

Chapter 2

Selected themes

2.1 High-productivity firms in Denmark

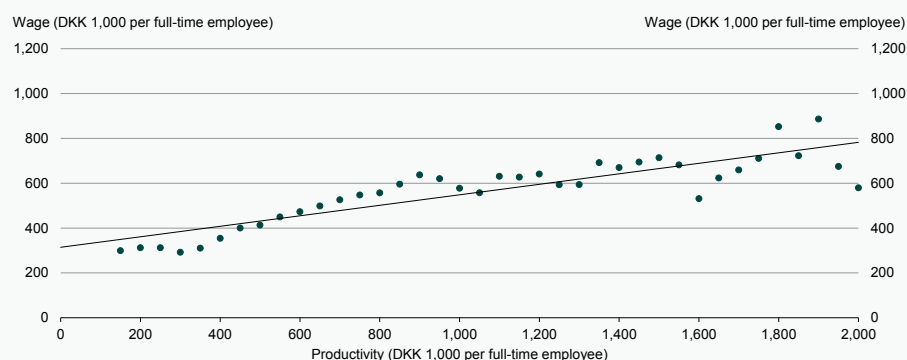
Fundamentally, productivity is a measure of how much we get out of the resources used in production. Productivity is inter alia supported by a well-educated workforce, effective markets, sound incentives, well-developed infrastructure, and a good institutional framework. Also, more diffuse concepts such as innovation and management matter.

Ultimately, productivity is the main source of prosperity. When Denmark is one of the most prosperous countries today, it is largely due to a high productivity level. This is partly because Denmark is a well-developed country with a good business framework. Industry and business specific characteristics also play a role, and there are differences between individual firms and different industries. However, one common feature is that the firms with the greatest value added also on average reward their employees with the highest salary.

For example, the annual salary amounts to around DKK 575,000 on average for employees in firms with a productivity of DKK 1 m per full-time employee, while the annual salary is around DKK 400,000 for employees in firms with a productivity of DKK 500,000, cf. figure 2.1.

Figure 2.1

Employees in high-productivity firms are paid more



Note: The figure shows the link between average wages and productivity (GVA per full-time employee) in 2015. The larger variation in average wages in firms with a high productivity level is partly related to the fact that there are fewer of these firms in the data set.

Source: Statistics Denmark and own calculations.

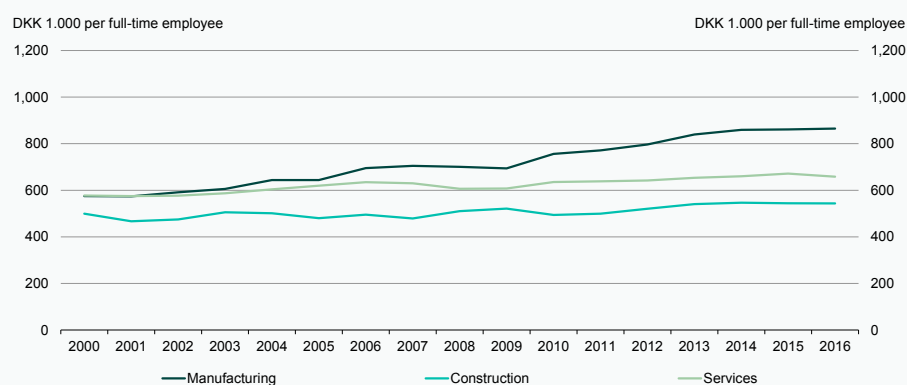
The value added in each firm remunerates both capital and labour. A larger share of the value added is typically used to pay labour in the least productive companies, while the ratio decreases as productivity increases. This reflects in part that the most productive firms to a larger extent use capital inputs in the production process.

Higher productivity is the main source of increased wealth. Greater wealth can be spent on increased consumption or more leisure, thus giving greater freedom and more opportunities to the individual.

Productivity levels differ between industries. On an aggregate level, the manufacturing sector is more productive than the service sector, which in turn has a higher productivity level than construction. Especially since the end of the 2000s, the manufacturing sector's productivity lead has been expanding further, cf. figure 2.2.

Figure 2.2

The productivity level is highest in manufacturing



Note: Services is comprised of wholesale and retail trade, transportation, accommodation and food services, information and communication, knowledge-based services, and travel agents, cleaning, etc. This corresponds to the industries in the following figures, but does not include all service industries. Productivity is shown in 2010-prices, chained values.

Source: Statistics Denmark and own calculations.

Behind these general trends, however, there are significant differences, not only *across* industries and sectors, but also *within* individual industries. This variation is best illustrated by looking at productivity at firm-level.

The remainder of the analysis uses information at firm-level to investigate what characterises the most productive firms. The main results of the analysis are:

- Danish firms are very different. This also applies to their productivity level.
- Differences between firms' productivity reflect industry differences and other factors. Some industries are better suited for automating production processes to achieve higher productivity than others.

