THE GEOGRAPHIC DIMENSION OF PRODUCTIVITY IN GREAT BRITAIN, 2010-2016

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ABSTRACT
Over the last 20 years, improving productivity has been one of the central aims of the UK Government's industrial policy. The government's more recent focus on spatial rebalancing of the economy has meant the creation of locally-developed 'local industrial strategies' which, aligned to the overarching national strategy, will set out how areas will improve their productivity. However, detailed information on the geography of productivity, that is mostly unavailable at present, is needed if these are to be successful. This paper aims to provide some of the necessary information by giving estimates of total factor productivity (TFP) at different spatial levels as well as information on what drives TFP and in particular the relative contributions of 'place' versus 'non-place' effects. Our main results show that London is ranked highest in terms of average TFP, and Wales the lowest. Aside from Scotland, productivity levels generally fall when moving towards the north and periphery of Great Britain. As to productivity across the LEPs, there was significantly higher TFP for the London and adjacent LEPs mostly north and south of the capital, with spatial factors accounting for on average between 41-50% of the differential between productivity in London and other LEPs. Only London and Edinburgh have statistically significantly higher productivity than the South East region, and many cities do not outperform their hinterlands.

Keywords: Productivity; TFP; LEPs; Cities; Regions

JEL classifications: C23; D24; R12

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1. INTRODUCTION

In the last 20 years, except for a period during 2010-14 where 'austerity' dominated the policy landscape, improving productivity has been at the centre of the United Kingdom (UK) Government's industrial policy (Cook et al., 2019). Whilst the exact policy practice has varied across different governments, the role and importance of productivity has been recognised and emphasised throughout. This has coincided in more recent years with a greater emphasis on the need for spatial 'rebalancing' (cf. Martin et al., 2016; UK2070 Commission), and the return of a regional and cities agenda for stimulating growth in less well-off areas (in contrast to the decline of regional industrial development assistance beginning in 1979 – cf. Broadberry and Leunig, 2013; Wren, 2005).

This joint focus on productivity and spatial rebalancing is embodied in the creation of 'Local Industrial Strategies' (BEIS, 2017) to complement the overarching national strategy introduced in 2017. These are being drawn up by Local Enterprise Partnerships (LEPs)[1] and will set out "…clearly defined priorities for how cities, towns and rural areas will maximise their contribution to UK productivity" (BEIS, 2018a). However, a major issue for the LEPs is the lack of information on productivity differences across areas. As a result, the published local industrial strategies (LIS's) have, to date, tended to rely on labour productivity data from the Office for National Statistics (ONS),[2] which is aggregated to a small number of broad sectors at local level. However, it is generally recognised that a superior measure is total factor productivity (TFP), which measures how productively firms produce outputs of goods and services using all factors of production (i.e. labour, capital and intermediate inputs). Labour productivity will – de facto – be higher in firms that are capital- or intermediate input intensive. Increasing labour productivity can thus be achieved by substituting capital or intermediate inputs for labour (see section 4 in Harris and Moffat, 2017) without any improvement in the efficiency of or technology employed by the firm. A second major problem is that aggregate productivity measures hide the heterogeneous nature of productivity distributions, since every sector and geographic area has a mix of high- and low-productivity plants (Haldane, 2017; BEIS, 2018b).

Thus, a major aim of this paper is to provide estimates of TFP at different spatial levels (here we focus on administrative regions, LEPs and major cities) to add directly to the evidence base needed when developing LIS's. Secondly, we disaggregate productivity differentials into 'place' and 'non-place' effects, where the latter comprise factors such as the age of the plant, ownership, R&D, trade, and the industrial sector to which it belongs, while 'place' factors include potential spatial spillovers due to agglomerations. Such information will also be useful for LEPs in allowing them to identify the extent to which policy should focus on improving the characteristics of plants and/or the environment in which they operate.

The importance and benefits of increasing productivity, especially in underperforming areas, is generally accepted. As Paul Krugman (1997) noted "… Productivity isn't

[1] Established in 2010 to replace Regional Development Agencies (RDA's), the 39 English LEPs comprise local businesses, local authorities with central government support tasked with developing local growth agendas.

[2] For example, the evidence underpinning the Greater Manchester LIS reported the following "The work also aimed to trial work on Total Factor Productivity (TFP), however due to data limitations, the advice from external reviewers and ONS was to focus on Labour Productivity. Revisiting TFP will be an important step beyond the Review, and will require additional work on data availability at lower spatial levels, including information on capital stock, and measuring intangible assets at the firm level." (GMCA, 2019).

everything, but in the long run it is almost everything". Additionally, the influential work of Porter is based on the premise that competitive advantage derives from higher productivity (e.g., Porter, 1998). As well as the empirical evidence regarding its role, productivity is also a key element in models of regional growth. For example, in the neoclassical model (long-run) differences in regional growth are mostly due to differences in TFP, and even when technological change is partly determined by an endogenous process (e.g., depends on knowledge), 'catch-up' via diffusion is likely to be limited if there are interregional differences in knowledge stocks (cf. 'technology-gap' models of regional growth). And while the Kaldorian model of regional growth (developed by Dixon and Thirlwall, 1975, and Thirlwall, 1980) concentrates on the demand-side (export-base) as the core reason for regional growth differences, at its centre is the Verdoorn relationship which is derived from a production function (McCombie, 1988). That is, cumulative-causation is predicated on the basis that increases in labour productivity result in improvements in the demand for exports (either because of price reductions, as in the original model, or quality improvements, as in Harris, 2011). In New Economic Geography models (e.g., Baldwin and Martin, 2004), concentration/clustering has a positive effect on productivity because of agglomeration economies (leading to firms at 'core' locations gaining an advantage), and the resultant centralisation of highly innovative, knowledge intensive firms (as well as the high skill labour they employ) is expected to perpetuate the economic advantage of the core over the periphery (i.e., cumulative-causation).

