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Where to get the best bang for the buck in the United Kingdom? Industrial strategy, investment and lagging regions

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WHERE TO GET THE BEST BANG FOR THE BUCK IN THE UNITED KINGDOM? INDUSTRIAL STRATEGY, INVESTMENT AND LAGGING REGIONS

ECONOMIC DEPARTMENT WORKING PAPERS No. 1426

By Rafal Kierzenkowski, Peter Gal and Gabor Fulop

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ABSTRACT/RÉSUMÉ

Where to get the best bang for the buck in the United Kingdom? Industrial strategy, investment and lagging regions

The United Kingdom is preparing a modern industrial strategy to boost labour productivity across the whole country and to narrow regional gaps in living standards. This raises the question of the optimal allocation of scarce resources in meeting these targets. This study identifies industrial strengths of each region and scope to boost regional productivity through the channel of higher capital intensity. Overall regional investment ratios appear weakly linked to regional productivity, but the sectoral composition of regions and their type of investment are more important determinants. Each region has productivity leaders, but the concentration of such firms is the highest in the south of England. Differences in the representation of the most productive firms in regions are strongly related to differences in regional productivity. The empirical methodology quantifies the productivity effects of raising the capital intensity in each sector-region, focusing on viable firms falling behind the national productivity frontier in all but the finance and insurance sectors over 1995-2014. To enhance labour productivity of lagging regions, the industrial strategy should promote the catch up of firms with the national best performers in services sectors, in particular knowledge intensive services such as ICT and business services, but also wholesale and retail trade. This finding is consistent with the UK's leading global position in high value-added services sectors. The type of investment matters: boosting research and development in the manufacturing sector in some lagging regions would also be effective in stimulating productivity. Manufacturing investment cannot be a substitute to investment in services given the small size of the manufacturing sector and its high exposure to competition from rapidly emerging global hubs. However, this study does not quantify the effects of skills, the benefits of greater industrial diversification and the positive impact that larger cities would have on agglomeration effects.

This Working Paper relates to the *2017 OECD Economic Survey of the United Kingdom* (www.oecd.org/eco/surveys/economic-survey-united-kingdom.htm).
JEL classification: L52, O14, O18, O25.
Keywords: investment, capital intensity, regions, sectors, industry, firms, productivity, industrial policy, R&D, United Kingdom.

Où investir le plus judicieusement au Royaume-Uni? Stratégie industrielle, investissement et régions accusant un retard

Le Royaume-Uni est en train d'élaborer une stratégie industrielle moderne qui vise à stimuler la productivité du travail dans tout le pays ainsi qu'à réduire les écarts régionaux constatés dans les niveaux de vie. Ceci soulève la question, dans un contexte de ressources peu abondantes, de leur allocation optimale et qui permettrait d'atteindre ces objectifs. Dans la présente étude, on s'attache à identifier les points forts de chaque région ainsi que la possibilité d'améliorer la productivité régionale au moyen d'un accroissement de l'intensité capitalistique. Globalement, les ratios d'investissement semblent n'être que faiblement liés à la productivité régionale ; la composition sectorielle des régions et le type d'investissement qu'on y rencontre sont des déterminants plus importants. Ainsi, chaque région possède ses champions en matière de productivité, mais leur concentration est plus élevée dans le sud de l'Angleterre. Les différences d'implantation des entreprises les plus productives dans les régions sont fortement corrélées à des différences de productivité régionale. En utilisant une méthodologie empirique, il est possible de quantifier les effets, sur la productivité, d'une hausse de l'intensité capitalistique dans chaque secteur-région, en se concentrant sur les entreprises viables en dessous de la frontière nationale de la productivité dans tous les secteurs, à l'exception de la finance et des assurances, sur la période 1995 2014. Pour améliorer la productivité du travail dans les régions accusant un retard, la stratégie industrielle devrait avoir pour objectif que les entreprises concernées rattrapent celles qui affichent les performances les plus fortes dans les secteurs des services, en particulier les services à forte intensité de connaissances comme les TIC et les services aux entreprises, mais aussi dans le commerce de gros et de détail. Cette observation concorde avec la place de leader mondial qu'occupe le Royaume-Uni dans les services à forte valeur ajoutée. Le type d'investissement a une importance, et promouvoir la recherche développement du secteur manufacturier dans certaines régions à la traîne permettrait aussi de stimuler efficacement la productivité. Cela étant, l'investissement dans le secteur manufacturier ne peut pas se substituer à l'investissement dans les services, parce que la taille de ce secteur est trop modeste et parce qu'il est fortement exposé à la concurrence des plateformes mondiales qui sont en train d'émerger rapidement. Toutefois, la présente étude fait abstraction de l'impact des compétences, des avantages d'une plus grande diversification industrielle et de l'effet positif que de plus grandes villes auraient sur les effets d'agglomération.

Ce Document de travail se rapporte à l'*Étude économique de l'OCDE du Royaume Uni, 2017* (http://www.oecd.org/fr/economie/etude-economique-royaume-uni.htm)
Classification: L52, O14, O18, O25.
Mots clefs: Investissement, intensité de capital, régions, secteurs, industrie, entreprises, productivité', politique industrielle, recherche développement, Royaume-Uni

TABLE OF CONTENTS

Introduction 5
Background 5
Productivity and investment across UK regions, sectors and firms 5
Empirical assessment 11
Methodology and data 11
Estimation results 13
Conclusion 18
ANNEX 19
REFERENCES 23

Figures

1. Least productive regions tend to have comparatively higher investment ratios 6
2. Most productive regions are heavily specialized in knowledge intensive services 6
3. Productivity differences across regions tend to be largest for knowledge intensive services 7
4. Investment ratios vary significantly by sector and asset composition 7
5. Most regions fall behind London in terms of percentage of firms at the productivity frontier 8
6. Positive link between regional productivity and the percentage of frontier firms by region 8
7. Median distance from the productivity frontier is high across all sectors 9
8. Frontier firms in the top three sectors for each region in the mid-2010s 10
9. Frontier firms in the top three sectors for each region in the mid-1990s 11
10. Sector-region labour productivity impacts in services sectors 14
11. Sector-region productivity impacts in goods sectors 15
12. Regional labour productivity impacts 16
13. Sector-region labour productivity impacts of higher R&D capital intensity in the manufacturing sector 16
14. The United Kingdom has been losing ground as a manufacturing hub 17
15. The United Kingdom has preserved its position as a global hub in business and IT services 18
A1. Sectors with high and medium total investment ratios over time 19
A2. Sectors with low total investment ratios over time 20
A3. Sectors with high investment in intellectual property products over time 21

Tables

A1. Estimation results 22

WHERE TO GET THE BEST BANG FOR THE BUCK IN THE UNITED KINGDOM? INDUSTRIAL STRATEGY, INVESTMENT AND LAGGING REGIONS

Rafal Kierzenkowski, Peter Gal and Gabor Fulop[1]

Introduction

Background

1. **The UK government is elaborating a modern industrial strategy.** In January 2017, the authorities published a consultation report (green paper) with a view to develop an industrial strategy that would help to address long-term challenges facing the UK economy (HM Government, 2017). The key objective is to boost productivity and living standards across the whole country, by stimulating investment and skills. The aim of the industrial strategy is threefold, to: *i*) build on existing strengths and extend excellence into the future, notably in sectors such as automotive, aerospace, financial and professional services, and creative industries; *ii*) close the gap between the UK's most productive companies, industries, places and people and the rest; and *iii*) make the UK one of the most competitive places in the world to start or grow a business, develop new industries which could possibly displace existing ones, and not to protect the position of the biggest incumbent firms.

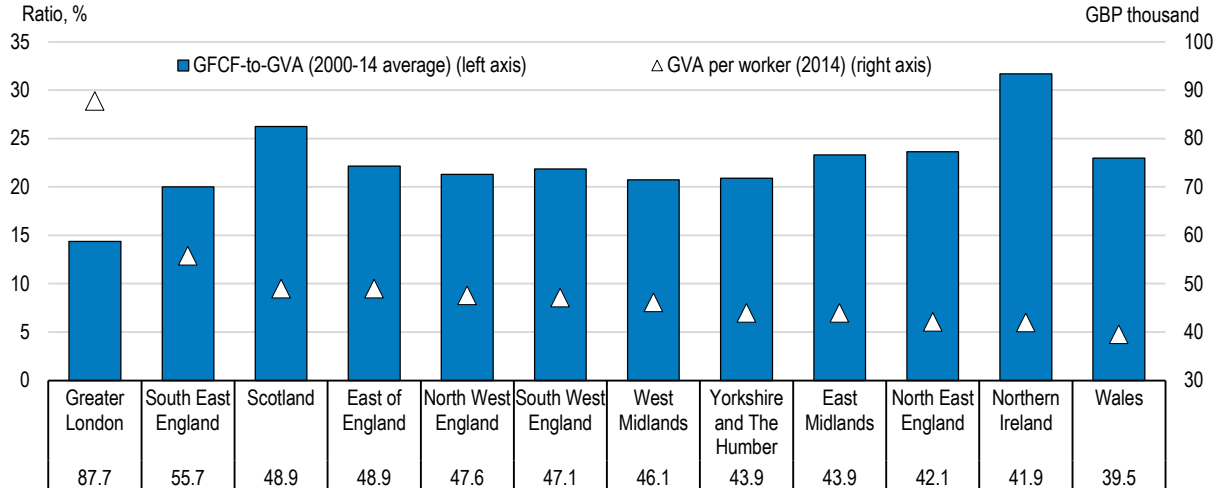
Productivity and investment across UK regions, sectors and firms

2. **Aggregate investment is weak, but its regional distribution does not explain regional differences in productivity.** The overall investment ratio was 17% of GDP in the United Kingdom in 2016, against around 21% of GDP in other G7 and OECD countries, which is consistent with subdued aggregate productivity since the global financial crisis. Yet, the least productive UK regions have had significantly higher investment ratios than the most productive regions over the last fifteen years (Figure 1). This suggests that the sectoral composition of regions and the type of investment that they undertake are stronger determinants of regional productivity. In particular, services activities have a lower capital intensity and are well developed in the most productive regions of Greater London and South East England, which contrasts with more capital-intensive manufacturing activities which are more prominent in all other less productive regions (Figures 2 and 3). Moreover, ensuring that the local workforce has relevant skills would help to make the most out of the existing capital stock and future investments. Further drivers of productivity, especially for small and medium-sized enterprises, are related to infrastructure, density of consumers, network of subcontractors and cluster effects – the so-called "ecosystem" where enterprises are located.