- The differences are prominent in services. In some industries, firms are very productive (these include *legal and accounting activities*, *telecommunications*, and *rental and leasing activities*), while in other industries the productivity is typically low (e.g. *cleaning services* and *accommodation and food services*).
- The good news is that in every industry there are firms that have cracked the code to a high productivity level.
- The most productive firms are important for the Danish economy. The 25 per cent most productive firms account for more than 40 per cent of total value added.
- The most productive 25 per cent of firms are characterised by using more capital, and the employees in these firms have a higher education level than employees at other firms.
- Some firms will always be faster at implementing new knowledge and new methods in production. This allows them to achieve a higher productivity level than other comparable firms.
- However, it is problematic, if knowledge and productivity gains do not spread to other firms. An analysis by OECD shows that the productivity gap between firms at the productivity frontier and other firms has increased in the 2000s. This could indicate that something is inhibiting the diffusion of technologies to all firms, thereby slowing down productivity growth.
- This analysis finds that OECD's results for firms in the service sector cannot be found in Danish data. There is thus no indication that the productivity lead for service sector firms at the productivity frontier has increased.
- This indicates that it is more relevant to focus on general framework conditions and promote competition as recommended by the Productivity Commission and the Economic Council based on studies on Danish data.

Significant differences in firms' productivity levels

Micro-level data on Danish firms allows a more detailed analysis in the effort to understand productivity. This analysis is based on firm-level observations from Statistics Denmark's accounting statistics, which contains information about a large number of firms.

Micro-founded firm data must be used and interpreted with caution. For example, not all firms are required to report accounting information and it is necessary to make a number of data-specific selections to ensure a robust data set, *cf. appendix 2.1*.

Productivity can be measured in different ways. In line with Nationalbanken (2017), labour productivity is defined as gross value added divided by the number of full time employees (hereafter referred to as productivity).¹ This measure describes how much value the production factors – including labour and capital – create per hour worked, but it does not say anything about the distribution of the various inputs in the individual firm, e.g. whether it is very capital intensive or employs highly educated workers.

¹ See Nationalbanken (2017): Diffusion of new knowledge benefits firms' productivity. Analysis no. 18.

Normally, the greater the capital stock, the greater the value added per employee. Alternatively one might therefore look at the so-called total factor productivity, which theoretically takes into account differences in production inputs and thus is a more precise term. In practice, however, there are a number of challenges associated with measuring total factor productivity.

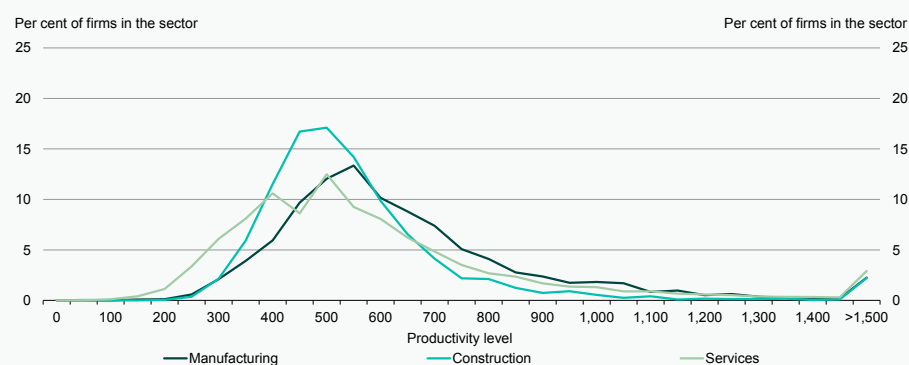
A first conclusion of this study is that there is a large variation in individual firms' productivity levels within the main industries, *manufacturing*, *construction*, and *services*.

When distributing firms in these main industries according to their measured productivity level, the distribution peaks at the most common level of productivity in the industry (i.e. the distribution is "bell-shaped"). However, there are also "tails" of firms with particularly high or low productivity.

The diffusion in firms' productivity is greatest in manufacturing and in services. Within *services*, there are many firms that stand out with relatively low productivity, while in *manufacturing* there are many firms with relatively high productivity. *Construction* is, on the other hand, a somewhat more homogenous industry, cf. *figure 2.3*.

Figure 2.3

Large differences in firms' productivity levels – especially in services and manufacturing



Note: The figure shows the distribution of productivity levels in different industries in 2013-2015. The productivity level is measured in DKK 1,000 per full-time employee (2010-prices, chained values).