The rest of the paper is structured as follows: in the next section we review some of the literature on what determines plant-level productivity. Section 3 discusses the data used and modelling strategy for deriving estimates of plant-level TFP. This is followed by our main results: estimates of the average level of (logged) TFP by three levels of geography (11 administrative regions; 12 leading cities; and 39 English LEPs) together with a disaggregation of TFP differences into spatial versus non-spatial factors. The paper concludes with a summary and conclusions.

2. FACTORS DETERMINING PLANT-LEVEL PRODUCTIVITY[3]

Our emphasis in this section is on the variables used below to model TFP using UK micro-data. The non-spatial variables consist of measures of R&D, plant age, ownership and trade. R&D is expected to have an impact on TFP through two channels. Firstly, performing R&D may generate process innovations that allow existing products to be produced with greater efficiency or product innovations which will improve TFP if the new products are produced more advanced technology than existing products. The second channel is through the development of absorptive capacity (Cohen and Levinthal, 1989, Zahra and George, 2002; and especially Harris and Yan, 2019, for a detailed discussion of the concept), which permits the identification, assimilation and exploitation of innovations made by other firms and other R&D actors.

An 'age' variable is included to measure whether through learning-by-doing productivity increases as the plant ages (e.g., Jovanovic and Nyarko, 1996) or younger plants produce with greater efficiency and better technology than older plants. Moreover, since it is

[3] A more detailed review of literature on the micro-dynamics of productivity is available in Harris and Moffat (2012, 2015a,b, 2017) and Harris (2019).

unlikely that capital stock estimates are fully adjusted for obsolescence, there may also be a vintage capital effect and new plants may have a relative advantage in adopting new technology if existing plants face sunk costs (Campbell, 1998).

There are various dimensions of ownership that may impact upon a plant's TFP. Being foreign owned is argued to be related to higher levels of TFP. This is justified by the observation that, to make it worthwhile for a foreign firm to incur the costs of setting up or acquiring a plant in the domestic market, foreign firms must possess characteristics that give them a cost advantage over domestic firms (Hymer, 1976). These characteristics may include specialised knowledge about production or better management capabilities. Conversely, "cultural" differences between the owners of the plant and the workforce may act to lower levels of TFP in foreign owned plants (Dunning, 1988). The motivation of firms for undertaking foreign direct investment (FDI) will also have an impact on their relative TFP (Driffield and Love, 2007). For example, firms that undertake FDI to source technology from the host economy rather than to exploit superior technology from the home country are likely to have lower TFP. As well as the motivation for inward-FDI, the type of investment ('greenfield' versus 'brownfield') matters. For firms undertaking FDI in order to source technology, 'brownfield' investment would be the preferred form of investment (Buckley and Casson, 1998), implying that 'brownfield' plants may have higher TFP than 'greenfield' plants. However, 'greenfield' investments may allow foreign-owned firms to introduce more modern technology and management practices, and establish their own forward and backward supply-chains with plants that are a closer match with their own needs. As well as inward-FDI, plants operating in Britain may also belong to firms that engage in outward-FDI (whether UK-owned or foreign-owned), and it is presumed that these will also benefit from the proprietary knowledge resided in the parent company engaged in overseas investment.

Multi-plant enterprises may benefit from economies of scale (or scope), especially in industries with high transport costs that serve a large geographic market, since they are able to locate plants close to their markets. They also benefit from centralised services which assist in spreading risks, raising capital, procuring materials, supporting R&D, and engaging in sales promotion activities. Plants belonging to larger enterprises will also be at an advantage if this provides access to superior technology (Jarmin, 1999). Conversely, multi-plant firms may be less efficient if they suffer from X-inefficiency (Leibenstein, 1966) due to the greater scope for principal-agent problems.

A large literature exists on the relationship between exporting and productivity. In addition to emphasising that firms need to be more productive prior to exporting in order to overcome the fixed costs of exporting (Melitz, 2003), this literature discusses the potential for a 'learning-by-exporting' effect which further enhances exporters' productivity. This arises because firms may benefit from knowledge flows from international consumers of their outputs and also because the more competitive nature of international markets may require exporters to improve their productivity. A positive impact of importing could arise due to the superior quality of foreign intermediate inputs. In addition, the import of intermediate inputs from foreign firms could open channels of communication with more technologically advanced firms through which knowledge may be diffused. The availability of varieties of inputs that are not available domestically may also improve the productivity of importing firms. For the UK, Harris and Moffat (2015c) covered both trade in goods and services, finding that plants in both manufacturing and services that both export and import have higher productivity than plants that only do one of these activities.

The concentration of output across firms, a measure of market power, is considered to be a determinant of TFP due to its relationship with competition; under the assumption that the elasticity of demand does not vary too greatly across firms in an industry, this is a valid measure of competition within an industry (see, for example, Cabral, 2000). The theoretical premise of Nickell (1996) was that greater market competition provided firms with an incentive to reduce internal (X-) inefficiencies and therefore increase their productivity. Greater competition also raises the elasticity of demand which provides greater incentives for management to improve efficiency in order to reduce prices and realise larger profits. Others have shown that competition is good for innovation (Arrow, 1962; Scherer, 1980; Aghion and Howitt, 1999). However, it can also be argued – following Schumpeter (1943) and more recent endogenous growth theory models – that the level of competition may be inversely related to productivity if monopoly rents are required for management to invest in R&D (Dixit and Stiglitz, 1977; Aghion et al., 2001; Aghion and Howitt, 1992 and 1999; Romer, 1990; Grossman and Helpman, 1991). It has also been shown that, under some conditions, increased competition can lower the expected income of managers and therefore their effort (Hermalin, 1992).

