Office for National Statistics

Article

Understanding spatial labour productivity in the UK

Analysis of labour productivity across different areas of the UK, including discussion on the sources and drivers of productivity differences between areas.

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1 . Main points

- This article summarises information on labour productivity across different areas of the UK, including discussion on the sources and drivers of productivity differences between areas.
- There are geographical clusters of high-productivity areas, particularly around London and the South East of England.
- Between most other areas of the country, productivity differences are relatively small.
- Differences in firm-level productivity within industries are a bigger determinant of the geographical differences in productivity than the different industry structures of the areas.
- Differences in productivity within service sectors of the economy between London and other areas of the country are a particularly important source of the difference in productivity levels.
- Internal factors that appear to have a particular influence on a firm's productivity level include whether a firm trades internationally, its management practices, and its ownership; age and size of a firm can also have an influence.
- External factors associated with the location of a firm, such as differing local labour markets, existence of agglomeration benefits, and levels of local consumer spending can also affect a firm's productivity performance.

2 . Introduction

The aim of this article is to be an accessible guide to local productivity, its sources and drivers, bringing together the information found across various Office for National Statistics (ONS) outputs as well as the topic literature into a single introductory publication.

The article is particularly focused on explaining existing differences between productivity levels between different areas of the country. The questions the article examines are:

- which areas of the UK display high or low labour productivity levels?

o are the differences between areas persistent over time?

o have these differences increased or decreased over time?

- why are some areas more productive than others?

o is it industry mix or differences within industries?

o what does the distribution of firm productivities tell us?

- why do some firms outperform others?

o what is the impact of factors internal to firms?

o what is the impact of external factors related to a firm's location?

The article then ends by summarising the main messages on the sources and drivers of regional and subregional productivity differences. The article includes main points and illustrative data, and signposts where necessary to previous ONS outputs for more detail. We would recommend reading this article in combination with the latest Regional and subregional productivity release (ONS, 2019a), which includes the headline productivity statistics for local areas.

3 . Things you need to know about this release

What is labour productivity?

In economic terms, productivity is simply the level of output per unit of input. Labour productivity, therefore, is defined as the quantity of goods and services produced per unit of labour input, for example, per hour worked or per filled job.

Productivity matters because increasing productivity is critical to increasing the standard of living in an economy. A more productive economy is able to produce more goods and services, not by increasing inputs such as labour hours, but by making production more efficient. Furthermore, in the long run, real earnings are closely related to labour productivity. Productivity growth also helps to offset inflation and improves public finances.

Productivity growth versus productivity levels

Analysis of productivity usually focuses on the extent of productivity growth (or decline) over time and the contribution that productivity improvements are making to the growth in economic output.

This article is focused on the issue of differences in levels of productivity between different areas in the UK. It asks the question:

why is the level of productivity higher in area A compared with area B?

This is a different question to comparing differences in growth of productivity between the two areas. While it is possible to examine both these questions with the existing data – the analysis within this article is mostly focused on examining the differences between levels of productivity with time series analysis limited to a brief examination of whether these overall differences between areas are increasing or decreasing over time.

For users wishing to focus on the growth of subregional productivity within particular areas over time, data are available in the Regional and subregional productivity output (ONS, 2019a).

Approaches to measuring labour productivity

There are two different approaches that we have adopted for examining labour productivity in recent ONS outputs and both are referenced in this article.

The first approach provides a whole economy approach utilising the published regional gross value added (GVA) data. These economic output data are compared with labour input data on hours worked and jobs filled to provide the headline measures of labour productivity for a range of different subnational geographies. These productivity data can be found in the Regional and subregional productivity (ONS, 2019a) output.

The second approach is based on examining firm-level productivities using ONS microdata, in particular the Annual Business Survey (ABS). This approach excludes the public sector and the agriculture and financial sectors of the economy. However, for the rest of the business economy this approach can provide a rich source of information on distributions of firm-level productivities and the opportunity to analyse sources and drivers of productivity. A number of outputs using this approach have been published by the ONS and these are referenced through the article.

Multi-factor productivity

Multi-factor productivity data are not available for regional and subregional areas. However, it is worth understanding the concept and how it is measured as it can help explain why we might see differences occurring in labour productivity between areas.

The calculation of multi-factor productivity is based on the theory that economic output can be influenced by three different types of input, namely labour, capital and “other”. The aim of the calculations is to estimate the size of the “other” component (known as the residual multi-factor productivity component).

A simple guide to multi-factor productivity provides a much fuller explanation. However, of relevance to this article is that it is not only the quantity of labour input (for example, hours worked) that impacts on overall productivity. Additionally, productivity can be influenced by the:

- quality of labour input (QALI), reflecting the composition of the workforce in terms of skills
- inputs of capital
- the residual multi-factor productivity component encompassing “other” input factors such as spillovers and improvements in technology

At the moment, neither QALI nor suitable capital data are available for regions and subregions to allow these calculations to be made at the regional level. However, in assessing the labour productivity results in this output it is worth remembering that capital inputs, quality of labour and the residual multi-factor components can all influence an area’s headline labour productivity values.

UK geographies

Subregional productivity data are published for the NUTS1, NUTS2 and NUTS3 geographies, selected city regions and for local enterprise partnerships (LEPs). For the purposes of the European Regional Statistics, geographical distinctions are made according to the European Union’s Nomenclature of Units for Territorial Statistics (NUTS) boundary classification that exists to allow comparable economic statistics across Europe. There are three NUTS levels in the UK:

- NUTS1 (12 regions)
- NUTS2 (41 subregions)
- NUTS3 (179 local areas)

LEPs are partnerships in England between local authorities and businesses. They were created in 2011 and their role is to help shape local economic priorities and undertake activities to encourage local economic growth and the creation of jobs. There are currently 38 LEPs. We also present data for selected city regions, defined where applicable by combined authority boundaries. These data are available in the Regional and subregional productivity publication (ONS, 2019a).

Reporting units versus local units

When undertaking productivity microdata analysis using the Annual Business Survey, it is possible to carry out the analysis on a reporting unit basis or a local unit basis. The reporting unit is, as the name suggests, the unit at which ABS information is collected from firms by the ONS and there will be a location associated with this reporting unit (often the head office address).

However, the firm itself may actually operate from lots of different sites (local units) and not just from the single reporting unit site. In this case, any geographical analysis would ideally want to be able to capture the amount of output or employment taking place at each distinct site.

Most productivity analysis carried out at the national level uses a reporting unit version of the ABS for microdata analysis. When geography is not a major element of any required analysis then this approach benefits from the fact that the analysis is occurring at the same unit as the data collection. ONS outputs such as ONS (2017 d) and ONS (2018 e) use the reporting unit dataset.

There is a downside, however, to using the reporting unit approach when there is an interest in the geography of output, which is that all a firm's output gets allocated to one site, rather than spread over the full range of sites responsible. This has the potential to lead to misleading geographical results.

To avoid this problem, a local unit version of the ABS is available in which data from the reporting unit are allocated across the respective local units. This means analysis can then be based on the location of each local unit (such as a factory, office or depot) rather than just the single reporting unit. The limitation of this approach is that a certain amount of modelling is required to produce the local unit dataset. However, the benefit is a far better accuracy in terms of geography.

The microdata analysis in this output is based on the local unit approach unless noted.

Recent ONS outputs on regional and subregional labour productivity

Regional and subregional productivity in the UK: February 2019

Estimates for measures of labour productivity using a balanced gross value added (GVA) approach for NUTS1, NUTS2 and NUTS3 subregions of the UK, selected city regions and English local enterprise partnerships (LEPs) up to 2017. Estimates are in both real and nominal terms.

Industry by region estimates of labour productivity:2017

The article presents annual productivity estimates for 16 industries in Standard Industrial Classification 2007 section groups for each of the NUTS1 regions for 1997 to 2017. It compares annual productivity growth by region, as output per hour, relative to the UK and explains how manufacturing and services have grown across the regions.

Economic review: April 2018

A compendium on analysis of economic statistics related to the performance of the regional economy.

