040) ** | -0.274 (0.038) ** |
| Královéhradecký kraj | -226.106 (41.243) ** | -410.595 (105.573) ** | -0.251 (0.034) ** | -0.281 (0.037) ** |
| Liberecký kraj | -43.420 (47.488) | -399.277 (112.003) ** | -0.145 (0.039) ** | -0.226 (0.039) ** |
| Moravskoslezský kraj | -196.771 (32.594) ** | -418.227 (76.629) ** | -0.174 (0.027) ** | -0.277 (0.027) ** |
| Olomoucký kraj | -136.303 (41.316) ** | -312.299 (98.250) ** | -0.177 (0.034) ** | -0.213 (0.034) ** |
| Pardubický kraj | -228.705 (41.271) ** | -397.174 (100.254) ** | -0.210 (0.034) ** | -0.233 (0.035) ** |
| Plzeňský kraj | -152.875 (44.967) ** | -416.529 (100.335) ** | -0.222 (0.037) ** | -0.187 (0.035) ** |
| Středočeský kraj | -43.649 (33.401) | -170.520 (79.354) * | -0.108 (0.028) ** | -0.132 (0.028) ** |
| Ústecký kraj | -124.061 (50.228) * | -47.171 (95.813) | -0.195 (0.041) ** | -0.246 (0.033) ** |
| Zlínský kraj | -156.407 (36.693) ** | -216.696 (89.974) * | -0.133 (0.030) ** | -0.166 (0.031) ** |
| Year | | | | |
| 2010 = ref. | | | | |
| 2012 | 16.058 (24.180) | 38.937 (54.548) | 0.009 (0.020) | -0.017 (0.019) |
| 2014 | 76.528 (24.211) ** | 154.590 (63.899) * | 0.098 (0.020) ** | 0.073 (0.022) ** |
| 2016 | 138.616 (24.643) ** | 132.895 (60.535) * | 0.159 (0.020) ** | 0.076 (0.021) ** |
| R^2 | 0.174 | 0.137 | 0.103 | 0.124 |
| Adjusted R^2 | 0.169 | 0.131 | 0.098 | 0.118 |
| Observations | 7891 | 6513 | 7742 | 6461 |
| RMSE | 738.062 | 1593.433 | 0.604 | 0.553 |

Note: Linear regression of value added per worker and total factor productivity on R&D variables from the RAD (column (1) and (3)) and TI (column (2) and (4)). TFP is reported in logarithmic values. ** $p < 0.01$, * $p < 0.05$.

Larger firms do not only invest more in R&D, there is some evidence that returns to R&D expenditure are higher as well. Regressions suggest that the relationship between R&D expenditure and productivity is stronger for larger firms (Figure 19), even though many of the differences are not significant. The coefficient representing the return of R&D expenses to value added per worker is 71 percent higher for large firms compared to micro firms. The return to total factor productivity for micro firms is close to zero, while positive for larger firm sizes.

Figure 19. Productivity returns to R&D expenses are higher for larger firms

(Returns of R&D expenditure to value added per worker/TFP, 2010-16)



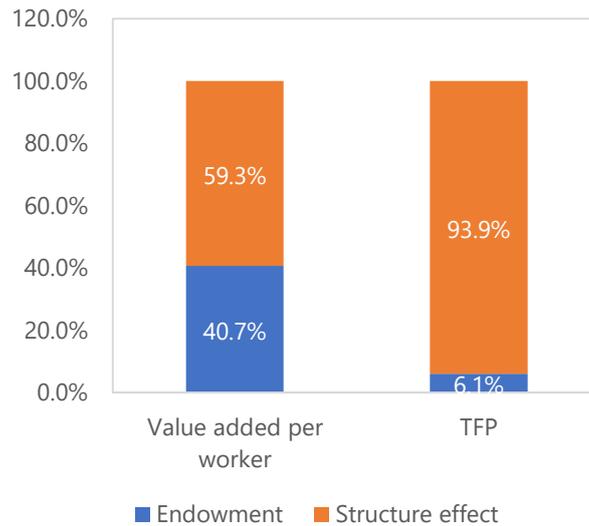
Note: The reported value is the coefficient of the regression of value added per worker or total factor productivity on R&D expenditure, interacted with firm size. In addition, the regressions controls for firm size, ownership, region and year. Source: Authors' calculations based on SBS, RAD and TI data.

Differential returns to innovation expenditure could explain most productivity differences related to R&D between small and large firms. The previous analysis has shown that large firms invest more in R&D than smaller firms, which is positively related with higher productivity, but also that they see a stronger correlation between R&D investment and productivity gains (higher returns). Both these factors – higher innovation spending and higher returns – contribute to productivity differences between small and large innovative firms. Figure 20 shows the result of an Oaxaca-Blinder decomposition, which allows to calculate the contribution of these two factors separately. This decomposition suggests that 59.3 percent of value added per worker differences and 93.9 percent of total factor productivity differences between smaller and larger firms due to R&D expenditure can be

explained by differential returns (the structure effect) rather than different spending (the endowment effect).²⁰

Figure 20. Differential returns to R&D expenditure (the structure effect) dominate differences in R&D expenditure (the endowment effect) in explaining productivity differences between small and large firms

(Oaxaca-Blinder decomposition of the coefficient of R&D expenditure on productivity, 2010-16)



Source: authors' calculations based on SBS, RAD and TI data.