Finally, we consider the productivity advantages or disadvantages that firms derive from their location which will be captured by the 'spatial' variables in the empirical analysis. These are spatial spillovers or agglomeration externalities - potential benefits that accrue to plants from being located in the vicinity of large concentrations of other plants - as well as other, more general, 'place – or spatial – effects' attributed to factors such as the quality of the infrastructure (e.g., access to quality transport networks, access to specialised knowledge in universities or R&D hubs), or being located in an 'assisted area' where public support to firms is available. Duranton and Puga (2004) describe the mechanisms that give rise to such agglomeration externalities; as summarised by Overman *et al.* (2009) these are: 'sharing', 'matching' and 'learning'. Marshallian (or MAR) externalities arise due to the concentration of plants from the same industry in a given area (Marshall, 1890; Arrow, 1962; Romer, 1986) . These externalities may take the form of reductions in cost from being in close proximity to upstream suppliers of inputs and downstream purchasers of outputs due to reductions in transports costs. Cost reductions may also arise due to the presence of a large pool of labour that has experience of working within the industry as this will reduce the costs of training. Finally, it may be hypothesised that knowledge spillovers may arise when firms jointly engage in R&D to solve common problems or as employees move between firms. By contrast, urbanisation or Jacobian externalities are benefits that accrue to plants from diversity in the activities of plants in a particular area (Jacobs, 1970). One explanation for the existence of such externalities is that a more diversified industrial base (e.g., in cities) will provide access to a wider array of business services. Urbanisation externalities may also take the form of knowledge spillovers which arise across industries because 'the exchange of complementary knowledge across diverse firms and economic agents facilitates search and experimentation in innovation' (Van Der Panne, 2004). Note that this conception of knowledge spillovers contrasts with the Marshallian view that knowledge spillovers are primarily an intra- rather than an inter-industry phenomenon.

Agglomeration can be captured in different ways with the most common approach being to include direct or proxy measures in models that determine productivity (Harris and

Moffat, 2015a,b)[4] such as Marshallian and Jacobsian agglomeration measures. These studies also try to capture other 'place effects' using dummy variables to proxy for the wider impacts of being located in particular geographic areas (e.g., city and/or region dummies). While such an approach – reflecting the lack of variables to capture other plant-level determinants (such as 'labour-mix' and the location of upstream suppliers – cf. Baldwin *et al.*, 2010 – or the extent to which co-agglomerating firms trade with each other and/or employ similar workers – cf. Ellison *et al.*, 2010) – is not optimal, it is better than the alternative of ignoring wider spatial impacts.

3. DATA AND MODEL ESTIMATED

Using plant-level panel data covering 2010-16 from the Annual Business Survey (ABS) conducted by the Office for National Statistics (ONS),[5] and the methodology used by Harris and Moffat (2012, 2015a,b, 2017), estimates of TFP are obtained from estimation of log-linear Cobb-Douglas production functions (including fixed-effects)[6] using system-GMM (Blundell and Bond, 1998) to address the issues of endogeneity inherent to production function estimation.[7] The model is:

$$\tilde{r}_{it} \equiv y_{it} + p_{it} - p_{It}$$
$$= \left(\frac{\sigma-1}{\sigma}\right)(\alpha_i + \alpha_E e_{it} + \alpha_M m_{it} + \alpha_K k_{it} + \alpha_X X_{it} + \alpha_T t) + \frac{1}{\sigma}(r_{It} - p_{It}) + \varepsilon_{it} \qquad (1)$$

where $\tilde{r}_{it}$ is revenue, y_{it} is output, p_{it} is price, e_{it} is employment, m_{it} is intermediate inputs,[8] k_{it} is the capital stock in plant i at time t. X_{it} is a vector of variables determining

[4] The results from this work suggest – see Harris (2017, Table 4.1) – intra-industry agglomeration has an important and significant affect in most sectors (particularly in manufacturing) but (ceteris paribus) diversification is often significant *but* negative (perhaps reflecting congestion costs). Similar results have been obtained for the US – see Henderson (2003), Baldwin et al (2010), Martin et al. (2011).

[5] The period covered in this study begins in 2010 and ends with the latest data available to us (2016); this is because the ABS did not start collecting information on the exporting and importing of goods until 2011. Since the model estimated below is dynamic (i.e., involves a one-year lag in the data), observations are not required for 2010 for exporting and importing of goods. Note also, the ABS has included information on exporting and importing of services for a much longer period, but to include the impact of trade we need both goods and services data.

[6] The inclusion of fixed effects is necessary as empirical evidence using plant- and firm-level panel data (BAILY *et al.,* 1992; BARTELSMAN and DHRYMES, 1998; HASKEL, 2000; MARTIN, 2008) shows that the distribution of productivity is persistent. Such persistence suggests that plants have 'fixed' characteristics (associated with access to different path dependent resources, managerial and other capabilities) that change little through time.

[7] Estimators (such as OLLEY and PAKES, 1996; LEVINSOHN and PETRIN, 2003) that purport to overcome these endogeneity issues are based on assumptions we believe are more restrictive than those implied by system-GMM (ACKERBERG *et al.*, 2015). In particular, these estimators do not allow for fixed effects, which are important (see footnote 6). DEL GATTO *et al.* (2011) and VAN BEVEREN (2012) provide useful surveys on these different approaches to measuring TFP. Note, equation (1) is estimated in dynamic form (providing short-run estimates), and these are converted to long-run (equilibrium) values to obtain the long-run relationship between output and factor inputs.

[8] Intermediate inputs cover materials, fuels, semi- and finished-goods and (especially business) services used in the production of new goods and services. We do not estimate a gross valued-added function to avoid the imposition of weak separability (capital and labour are separable from intermediate inputs in production) and thus homogeneity with respect to α_M - see GANDHI *et al.* (2012) for a discussion.