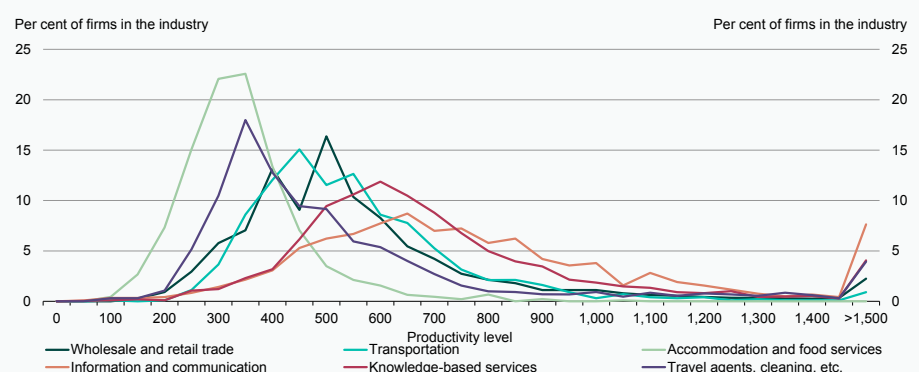
Source: Statistics Denmark and own calculations.

There are several reasons why firms in manufacturing and services exhibit more variation in productivity levels compared to construction. First and foremost, it is due to the fact that the two main industries cover a wide variety of sub-industries, each of which has their own prerequisites for achieving a high productivity level. For example, some industries are operating on highly competitive international markets, so there may be an increased need for a high productivity level if a firm is to succeed. At the same time, the possibilities of taking advantage of new technologies or high-quality labour also differs between sub-industries and between individual firms.

The service sector consists of a wide range of industries – from land, air, and water transport, cleaning, accommodation and food services to legal, architectural, and engineering activities. However, there are also relatively large variations in productivity levels among firms within the various sub-industries in the service sector, *cf. figure 2.4*.

Figure 2.4

Significant differences in productivity levels across service industries



Note: The figure shows the distribution of productivity levels in the service industries in 2013-2015. The productivity level is measured in DKK 1,000 per full-time employee (2010-prices, chained values).

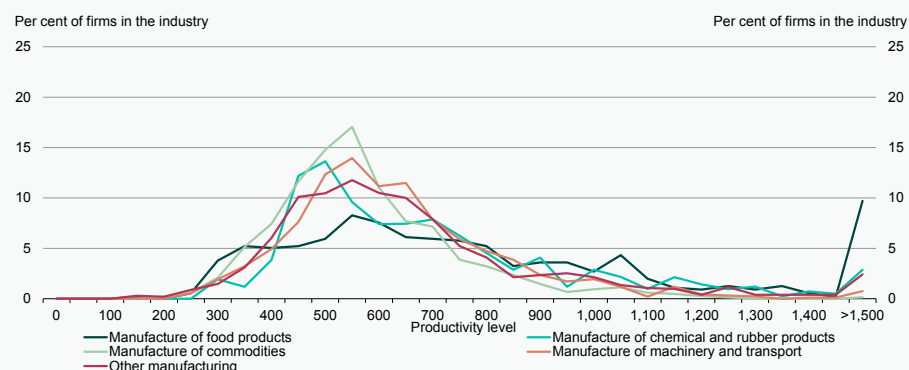
Source: Statistics Denmark and own calculations.

This applies, for example, to *information and communication*, which covers publishing activities (e.g. newspapers and books) where there are relatively small differences between firms' productivity. *Information and communication* also includes providers of telecommunications that sell a completely different product, and typically have a higher productivity level.

Conversely, there is generally a lower productivity level and a relatively small variation between firms in *accommodation and food services*, which consists solely of accommodation facilities and catering companies.

The sub-industries in manufacturing generally look more alike when viewing productivity distributions. However, manufacturing of food products differs with a slightly larger share of high-productivity firms compared to other sub-industries, *cf. figure 2.5*.

Figure 2.5

Manufacturing is more homogenous

Note: The figure shows the distribution of productivity levels in the manufacturing industries in 2013-2015. The productivity level is measured in DKK 1,000 per full-time employee (2010-prices, chained values).

Source: Statistics Denmark and own calculations.

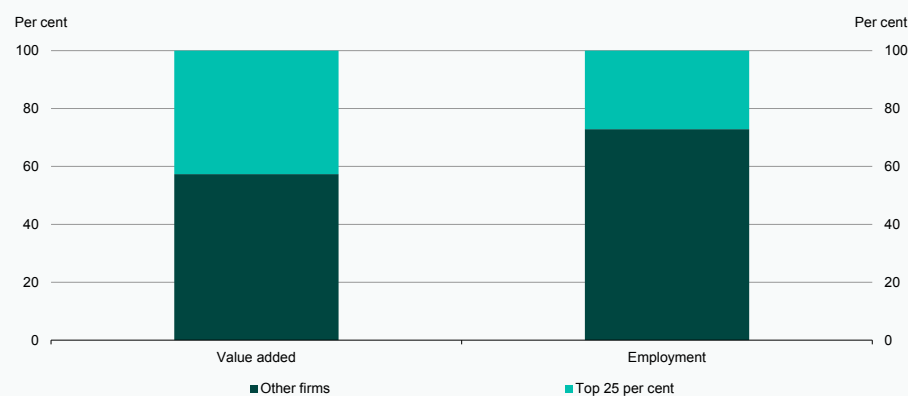
The wide spread in firms' productivity levels emphasises that in general – and especially in the service sector – it is not enough just to look at the overall industry. It is necessary to go into more details.