Chapters in this compendium:

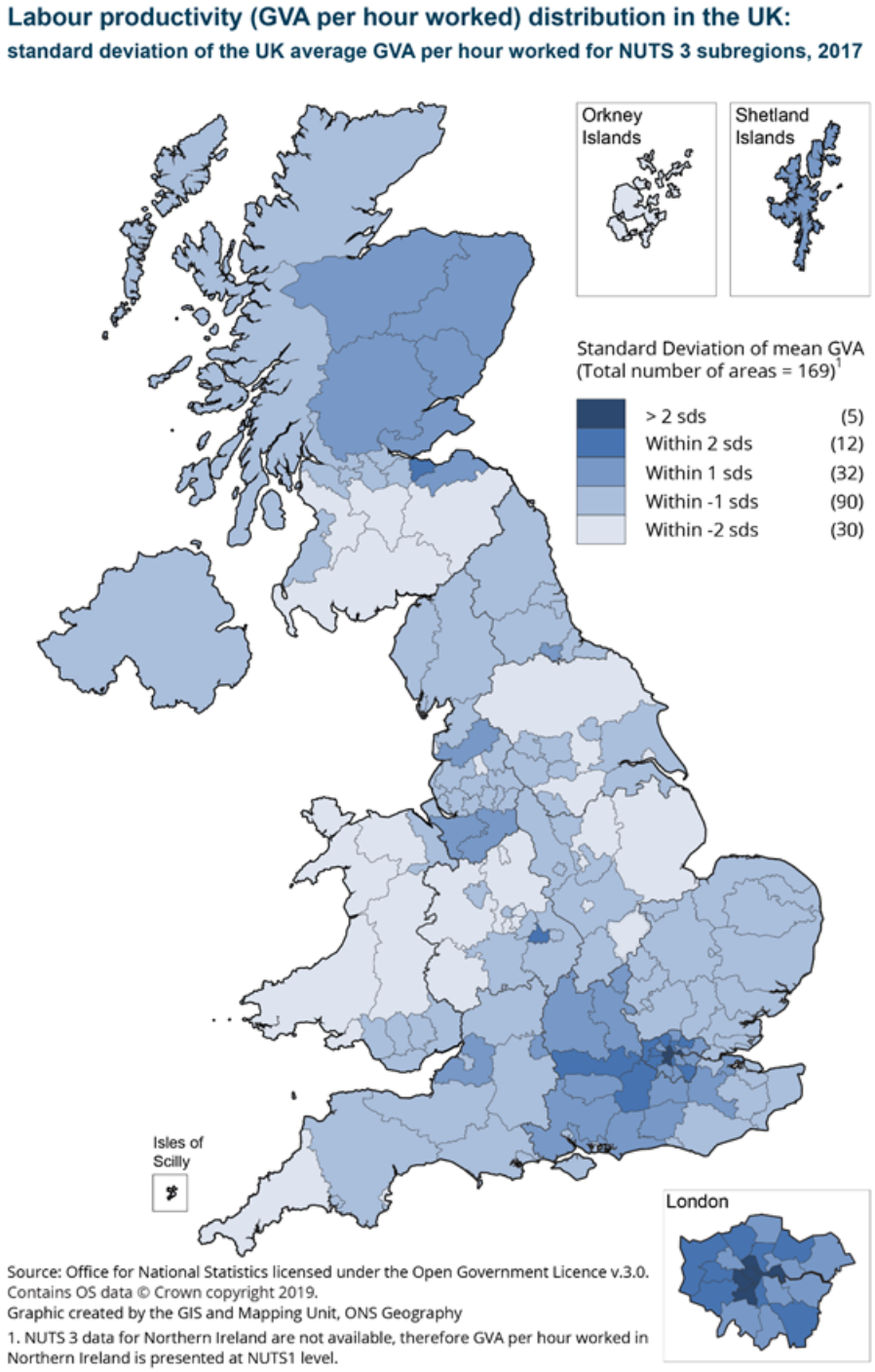
This article provides experimental analysis on the sources of regional differences in labour productivity in the non-financial business economy in Great Britain.

Analysis of productivity (GVA per worker), 2014, by Rural Urban Classification (RUC2011), Classification of Workplace Zones England and Wales (COWZ-EW) and Built-Up Areas (BUA).

4 . Trends in labour productivity by area

This first section uses the headline gross value added (GVA) per hour worked subregional productivity estimates to illustrate levels of labour productivity across different areas of the country. These data are shown in Figure 1.

Figure 1: Many NUTS3 subregions of the UK have very similar productivity levels to each other



The data highlight that many subregions of the UK have very similar productivity levels to each other. Figure 1 shows that 122 out of 169 Nomenclature of Units for Territorial Statistics: NUTS3 subregions have a productivity level within one standard deviation of the UK average.

The subregions outside of this range are those displaying the highest and lowest productivity levels. Figure 1 shows 17 areas with productivity above one standard deviation of the UK average. Fifteen of these are located either in London or the South East region illustrating that this part of the UK is the home of most of the UK's high-productivity subregions. The map in Figure 1 shows that the high-productivity areas in the South East region are mainly located in the west of London along the M4 and M3 corridorS. Productivity levels are particularly high in central London where there are five NUTS3 areas with productivity over two standard deviations above the UK average.

Figure 1 also shows 29 NUTS3 subregions with average labour productivity more than one standard deviation below the national average. These subregions are spread across all regions. Predominantly rural areas in England and Wales were among the areas with the lowest levels of labour productivity in 2017.

These results all stemmed from Office for National Statistics (ONS) all-industry regional output data with these productivity estimates available for NUTS, local enterprise partnerships (LEPS) and city region areas.

Labour productivity disparities and international comparisons

Overall, comparing the areas with highest and lowest productivity shows that labour productivity in Tower Hamlets in London is around 2.5 times higher than productivity in the rural area of Powys in Wales. Therefore, while it is the case that many subregions in the UK have very similar productivity to each other, there also exists a large disparity in productivity levels between the areas with the lowest productivity and those with the highest in Central London.

To understand how these disparities compare with other countries, data can be compared with some other major European countries using data available via Eurostat. The data show that the disparities in the UK are slightly higher than other countries. However, equally relevant is how UK subregions rank.

The analysis shows that London compares with Paris with the highest levels of labour productivity amongst regions and the South East region of England also compares favourably with regions in Europe. However, in the north and Midlands of England, and Wales and Northern Ireland, labour productivity levels are relatively low, comparable with productivity levels in eastern Germany and southern Italy (see ONS (2018a)).

It should be noted that when comparing UK regional data with that of regions elsewhere in Europe, care needs to be taken on both the metrics and geographies used in the analysis to avoid misleading results. An ONS blog provides some guidance on this topic.

Persistence of productivity disparities

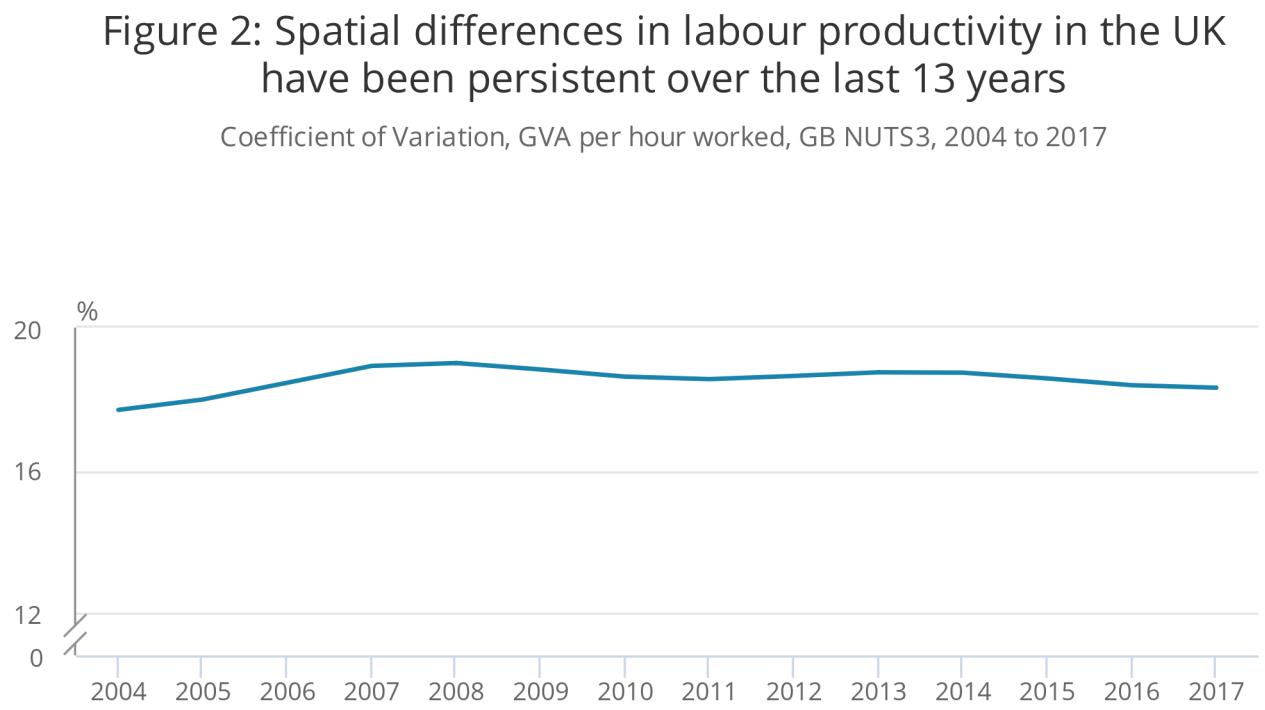
Geographical differences in labour productivity in the UK have been persistent over the last 13 years.