TFP (as set out in Table A.1 below). Since individual firm level prices (p_{it}) are not observed, and firm's nominal gross output is therefore deflated by *industry* price (p_{It}) to obtain output in constant prices, then if firm prices depart systematically from the average industry price level, estimating the production function results in biased parameter estimates because of the omitted firm price variable; hence, $(r_{It} - p_{It})$ (the natural logarithm of real industry output) is included to address any omitted price bias (Ehrl, 2013), with σ being the elasticity of demand obtained from the firm's demand function.[9] ε_{it} is an error term capturing both demand and production shocks (i.e., $\varepsilon_{it} = \varepsilon_{it}^{d} + \varepsilon_{it}^{s}$); and e_{it}, m_{it} and k_{it} are treated as endogenous.

Logged TFP can be calculated as the level of (logged) output that is not attributable to factor inputs– i.e., TFP is due to efficiency levels and technical progress – having corrected for omitted price bias:[10]

$$\widehat{lnTFP_{it}} = \tilde{r}_{it} - \frac{1}{\hat{\sigma}}(r_{It} - p_{It}) - \left(\frac{\hat{\sigma}-1}{\hat{\sigma}}\right)(\hat{\alpha}_E e_{it} + \hat{\alpha}_M m_{it} + \hat{\alpha}_K k_{it}) \quad (2a)$$

$$= \left(\frac{\hat{\sigma}-1}{\hat{\sigma}}\right)(\hat{\alpha}_i + \hat{\alpha}_X X_{it} + \hat{\alpha}_T t) + \hat{\varepsilon}_{it} \quad (2b)$$

Equation (1) was estimated separately for 12 industry sub-groups defined according to their technology. Industries were classified using OECD and Eurostat definitions,[11] although with some minor amendments. Table U.1 in the unpublished appendix sets out the classifications. We have excluded Electricity, Gas and Water supply (SIC40-41) and Construction (SIC45) mainly due to a lack of data on capital stocks. All data were weighted to ensure that the samples are representative of the population of GB plants.

The detailed results from estimating equation (1) are not the main focus in this paper and so are provided in an unpublished appendix (Table U.2). The elasticities of output with respect to the factor inputs that are used to calculate $\widehat{lnTFP_{it}}$ are presented in Table 1 (along with the diagnostic tests associated with each of the 12 equations estimated). The estimates obtained are economically sensible and pass tests of the validity of the instruments used (the Hansen test) and tests of second-order autocorrelation.

(Table 1 around here)

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[9] That is, a DIXIT and STIGLITZ (1977) constant elasticity of substitution firm-level demand function is assumed:

$$y_{it}^{d} = -\sigma(p_{it} - p_{It}) + q_{It} + \varepsilon_{it}^{d} \quad (3)$$

where y_{it}^{d} is the (logged) demand for output from firm i; q_{It} is an aggregate demand shifter; and ε_{it}^{d} represents demand shocks faced by the firm. Hence, $(\sigma/\sigma - 1)$ measures the mark-up (or mark-down – see CASELLI et. al., 2018), of price over marginal cost, and thus the extent to which firms exploit market power.

[10] TFP here comprises those factors contained in X_{it} that influence efficiency and technological progress. It also comprises an error term ($\hat{\varepsilon}_{it}^{s}$), which will pick up any unobserved inputs (e.g., intangibles not captured by the R&D variable, the use of outsourcing, increased quality of labour inputs, etc.), and changes in the level of utilisation of factor inputs. Since the current approach estimates a reduced-form model (equation 1) it is not possible to separate $\hat{\varepsilon}_{it}$ into the separate components $\hat{\varepsilon}_{it}^{d}$ and $\hat{\varepsilon}_{it}^{s}$., Approaches used in the literature that exclude X_{it} from the right-hand-side of (1) treat X_{it} as part of the random error term ($\hat{\varepsilon}_{it}^{s}$), and it is to be expected that estimates of the coefficients on the factor inputs and thus $\widehat{lnTFP_{it}}$ from such an approach to be biased because of an omitted variable(s) problem.

[11] E.g. https://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an2.pdf; and https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Knowledge-intensive_services_(KIS).

The results in Table U.2 shows that, overall, UK-owned plants belonging to firms engaged in outward FDI, plants that were foreign-owned, plants belonging to firms that engaged in R&D and trade, were generally more productive (ceteris paribus) than those who did not have these characteristics, which is in line with past empirical work, and prior expectations based upon the likely comparative advantages attached to such practices. The effect of urbanisation and agglomeration was small with the former having no significant impact in manufacturing and a negative effect in services; by contrast, the estimated coefficient on the agglomeration variable was positive and significant in most industries. These results are in line with previous results in the literature (see footnote 9 above).

4. DIFFERENCES IN PRODUCTIVITY LEVELS ACROSS SPACE

(a) Productivity levels

TFP estimates were calculated for each plant for 2010-16 using equation (2a),[12] to provide (weighted) means[13] at three levels of geography: (i) the 11 administrative regions of Great Britain; (ii) 12 leading cities and their non-city hinterlands; and (iii) 39 English LEPs (the English LEPs, shown in Figure U.1. in the online appendix, are supplemented with Glasgow, Edinburgh, the rest of Scotland, and Wales to ensure coverage of Great Britain). Table U.3 in the unpublished appendix shows that TFP was highest in high-tech sectors, with manufacturing high-tech plants having the highest mean TFP. Plants in the (other) low-KI market services sector (which here includes wholesale, retail and hotels and restaurants) generally had the lowest mean levels of TFP during 2010-16.