At the same time, productivity distributions show that there are high-productivity firms in almost all industries. This applies not only to manufacturing, but also to a large number of firms in services and construction.

The most productive firms can be defined in different ways. This analysis looks at the top 25 per cent of firms *within* a given sub-industry, which in a given year has the highest productivity level.

The distribution of productivity levels within the various industries does not in itself say anything about whether large or small firms are the most productive. However, in all industries, it is generally the case that the most productive firms account for a large part of the industry's revenue or value added. The 25 per cent most productive firms accounted for 40 per cent of total value creation in 2015 while employing around 30 per cent of total employment in the data set, *cf. figure 2.6*.

Figure 2.6

The 25 per cent most productive firms account for more than 40 per cent of value added

Note: The figure shows how value added and employment is divided between the 25 per cent most productive firms and other firms in the data in 2015. Value added is in current prices.

Source: Statistics Denmark and own calculations.

What characterises highly productive firms?

This section takes a closer look at what characterises the most productive firms. Many factors affect the productivity of individual firms. Different industries have different prerequisites for using, for example, capital in production and therefore they have different productivity potentials. This analysis therefore looks at productivity levels *within* the individual industries.

The sectoral groups are relatively detailed with the aim of comparing firms with as similar as possible prerequisites for high productivity. For instance, the sub-industries within *information and communication* are examined. This means that *publishing activities* are compared with *publishing activities*, and *telecommunications* are compared with *telecommunications* while there is no comparison made between sub-industries.

In most cases, firms operate within a given industry on the same markets and terms, such that the firms in theory should be identical in their prerequisites for utilising, for example, capital or highly skilled labour. However, the analysis shows that some firms are more productive than others. It furthermore shows that the most productive firms differ from other firms on a number of characteristics.

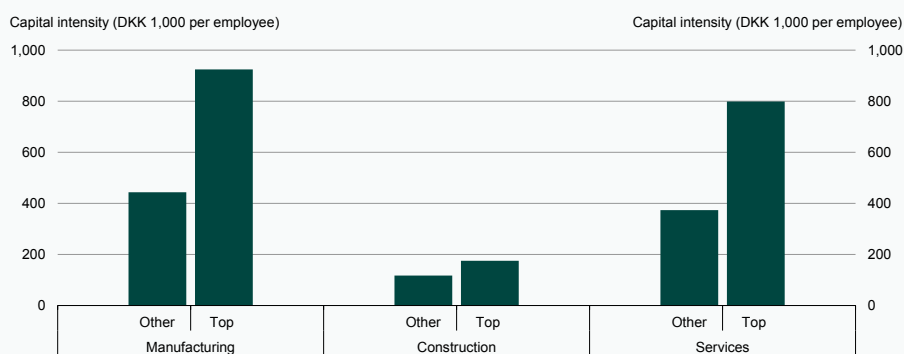
Measured by capital intensity the 25 per cent most productive firms stand out. Capital intensity measures the utilised capital in production relative to the employed labour. Capital can be, for example, buildings or machinery, but also intellectual property rights such as a patent.

In particular, the most productive firms in both service and manufacturing are characterised by a high level of capital per employee. This holds across sub-sectors that the capital intensity of the top 25 per cent firms is about twice as high as the other firms in

the industry. The same ratio is also observed in construction, where the capital intensity generally is somewhat lower than for firms in manufacturing or services, *cf. figure 2.7*.

Figure 2.7

Highly productive firms in service and industry use more capital



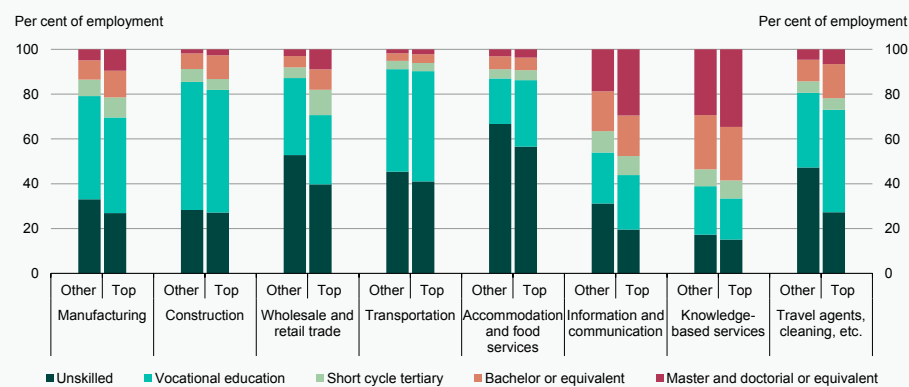
Note: The figure shows the capital intensity across industries and productivity groups in 2015. Top indicates top 25 per cent of firms measured by productivity levels within a given industry. The capital intensity is measured as the sum of intangible assets and property, plant and equipment divided by the level of employment in each industry and then weighted by each industry's share of total employment.