3. **Goods-producing sectors tend to invest more than services-providing sectors, and R&D intensity is particularly sector-specific.** Most goods sectors have investment ratios at or above 20% (except mining and utilities which are two highly capital-intensive sectors), nearly two times higher than the investment intensity of services sectors (Figure 4). The finance and insurance has the lowest investment ratio despite being the most productive of all sectors (Figure 3), but the lack of firm-level data does not allow considering the sector for the empirical analysis. Some sectors invest significantly into intellectual property products − software and R&D −, which include ICT, car and other high-tech manufacturing, and chemical sectors. Spending on R&D is essential not only to invent but also to adopt the latest technologies (Cohen and Levinthal, 1989). By contrast, the investment of transport and storage, construction, business services, and accommodation and food is mainly allocated into buildings. The sectoral investment intensity has been changing over time (Figures A1 to A3 in the Annex). For instance, since the global financial crisis the mining sector has invested heavily in buildings, the opposite of the business services sector.

1. The authors are respectively Senior Economist, Economist and Analyst in the Economics Department at the OECD. They would like to thank OECD Economics Department colleagues Dan Andrews, Pierre Beynet, Catherine L. Mann and Joaquim Oliveira Martins (OECD Centre for Entrepreneurship, SMEs, Local Development and Tourism) for useful comments and suggestions. Special thanks go to Elisabetta Pilati for editorial assistance (also from the Economics Department).

Figure 1. Least productive regions tend to have comparatively higher investment ratios[1]

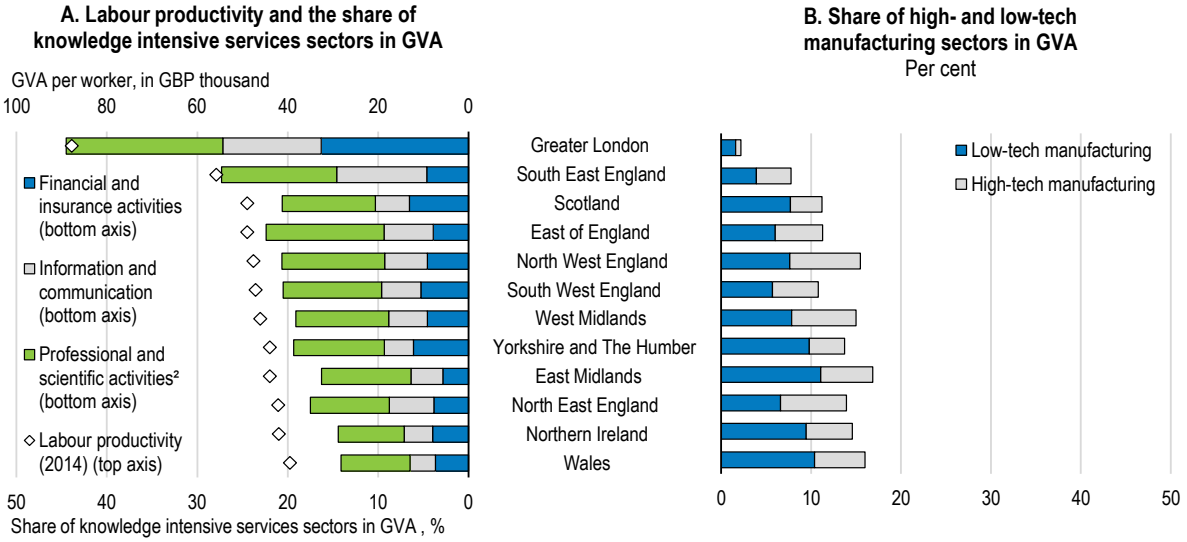


1. Current levels (in GBP thousand, current prices, 2014) of labour productivity are shown on the second line of the x-axis' label. Regions are ranked in descending order of the level of labour productivity.

Source: ONS (2017), "Regional Gross Fixed Capital Formation, 2000 to 2014", *User Requested Data*, Office for National Statistics, March; ONS (2016), "Regional gross value added (income approach), UK: 1997 to 2015", Office for National Statistics, December; and OECD (2017), "Regional Economy", *OECD Regional Statistics* (database), June.

Figure 2. Most productive regions are heavily specialized in knowledge intensive services

By regions at TL2 level, 2015[1]



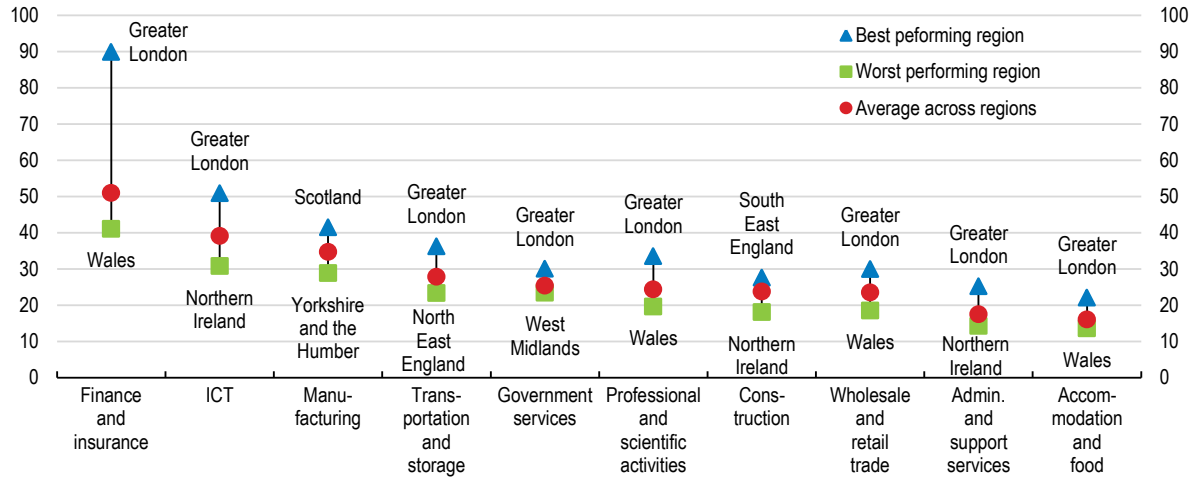
1. Data for labour productivity (i.e. gross value added (GVA) per worker) refer to 2014. Regions are ranked in descending order of their level of labour productivity. High-tech manufacturing refers to chemicals and chemical products (CE), basic pharmaceutical products and preparations (CF), computer, electronic and optical products (CI), electrical equipment (CJ), machinery and equipment not elsewhere classified (CK), transport equipment (CL) based on SIC07 industry classification. Low-tech manufacturing refers to food products, beverages and tobacco (CA), textiles, wearing apparel and leather products (CB), wood and paper products and printing (CC), coke and refined petroleum products (CD), rubber and plastic products (CG), basic metals and metal products (CH), other manufacturing and repair (CM) based on SIC07 industry classification.

2. Professional, scientific and technical activities and administrative and support service activities.

Source: ONS (2016), "Regional gross value added (income approach), UK: 1997 to 2015", Office for National Statistics, December; and OECD (2017), "Regional Economy", *OECD Regional Statistics* (database), July.

Figure 3. Productivity differences across regions tend to be the largest for knowledge intensive services

Labour productivity measured by gross value added per hour, in GBP, 2015[1]

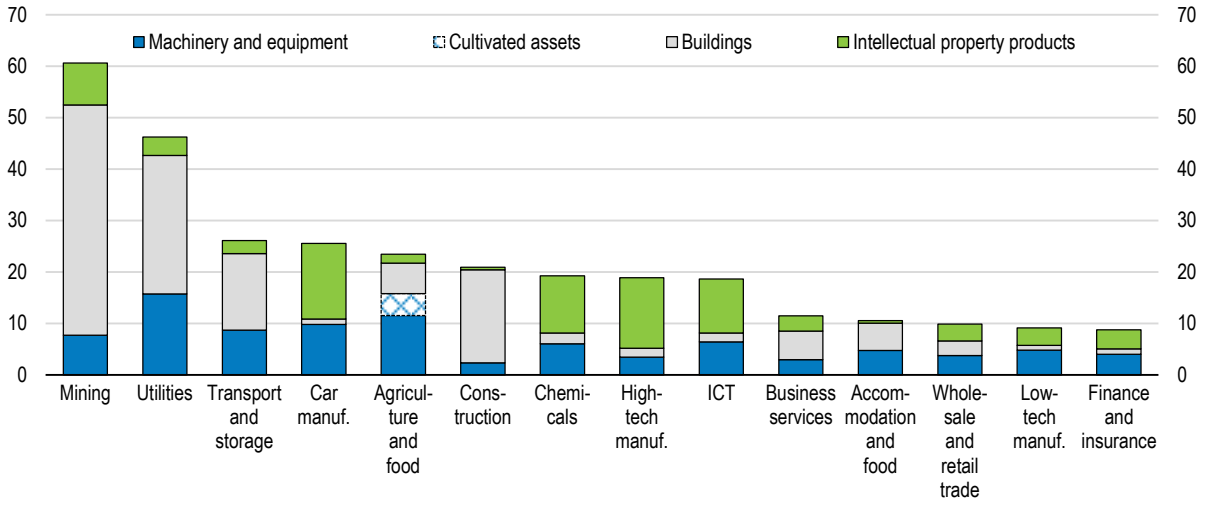


1. Sectors are ranked in descending order of the average level of labour productivity. The chart uses the TL2 definition of regions which yields 12 regions for the UK.

Source: ONS (2017), "Labour productivity: April to June 2017", Office for National Statistics, October.

Figure 4. Investment ratios vary significantly by sector and asset composition

Investment ratio by industry and asset type, per cent, 2015[1]



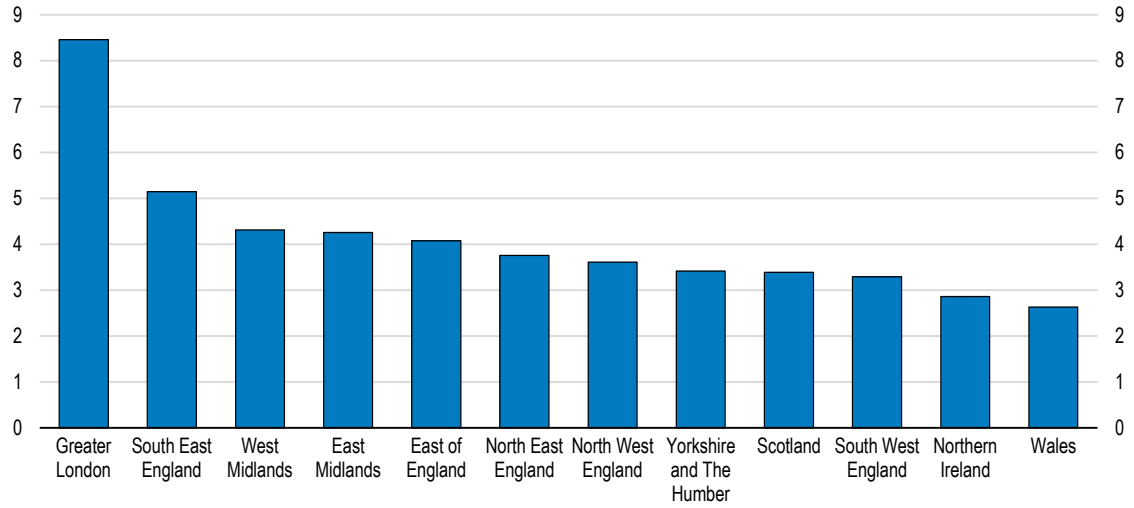
1. Investment ratio refers to the ratio of gross fixed capital formation to gross value added and it is calculated in nominal terms. Machinery and equipment includes transport, other machinery and equipment and ICT equipment. Buildings exclude dwellings, but include other buildings and structures, and costs associated with the transfer of non-produced assets. Intellectual property products include software and research and development.