Figure 2 shows the coefficient of variation (CV)[1] of average GVA per hour worked for NUTS3 subregions between 2004 and 2017. It is a measure showing whether NUTS3 subregions are becoming more or less similar in terms of their average labour productivity. It shows that spread in average productivity was increasing slightly (that is, average productivity differences between the areas were widening) before the financial crisis of 2007.

However, after 2007, the spatial productivity (in real terms[2]) differences at NUTS3 level have decreased slightly due mainly to lower productivity growth rates in the high-productivity areas of London. Overall, therefore, while high-productivity differences continue to exist between areas, Figure 2 suggests these differences have not increased over the past decade.

Figure 2: Spatial differences in labour productivity in the UK have been persistent over the last 13 years

Coefficient of Variation, GVA per hour worked, GB NUTS3, 2004 to 2017



Source: Office for National Statistic

While productivity differences have not been increasing, it is also the case, however, that there has not been much change in the relative rankings of areas through the period,

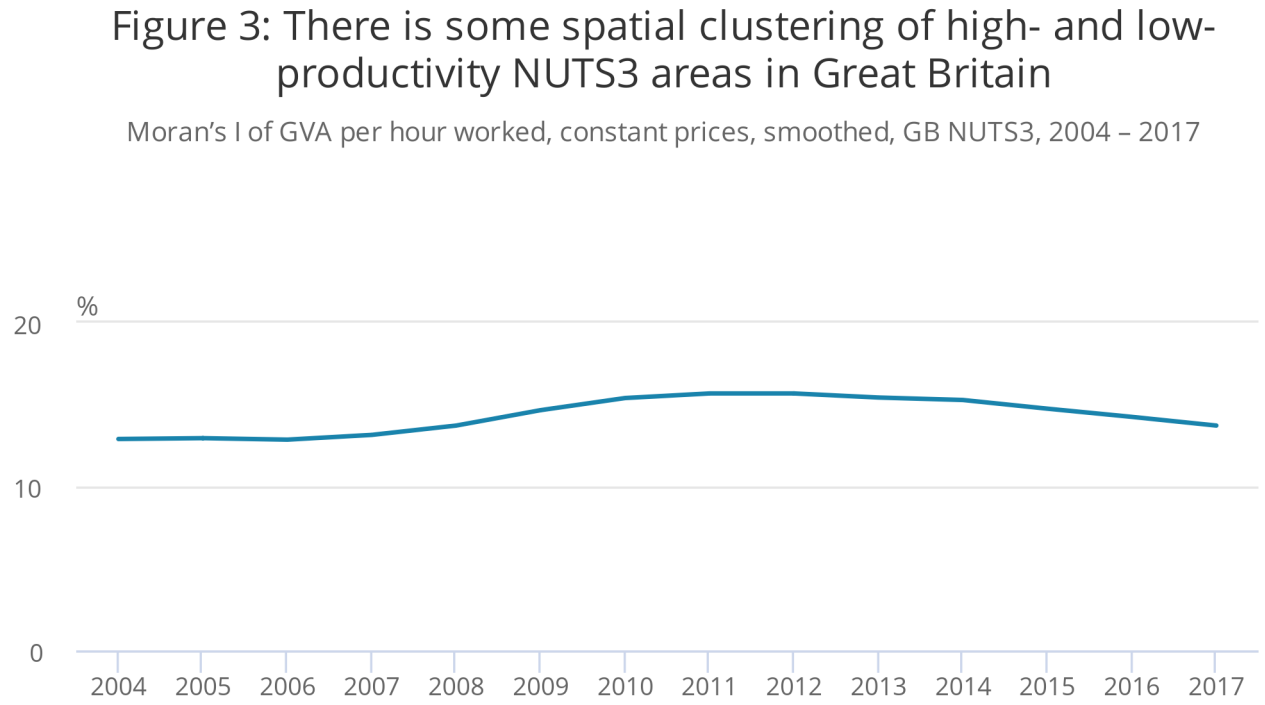
Calculation of a rank correlation coefficient[3] equals 0.87 for 2004 to 2017 and 0.90 for 2008 to 2017. These high values of the coefficient are an indication that the relative rankings of NUTS3 subregions in terms of their average productivity levels have changed very little over this period.

Finally for this section, Figure 3 investigates whether there is a spatial clustering of high- and low-productivity areas and whether it has increased over time or not. The existence of geographical or spatial clustering can be seen in Figure 1 by the gathering of high-productivity areas within London and the South East region.

A measure of spatial clustering is Moran's I statistic[4], which is a global measure to assess whether areas (for example, NUTS3) with high (or low) productivity are clustered in space or are randomly spread over the country (a level of spatial autocorrelation). The higher the Moran's I statistic the higher the spatial autocorrelation, so the greater the tendency for clustering of areas with high (or low) levels of average productivity. Figure 3 shows that this clustering increased between 2007 and 2010 but has fallen back over the 2010 to 2017 period.

Figure 3: There is some spatial clustering of high- and low-productivity NUTS3 areas in Great Britain

Moran's I of GVA per hour worked, constant prices, smoothed, GB NUTS3, 2004 – 2017



Source: Office for National Statistics

Overall, the main messages from this section are the existence of a cluster of high-productivity subregions in London and the South East. These contrast sharply with much of the rest of the country, in which many areas have relatively similar average productivity levels that compare poorly with other major European regions. This contrast between London and the South East, and elsewhere means disparities in regional productivity within the UK are relatively high compared with many other countries, although the data suggest that over the past decade these disparities have no longer been increasing and may have slightly reduced.

Notes for: Trends in labour productivity by area

1. It is a commonly used standardised measure of dispersion of a distribution (expressed as a percentage).

2. The constant price regional and subregional GVA data have been derived by deflating the current price estimates for 112 industries using national industry deflators obtained from the UK gross domestic product (output) system. These deflators are consistent with the UK National Accounts, the Blue Book 2017 and they are used because in most cases, regional price indices are currently not available. The Eurostat Manual on Regional Accounts (2013) recommends that in the absence of regional prices the use of national deflators is acceptable, provided that deflation occurs at a minimum level of 38 industries. Therefore, users should be aware that the “real” data used in our regional and subregional productivity publication are mostly based on use of national industry deflators, rather than specifically regional price deflators.

3. Spearman’s Rank correlation coefficient is a technique which can be used to summarise the strength and direction (negative or positive) of a relationship between two variables. Spearman's correlation coefficient measures the strength and direction of association between two ranked variables.

4. When Moran’s I equals to: Negative 1 is perfect clustering of dissimilar values (you can also think of this as perfect dispersion). 0 is no autocorrelation (perfect randomness.) Positive 1 indicates perfect clustering of similar values (it is the opposite of dispersion).

The statistical significance is tested as follows:

The null hypothesis for the test is that the data are randomly disbursed.

The alternate hypothesis is that the data are more spatially clustered than you would expect by chance alone. Two possible scenarios are:

1. A positive z-value: data are spatially clustered in some way.

2. A negative z-value: data are clustered in a competitive way. For example, high values may be repelling high values or negative values may be repelling negative values.

5 . Why are some areas more productive than others?

In this section, the question of why some areas are more productive than others is explored. This question is examined using firm-level productivity microdata from the Annual Business Survey (ABS) [1].

A number of Office for National Statistics (ONS) outputs have explored the question of what the sources are for productivity differences between areas. The Regional firm-level productivity analysis for the non-financial business economy, Great Britain, (ONS, 2018b) and (ONS, 2017a) and Exploring labour productivity in rural and urban areas in Great Britain, (ONS, 2017b) outputs provided experimental analysis on the sources of regional, subregional and types of spatial differences in labour productivity in the non-financial business economy using firm-level microdata from the ABS. Therefore, the analysis does not include the finance, agricultural and public sectors. Also note that the results are based on nominal terms such that any local variation in price level has not been considered.

Sources of productivity differences

An important element in understanding the average productivity differences between regions requires an examination of the relative influence of industry structure compared with firm-level productivity within industries on the average productivity level of a region.