Source: Statistics Denmark and own calculations.

There are also differences in the general level of education among employees across firms. Employees in the top 25 per cent firms generally have a higher education level than those employed in other firms. This applies in most industries, *cf. figure 2.8*.

Figure 2.8

The most productive firms employ individuals with a higher education level



Note: The figure shows the employment composition across industries and productivity groups in 2015. Top indicates top 25 per cent of firms measured by productivity levels within a given industry. The education composition for each sub-industry is weighted with the industry's share of total employment. People with primary school of education and lower secondary education include a small group of foreign workers with unknown level of education.

Source: Statistics Denmark and own calculations.

For example, highly educated workers accounted for about 30 per cent of the employees in the 25 per cent most productive firms in manufacturing in 2015. The share was a little over 20 per cent for the other manufacturing firms. However, there are also examples of highly productive firms, which employ workers with vocational education.

In the service sector there are clear differences. In *knowledge based services* around 60 per cent of workers had a tertiary education. This was the case in both the 25 per cent most productive firms and in the rest of the firms, but with a slightly higher share for the most productive firms. In *transportation* and *accommodation and food service activities* it was around 10 per cent and 15 per cent of workers, while there was no particular difference between the most productive firms and the rest.

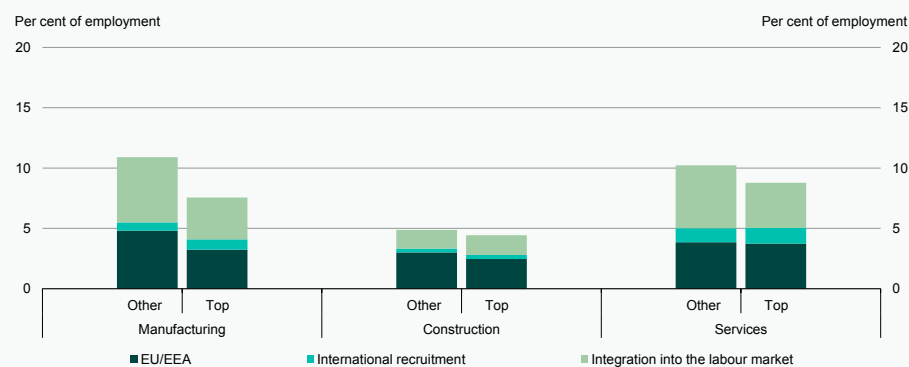
In order to support productivity, it is important that resources are moved to where they are best utilised. Denmark is characterised by the fact that a large proportion of highly educated workers are employed in the public sector compared to other OECD countries.

Foreign workers can contribute to a high level of productivity by adding new knowledge to the production and by opening up new markets for firms.

As a whole, highly productive firms employ fewer foreign workers. In particular, refugees and migrants tend to find employment in firms with low productivity, *cf. figure 2.9*.

Figure 2.9

Small differences in the use of foreign labour



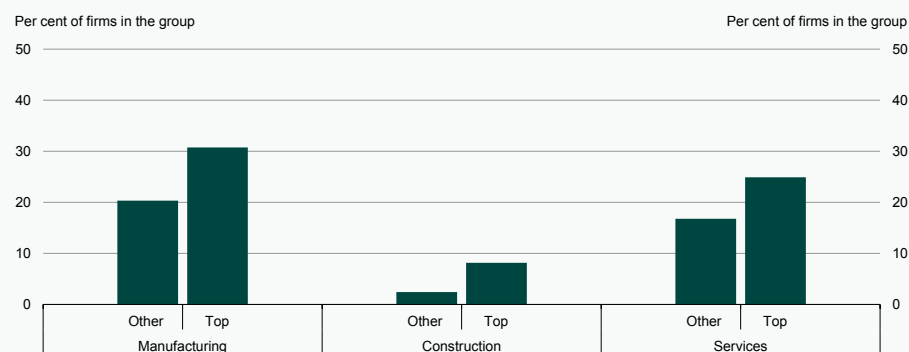
Note: The figure shows foreign labour by industry and productivity group in 2015. Top indicates top 25 per cent of firms measured by productivity levels within a given industry. *International recruitment* includes persons from third countries outside the EU with residence permit related to either business agreements or as students, who participate in the workforce. *Labour market integration* includes refugees, reunited family members to refugees and other immigrants with family ties to persons with residence in Denmark. There is no information on reasons for immigration for individuals who immigrated before 1997. This group is distributed between *international recruitment* and *labour market integration* based on the country of origin (western/non-western). The composition of foreign labour in each sub-industry is weighted by the share of total employment.