Source: ONS (2016), "Annual gross fixed capital formation by Industry and Asset", *Dataset*, Office for National Statistics, September.

4. **The national best practice is not equally diffused across regions: the south of England stands out with a high percentage of its firms at the frontier while other regions have only a few of them**. As in many OECD countries, there is a gap between the most productive UK firms – the "national frontier" – and all other businesses (Haldane, 2017; Berlingieri et al., 2017). Such differences imply that the best practices, and the latest technologies and knowledge are not diffused easily across the economy (OECD, 2015a). In Greater London, more than 8% of firms belong to the national frontier, which is significantly more than in all other regions (Figure 5). A stronger regional presence at the national frontier is positively related to regional productivity (Figure 6). Since geographical proximity is a key determinant of the catch up in productivity, the unequal regional distribution of top-performing firms could explain the

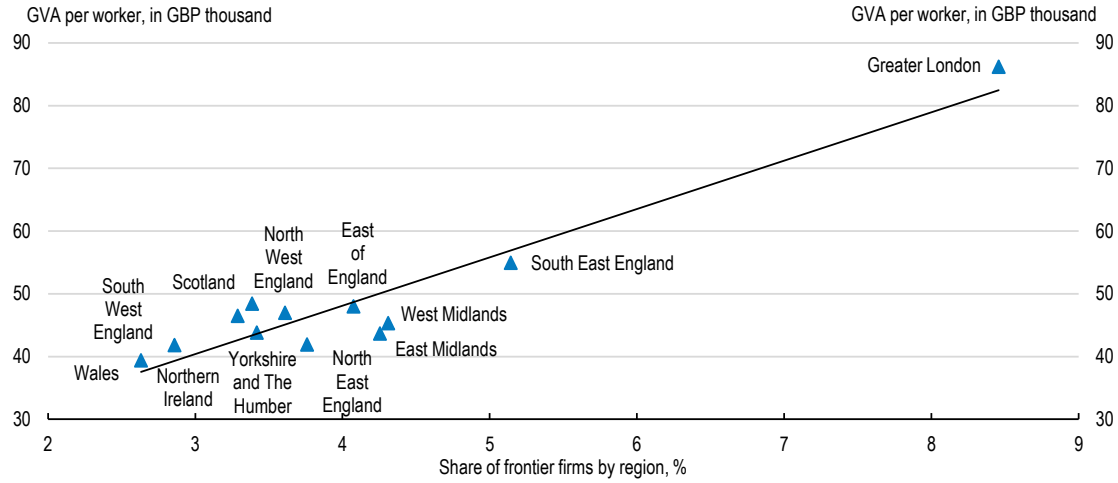
absence of convergence of the lagging regions that are further away from the south of England. In particular, a third of England's population lives in Greater London and South East England, while people's proximity increases the agglomeration effects of large cities by fostering highly productive knowledge-based activities (OECD, 2016, Bartolini et al., 2016). However, agglomeration effects outside the south of England are low in the United Kingdom compared to other OECD countries, as measured by the correlation between city size and city productivity (OECD, 2015b). Thus, making second-tier cities more functional and better equipped to deliver urban amenities and services would be an important source of regional convergence.

Figure 5. Most regions fall behind London in terms of percentage of firms at the productivity frontier
The number of national frontier firms as a percentage of all firms in a region, 2013-14 average[1]



1. National frontier firms are defined as the top 5% in terms of productivity within each 2-digit sector.
Source: Calculations based on the Orbis firm level data by Bureau van Dijk.

Figure 6. Positive link between regional productivity and the percentage of frontier firms by region
2013-14 average[1]



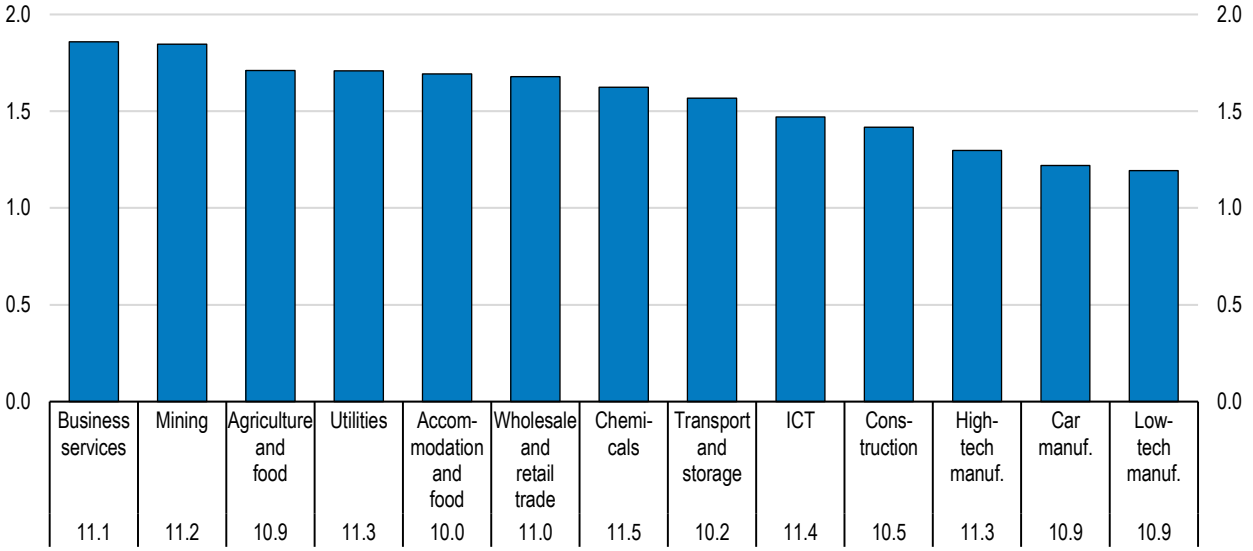
1. Frontier firms are defined as the top 5% in terms of productivity within each 2-digit sector. The share of frontier firms by region is calculated as the number of frontier firms in a region divided by the total number of firms in the region.

Source: Calculations based on the Orbis firm level data by Bureau van Dijk; and OECD (2017), "Regional Economy", *OECD Regional Statistics* (database), June.

5. **There are large productivity gaps between the frontier and other firms in each sector.** There is scope to improve productivity in all sectors as many firms fall behind the sectoral frontier (Figure 7). The gap is the highest for business services and the lowest for low-tech manufacturing, which implies that the diffusion of innovation and knowledge is the weakest for the former sector and the greatest for the latter sector.

Figure 7. Median distance from the productivity frontier is high across all sectors

In logarithmic scale, 2013-14 average[1]



1. Median productivity (in logarithmic scale) is shown on the second line of the x-axis' label. Frontier firms are defined as the top 5% in terms of productivity within each 2-digit sector.

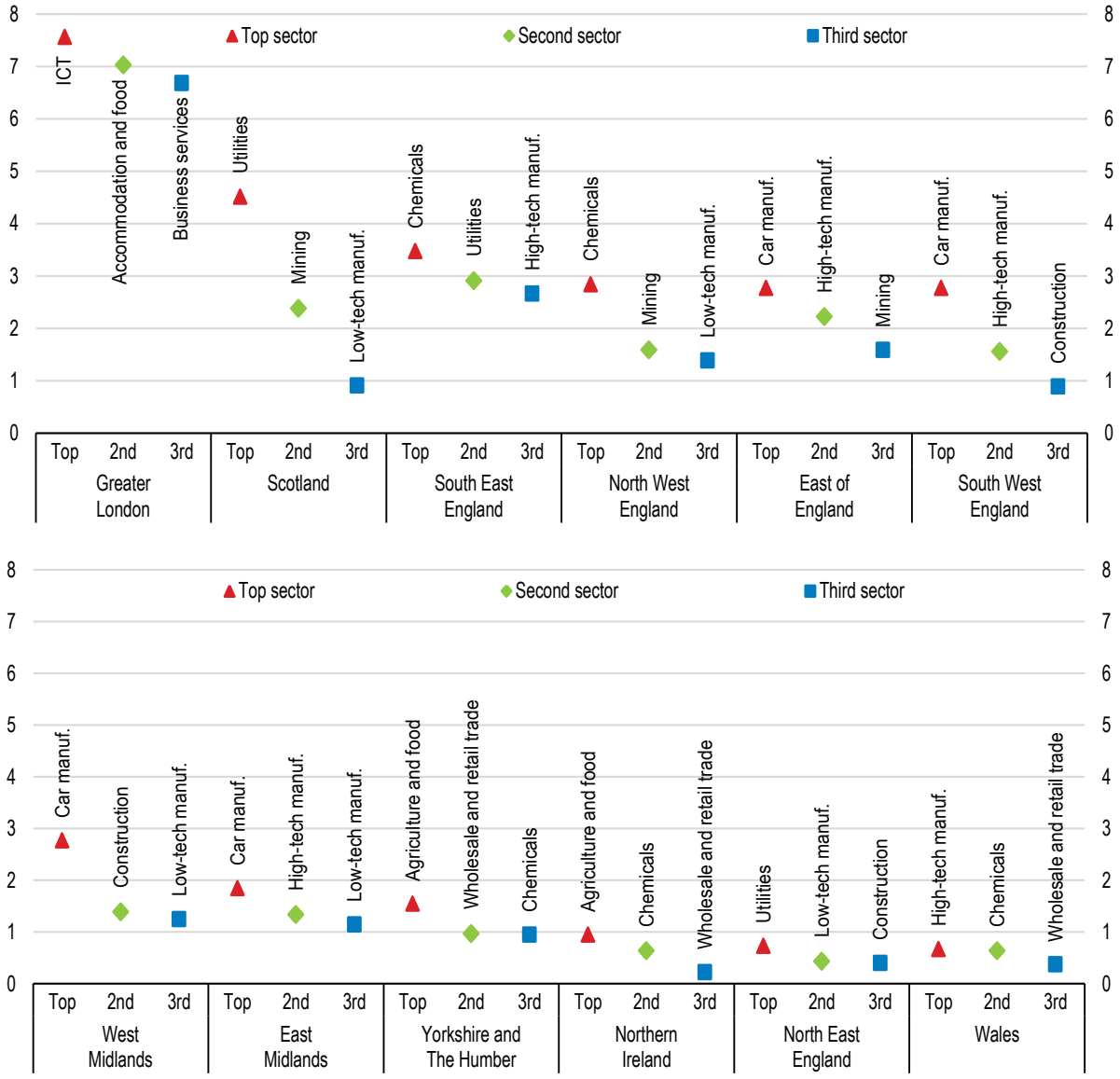
Source: Calculations based on the Orbis firm level data by Bureau van Dijk

6. **Each region has its sectoral productivity leaders**. The relative representation of frontier firms for the top three sectors for each region shows important differences in regional specialisation (Figure 8). On this metric, car manufacturing appears as the biggest strength of four regions (East of England, South West England, West Midlands and East Midlands) and chemicals in two other regions (South East England and North West England). Greater London is the only region where ICT and business services are in the top three sectors.