Explaining this point in more detail, we can observe that differences in the average aggregate productivity between areas can arise from two main sources:

- the areas can have a different industry mix
- within the same industries, the firm productivities in one area can differ from those in the same industry in other areas

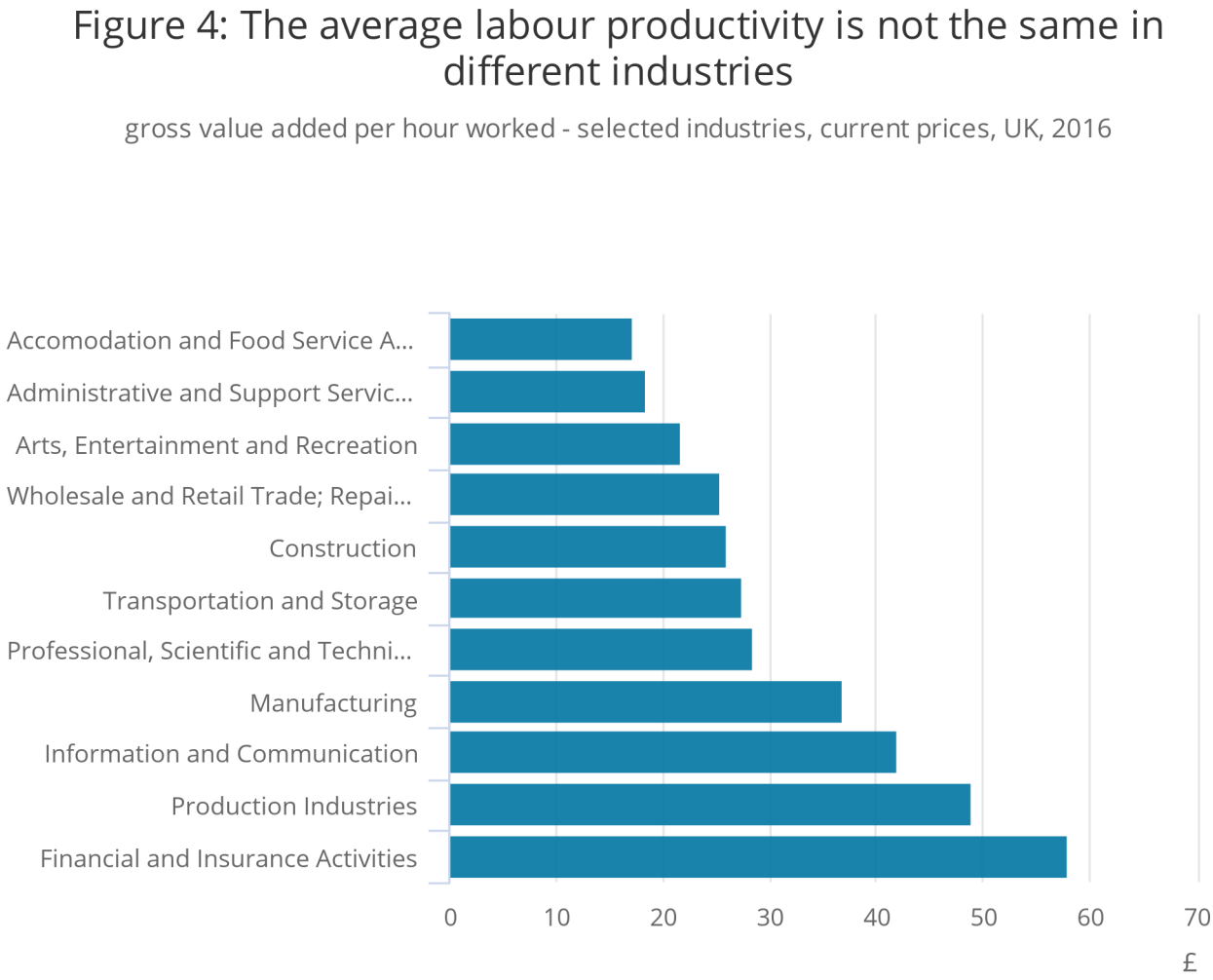
The rest of this section examines how important each of these effects is in explaining spatial productivity differences between regions and highlights that it is the latter effect (differing firm productivities within sectors) that is usually the more important.

Figure 4 shows that the average labour productivity is not the same in different industries. While there are differences across regions (see ONS, 2018c) the general pattern is that average gross value added (GVA) per worker is generally lower in the accommodation and food service activities, administrative and support services activities, and wholesale and retail trade industries than in most other industries. The production sector, by contrast, has relatively high productivity.

Among the service sectors, the professional, scientific and technical activities, financial and insurance activities, and the information and communication sector also tend to have relatively high-productivity. Therefore, a relatively high aggregate productivity in a region may sometimes be a reflection of a relatively large share of more productive industries in that location.

Figure 4: The average labour productivity is not the same in different industries

gross value added per hour worked - selected industries, current prices, UK, 2016



Source: Office for National Statistics

Notes:

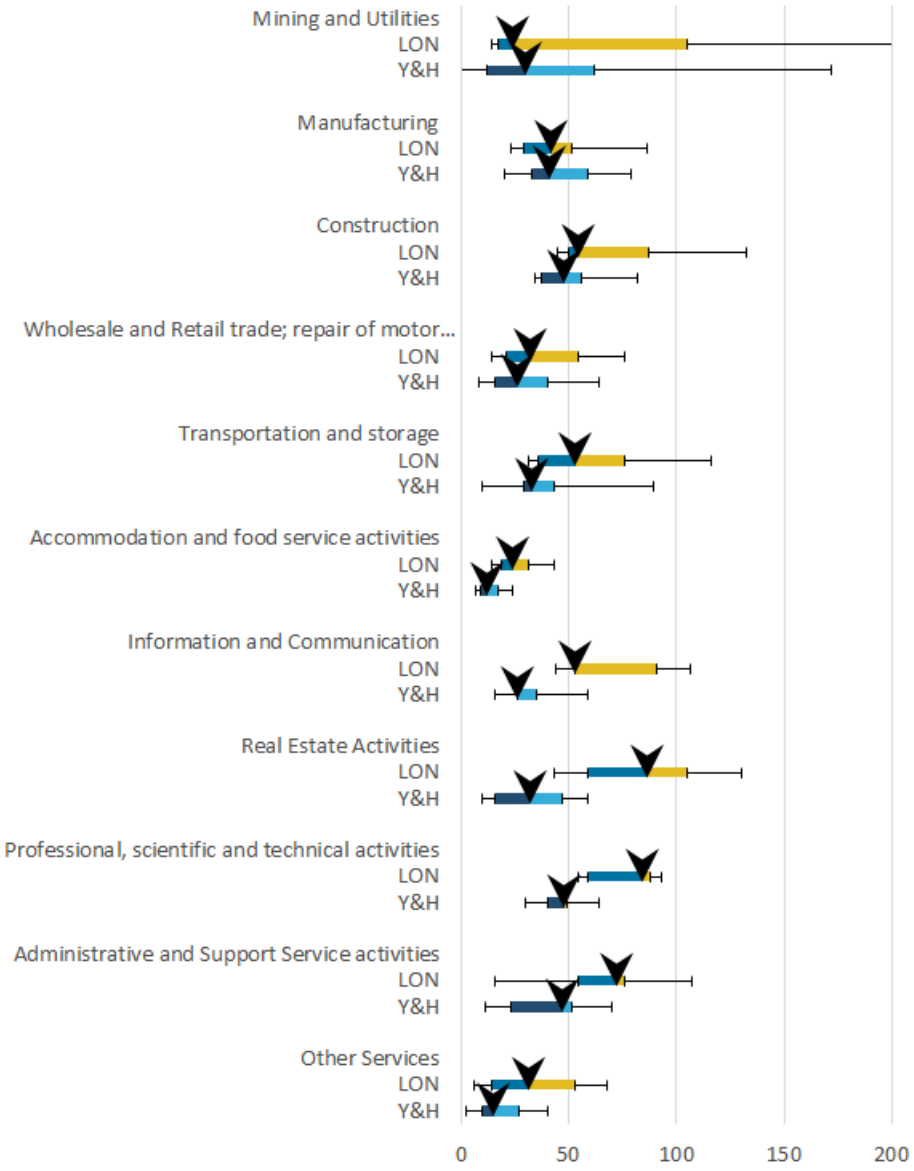
1. Production industries include Agriculture, Forestry and Fishing, Mining and Quarrying, Electricity, Gas, Steam and Air Conditioning Supply and Water Supply; Sewerage, Waste Management and Remediation Activities.

However, in Figure 5 (from ONS, 2017 a) we see that productivity levels within the same industries can differ substantially between different areas. It shows firm-level distributions in selected industries comparing London, and Yorkshire and The Humber regions. It shows the median level of GVA per worker (the arrow) and the inter-quartile range (the bars) and the 10th and 90th deciles (the lines).

It can be seen that median firm-level GVA per worker is higher in almost all industries in London compared with the firm-level GVA per worker in the same industries in Yorkshire and The Humber region.

Figure 5: Labour productivity levels within the same industries can differ substantially between different regions

Firm level productivity distributions by Industry, London and Yorkshire and the Humber, 2014



Source: Office for National Statistics –Annual Business Survey (ABS) 2014, Business Register and Employment Survey (BRES), Inter-Departmental Business Register (IDBR)

So, what explains the difference in average productivity levels between London, and Yorkshire and The Humber? Is it that London has a higher share of output occurring in high-productivity industries? Or, within any particular industry do firms located in London generally have higher average productivity levels than firms located in Yorkshire and The Humber?