(Table 2 around here)

Table 2 shows the mean, 80th percentile and 90th percentile of *ln* TFP for plants operating in the administrative regions of Great Britain during 2010-2016. Regions are ranked from highest (London) to lowest (Wales), on the basis of the mean data provided for all sectors (column 1). The correlation between the mean, 80th percentile and 90th percentile in all three sectoral groupings is above 0.97 while the correlation between the means for Manufacturing and Services is 0.97; this indicates that regional rankings are very consistent across mean values, the top percentiles, and sectors. The gap between the highest and lowest regions when all sectors are considered (column 1) is 0.29, and this increases to 0.40 and 0.66, respectively, when looking at the 80th and 90th percentiles (columns 2 and 3), showing that the largest differences across regions are between plants

[12] The results obtained using equation (2a) were modified for presentational purposes by subtracting 2.53 from each plant-level estimate; essentially the constant subtracted is equal to the average value of the intercept term obtained across the 12 production functions estimated.

[13] These are means of the plant-level estimates of TFP (weighted to ensure the ABS data is representative of the population of plants in operation in Great Britain); estimates have not been additionally weighted by each plant's share in total gross output. Doing the latter would result in an aggregate estimate of TFP (for the sub-group being considered) that also takes into account how much (gross output) each plant contributes to overall sales. Below, we present information on the entire distribution of TFP for sub-groups of plants, to show that our preferred results (only weighted by population weights) are not misleading. We have also calculated 'double-weighted' estimates, and the correlation between weighted and double-weighted means across LEPs is 0.972, 0.946 and 0.961 for all sectors, manufacturing with HT KI services and services (less HT KI services). Full results are provided in Table U.4 in the unpublished appendix.

at the top end of the TFP distribution. The last row in Table 2 shows the gap between London and the next highest region, the South East, indicating that (with respect to highs and lows in columns 4 and 6) some 40-48 per cent of the top-to-bottom gap is accounted for by the gap between London and the South East; that is, productivity differences between London and other regions are far greater than differences between other regions. Table 2 also shows that, aside from Scotland, productivity levels generally fall when moving towards the north and periphery of Great Britain (cf. McCann, 2016).

Table U.5 provides the full set of information including (weighted) mean values and the 80th and 90th percentiles, for each of the English LEPs as well as Glasgow, Edinburgh, the rest of Scotland and Wales.[14] Figure 1 summarises the mean values, showing significantly higher TFP for the London and adjacent LEPs mostly north and south of London (viz., Thames Valley, Enterprise M3, Hertfordshire and Coast-to-Capital). The correlation between the means of TFP across LEPs for manufacturing and services is 0.82, indicating that rankings are similar across sectors (hence, the similarity between Figures 1b and 1c). As with larger administrative regions (Table 2), aside from Scotland, productivity levels generally fall when moving towards the north and periphery of Great Britain. Cumulative distributions of *ln* TFP are provided in Figure U.2 for a selection of LEPs. These confirm the dominance of London, especially in manufacturing, and relatively little evidence of different rankings of LEPs at different points of the TFP distribution.

(Figure 1 around here)

(Table 3 around here)

Table 3 shows the mean productivity (ranked from highest-to-lowest) of the major cities both relative to the South East region and their regional hinterlands.[15] Across all sectors, London and Edinburgh have statistically significantly higher productivity than the South East region; all other cities have lower productivity than the South East (although the difference is not statistically significant for Glasgow and Nottingham). For manufacturing (with HT KI market services) London, Glasgow and Manchester have higher average *ln* TFP vis-à-vis the South East while in Nottingham and Edinburgh the differential is positive (although not significantly different to zero). As to whether cities have higher TFP than their hinterlands (the rest of the region in which they are located, excluding any major city), there is a significant differential in manufacturing for Manchester, Nottingham and Glasgow, and to a lesser extent Cardiff, Coventry, Edinburgh and Liverpool. In other cities for manufacturing there is no statistically significant difference with their hinterlands (although the differential is positive). In services, Cardiff, Liverpool, Bristol and Edinburgh have higher average TFP, while Glasgow and Leicester have significantly lower TFP than their hinterlands; for other cities the difference is not statistically different to zero. (the cumulative distributions of *ln* TFP across plants for both the city or cities compared to the rest of the region in which they are located are provided in Figure U.3).

[14] The correlation between mean values for all sectors and those of the 80th and 90th percentiles, for both manufacturing and services is never less than 0.94.

[15] These results are not directly comparable to those reported in Table 3 in HARRIS and MOFFAT (2012); not only are different periods covered (1997-2006 in HARRIS and MOFFAT, op. cit.), but the approach used in that paper involves predicting TFP using only spatial factors (rather than all variables in the present paper).

(b) Spatial versus non-spatial factors

The results presented in the previous section confirm that there exist substantial differences in average productivity levels across different spatial areas – especially London versus other administrative regions and cities, and London and surrounding LEPs vis-à-vis other LEPs in England. These differences arise from both non-spatial and spatial impacts, with the latter including where the plant is located (in terms of LEP, and main city) as well as whether it was in an assisted area and the extent to which plants co-locate in each travel-to-work area (represented by measures of urbanisation and agglomeration), Note, we expect all of these variables – industrial agglomeration and diversification, as well as assisted-area status, and LEP and city location – to capture different aspects of 'spillovers', with different locations (e.g., a single city) experiencing a mix of potentially diverse impacts.