7. **Industrial specialisation is not constant**. The sectoral strengths of regions have been evolving over time (Figure 9). Two out of three top performing sectors in Greater London, North West England, West Midlands, East Midlands and Wales are the same as two decades ago, and in some cases have become even more represented at the frontier (such as ICT and business services in Greater London). By contrast, the sectoral strengths of two lagging regions – Yorkshire and The Humber, and North East England – have been overhauled relative to the mid-1990s, shifting from sectors intensive in intellectual property products (car manufacturing and chemicals) to sectors that are much less so (agriculture and food, wholesale and retail trade, low-tech manufacturing, construction and utilities).

Figure 8. Frontier firms in the top three sectors for each region in the mid-2010s

Relative representation of frontier firms for the top three sectors for each region, 2013-14 average[1]

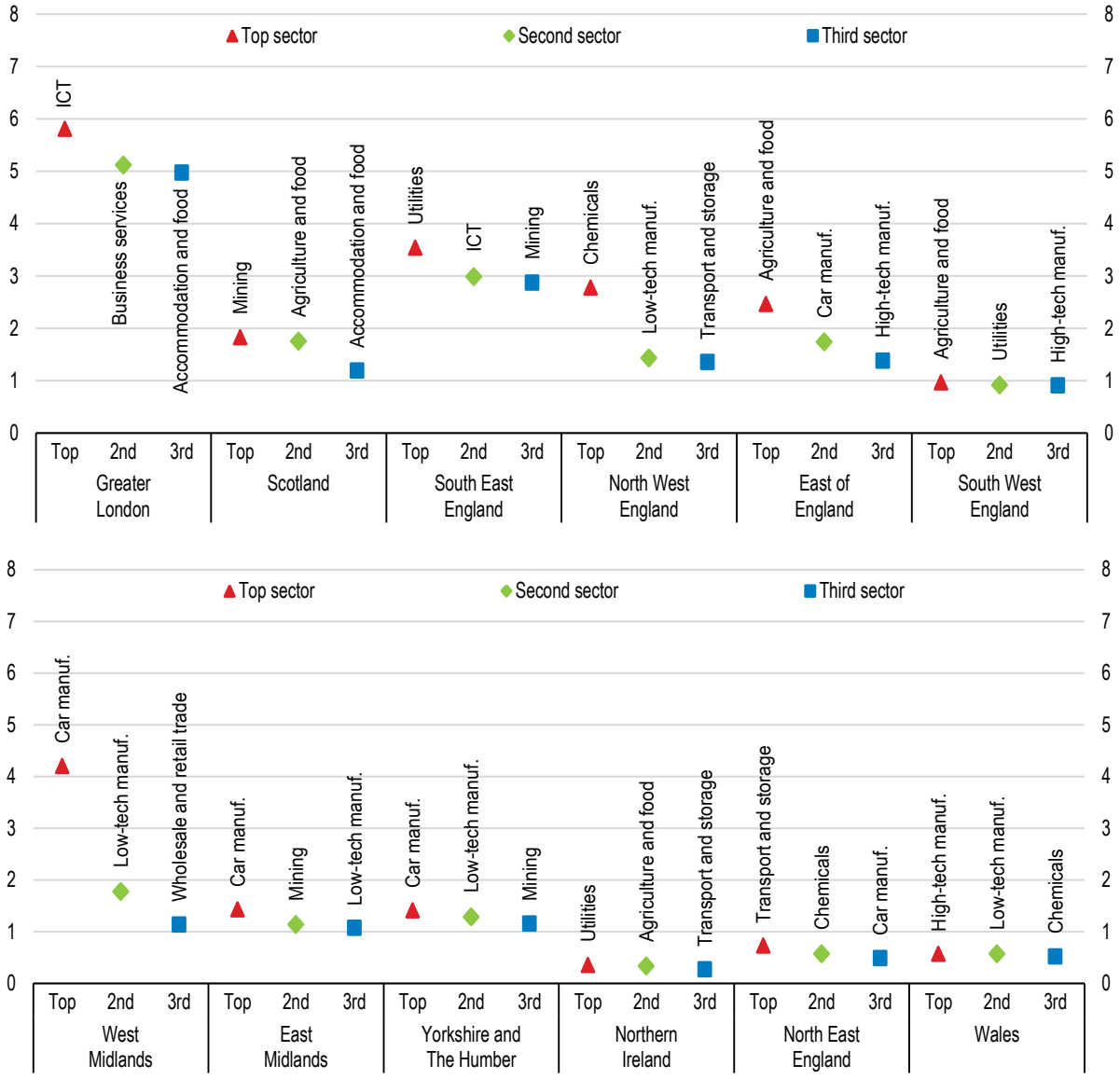


1. Values above 1 mean that the region is more represented in the frontier in the given sector than the country average. The three sectors with highest values are shown for each region. Frontier firms are defined as the top 5% in terms of productivity within each 2-digit sector.

Source: Calculations based on the Orbis firm-level data by Bureau van Dijk.

Figure 9. Frontier firms in the top three sectors for each region in the mid-1990s

Relative representation of frontier firms for the top three sectors for each region, 1995-96 average[1]



1. Values above 1 mean that the region is more represented in the frontier in the given sector than the country average. The three sectors with highest values are shown for each region. Frontier firms are defined as the top 5% in terms of productivity within each 2-digit sector.

Source: Calculations based on the Orbis firm-level data by Bureau van Dijk.

Empirical assessment

Methodology and data

8. **The empirical approach estimates the impact of raising sector-level capital intensity on the firm-level productivity gap from the frontier.** The idea behind this approach is twofold. *First*, higher capital intensity translates into higher labour productivity, independently of impacts on multi-factor productivity (MFP). *Second*, to the extent that MFP increases, productivity is also affected by new

technologies embodied in newer vintages of capital goods (Solow, 1960; Sakellaris and Wilson, 2002). These two channels can facilitate the catch up of laggard firms. Developments at the frontier are more likely to be led by genuine innovations through multi-factor productivity increases, potentially even at the global level, and not primarily by raising the domestic capital stock. For this reason, the scope of the analysis is limited to the catch up with the national frontier, i.e. the best practice in terms of business productivity. Also, the analysis does not consider the role of human capital – skills –, although intangible capital is included in total capital, which has a strong skill component, related to R&D, for instance.

9. **The dependent variable is a firm-specific productivity gap as a function of changes in sector-level capital intensity.** This productivity gap, Gap_{srit}, is defined as the difference between the sector-specific labour productivity frontier lp_{sFt} and the firm-specific labour productivity lp_{srit}:

$$Gap_{srit} = lp_{sFt} - lp_{srit} \quad (1)$$

All variables are measured in logs, and *s, r, i, t* stand for sector, region, firm and year, respectively, and *F* denotes the productivity frontier. Labour productivity is measured as value added divided by the number of employees (hours worked are not available). Value added is computed as the sum of labour costs and gross operating profits. The productivity frontier is measured as in Andrews et al. (2016a), i.e. the average productivity of firms in the top 5% of the productivity distribution within each detailed (2-digit) sector.

The productivity gap is regressed on the growth in sector-level capital intensity (capital per employee), Δkl_{st}, conditional on firm- and year-specific fixed effects D_i and D_t, respectively:

$$Gap_{srit} = \beta \Delta kl_{st} + D_i + D_t + \varepsilon_{it} \quad (2)$$

The growth in the sector-level capital intensity is obtained as the employment-weighted firm-level capital intensity changes over three year periods to focus on medium-term changes rather than year-to-year ones.

To allow for differences across sectors for the estimated impacts, a richer variant of equation (2) is estimated, separately for each region *r*:

$$Gap_{srit} = \sum_s \beta_{sr} \Delta kl_{st} + D_i + D_t + \varepsilon_{it} \quad (3)$$

Finally, to allow for a potentially different impact of R&D spending, the capital intensity in equation (3) is replaced by R&D capital intensity, which is built up from firm-level capital to labour ratios by applying the R&D capital to total capital ratio from the Office for National Statistics at a sector-year level.

10. **Deficient and top performing firms are excluded from the estimation to narrow the focus of policy intervention.** During the estimation, two groups of firms are excluded from the sample: *i*) the frontier firms – the firms with the highest level of productivity within each 2-digit sector (Andrews et al., 2016a) – as these firms are well performing and do not require policy action; and *ii*) the zombie firms – firms that are more than 10 years old but cannot cover interest payments from their operating profits for 3 consecutive years (Andrews et al., 2016b) – as these firms are inefficient, could hold back productive resources and should not benefit from support measures that would raise their capital intensity.

11. **The estimation is done for thirteen sectors and twelve regions, with the policy experiment being a one percent increase in capital intensity.** Regions are defined as NUTS1 level regions using the Orbis firm-level data that contains several hundred thousand annual financial accounts – income statements and balances sheets – for the period 1995-2014. Only unconsolidated accounts are retained, so as to avoid the potential lumping of activities across various geographical locations captured by consolidated accounts.

To the extent that unconsolidated accounts refer to a unit that is present only at a single location, this mitigates the risk of misallocating economic activities across regions due to companies stretching over several plants. Companies in the financial and insurance sector are omitted from the analysis due to lack of available data. Firms that show growth rates in either the capital stock or labour productivity that fall in the top and bottom 1% of the growth distribution are excluded to minimize the role of extreme changes that could potentially occur during mergers and acquisitions, spinoffs or other rare events which are outside the scope of the analysis.

12. **After the estimation phase, the sector-region productivity impacts of a one percent increase in capital intensity are calculated as follows:**

$$\Delta \widehat{lp_{sr}} = -\hat{\beta}_{\mathrm{sr}} A_{sr}, \tag{4}$$

where the inverse of the estimates for sector-region effects on the productivity gap $\hat{\beta}_{\mathrm{sr}}$ is obtained by running regression (3) (on the gap which contains productivity with a negative sign), and A_{sr} is the share of non-frontier and non-zombie firms in sector *s* and region *r* that policy is assumed to be able to affect through higher capital intensity.

13. **The regional aggregate effect is obtained as follows:**

$$\Delta lp_r = \sum_s w_{sr} \Delta lp_{sr}\, lp_{sr}^{Rel}, \tag{5}$$

where employment weights, $w_{sr} = L_{sr}/L_r$, are derived from the sector-region distribution of the Office for National Statistics and the relative productivity level of sector *s* in region *r* is compared to the regional average $lp_{sr}^{Rel} = lp_{sr} - lp_r + 1$, which captures the fact that a boost to a high productivity sector will have a larger impact on the regional aggregate.