Using a statistical decomposition technique, we have shown that, with occasional exceptions, industry mix appears to only play a relatively small role in explaining average productivity differences between different areas (as measured at the NUTS1 and NUTS2 geographical level). Instead, it is the differences between average firms' productivity within industries that has the most significant effect on aggregate regional or subregional productivity differences; for example, firms in London have higher average levels of productivity in most industry sectors when compared with other regions and it is these differences that are the larger factor in its higher overall labour productivity. This result holds even within narrowly-defined industry sectors[2] with firm-level productivity highly varied within each sector and between the regions.

The example of London compared with Yorkshire and The Humber in Figure 5 is also illustrative of similar differences between London and most other regions of the UK. As such, the average productivity gaps between regions within sectors are particularly high in some of the service sectors such as professional, scientific and technical activities, real estate activities, and information and communication in which London significantly outperforms other regions. It is these differences between London and other regions, in firm-level productivities within individual service sectors, that are responsible for much of the UK's regional productivity gap.

Distributions of firm-level productivity

Figure 5 also shows that within specific industries in the same region there is large variation in productivity levels as shown by the differences between the deciles. The widest spread is observed for the production and utilities industries while accommodation and food services – a service industry with relatively low labour productivity – has the narrowest range among the industries. This result leads us onto the next set of results, which explore the distributions of productivity across all firms in each region.

Figure 6 (from ONS, 2018 b) shows that in every region there are local plants with very low and very high-productivity performance. The skewed distributions illustrate that there are more plants in all the regions with productivity clustered at lower levels and few with productivity clustered at higher levels. It is important to note that no single region has a large cluster of high (or low) productivity firms. Instead, each region has a mix of both high and low-productivity local plants, with average productivity in an area explained by firms across the whole distribution and not just by the low-productivity and high-productivity tails.

Figure 6: Each region and country in Great Britain has a mix of both high- and low-productivity local plants

Distribution of firm level productivity (GVA per worker), GB regions and countries, 2015

Further analysis (see ONS, 2018 b) has shown that both-high-and low-productivity plants can be found in all industries, however, throughout Great Britain, plants in production, manufacturing and knowledge-intensive services industries such as business and professional services are more likely to fall in the group of most productive plants. On the other hand, firms in less knowledge-intensive services industries and sectors such as accommodation and food service activities, wholesale and retail trade, and health and social care are more likely to fall in the group of least productive organisations.

The main conclusion of this analysis is that aggregate average productivity differentials between regions is largely explained by the different average levels of productivity within individual industries and not by different industry structures. The different distribution in Figure 6 for London and the South East (with more plants at the top tail of the distribution compared with other regions and countries, and fewer plants with lower productivity) reflects its higher productivity levels across a range of different industries (as shown in Figures 5 and 7).

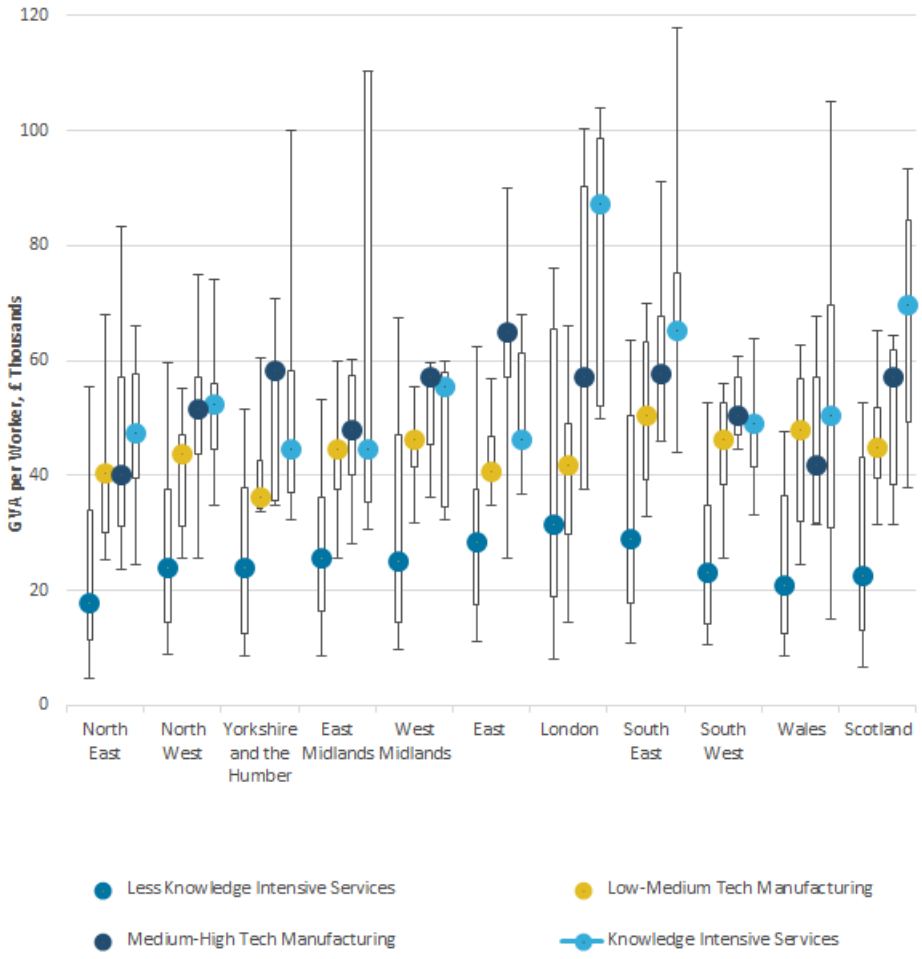
Knowledge intensity and technological intensity

The analysis discussed in this section on industry and firm-level productivity (shown in Figure 5) was repeated using 2015 data (ONS, 2018 b) except for one difference. Instead of analysing industries by their standard industrial classification, the industries were characterised by either their level of knowledge intensity (for services) or technological intensity (for manufacturing) to provide an alternative way of considering the data. The results confirmed the conclusions shown previously.

For example, Figure 7 shows that across all regions average productivity levels are highest in knowledge-intensive services and medium and high-tech manufacturing sectors, and lowest in less knowledge-intensive services. Furthermore, London's high-productivity performance can be explained by its firms in both high knowledge- and less knowledge-intensive services having higher productivity than the services firms in other regions and countries of the UK.

Figure 7: Local plants in London have higher median levels of productivity in most industry sectors when compared with other regions

Distribution of local plant productivity (GVA per worker) by industry groups, GB regions and countries, 2015



Source: Office for National Statistics

Overall, the main conclusions from this section is that firm-level productivity is important to understanding aggregate productivity differences between different areas. The analysis of the non-financial business economy suggests that with occasional exceptions, a region's industry structure appears to only play a relatively small role in productivity differences between regions. Instead, it is the differences between average firms' productivity within industries (as shown in Figures 5 and 7) that has the most significant effect on aggregate regional productivity differences; for example, firms in London have higher median levels of productivity in most industry sectors when compared with other regions and it is these differences that are the larger factor in its higher overall labour productivity.

Furthermore, in explaining the difference between London and the South East of England to many other areas of the UK it is the large productivity difference within service sector firms that is the main source of the productivity gap.

Notes for: Why are some areas more productive than others?

1. The ABS does not include the finance or agriculture sectors and also excludes the public sector.

2. Even within a narrow industry sector (we have used 85 two-digit industry groupings for the industry composition index) the groupings could still cover a range of slightly different types of firms. More broadly, the results are likely to reflect the fact that even within a particular industry sector, there can be differences in the types of outputs and the skills of workers involved that may explain productivity differences. For example, a multinational law firm in London may have different specialisation (hence different labour productivity levels) to a small local law firm elsewhere but both will have the same two-digit industry grouping.

6 . Why do some firms outperform others within the same industry?

Section 2 highlighted the importance of different firm-level productivities across the country in explaining the differences in overall regional and subregional average productivity levels. This section, therefore, explores the factors that can influence the productivity of a firm, including those factors that are related to a firm's location. Understanding these factors can help local policymakers consider the productivity performance of their local firms. It also provides evidence that helps to identify the factors that influence the regional productivity differences identified in Section 1.

This section begins by identifying a range of internal and external factors that can impact the productivity of a firm. It then explores the evidence, from the Office for National Statistics (ONS) and other researchers, on a range of internal factors and their relationship with productivity followed by some information on relevant external factors. Next, we consider the results of regression analyses, which allows us to consider the relationship between productivity and all the factors simultaneously and investigate the impact of each factor when all the other factors are held constant. Then finally, we conclude by linking the results of this section back to Sections 1 and 2 of this article to summarise the main messages from the article.