To provide insights into the relative role of non-spatial and spatial effects, we have disaggregated equation (2b) into two parts reflecting the different effects, and calculated differences between each spatial area and London as the benchmark. That is, we define the (weighted) average *ln* TFP differences for each region/LEP/city relative to London as:[16]

$$\sum_{it}^{N^r} \widehat{lnTFP}_{it}^{r}/N^r - \sum_{it}^{N^L} \widehat{lnTFP}_{it}^{L}/N^L = \sum_{it}^{N^r} \hat{\alpha}_{X\in NS}(\bar{X}_{it}^{r} - \bar{X}_{it}^{L}) + \sum_{it}^{N^L} \hat{\alpha}_{X\in S}(\bar{X}_{it}^{r} - \bar{X}_{it}^{L}) \quad (4)$$

where N^r is the number of plants i across time t in r (region/LEP/city), and N^L is the number of plants in L (London); $X \in NS$ are the non-spatial determinants (e.g., *ln* age, ownership, R&D, trade, and industry dummies) listed in Table A.1; $X \in S$ are the spatial determinants (i.e.., assisted area, urbanisation index, agglomeration index, and LEP and city dummies); and $\hat{\alpha}_X$ are the estimated output elasticities for the *X* variables (see Table U.2). Note, the constant term from the regression measuring average fixed effects is included in the non-spatial part of equation (4), but this cancels out across plants within an industry. We have also ignored the error term in equation (2b) because its average value was close to zero across plants in 2010-16 and it includes demand shocks, ε_{it}^{d} (Table U.2 which presents the full set of results shows that R^2 – calculated as the correlation squared between predicted and actual $\tilde{r}_{it}$ in equation (1) – was very high for each of the production functions estimated).

(Figure 2 around here)

Tables U.6 – U.8 present the full results from applying equation (4) to disaggregate the difference between (weighted) average *ln* TFP in each area and London. Our results show that the importance of spatial factors in accounting for the differential between productivity in London and other areas is higher than expected: across the LEPs it accounts for on average between 41.2-49.6% of the differential depending on the sector.

[16] It is important to recognise that equation (1) as estimated does not allow for the parameters of the production function to vary across spatial areas, except in the case of the LEP and city dummies. This means that for the most part, differences across space are due to 'mix' – the extent to which a geographical area has more or less of a characteristic that has a positive or negative output elasticity and hence a positive or negative impact on TFP. In principle, equation (1) could be reformulated to not just include LEP and/or city dummies (which show deviations across areas vis-à-vis the overall regression intercept term), but also allow for each variable in the vector X to have a different slope term across LEP/city (this could be achieved by including a large number of composite dummies). But, in practice we find that such an extended approach cannot be used within a sys-GMM framework, as the model fails to converge, fails to provide tests for overidentification that pass the Hansen test, and/or provides parameter estimates that are not credible.

Figure 2 presents the results from Table U.6 showing how the *ln* TFP differential is accounted for across the LEPs; for all sectors, Thames Valley Berkshire did better than London (by 0.006), due to a 0.036 and -0.030 contribution from non-spatial and spatial factors, respectively (i.e., the effect of 'better' non-spatial characteristics of plants in Thames Valley Berkshire than London is effectively cancelled out by the negative effect of location). For most LEPs, the differential with London is the result of both negative non-spatial and spatial effects (e.g., in Cornwall & the Isles of Scilly the non-spatial and spatial contributions for all sectors are -0.247 and -0.110, respectively, resulting in an overall differential with London of -0.357); but for certain LEPs large negative non-spatial (spatial) effects are counter-balanced by positive spatial (non-spatial) effects, such as the West of England LEP (the latter has favourable non-spatial characteristics, leading to a contribution of 0.128 but the spatial contribution is -0.329, hence an overall TFP differential of -0.201). For manufacturing (including HT KI services), non-spatial and spatial effects are always both negative (except for Thames Valley Berkshire where they are both positive, hence its positive differential vis-à-vis London of 0.117).

5. SUMMARY AND CONCLUSIONS

The use of aggregate labour productivity data to underpin LIS's is problematic because of the sensitivity of the measure to factor input ratios and inability to capture the distribution of productivity. There is therefore an urgent need for estimates of TFP - which measures the productivity of all factors of production - at a disaggregated spatial level, so that LEPs are able to gauge the extent to which they have productivity problems, and analysis of the sources of differences in TFP across LEPs. This paper has therefore provided information for 2010-16 on both the level of TFP in different geographical areas, and the extent to which differences can be accounted for by 'spatial' factors.

In terms of average TFP, London was ranked highest and Wales the lowest (with regional rankings being very consistent across mean values, the top percentiles, and sectors). The gap between London and the next highest region, the South East, accounted for some 40-48 per cent of the gap between London and Wales; that is, productivity differences between London and everywhere else dominates with differences between the other regions being much smaller. Aside from Scotland, productivity levels generally fall when moving towards the north and periphery of Great Britain. As to productivity across the LEPs, there was significantly higher TFP for the London and adjacent LEPs mostly north and south of the capital (viz., Thames Valley, Enterprise M3, Hertfordshire and Coast-to-Capital). Lastly, with respect to the mean productivity of the major cities, only London and Edinburgh have significantly higher productivity than the South East region. In manufacturing, 7 out of 11 major cities had higher productivity than their hinterlands (the rest of the region in which they are located, excluding any major city) but in services this was reduced to only 4 with two cities having significantly lower TFP than their hinterlands. As to the relative importance of spatial factors in accounting for the differential between productivity in London and other LEPs, this accounts for on average between 41-50% of the differential depending on the sector considered. For most LEPs the differential with London is due to negative non-spatial and spatial effects; but for certain LEPs large negative non-spatial (spatial) effects are counter-balanced by positive spatial (non-spatial) factors, although for manufacturing non-spatial and spatial effects are always both negative (except for Thames Valley Berkshire where they are both positive).

Further work is needed to understand better what determines these spatial differentials particularly as an aid to policy-makers. That is, we recognise the small number of determinants of spatial factors that we were able to include in the modelling of TFP, because the UK plant-level dataset does not contain such information (and is unlikely to do so in the future). While we have direct estimates to account for agglomeration and whether a plant was located in an assisted area, we have to rely on proxies for other spatial factors in the form of simple LEP and city dummy variables to capture differences across areas covering potentially a wide range of influences (including the general 'infrastructure' surrounding plants in the areas in which they operate, including physical infrastructure and labour market composition and skills). In particular, we do not have information on inter-plant linkages (either input-output trade linkages nor from whom, and thus where, plants obtain external knowledge and information). So while we have been able to provide estimates of the importance of spatial influences on TFP, in the future more needs to be done theoretically and empirically to explain more fully the factors that lie behind such influences and how they evolve over time.