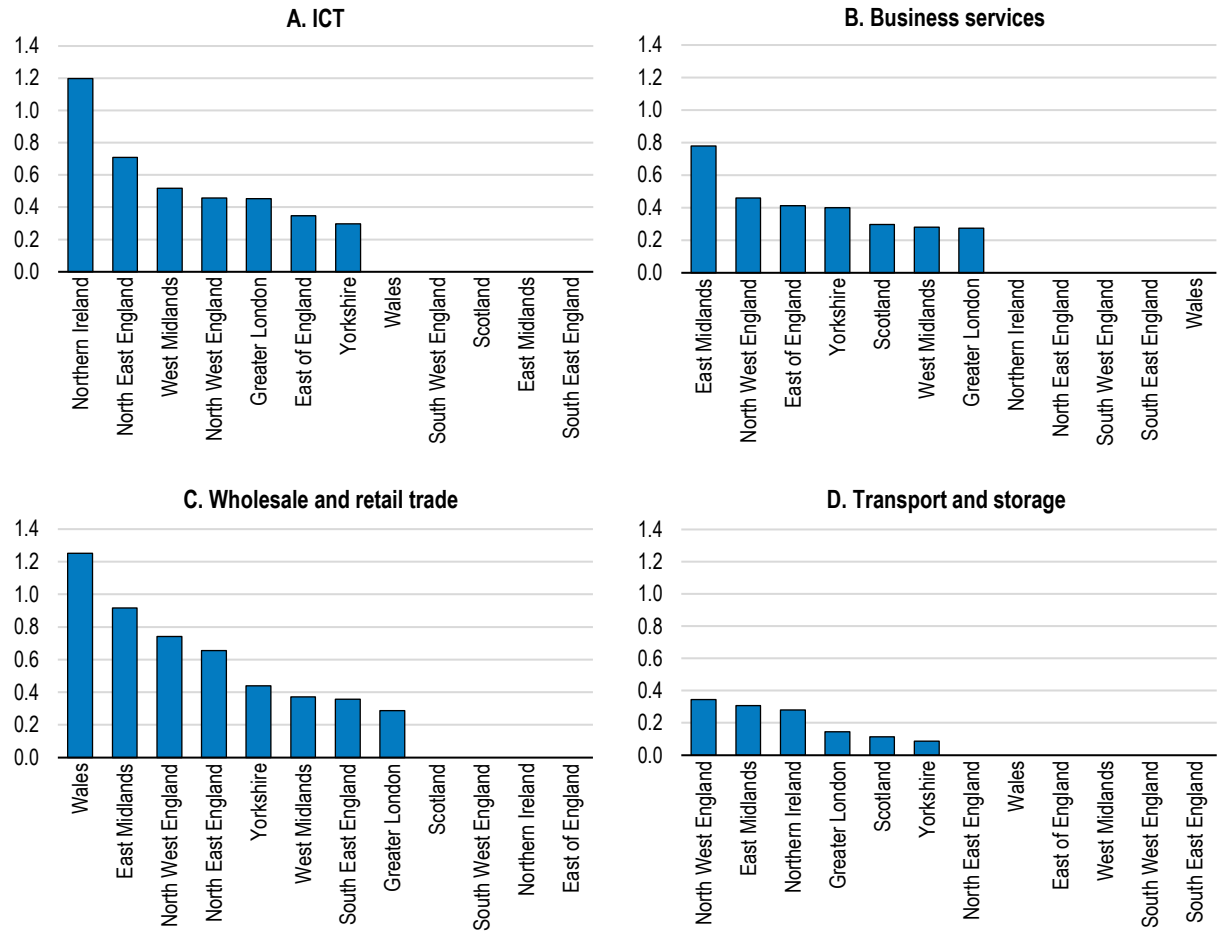
Estimation results

14. **The estimation results reveal that in most sectors, the productivity gap narrows significantly after an increase in capital intensity, although there is a large variation across sectors and regions.** The impacts have the expected negative sign and are significant in most services sectors (such as ICT and business services) and in most regions (Table A1 in the Annex). However, higher capital intensity does not always translate into a closure of the gap in some sectors (utilities, construction, accommodation and food, car manufacturing) or the effect is not statistically significant for most regions (agriculture and food). The likely explanation is that some of these sectors have already a high capital intensity (e.g. utilities – see Figure 4), reducing the need for additional increases to close the gap. Also, capital tends to be concentrated among a few highly productive firms (e.g. car manufacturing), hence more capital intensity would result in a growing gap between the frontier and the laggard firms. Since the purpose in this exercise is to reduce the productivity gap *vis-à-vis* the frontier, these sectors are left out from subsequent simulation.

15. **The greatest potential to increase productivity in most regions is by raising the capital intensity of services sectors.** A one percent increase in the capital-to-labour ratio has a greater impact on labour productivity in services sectors than in goods sectors. In particular, the largest and most widespread impacts are in knowledge intensive services sectors – ICT and business services – and in the wholesale and retail trade sector, ranging between 0.25% and 1.2% across 7-8 regions (Figure 10). Increasing the capital intensity of the manufacturing sector, both in the low-tech and high-tech segments, is effective in fewer regions (3 to 4), with an impact of about 0.3-1% (Figure 11).

Figure 10. Sector-region labour productivity impacts in services sectors

Impact of 1% increase in capital intensity on labour productivity, per cent[1]



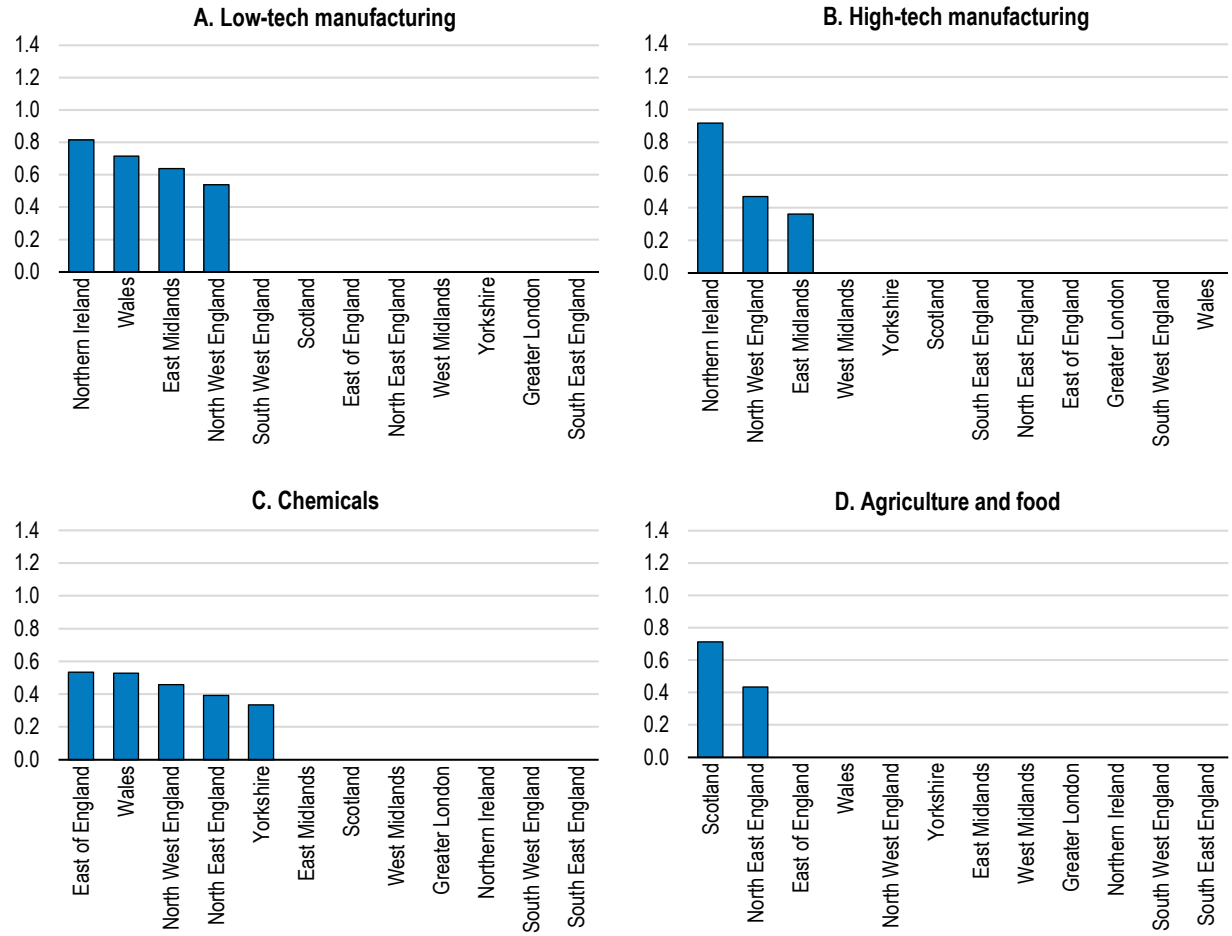
1. The values are obtained using equation (4). The impacts are measured in percentages (approximated by changes in logarithms) and are ranked from the largest to the smallest impact. Only those sectors are shown where the estimated impacts are correctly signed and significant, and which represent a significant share of total regional employment. Yorkshire refers to Yorkshire and The Humber.

Source: Calculations based on the Orbis firm-level data by Bureau van Dijk.

16. **Sector- and region-specific support for investment could be tailored to deliver the most "bang for the buck".** The weakest regions in terms of productivity would benefit relatively more from investment in the services sectors than in the goods sectors. For instance, raising the capital-to-labour ratio in the wholesale and retail trade sector would boost Welsh productivity significantly more (consistent with the lowest productivity of this sector in the United Kingdom – see Figure 4), than doing so in the low-tech manufacturing and chemical sectors. In Northern Ireland, increasing the capital intensity of the ICT sector would be more effective than by expanding the capital intensity of the high-tech and low-tech manufacturing sector, for which estimated impacts are nevertheless sizeable. This result is consistent with the observation that the ICT sector has the weakest productivity in Northern Ireland (Figure 4).

Figure 11. Sector-region labour productivity impacts in goods sectors

Impact of 1% increase in capital intensity on labour productivity, per cent[1]



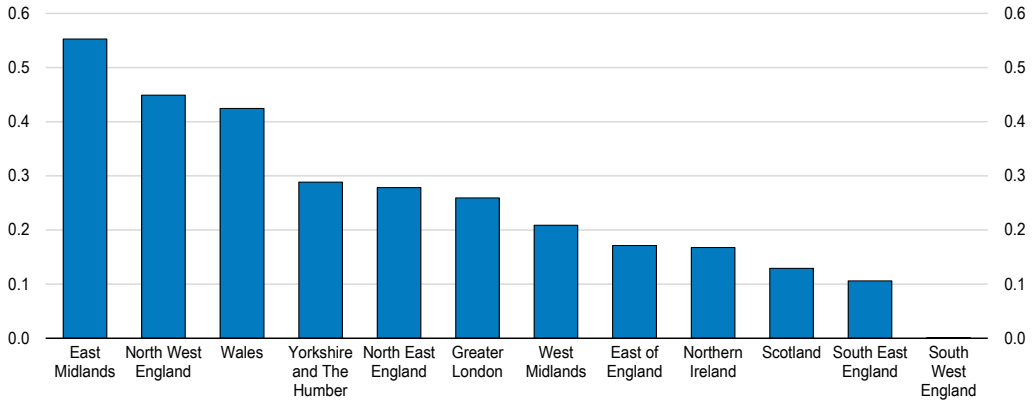
1. The values are obtained using equation (4). The impacts are measured in percentages (approximated by changes in logarithms) and are ranked from the largest to the smallest impact. Only those sectors are shown where the estimated impacts are correctly signed and significant, and which represent a significant share of total regional employment. Yorkshire refers to Yorkshire and The Humber.