Internal and external factors associated with firm productivity

An extensive amount of literature exists on the determinants of firm productivity. During the last three years, ONS has also undertaken a considerable amount of research in this area. This section highlights the main findings from this research and presents a summary of the main findings from our recent productivity work using firm-level microdata from the Annual Business Survey.

The academic research provides two broad sets of factors (internal factors and external factors) to explain productivity at the level of the firm (for example, for a detailed review see Syverson (2011)).

Internal factors are factors directly related to the operation of the business within the local plant or the enterprise. These include firm size, age, production technology, capital intensity, research and development, innovation, investment, trade and input quality such as higher-quality labour and capital, ownership and managerial capability. Management or other employees in a firm can potentially use these factors to impact the productivity of their businesses.

External factors are factors in relation to the location of a business. They can influence the productivity either directly or indirectly through their effect on the internal factors. They can be split into demand and supply side factors (for a detailed theoretical discussion of the external factors see Webber and Horsewell, 2009).

The external supply side factors include distance, accessibility to transport, local supply chains, local input and factor markets, infrastructure, productivity spillovers (that is, agglomeration[1]), local business support, the degree of competition between firms and the extent of firm market power. Amenities in a location such as natural, commercial and/or cultural attractions may also help attract and retain a more productive workforce, which may influence the firm productivity in the area either directly or through innovation, entrepreneurial or organisational practices.

The external demand side[2] factors include product substitutability and complementarity, consumer tastes and preferences, and consumer spending power (includes commuters and visitors to the area). These factors can influence a firm's productivity directly or indirectly through different mechanisms such as their effect on its input costs and/or on product prices (both own and competitors') or through barriers to entry into the local markets.

Overall, the internal factors are important for understanding average productivity performance of the firms in the UK and in considering policies that may help firms, irrespective of location, to improve their productivity performance. However, when it comes to understanding spatial productivity differences, the external factors can be particularly important. Each firm location can have its own local demand and supply conditions, which can affect its productivity performance differently.

Evidence on internal factors

This section presents a summary of main findings from our research using firm-level microdata from the Annual Business Survey (ABS). The research was published in a number of articles, which explored a variety of firm characteristics and their association with productivity. We also present additional analysis for this article. The internal factors examined include firm size, firm age, firm ownership, foreign direct investment, trade, and workforce skills and the analysis shows that a number of factors have an influence on a firm's productivity level including whether a firm trades internationally, its management practices, and its ownership.

Firm size and productivity

Firm-level labour productivity measures from the Annual Business Survey, Great Britain: 2017 (ONS 2019b) , labour productivity measures from the Annual Business Survey: 2006 to 2015 (ONS, 2017 c) and Understanding firms in the bottom 10% of the labour productivity distribution in Great Britain: "the laggards", 2003 to 2015 (ONS, 2017 d) found that in general, larger firms (by employment size) have higher productivity levels on average compared with smaller firms. These analyses were undertaken at the level of the reporting unit (RU) of a firm.

By contrast, analysis at the local plant level (ONS, 2018 b) used the size (by employment) of the enterprise to which the local plants were attached to. It found that in all the Great Britain regions and countries, the median gross value added (GVA) per worker in micro-plants (one to nine persons employment) was slightly higher than in local plants of small and medium firms.

It also showed that the top tail of the distribution of the local plants, which are part of the largest firms (250 or more employees), is very long, suggesting on average there are productivity advantages of large firms. The latter finding is consistent with the RU-level analysis and expectations that the large businesses may have more scope to benefit from specialisation of functions and economies of scope and scale.

However, because of the very wide spread of productivity levels of local plants belonging to largest firms, they also have a relatively high representation at the bottom 20% of the productivity distribution in all the Great Britain regions and countries. One reason for this is that some of the multi-plant large firms in the UK operate in the relatively low-productivity service sectors such as retail. Another reason for this could be that very large firms may also suffer from diseconomies of scale when they become too large. It could also be that plants belonging to the same firm have diverse characteristics and productivity. More research is needed to investigate this finding further.

Local plant-level analysis has also shown that firms of all sizes are distributed across the full productivity spectrum in all the regions and countries of Great Britain suggesting that there is no clear relationship between the firm size and regional average aggregate productivity disparities.

Firm age and productivity

The literature (for example, see Brouwer and others, 2005) suggests that productivity levels of new firms tend to be below average as they are in the early phase of their lives, during which start-up and experimentation costs can exceed the value generated by sales. New firms can also face steep competition from incumbents, who gain advantage through greater market experience, learning by doing, their relative capital intensity and economies of scale, making high-productivity outcomes for young firms difficult. However, the productivity of surviving young firms tend to be above average. For older, established firms, the relationship between age and productivity becomes less clear.

ONS (2017 d) analysis at the RU level found that prior to the economic downturn, around half of the least productive businesses were no more than five years old and between two-thirds and three-quarters of these businesses were no older than 10 years. This may partly reflect the fact that a majority of these firms are also micro-firms (one to nine persons employment).

These trends have changed to some extent over time with the “laggard” group becoming slightly older (and slightly larger in size). This may partly reflect the fact that the share of the micro-firms in the least productive group has been falling. The share of the older firms – which are mostly larger – in the least productive firms is higher than their share in the business population in 2015, suggesting that they may have reserves to draw on even when they become relatively unproductive.

Analysis at the local plant level (ONS, 2018 b) shows that in 2015, median GVA per worker in local plants that are associated with younger enterprises is generally higher than in local plants that are associated with older firms. However, the long top tail in the distributions of the local plants which are attached to older enterprises, particularly those aged 21 years or older, makes the average GVA per worker higher in those groups. The relatively high median productivity level of the local plants that are associated with young firms (shown in Figure 10 in ONS, 2018 b) can be partly explained by their heavier representation in the knowledge-intensive sectors than their distribution in the non-financial business economy as a whole.

Local plant-level analysis has also shown that firms of all ages are distributed across the full productivity spectrum in all the regions and countries of Great Britain, suggesting that there is no clear relationship between the firm age and average aggregate productivity differences for the spatial scale investigated in the article.

Foreign ownership and productivity

Recent work by the Bank of England, ONS (2018 d) and other studies (for example, see Griffith and others (2004)) have shown that foreign-owned companies are more productive than domestically-owned firms and that their presence boosts domestic labour productivity. Among the reasons are: foreign-owned companies invest more in research and development, they are better-managed and they collaborate with other organisations and promote the diffusion of ideas.

Figure 8 displays the distribution of local plants by their productivity (GVA per worker) in Great Britain by type of ownership (ownership of the parent company). It shows that local plants belonging to foreign-owned firms tend to have a higher GVA per worker than local plants belonging to domestically-owned firms (shown by the right shift and the shape of the distribution). Our analysis shows a similar pattern for all the regions and countries of Great Britain.

Further analysis suggests that foreign firms tend to be large and to be exporters and have higher average management scores (see next section). All of these characteristics are associated with higher productivity levels.

Figure 8: Local plants belonging to foreign owned firms tend to have a higher gross value added per worker than local plants belonging to domestically-owned firms

Distribution of firm-level (local plant) productivity (gross value added (GVA) per worker) for the non-financial business economy by country of ownership, Great Britain, 2015

Further analysis shows that local plants belonging to foreign-owned enterprises are distributed relatively evenly across Great Britain regions and countries, suggesting that there is no clear link between the average productivity of a region and the firm mix in terms of ownership.

Foreign direct investment and productivity

There is a wide range of academic literature investigating the link between foreign direct investment (FDI) and productivity. Firms that attract flows of investment from overseas corporations (inwards investment) are widely thought to benefit from increased investment, access to technology and expertise, as well as stronger management and organisational practices, while firms that undertake investment overseas (outwards investment) are thought to benefit from access to larger markets.

A considerable proportion of the literature is also devoted to identifying the indirect impact of FDI flows on domestic firms. The literature proposes that new FDI in an industry can have an impact on domestic firms in the same industry (horizontal spillovers) or on firms in the supply chain (vertical spillovers), through a wide range of transmission mechanisms. Flows of FDI are consequently thought to have considerable potential to affect firm-level productivity.

ONS (2017e) provides some facts about the nature of UK firms that are involved in FDI and their productivity, building on previous ONS research in this area. One of the main conclusions of this research is that keeping size, industry, time and region constant, firms with inward FDI were 74% more productive than non-FDI firms and, taking other directions of FDI flows into account, there were higher productivity outcomes among firms with outward than inward FDI, with the highest productivity outcomes among firms with both inward and outward FDI flows.

International trade (exporting) and productivity

There are broadly two theories that link exporting behaviour to productivity:

- direct link: exporting has a positive impact on productivity
- self-selection: most efficient (productive) firms export while the least productive firms only operate in domestic market.