Source: Statistics Denmark and own calculations.

A large share of the workers in *labour market integration* is employed in *accommodation and food service activities* and *travel agents, cleaning, and other operational services*, where the value added per work hour is relatively low. On the contrary, a larger share of internationally recruited workers find employment in *information and communication* as well as *knowledge based services*, where they can contribute with new technical know-how and knowledge of international markets.

Across firm ownership, there is a difference in productivity levels, however. Foreign-owned firms tend to have higher productivity levels than other firms. It holds across industries that the share of foreign-owned firms is higher for the 25 per cent most productive firms compared to the rest, *cf. figure 2.10*.

Figure 2.10

Greater share of foreign ownership among the most productive firms

Note: The figure shows the share of firms with foreign ownership in 2015. Top indicates top 25 per cent of firms measured by productivity levels within a given industry. The ownership of the firms is linked to the ultimate owner, who directly or indirectly holds more than 50 per cent of the shareholders' equity or shareholders' voting rights. Ultimate ownership should be understood in relation to the direct owner, since a firm can be directly owned by an entity in one country, although ultimately owned by an entity in another country. The share of firms with foreign ownership in each sub-industry is weighted by its share of total employment.

Source: Statistics Denmark and own calculations.

Many factors may explain why the share of foreign-owned firms is higher for the 25 per cent most productive firms. It can reflect, among other things, that foreign owners are able to provide industry-specific know-how that can help boost the firm's productivity. It may also reflect that foreign-owned firms are more internationally oriented than Danish-owned firms and therefore have access to a larger global market.

It may also indicate that foreign investors see a greater potential in firms that already have a high level of productivity and therefore potentially yields a higher return. It is therefore ambiguous whether firms become more productive by being foreign-owned or whether foreign ownership follows from being a highly productive firm.

The most productive firms are not outpacing the rest

In a dynamic economy with adaptable firms it is natural that some firms increase their productivity more rapidly than others by incorporating new technology, knowledge, or new production processes. Typically, the gains will diffuse to other firms within a given industry, making sure that eventually they too reap the potential gains.

However, if there are barriers that hinder the diffusion of new knowledge from the most productive firms to the rest, it might result in the most productive firms "outpacing" the other firms. This could dampen productivity growth in the economy as a whole. An analysis from OECD for a number of countries indicates that this might be the case, *cf. box 2.1.*

Box 2.1**OECD study indicates that the most productive firms in many economies outpace the rest**

An OECD article from 2015 investigates the diffusion of new knowledge and technology from the most productive firms in the economy to the rest. Part of the reason for the investigation is the general slowdown in aggregate productivity growth for a range of advanced OECD countries over recent decades.

The analysis is based on data from 23 different countries, including Denmark. OECD finds that the most productive firms have been able to retain high productivity growth throughout a period in which the productivity growth for a number of Western countries as a whole has been on the decline. This could also indicate that new firms with high productivity growth are continually created and able to eliminate less productive firms, or that technological progress does not dampen productivity growth compared to earlier.

New knowledge and new technology are typically implemented in the most productive firms first, while the less productive firms benefit later. If the most productive firms have managed to increase their productivity significantly compared to the less productive firms, this could indicate that knowledge is diffusing at a slower pace now compared to previously. The difference in productivity growth between the most productive firms and the main group is denoted the productivity gap. OECD finds that a productivity gap has emerged both in manufacturing and services from 2001 to 2009, but also that the gap is wider for services.

With this in mind OECD investigates the reasons why some firms have been able to retain high productivity growth while others seem to struggle to keep up with the top.

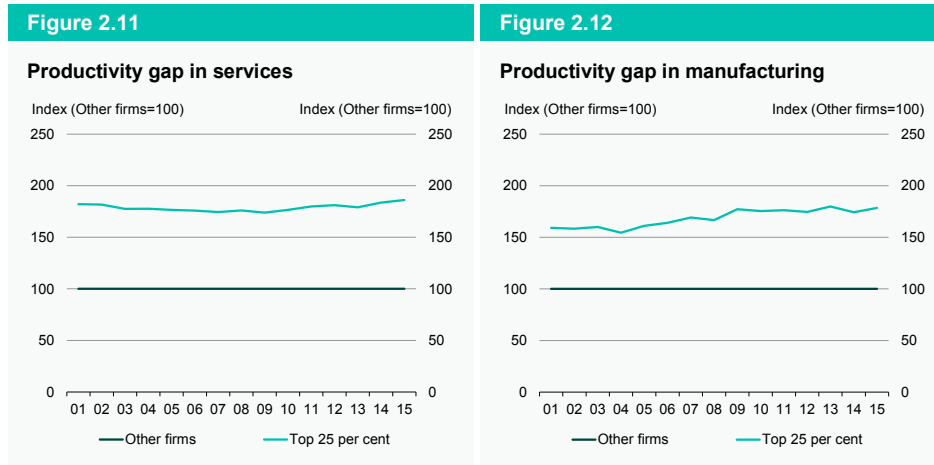
Multiple factors appear to be at play. Firstly, OECD finds that initiatives which increase competition between firms can enable the less productive firms to catch up faster to the leading firms. This is both the case for the group of firms furthest away from the frontier and the firms closest to the leading firms. Also, increased mobility in the labour market can contribute to ensuring that the less productive firms catch up faster with the frontier firms. OECD finds that the growth potential by increased mobility in the labour market is largest for firms close to the frontier while the potential gains are smaller for firms furthest away from the frontier.