Source: Calculations based on the Orbis firm-level data by Bureau van Dijk.

17. Cumulating sectoral impacts across regions shows that the least productive regions would tend to benefit the most from greater capital intensity. The overall regional productivity impacts are driven by a combination of sector- and region-specific effects: *i*) the estimated responsiveness of the sectoral productivity gaps to capital intensity in each region; *ii*) the share of firms that can be impacted; *iii*) the weight of the sectors; and *iv*) the relative productivity of sectors (equations 4 and 5). Taking all these determinants into account, Figure 12 shows the overall regional productivity effects of increasing capital intensity by one percent uniformly across the sectors where higher capital intensity is estimated to decrease the productivity gap (i.e. negative and significant coefficients in Table 1). The regional productivity impacts are the largest in four out of five least productive regions. Put differently, the weakest regions present a large number of sectors for which policy intervention would be effective in stimulating labour productivity.

Figure 12. Regional labour productivity impacts

Impact of 1% increase in capital intensity on labour productivity, per cent

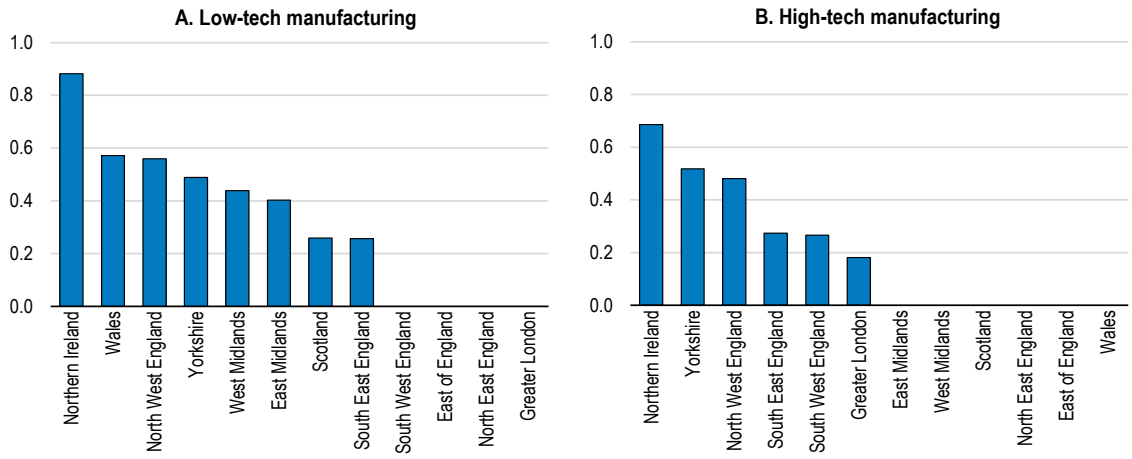


Source: Calculations based on the Orbis firm-level data by Bureau van Dijk.

18. **More granular analysis of investment suggests that R&D spending could be effective in raising the productivity of the manufacturing sector in some regions.** Focusing on R&D capital intensity (Figure 13) would lead to more widespread productivity effects in manufacturing, especially in its low-tech segment, as R&D spending helps not only in creating new innovation, but also in adopting existing technology by firms below the technological frontier. Significant productivity impacts of R&D spending in manufacturing are also consistent with a large contribution of intellectual products in total investment (see Figure 4, in particular high-tech and car manufacturing as well as chemicals). Northern Ireland appears the most responsive, in line with estimates for total capital intensity (Figure 11), but slightly less so than by raising the capital intensity of the wholesale and retail trade sector (Figure 10). For Yorkshire and The Humber, the estimated impacts are slightly larger than for the services sectors (Figure 10), which is corroborated by having the least productive manufacturing sector in this region (Figure 4). The UK R&D tax credit appears effective (Dechezleprêtre et al., 2016), which is promising for using this policy lever.

Figure 13. Sector-region labour productivity impacts of higher R&D capital intensity in the manufacturing sector

Impact of 1% increase in R&D on labour productivity, per cent1



1. The values are obtained using equation (4). The impacts are measured in percentages (approximated by changes in logarithms) and are ranked from the largest to the smallest impact. Only those sectors are shown where the estimated impacts are correctly signed and significant and which represent a significant share of total regional employment. Yorkshire refers to Yorkshire and The Humber. R&D: research and development.

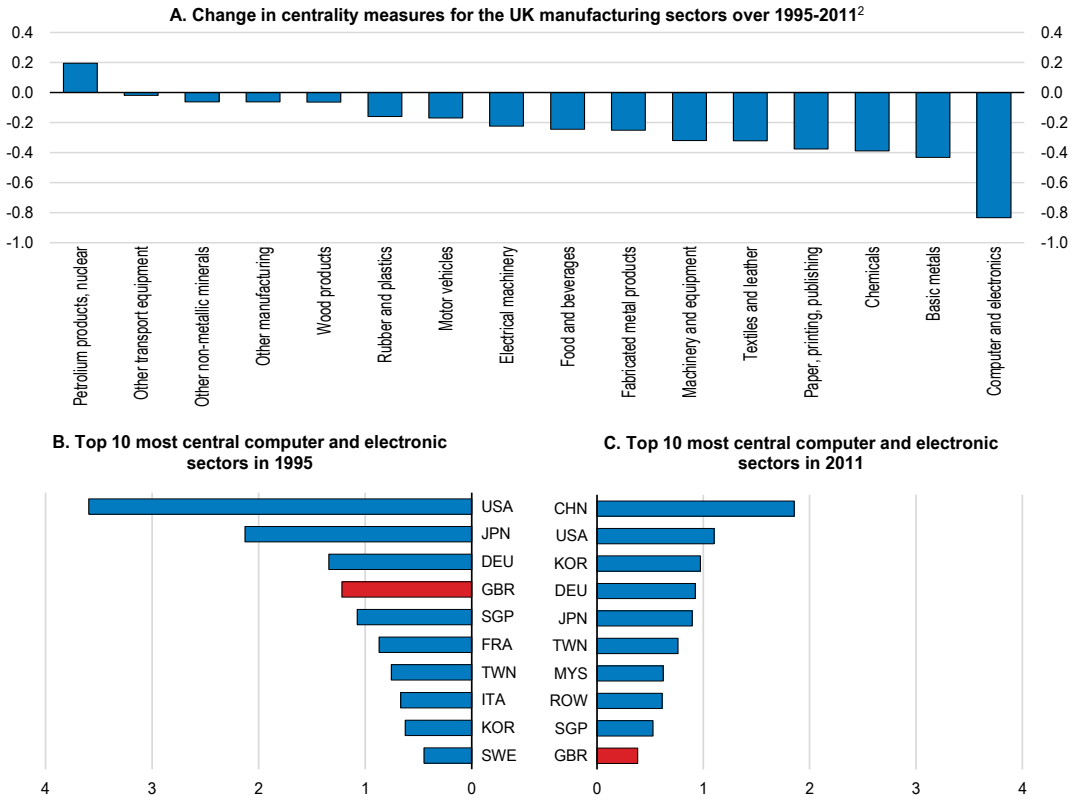
Source: Calculations based on the Orbis firm-level data by Bureau van Dijk and ONS (2016), "Annual gross fixed capital formation by Industry and Asset", *Dataset*, Office for National Statistics, September.

19. **This analysis does not take into account spillovers across sectors, but recent evidence for the United Kingdom suggests that they are likely to be small for the manufacturing sector.** Developing the sector of advanced manufacturing increases employment substantially, but it does not generate significant productivity effects in services in the same area (Lee and Clarke, 2017). Therefore, the region where such advanced industries are located also requires an improvement in productivity of services to make an impact on the overall regional productivity, given the larger size that services represent relative to manufacturing. This highlights the importance of focusing on services sectors if greater regional productivity gains are to be achieved. On the other hand, there could be other economic benefits of greater industrial diversification which this study does not quantify, such as greater resilience to shocks or spillovers between goods and services sectors located in different regions.

20. **A strong focus on services would be consistent with the position of UK sectors in global value chains.** Recent OECD work, focusing on so-called centrality measures to reflect the influence of sectors and countries within production networks (Criscuolo and Timmis, 2017), has found that the United Kingdom has been losing its position as a central hub in global value chains for all segments of the manufacturing sector (Figure 14, Panel A). The largest fall in the relative position has been in computer and electronics, where East Asia and Eastern Europe have been gaining ground and Germany managed to preserve a strong position (Figure 14, Panels B and C). By contrast, the United Kingdom has improved an already high centrality in business and IT services (Figure 15).

Figure 14. The United Kingdom has been losing ground as a manufacturing hub

Centrality measured as total foreign centrality[1]