As to policy implications, in order for LEPs to devise strategies at the local level that will underpin the policies that lead to higher productivity, they need to know the size of the task (and which sectors of particular importance to them have significant problems). The data underpinning the analysis presented here can be used by LEPs at a much more granular level (e.g., by different industries, different sub-areas, by ownership sub-groups and by looking at the data on those who trade and/or engage in R&D). But there are also wider policy implications to be drawn from our results; such as the sheer size of the task of rebalancing the economy given the dominance of London (and its immediate hinterland) both in terms of its significantly higher levels of TFP but also its size (the ABS data used shows that on average over 2010-2016, the London LEP accounted for over 18% of employment, 25% of gross value-added and 30% of gross output). We have also found that the South East tends to outperform most (smaller) cities – or at least do as well – in terms of productivity, while cities do not outperform their hinterlands to the extent that might be expected given popular views on their importance (e.g., a typical example is the UK Department of Business, Enterprise and Regulatory Reform (BERR, 2008)[17] policy document which states: 'larger, more diversified cities tend to be better placed to provide the flexibility required to take advantage of the opportunities and the challenges of globalisation and the knowledge-driven economy. However, specialised cities can bring significant value to those industries that benefit from localisation (including input sharing) and clustering with firms in the same sector'). Such information needs to be factored into the work of the Industrial Strategy Council that was set-up in 2018 to "… hold the government to account by monitoring its success in delivering the Industrial Strategy and its impact on the economy" (BEIS, 2018c).

[17] BERR is now the Department of Business, Energy and Industrial Strategy (BEIS).

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Table 1: Output elasticities used to obtain TFP estimates

Sectors[a]	Output Elasticities				Autocorrelation z-statistics		Hansen test χ^2	Observations	Plants
	α_M	α_E	α_K	α_T	AR(1)	AR(2)			
Manufacturing									
High-tech	0.826***	0.277***	0.111*	-0.015**	-4.137***	-1.492	8.294	3,551	1,348
Medium high-tech	0.205***	0.851***	0.192**	0.013***	-1.425	0.102	1.519	9,514	3,687
Medium low-tech	0.375***	0.604***	0.282**	0.010	-3.615***	-1.590	7.871	11,990	4,580
Low-tech	0.713***	0.288***	0.270***	0.005	-1.993**	-0.490	11.310	17,335	6,090
Services									
High-tech KI	0.622***	0.458***	0.181*	0.032***	2.906***	0.882	5.368	36,586	10,178
KI Market	0.247*	0.576**	0.229*	0.029***	-3.503***	-0.481	1.336	25,650	9,798
Low KI	0.374***	0.697***	0.126*	0.022***	-7.054***	1.693*	3.159	242,901	76,527
Other Low KI	0.785***	0.127*	0.136**	0.002	-6.293***	1.100	9.013	117,406	27,613
Wholesale	0.540***	0.487***	0.094***	0.027***	-1.314	-1.611	2.873	80,277	22,130
Retail (part)	0.336***	0.562***	0.240***	0.017***	-15.560***	1.482	1.773	144,015	31,534
Specialist retail	0.588***	0.365***	0.087***	0.021***	-11.012***	-1.640	16.210	250,332	61,698
Hotels & restaurants	0.337**	0.566***	0.126**	-0.019**	-6.351***	-1.441	1.436	146,743	38,994

[a] See Table U.1 ***/**/* significant at 1%/5%/10% level. Source: Table U2 for full details.

Table 2: Means and 80th and 90th percentiles of ln TFP 2010-16 by administrative region

Region	All Sectors			Manufacturing + High-tech KI Market Services			Services – High-tech KI Market Services		
	Mean[a]	p80	p90	Mean[b]	p80	p90	Mean[b]	p80	p90
London	0.561	1.272	1.941	1.028	1.985	2.721	0.468	1.154	1.700
South East	0.415	1.086	1.616	0.818	1.612	2.226	0.338	0.974	1.459
Scotland	0.391	1.042	1.550	0.779	1.516	2.098	0.336	0.962	1.447
Eastern	0.338	1.005	1.480	0.715	1.476	2.068	0.271	0.893	1.345
North East	0.337	0.980	1.394	0.745	1.474	2.083	0.277	0.907	1.300
West Midlands	0.332	0.961	1.406	0.670	1.351	1.891	0.267	0.869	1.290
North West	0.321	0.980	1.398	0.734	1.450	2.030	0.257	0.901	1.290
East Midlands	0.321	0.942	1.369	0.662	1.373	1.931	0.254	0.833	1.259
Yorkshire-Humberside	0.313	0.936	1.348	0.687	1.379	1.901	0.247	0.845	1.234
South West	0.287	0.908	1.356	0.662	1.412	1.924	0.225	0.811	1.239
Wales	0.267	0.871	1.285	0.601	1.367	1.886	0.218	0.788	1.184
Gap (highest-to-lowest)	0.294	0.401	0.656	0.427	0.618	0.835	0.250	0.366	0.516
Gap (London with South East)	0.146	0.186	0.325	0.210	0.373	0.495	0.130	0.180	0.241

[a] mean values are all significantly less (at the 1% level) than that of the South East except London (which is significantly larger at 1% level)

[b] mean values are all significantly less (at the 1% level) than that of the South East except Scotland (not significant) and London (which is significantly larger at 1% level)