OECD also finds that increased collaboration between universities and firms in implementing new knowledge and technology can help the less productive firms catch up faster to the leading firms. Here, the potential gains are largest for the firms that are furthest away from the frontier. This could be an indication that increased collaboration with universities gives these firms the opportunity to implement new knowledge and new technology that would otherwise only be accessible to the firms closest to the frontier due to considerable start-up costs.

Source: Andrews et al. (2016): Frontier firms, technology diffusion and public policy: Micro evidence from OECD countries.

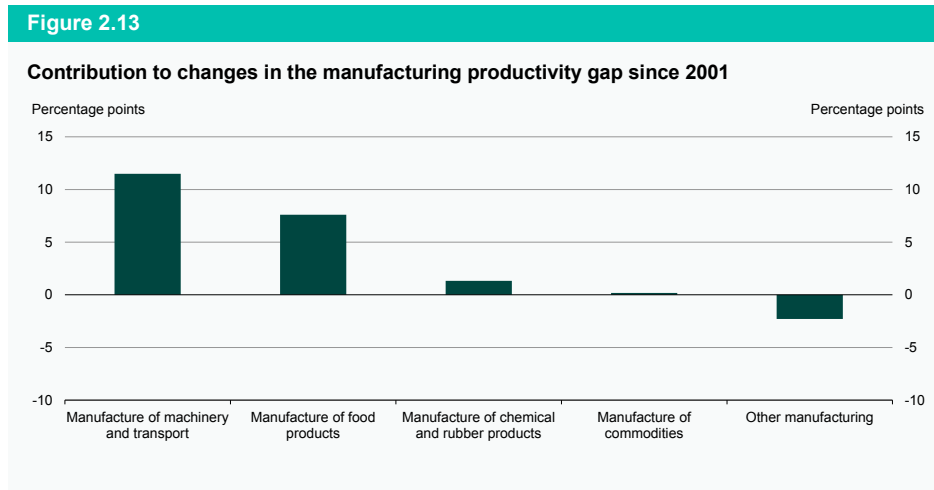
The results in this analysis point in a different direction than the results from OECD and seem to be in line with results from similar analyses from the Danish Economic Council and Nationalbanken.

Thus, in the Danish service sector there are no indications that the most productive firms have outpaced other firms since 2001, *cf. figure 2.11*. This indicates that knowledge is still diffusing from the most productive firms to the rest.



Source: Statistics Denmark and own calculations.

On the contrary, it seems that the most productive manufacturing firms have put somewhat greater distance to the group of other manufacturing firms since 2001, *cf. figure 2.12*. The development seems to be driven by a few industries only and hence does not appear to be a structural issue in the manufacturing industry as a whole. It is particularly *machinery and transport industry* and *food industry* that have been contributing to the wider manufacturing gap. For the remaining manufacturing industries the productivity gap between the most productive and the remaining firms has been relatively unchanged since the beginning of the millennium, *cf. figure 2.13*.



Note: To increase the robustness of the contributions the figure shows a mean of the contributions from the period 2001-2003 to 2013-2015.

Source: Statistics Denmark and own calculations.

A wider gap in a certain industries can theoretically also be the result of shifts in the composition of firms in the sector. This is not the case here. The most productive firms in *machinery and transport industry* and *food industry* have indeed increased the distance to the other firms.

The analysis above focuses on differences in productivity *within* industries at a relatively disaggregated level, but not on productivity differences *between* industries. However, the aggregate productivity level is also affected by the overall allocation of resources in the economy. If the share of workers employed in low-productivity industries increases, this will diminish the aggregate productivity level in the economy as a whole. It is therefore important that resources are continually allocated to industries where they contribute to increasing productivity. This can also be ensured through high turnover and job mobility in the labour market.