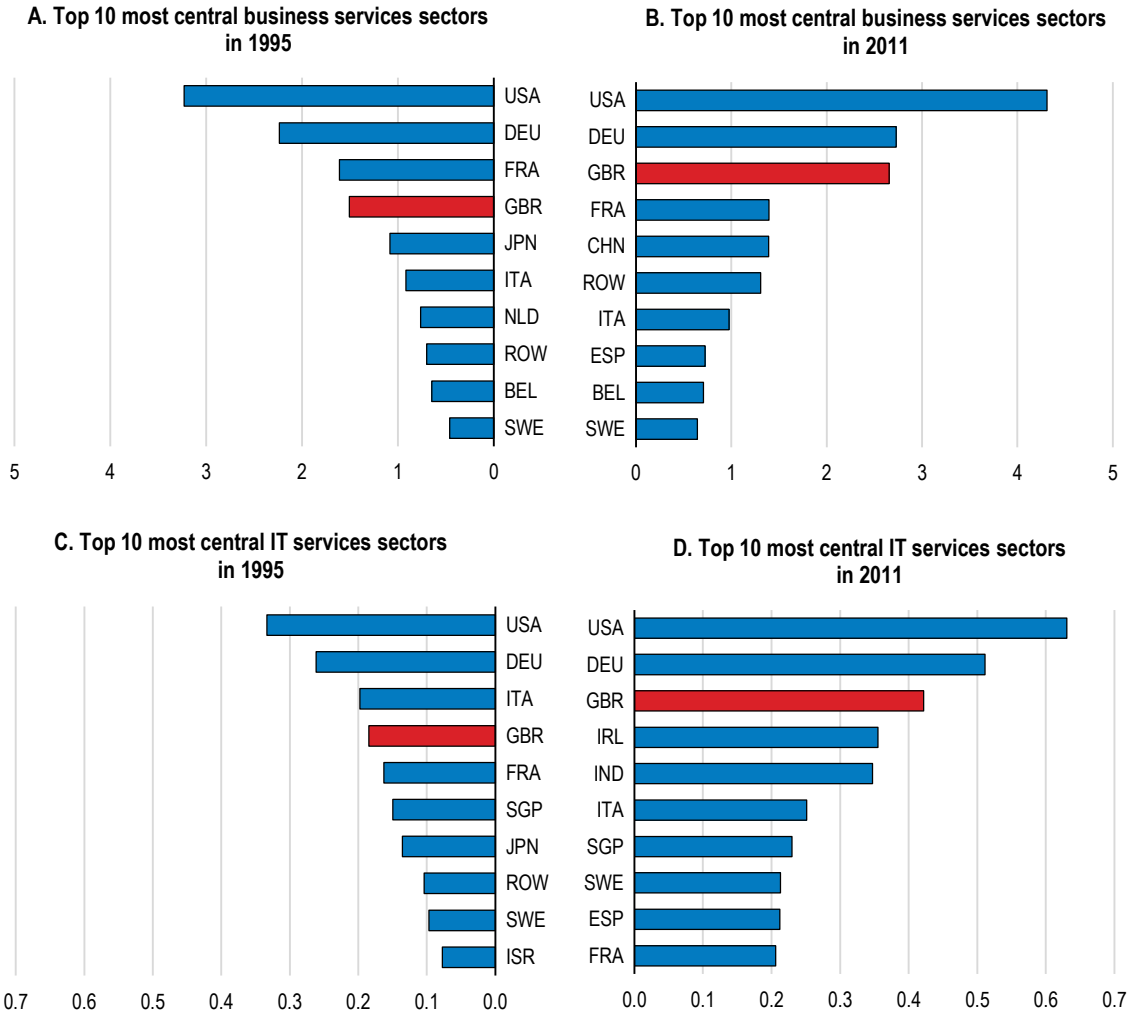
1. Centrality reflects the position in global value chains relative to all other country-industries in the network.

2. Fabricated metal products exclude machinery and equipment.

Source: Criscuolo, C. and J. Timmis (2017), "GVCs and centrality: mapping key hubs, spokes and the periphery", *OECD Productivity Working Papers*, forthcoming.

Figure 15. The United Kingdom has improved its position as a global hub in business and IT services

Centrality measured as total foreign centrality[1]



1. Centrality reflects the position in global value chains relative to all other country-industries in the network.

Source: Criscuolo, C. and J. Timmis (2017), "GVCs and centrality: mapping key hubs, spokes and the periphery", *OECD Productivity Working Papers*, forthcoming.

Conclusion

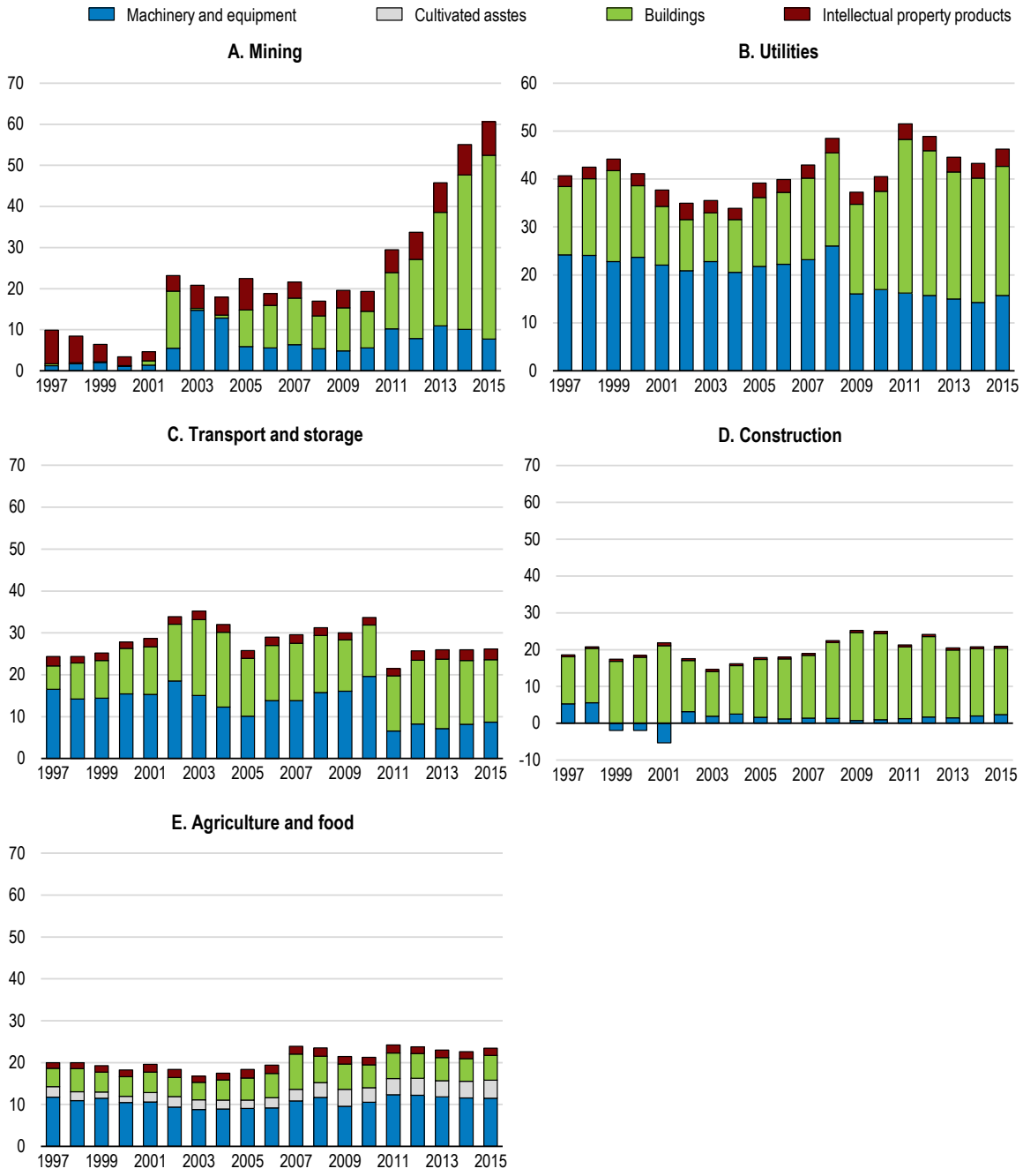
21. This analysis suggests that investment support as part of the industrial strategy should be targeted at sectors and regions that are lagging behind and whose productivity would be the most responsive to higher capital intensity. UK firm-level evidence suggests that for most regions, knowledge intensive services (ICT and business services) appear the most promising, given the strong potential for spillovers from leading firms in these areas and the large weight of such activities in regional output, comparable to the weight of manufacturing activities. However, raising R&D intensity of the manufacturing sector would also deliver important productivity increases in the most lagging regions.

22. Future work could seek to take account of further drivers of productivity, particularly the availability of skills and their matching to jobs (Adalet McGown and Andrews, 2015), with regional job-to-job mobility being reduced by a low elasticity of housing supply. Moreover, the ecosystem of companies could also be investigated more explicitly, including the role of infrastructure, and the density of consumers and suppliers.

ANNEX

Figure A1. Sectors with high and medium total investment ratios over time

Investment ratio by asset type, per cent[1]

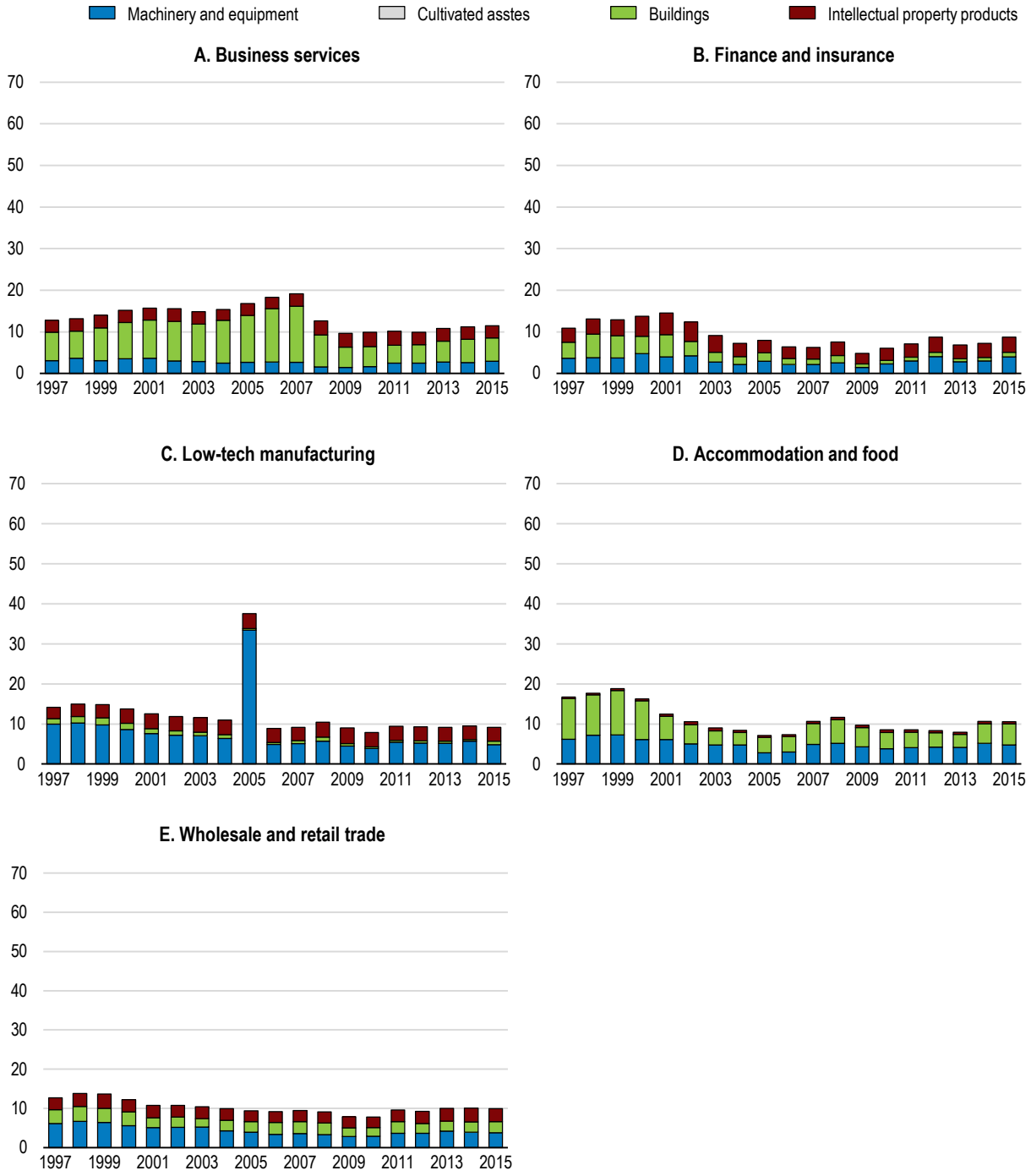


1. Investment ratio refers to the ratio of gross fixed capital formation to gross value added and it is calculated in nominal terms. Machinery and equipment includes transport, other machinery and equipment and ICT equipment. Buildings include other buildings and structures, and costs associated with the transfer of non-produced assets, but exclude dwellings. Intellectual property products include software and research and development.