²⁰ See Annex 1 for a description of the methodology. The regression in Figure 6 suggests a negative relationship between TFP and firm size. This is due to other factors than R&D expenditure: the partial effect of R&D expenditure on TFP increases by firm size as Figure 17b shows.

CONCLUSION: AREAS FOR POLICY ACTION

Aggregate data suggests that labor productivity in the Czech Republic is only slowly converging to German levels. As of 2017, labor productivity was at 68.3 percent of Germany, which is only 8 percentage points higher than in 2000. The productivity gap is in particular large for smaller firms, which represents the largest amount of value added and employment. MSMEs account for 67.3% of total employment and 55.2% of value added (at factor cost) in the Czech Republic.

Productivity increased for all size groups, but growth was lower for small firms (10-49 workers). Productivity is higher for older firms, large firms, foreign-owned firms and those headquartered in Prague. While productivity increased across all size categories, growth was the lowest for small firms, with 10 to 49 employees.

Despite this increase, productivity was dragged down by a lack of growth of more productive firms, suggesting allocative inefficiencies. These allocative inefficiencies are found in most sectors, but seem to be larger in services industries. Most of the regional differences are also explained by differences in growth of productive firms, suggesting that differences in allocative efficiency across regions explain a large part of the variation in productivity growth seen between regions. This points towards a clear need for policy action to remove barriers to doing business and barriers impeding competition.

More productive firms spend more on R&D, but returns to R&D differ across firms. Returns are lower for smaller firms. Smaller firms are less likely to spend on R&D compared to large firms, and the evidence – even though at times mixed – suggests that there are differential returns to R&D spending between firms of different size groupings. This suggests that innovation-enabling factors currently do not provide firms with the right mix of support or that firms of different size have distinct capabilities to use and benefit from the existent system.

Overall, the empirical results presented in this analysis can be useful to identify potential drivers for a comprehensive productivity and innovation policy for the Czech Republic. First, the fact that aggregate productivity in the country has been dragged down by lack of growth of more productive firms, particularly in services, points to the importance of removing barriers to resource allocation. In this regard, streamlining barriers against doing business – specially to reduce entry costs - and removing regulatory restrictions to competition – for instance by ensuring competitive neutrality in markets where SOEs and the private sector compete – emerge as key measures to be promoted. Second, while the within component has shown to be the key driver of aggregate productivity growth, there is still space to improve firms' capabilities, especially among SMEs as they account for the largest proportion of employment and value added in the country. In this regard, because firms with different characteristics – specially size – tend to have distinct capabilities to use and benefit from the

existent innovation system, it is key to revise the current mix of policies designed to support innovation among SMEs to identify programs and initiatives that have not been able to meet their targets. In this context, particularly important is to design new or adjust existent policies to increase the share of SMEs investing in innovation.

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APPENDIX. DESCRIPTION OF THE OAXACA-BLINDER DECOMPOSITION

This analysis uses an Oaxaca-Blinder decomposition to understand whether the productivity gap between SMEs and large firms are due to differences in R&D expenditure between the two groups (the “endowment” effect) and due to differences in productivity returns to R&D expenditure (the “structure” effect).

The regression used in the analysis regresses firm productivity Y on firm-level characteristics X , which includes R&D expenses:

$$Y^* = \beta_0 + X^{*'}\beta^* + \varepsilon. \quad (\text{entire sample})$$

This regression yields a set of coefficients β representing the partial correlations between the firm-level characteristics and productivity. For the Oaxaca-Blinder decomposition, this regression is run three times, first with the entire sample and then separately for each group:

$$\begin{aligned} Y^* &= \beta_0 + X^{*'}\beta^* + \varepsilon && (\text{entire sample}) \\ Y_{Small} &= \beta_{0,Small} + X'_{Small}\beta_{Small} + \varepsilon && (\text{small firms only}) \\ Y_{Large} &= \beta_{0,Large} + X'_{Large}\beta_{Large} + \varepsilon && (\text{large firms only}) \end{aligned}$$

In the Oaxaca-Blinder decomposition, the “endowment” effect represents the contribution of differences between X_{Large} and X_{Small} (i.e., large firms spending more on R&D), and the “structure” effect captures differences between β_{Large} and β_{Small} (i.e., whether the partial correlation between R&D expenditure and productivity differs across firms). The different components can be calculated as follows:

$$\begin{aligned} \text{Productivity gap} = E(Y_{Large}) - E(Y_{Small}) &= \underbrace{\sum_{k=1}^K [E(X_{k,Large}) - E(X_{k,Small})] \beta_k^*}_{\text{Component 1: Endowment Effect}} + \\ & \underbrace{(\beta_{0,Large} - \beta_0^*) + \sum_{k=1}^K E(X_{k,Large}) (\beta_{k,Large} - \beta_k^*)}_{\text{Large Firm Structural Advantage}} + \underbrace{(\beta_0^* - \beta_{0,Small}) + \sum_{k=1}^K E(X_{k,Small}) (\beta_k^* - \beta_{k,Small})}_{\text{Small Firm Structural Advantage}} \\ & \underbrace{\hspace{15em}}_{\text{Component 2: Structure Effect}} \end{aligned}$$

As Figure 20 shows, for the relationship between R&D expenses and productivity, the endowment effect represents 40.7% for the gap in value added per worker and 6.1% for the gap in TFP, while the structure effect represents respectively 59.3% and 93.9%. This suggests that for Czech firms differential returns to R&D between SMEs and large firms are more important in explaining productivity differences than differences in R&D expenditure.