If instead of considering the most productive 25 per cent of firms *within* a given industry, one considers the most productive 25 per cent of firms *across* industries, the result captures the most productive firms in the economy as a whole. However, this definition also implies sensitivity to composition effects because some industries will be overly represented in the top 25 per cent-group. Measured this way, a productivity gap in the service industry has emerged since 2010, *cf. box 2.2*.

Box 2.2

The productivity gap depends on measurement method

In this analysis, there is no indication that the 25 per cent most productive firms in services have outpaced the rest. The conclusion depends on using a method, which considers the 25 per cent most productive firms *within* a given industry and comparing them to the remaining 75 per cent.

By using this method, industries will be neither over- nor underrepresented at the top of the productivity ranking, since firms from different industries are represented by the same share each year. Furthermore, the shares reflect the relative weights of sub-industries in the economy. In turn, it is more straightforward to measure knowledge sharing between firms, seeing as the analysis takes a fairly detailed look at the development *within* a given industry.

However, overall productivity growth does not simply reflect the *within-industry* development. The composition of individual industries also matters, as well as the way in which it affects overall value creation. The standard method to examine productivity involves taking a more aggregate perspective on the industry level, e.g. productivity growth in *information and communication* as a whole. An industry such as this includes very different sub-industries like *publishing services* as well as *telecommunications and broadband*. As a result, overall productivity may mask highly heterogeneous developments in the sub-industries.

A way to illustrate this point is to define the 25 per cent most productive firms *across* instead of *within* industries. If the productivity gap in manufacturing is measured according to the *across*-criterion, data still points to faster productivity growth for the most productive firms relative to other manufacturing firms since 2001, *cf. figure a*. The size of the gap is approximately equal to the one found above.

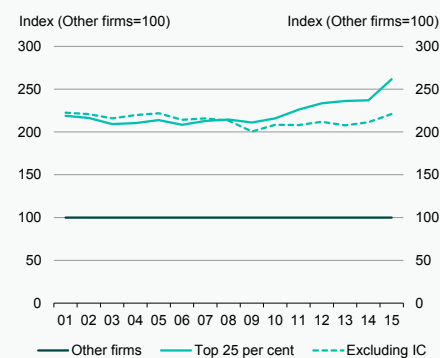
Conversely, when using the *across*-criterion services are also characterised by a higher productivity growth rate since 2001 for the 25 per cent most productive firms compared to the rest, *cf. figure b*. This trend is particularly pronounced since 2010. The increasing productivity gap also reflects that firms in services are very diverse and operate on considerably different markets. That is the case for *information and communication*, where the productivity gap between the most productive 25 per cent of firms and the rest has risen markedly since 2010.

Productivity growth in *information and communication* is of great importance to services overall. If this industry is excluded from services, the productivity gap has stayed roughly the same since 2001, *cf. figure b*.

Figure a

Productivity gap in manufacturing

Figure b

Productivity gap in services

Note: Firms in the top 25 per cent segment are defined as the most productive firms *across* manufacturing and services.
Source: Statistics Denmark and own calculations.

Appendix 2.1

Data used in the analysis

The data used in the analysis is based on Statistics Denmark's accounting statistics. The accounting statistics in turn are based on questionnaires for companies in the private non-farm business sector and reports to SKAT, the Danish tax agency.

The analysis disregards a number of industries that are either not representative or where productivity is difficult to measure. This applies to *finance and insurance, extraction of raw materials, real estate activities, shipping* and *oil refineries*. Funds and associations as well as firms characterised as an independent public enterprise are also excluded, as the focus in the analysis is on private firms exclusively.

In order to ensure a robust dataset, a number of individual firms must be excluded. In line with similar analyses, firms are excluded if they have fully or partially imputed accounting data in a given year, or if they have less than one employee (measured as full-time employees). Firms with a negative value added in the current year, the year before, or the following year are also excluded from the data set.

Subsequently, firms in the bottom 1 per cent and top 1 per cent of the productivity distribution grouped by 69 different industries are excluded. The purpose of this is to remove extreme observations that are not considered comparable to the rest of the data set. Finally, industries with fewer than 20 firms for one or more years are removed.

The data set contains about 115,000 observations, corresponding to 7,700 firms per year. Firms in services account for 60 per cent in the analysis, while firms in manufacturing and construction account for 15 per cent and 25 per cent respectively.

The value added in each industry is deflated by using price indices grouped by 69 industries from the national accounts. Thus, it is also assumed that prices do not vary across firms within each industry.

For each year, the top 25 per cent of firms is defined as measured by real GVA per full-time employee in all 69 industries. The average labour productivity at the industry level is then multiplied by the industry's share of total employment. The same method is used for the rest of the firms.

The conclusions in the analysis rely on the data selection and sorting. Another motivation for the industry-specific exclusions is an interest in being able to restore the aggregate development when comparing to the national accounts, e.g. as measured by value added or employment. In this way, the conclusions reached are also considered more reliable.