Source: ONS (2016), "Annual gross fixed capital formation by Industry and Asset", *Dataset*, Office for National Statistics, September.

Figure A2. Sectors with low total investment ratios over time

Investment ratio by asset type, per cent[1]

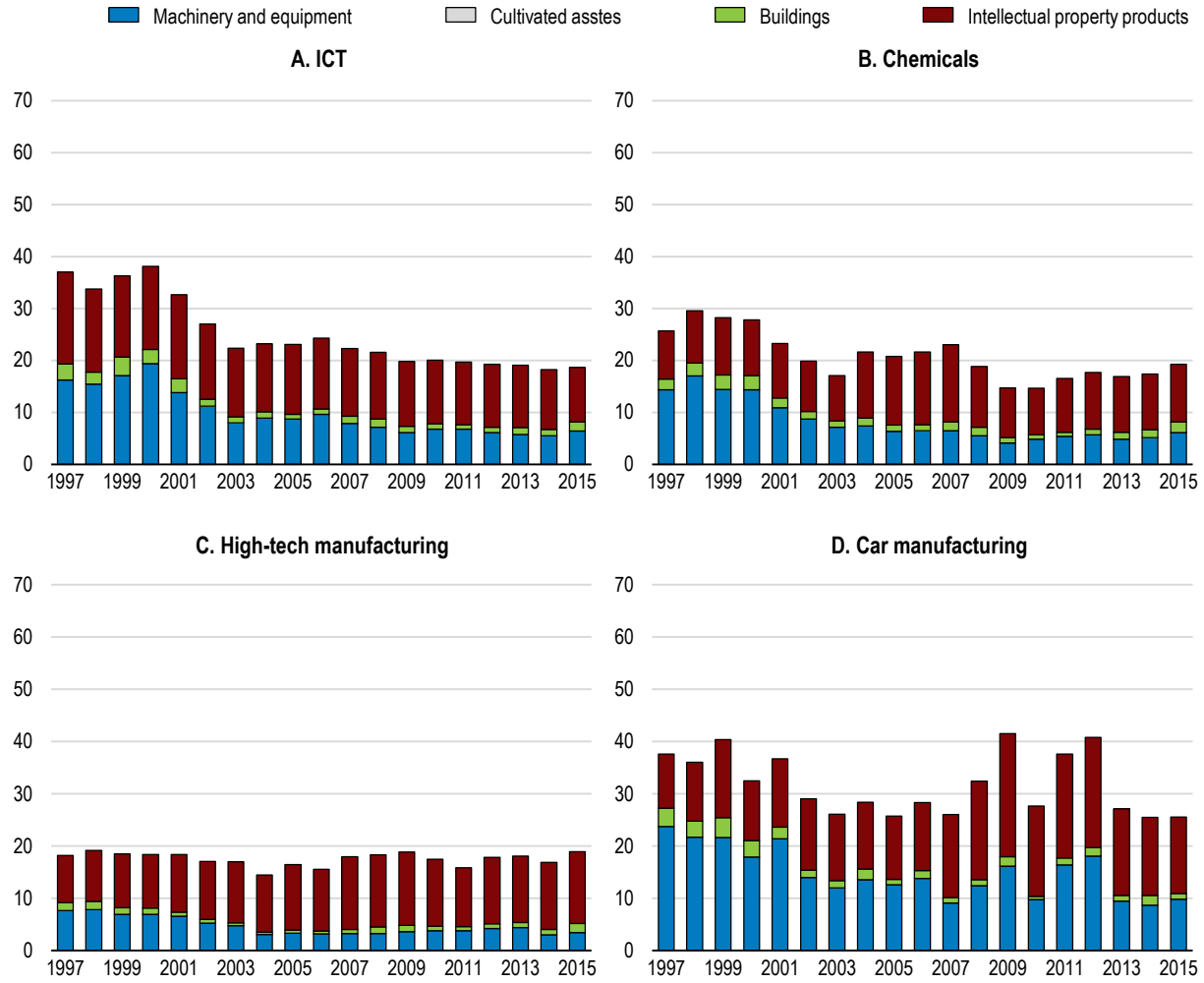


1. Investment ratio refers to the ratio of gross fixed capital formation to gross value added and it is calculated in nominal terms. Machinery and equipment includes transport, other machinery and equipment and ICT equipment. Buildings include other buildings and structures, and costs associated with the transfer of non-produced assets, but exclude dwellings. Intellectual property products include software and research and development.

Source: ONS (2016), "Annual gross fixed capital formation by Industry and Asset", *Dataset*, Office for National Statistics, September.

Figure A3. Sectors with high investment in intellectual property products over time

Investment ratio by asset type, per cent[1]



1. Investment ratio refers to the ratio of gross fixed capital formation to gross value added and it is calculated in nominal terms. Machinery and equipment includes transport, other machinery and equipment and ICT equipment. Buildings include other buildings and structures, and costs associated with the transfer of non-produced assets, but exclude dwellings. Intellectual property products include software and research and development.

Source: ONS (2016), "Annual gross fixed capital formation by Industry and Asset", *Dataset*, Office for National Statistics, September.

Table A1. Estimation results

Dependent variable: labour productivity distance from the frontier

Regions	East Midlands	East of England	Greater London	North East England	North West England	Northern Ireland	Scotland	South East England	South West England	Wales	West Midlands	Yorkshire and The Humber
Explanatory variables: change in capital intensity by sector	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Low- tech manufacturing	-0.726**	-0.251	-0.058	-0.317	-0.643*	-0.871**	-0.134	-0.078	-0.159	-0.896**	-0.290	-0.212
	(0.330)	(0.269)	(0.131)	(0.455)	(0.322)	(0.348)	(0.207)	(0.136)	(0.363)	(0.358)	(0.270)	(0.188)
High-tech manufacturing	-0.586***	-0.066	-0.130	-0.132	-0.520***	-1.098***	-0.057	-0.075	-0.193	-0.439	-0.059	-0.070
	(0.153)	(0.204)	(0.106)	(0.193)	(0.166)	(0.241)	(0.163)	(0.097)	(0.175)	(0.252)	(0.106)	(0.102)
Utilities	0.604***	0.579***	0.879***	3.717***	1.115***	4.371***	0.823***	0.479***	3.220***	1.562***	0.433***	-0.610***
	(0.131)	(0.105)	(0.094)	(0.177)	(0.152)	(0.170)	(0.093)	(0.050)	(0.190)	(0.207)	(0.113)	(0.076)
Construction	0.475	0.477	0.510**	-0.150	0.372	0.828**	0.938**	0.458*	0.208	0.584	0.137	0.423
	(0.418)	(0.352)	(0.201)	(0.460)	(0.408)	(0.327)	(0.319)	(0.227)	(0.504)	(0.558)	(0.337)	(0.254)
Wholesale and retail trade	-0.996***	-0.408	-0.340**	-0.691*	-0.809**	-0.447	-0.172	-0.404**	-0.171	-1.307***	-0.475*	-0.473**
	(0.298)	(0.353)	(0.144)	(0.331)	(0.315)	(0.393)	(0.242)	(0.180)	(0.371)	(0.383)	(0.262)	(0.188)
Transport and storage	-0.321**	-0.076	-0.260**	-0.145	-0.458***	-0.678***	-0.160*	-0.080	-0.231	-0.171	-0.154	-0.127**
	(0.123)	(0.089)	(0.086)	(0.162)	(0.134)	(0.179)	(0.075)	(0.048)	(0.130)	(0.175)	(0.089)	(0.055)
Accommodation and food	0.066	0.488**	0.057	-0.347	0.121	0.455	-0.102	0.158	0.558**	1.567***	0.751***	-0.146
	(0.210)	(0.168)	(0.084)	(0.293)	(0.223)	(0.388)	(0.124)	(0.150)	(0.239)	(0.293)	(0.240)	(0.191)
ICT	-0.112	-0.443*	-0.580***	-0.913**	-0.624**	-1.382***	-0.291	-0.193	0.018	-0.197	-0.569**	-0.453**
	(0.250)	(0.237)	(0.118)	(0.332)	(0.242)	(0.293)	(0.176)	(0.136)	(0.307)	(0.332)	(0.203)	(0.156)
Business services	-1.017***	-0.640**	-0.476***	-0.332	-0.738***	1.446***	-0.408**	-0.259	-0.373	-0.151	-0.475**	-0.567***
	(0.212)	(0.222)	(0.116)	(0.283)	(0.222)	(0.454)	(0.146)	(0.147)	(0.228)	(0.283)	(0.175)	(0.163)
Chemicals	-0.220	-0.732***	0.269**	-0.674*	-0.632**	-0.113	0.333*	0.039	0.457	-0.595*	-0.311	-0.452**
	(0.247)	(0.230)	(0.106)	(0.322)	(0.240)	(0.156)	(0.175)	(0.134)	(0.281)	(0.289)	(0.205)	(0.163)
Car manufacturing	0.986***	0.150	-0.404***	0.579***	1.406***	-0.279	-0.556***	0.555***	0.712***	0.084	0.202	0.723***
	(0.156)	(0.149)	(0.084)	(0.160)	(0.191)	(0.191)	(0.154)	(0.102)	(0.228)	(0.195)	(0.143)	(0.119)
Agriculture and food	0.241	-0.214	-0.060	-1.103***	-0.419	-0.171	-0.966***	0.096	0.052	-0.417	0.169	0.012
	(0.293)	(0.266)	(0.130)	(0.350)	(0.304)	(0.266)	(0.176)	(0.135)	(0.323)	(0.371)	(0.244)	(0.187)
Mining	-1.056**	-0.362	0.242*	-3.692***	-3.665***	-4.768***	0.250	-0.086	-1.093***	2.393**	-4.059***	-12.569***
	(0.358)	(0.218)	(0.132)	(0.642)	(0.350)	(0.534)	(0.244)	(0.107)	(0.316)	(0.853)	(0.212)	(0.708)
R-squared	0.862	0.855	0.846	0.877	0.851	0.864	0.867	0.875	0.887	0.856	0.862	0.867
Number of observations	6934	10837	25910	2386	8914	1096	5638	19202	6697	2388	8445	6943
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Cluster robust standard errors in parentheses. Significance levels: *** $p<0.01$, ** $p<0.05$, * $p<0.1$. See estimation details in the text.

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