Several studies (for example, Wagner (2007) and NBB (2008)) using microdata conclude that the self-selection of relatively efficient plants into the export market is the dominant source of the productivity differences between exporters and non-exporters and there is little evidence of significant (causal) impacts of exports on productivity.

In other words, it is not simply the case that any firm can simply become an exporter to increase its productivity. Rather, it is more likely that the more efficient, productive firms who are typically able to move into the export market thus leading to the productivity differences observed between exporting and non-exporting firms. Meanwhile, less-productive firms are more likely to remain only operating in the domestic market.

ONS (2018 d) analysis suggests that the productivity of UK businesses that declare international trade in goods was around 70% higher on average than for businesses that did not in 2016. After controlling for their size, industry and foreign ownership status, businesses that declare goods exports and imports have labour productivity premia relative to non-traders of around 21% and 20% respectively.

The analysis also found that the labour productivity premia associated with EU trade (4.3% and 1.7% for EU exports and imports respectively) are notably smaller than those associated with non-EU trade (19% and 18% for exports and imports respectively). These results may reflect differences in reporting thresholds, but are consistent with lower barriers to EU goods trade enabling relatively less productive businesses to access these markets, while only a considerable productivity advantage enables access to wider markets with varying goods trade regulations.

Figure 9 displays the distribution of GVA per worker of the local plants in Great Britain by their export status of their parent firm[3]. It shows that local plants belonging to firms that export have a higher GVA per worker than firms who operate in domestic markets only (shown by the right shift and the shape of the distribution). Our analysis shows a similar pattern for all regions and countries of Great Britain. However, this partly reflects the fact that exporting firms in the non-financial business economy are mainly in production, information and communication, and manufacturing industries, which typically have relatively high-productivity levels.

Figure 9: Local plants belonging to firms that export have a higher gross value added per worker than firms who operate in domestic markets only

Distribution of firm-level (local plant) productivity (gross value added (GVA) per worker) for the non-financial business economy by export status, Great Britain, 2015

Further analysis showed that local plants belonging to exporting enterprises are distributed relatively evenly across Great Britain regions and countries, suggesting that there is no clear link between the average productivity of a region and the firm mix in terms of its exporting status.

Skills and productivity

The skills of the workforce can influence productivity of a firm either directly or indirectly through innovation, entrepreneurial or organisational practices, however, skills are hard to measure because of their intangible nature [4]. As a result, several proxy measures have been used in the literature such as formal qualifications and workplace training.

The literature exploring the direct link between skills (mainly qualifications and training) and productivity suggests that overall increases in skills or higher levels of skills are associated with greater area productivity (see Gambin and others, 2009 for a literature review) and in a regional context the industry productivity differences between UK regions (as shown in Section 5 on the sources of productivity differences) may partly result from skills and occupational composition of employment in the regions (Dickerson, 2006).

Note that similar to the self-selection issue mentioned in the exporting and productivity section, a relatively high-productivity region is able to attract highly-skilled workers form other regions (as well as internationally) better than other areas with relatively low-productivity levels. Empirical evidence (for example, see Clarke, 2017, and Wandsworth, 1990) shows that skilled workers have a greater geographical mobility (both nationally and internationally) than less-skilled workers. Similarly, more businesses may start up in more productive regions rather than the high-productivity of a region being caused by greater levels of entrepreneurial activity (Gambin and others, 2009).

Currently we do not have a matched employee-employer dataset to explore the relationship between skills and productivity at the firm level, however, new research by ONS (2017 f, 2018 e) explored the relationship between management practices and firm level (at the reporting unit (RU level)) productivity.

Research (for example, see Bender and others, 2016) suggests that management and leadership skills are one of the main determinants of organisational performance. Management skills can affect productivity of a firm through constructing and implementing market strategy, managing technical and organisational change, and effectively utilising workforce skills.

The results from ONS's management practices and productivity analysis found that there is a statistically significant correlation between management practices and labour productivity, with an increase in management score of 0.1 associated with a 9.6% increase in productivity. The analyses also showed that there was a higher prevalence of structured management practices among services industries than production industries, among larger firms than smaller firms, among foreign-owned firms than domestically-owned firms, and among non-family-owned businesses than family-owned businesses. These findings are broadly consistent with the wider literature.

Related to the issue of management is the fact that neoclassical economic theory assumes that the principal objective of a firm is profit maximisation. Although profit maximisation and productivity are distinct concepts there is a close relationship between them. For example, using fewer resources to achieve the same output will increase both profit and productivity. However, according to behavioural theories of the firm they can also have a wide range of objectives other than profit maximising only. These include:

1. Sales maximisation
2. Increased market share and market dominance
3. Social and environmental concerns
4. Breaking into a new market or sector
5. Making sufficient profit in the long run

For example, Webber and others (2012) found that "an area's low-productivity value might reflect resident managers' motivations towards money and the presence of local opportunities to achieve economies of scale". They added that "reorienting managers' objectives towards enhancing their productivity values may actually reduce standards of living" in the area, which has a high standard of living measured in terms of well-being and life expectancy.

Meanwhile, it is also worth noting that theoretically, firms choose locations where they can maximise profits and can change location when the location is no longer optimal for the operation of the business. However, relocation is costly especially when it involves larger investments in buildings and equipment. Therefore, firms may stay in sub-optimal locations until they approach the local margins of profitability (for example, see van Dijk and Pellenbarg, 2000).

These issues link into a firm's association with its location and this is the subject of the following 'external factors' section.

Evidence on external factors

External factors, related to a firm's location, can be particularly important in understanding spatial productivity differences. Each spatial unit where the firm is located can have its own local demand and supply conditions, which can affect the performance of firms differently.

For example, firms in London have access to deep factor markets (such as a large labour market within commuting distance), the benefits of agglomeration (via spillovers of knowledge), specific consumer tastes associated with its residents and visitors, and probably high firm-level competition and high consumer spending power. By contrast, the mix of these factors in a sparse rural area of the UK is very different.

The external supply side factors include distance, accessibility to transport, local supply chains, local input and factor markets, infrastructure, productivity spillovers (that is, agglomeration), local business support, the degree of competition between firms and the extent of firm market power. Amenities in a location such as natural, commercial and/or cultural attractions may also help attract and retain a more productive workforce, which may influence the firm productivity in the area either directly or through innovation, entrepreneurial or organisational practices.

The external demand side factors include product substitutability and complementarity, consumer tastes and preferences, and consumer spending power (includes commuters and visitors to the area).

To date we have not explicitly explored the association between these external factors and firm productivity within ONS publications and it is something we would like to explore further in future work. Further understanding how location issues such as transport infrastructure, local labour markets, local amenities and local expenditure impacts on firm-level productivities is important to understanding the spatial productivity differences that exist across the UK.

For the moment, however, we do have a range of high-level results from our Exploring labour productivity in rural and urban areas in Great Britain: 2014 (ONS, 2017 b) publication that explored aggregate firm-level productivities of rural and urban[5] areas in Great Britain along with other geographical classifications (built-up areas and Classification of Workplace Zones). Given different types of locations will be characterised by their own different types of local supply and demand conditions, then these high-level results can provide some insights into typical relationships between types of location and productivity on the average. These add to the results already shown in Section 1 of this article, which highlighted the high-productivity levels displayed in London and other areas of South East England relative to most other areas of the country.

The rural-urban article (ONS 2017 b) found that in England and Wales, the overall average GVA per worker of the business economy in 2014 for urban areas (excluding London) was 5 percentage points higher than for rural areas. This gap was larger in the south of England than in the north and Midlands.

In some regions, such as the North West of England, average GVA per worker in rural areas was found to be higher than in urban areas. As shown in Figure 10 among the rural and urban areas aggregate average labour productivity was lowest in sparse areas (which are mostly rural areas). These are areas surrounded by areas of low population density.

For Scotland, the average productivity gap between rural and urban areas was 17 percentage points. Average GVA per worker was lowest in very remote rural areas and very remote small towns, while large urban areas generated the highest GVA per worker in 2014. Among the rural areas in Scotland, there was a 30 percentage points' difference in productivity levels between accessible rural and very remote rural areas.

Figure 10: Among the rural and urban areas aggregate average labour productivity is lower in sparse areas (which are mostly rural areas) than in non-sparse areas

Distribution of firm level productivity (GVA per worker) for the non-financial business economy, cities and towns and villages, England and Wales, 2014

As was the case with UK regions, decomposition analysis illustrated that in most cases firm-level productivity differences (that is, different average productivity levels in each industry) were more important than industry composition in explaining productivity differences across the rural-urban categorisation. However, in contrast to regions (discussed previously) industry structure was also found to play a role in the relatively low levels of productivity in the sparse areas. For example, there is a high concentration (in terms of employment) of relatively low-productivity industries such as agriculture, forestry and fishing, and accommodation and food services industries in sparse (particularly rural) areas.

This article also explored whether there is a relationship between the size or population density of the urban areas and their overall productivity levels in England and Wales. In the south of England, labour productivity differed by the size of the urban area, with large and medium-sized urban areas having a higher level of productivity than small urban areas. By contrast, for the north and Midlands of England, there was no correlation between the size of urban area and average labour productivity. The higher productivity of the medium and large urban areas in the south is an important source of the higher productivity levels that exist in the south of England compared with the north and Midlands.

Finally, the article also explored the relationship between the Classification of Workplace Zones [6] and labour productivity. It found that workplaces classified into the "Top jobs" Supergroup category generate the highest GVA per worker in England and Wales in both rural and urban settings. These are jobs for a highly-qualified workforce, usually found in city centres and other commuting areas such as science parks. Within this group, firms located in areas that are classified as "global business", "science and business parks" and "regional business centres" generated the highest levels of GVA per worker in 2014.

"Manufacturing and distribution" is the second Supergroup with the highest labour productivity. All its groups also have above average GVA per worker, with "Business parks" being the most productive of all. These business parks are scattered across the country, but usually clustered in, or near to, urban areas and generally close to major transportation corridors (that is, in non-sparse rural and urban areas). Firms located in these Supergroup zones performed better in terms of GVA per worker in the rural areas than their counterparts in urban areas (excluding London) in 2014.

GVA per worker was lower than the national average for most of the other groups. Among these groups, the "Retail" Supergroup generally has the lowest GVA per worker in England and Wales. However, there was no clear pattern to this group's productivity levels between rural and urban (excluding London) areas.

Identifying factors associated with spatial productivity differences using regression analysis

The previous analysis (particularly on internal factors) considered firm characteristics one at a time to explore their relationship with productivity. This creates a partial picture as firms have multiple characteristics (including location) that can impact on their productivity. A regression analysis allows us to investigate the impact of each characteristic when all other characteristics are held constant. Unfortunately, the ability to carry out an all-encompassing multivariate regression to identify the determinants of spatial productivity differences is hampered by the lack of a complete set of suitable data. The ideal analysis requires data on all of the various potential factors correlated with productivity to be available [7].

However, there are some important factors associated with firm productivity, such as capital stock or research and development expenditure, where there are not adequate local plant and/or location-level data available and other factors such as ability or motivation of workers, which are difficult to capture with data more generally. Therefore, multi-variate results have to be considered with these limitations in mind. Despite these data limitations, efforts have been made to carry out multi-variate analysis including a range of both internal factors and location factors. For example, some published regression analysis carried out by ONS (ONS 2017 d, ONS 2018 e) using reporting unit data and an additional investigatory analysis for this article using local plant data showed a number of statistically significant variables from a regression analysis. The results suggest that, after holding other firm characteristics equal (including location), both foreign ownership and exporting are significantly and positively related with firm-level labour productivity. For example, some published regression analysis carried out by the ONS (ONS 2017 d, ONS 2018 e, ONS 2019 b) using reporting unit data and an additional investigatory analysis for this article using local plant data showed a number of statistically significant variables from a regression analysis.

Meanwhile, in terms of location, the regression results showed that after holding other firm characteristics constant, plants located in London and Scotland had on average higher productivity levels than plants located in the North West (control variable) while there were no statistically significant productivity differences between plants located in the North West and in the other English regions and Wales.

Alternatively, using the Rural Urban Classification as the location variable identified plants located in London and in large urban areas in Scotland having higher productivity and plants located in very remote small towns in Scotland having lower productivity levels on average than plants located in non-sparse cities and towns in England and Wales (control variable).

Notes for: Why do some firms outperform others within the same industry?

1. There is a large body of research called New Economic Geography (NEG), which attempts to explain the formation of a large variety of economic agglomeration (or concentration) in geographical space (for example, see Fujita and Krugman, 2004). The NEG also explains how historical accident can shape economic geography, and how gradual changes in underlying parameters can produce discontinuous change in spatial structure.

Agglomeration economies or external economies of scale refer to the benefits from concentrating economic activity in particular areas. External economies of scale result from an increase in the productivity of an entire industry, region, or economy due to factors outside of an individual company. There are two types of external economies of scale or agglomeration economies; localisation and urbanisation economies.

Localisation economies – if an area specialises in the production of a certain type of good, all firms can benefit from various factors such as good supple networks, supply of trained workers, infrastructure built specifically for the industry and good transport links.

Urbanisation economies – the size of the city is associated with productivity. Firms located in large cities benefit from the common resources and large labour pool found in the city. Common resources such as roads, buildings and power supply benefit firms in cities regardless of their industry. The urban environment creates positive externalities that benefit several different industries.

1. Productivity is a supply side concept, defined as a parameter in a production function. So while productivity will depend on demand side factors, the effects are indirect/second order.

2. Since the 2007 reference year, the ABS has included two questions that ask businesses to provide the value of services exports and imports in the last calendar year. For the 2011 reference year two further questions were added to the ABS to determine which businesses exported or imported goods. The questions refer to international trade and are asked at the RU level. For this analysis we created an “export” dummy variable, which took a vale of one if the local plant of the firm (RU) exported either goods or services or both.

3. For example, cognitive skills, such as problem-solving, and non-cognitive or “soft” skills, such as motivation, interpersonal relationships, can be relevant in many jobs. The measurement of non-cognitive skills, and the complementarities between different types of skills are relatively challenging areas of research, particularly at the regional and/or firm level.

4. In the case of rural -urban, type of location can be considered as a proxy for some of the external factors such as distance or population density, which are thought to be associated with firm productivity.

5. This is a geo-demographic classification based on the characteristics of workers such as employed or self-employed, hours worked and highest level of qualification, and their workplaces such as industry, as recorded in the 2011 Census. The workplace zone population includes workers that both live and work in the workplace zone and workers that in-commute from another location. Based on similar responses to a set of domains, workplace zones are categorised into a two-tiered hierarchical classification of seven Supergroups and 29 Groups. For more detail of the classifications see ONS. Further information and downloadable files on the Classification or Workplace Zones for England and Wales (COWZ – EW) can be accessed from the University of Southampton website.

6. In an ideal world, a regression model should include all the relevant variables that are associated with the outcome (that is, variable being analysed such productivity). In reality, however, we either cannot observe all the potential factors affecting productivity (such as the intangible skills of the employees) or are limited by whatever information is collected in the survey data used in the regression analysis. If a relevant factor is not included in the model, this may result in the effects of the variables that have been included being mis-estimated. When the omitted variables are correlated with the included variables in the model, the coefficient estimates of those variables will be biased and inconsistent. However, the estimated coefficients are less affected by omitted variables when these are not correlated with the included variables (that is, the estimates will be unbiased and consistent). In the latter case, the only problem will be an increase in the estimated standard deviations of the coefficients, which are likely to give misleading conclusions about the statistical significance of the estimated parameters.

7 . Discussion

Section 1 of the article highlighted the existing labour productivity differences between areas of the UK. While many areas have relatively similar productivity levels, labour productivity is higher around London and the South East of England, and lower in more isolated rural areas.

In Section 2 of the article we asked the question as to whether the differences can just be explained by industrial structure? We concluded that typically this is not the case. Even within single industries we can observe large differences in average productivity levels between different parts of the country, particularly in service industries.

Section 3, therefore, investigated in more detail the factors that are associated with firm-level productivity. In particular it focused on examining and contrasting factors that are internal to firms with those that are external and associated with location. While obtaining conclusive evidence is difficult, the available evidence suggests that while there are some important internal factors influencing firm-level productivities (such the ownership of a firm and whether it exports), it is also the case that to understand the larger geographical or spatial differences, for example, between London and other areas of the UK, focus also has to be placed on external (location) factors.

Such a focus on external factors recognises that each firm operates in its own locale with, for example, a specific mix of local factor markets, agglomeration benefits, firm competition, consumer tastes and local spending power and these factors can affect firm-level productivities and ultimately average productivity in an area.

In terms of policymaking for local areas, therefore, it is worth being aware that both internal and external (location) factors can affect firm-level productivity. The ability to influence the location factors can be relatively constrained (for example one cannot hope to recreate both the deep labour market and consumer spending power of London in a rural area of the country). However, there may be more local improvements that can be made to influence the external factors locally such as improving transport accessibility, IT infrastructure or improving local skills[1]. Meanwhile, all areas of the country can benefit from policies that aim to improve the internal factors that influence firm-level productivity.

Further work

This article presented a summary of the factors that can have a significant association with firm-level productivity based on our existing data. Looking ahead, we aim to continue further work in this area to increase our understanding of the observed spatial labour productivity differences in the UK. In particular we would like to investigate in more detail the external (location-based) factors that influence spatial productivity differences.

Notes for: Discussion

1. Improving skills locally may not necessarily improve the skills of the local workforce as highly skilled workers have a greater geographical mobility than less skilled workers.

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