Table 3: Relative mean ln TFP 2010-16 by city and sector

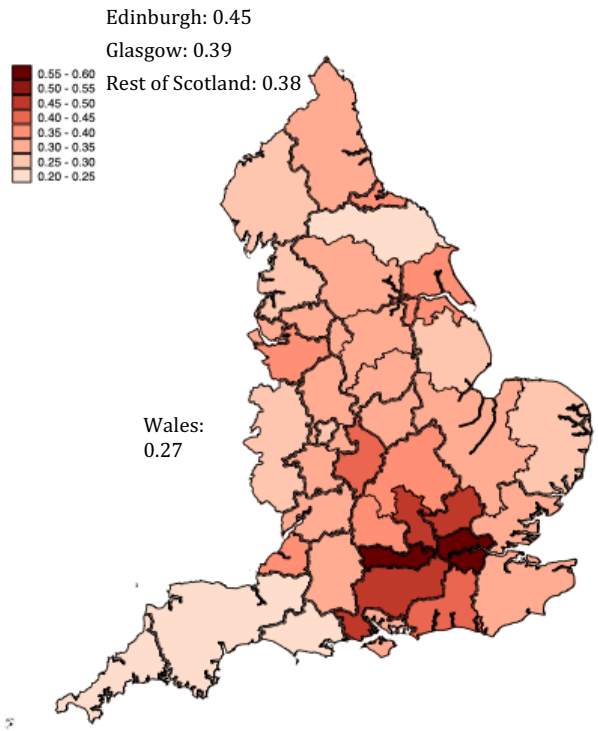
City	All Sectors		Manufacturing + High-tech KI Market Services		Services – High-tech KI Market Services	
	City – South East[a]	City – rest of region	City – South East	City – rest of region	City – South East	City – rest of region
London	0.145***		0.209***		0.129***	
Edinburgh	0.044*	0.076***	0.082	0.180***	0.046*	0.048*
Glasgow	-0.032	0.000	0.181***	0.279***	-0.052**	-0.050**
Nottingham	-0.042	0.055*	0.107	0.285***	-0.061**	0.020
Liverpool	-0.046**	0.054**	0.012	0.131*	-0.027	0.056**
Coventry	-0.056*	0.026	0.031	0.191**	-0.072**	-0.002
Bristol	-0.057*	0.078***	-0.056	0.111	-0.062**	0.056*
Manchester	-0.067***	0.033	0.230***	0.349***	-0.098***	-0.015
Cardiff	-0.068**	0.093***	-0.050	0.195*	-0.056**	0.074***
Birmingham	-0.091***	-0.009	-0.134***	0.026	-0.080***	-0.010
Tyneside	-0.092***	-0.018	-0.048	0.032	-0.077***	-0.021
Leicester	-0.118***	-0.021	-0.111	0.067	-0.150***	-0.069**

[a] Administrative region (not LEP). Note, mean productivity in the South east was 0.415, 0.818, and 0.338, respectively for all sectors, manufacturing (plus HT KI market services) and the rest of services (Table 2)

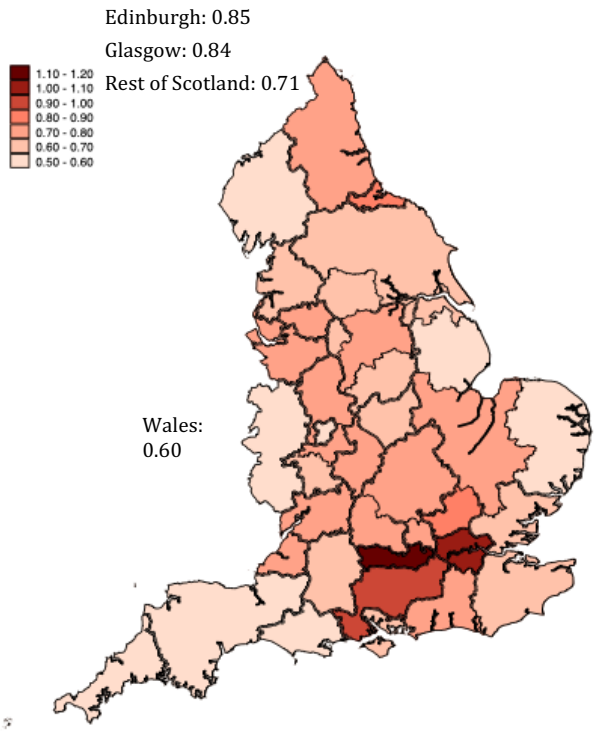
***/**/* statistically significant (based on *t*-tests) at 1/5/10% levels.

Figure 1: Mean ln TFP 2010-16 by LEP

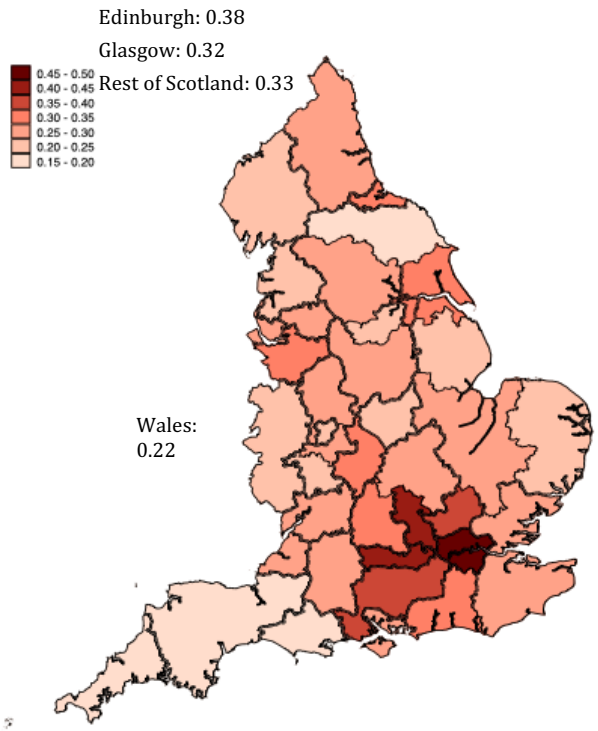
(a) All sectors



(b) Manufacturing + high-tech KI market services

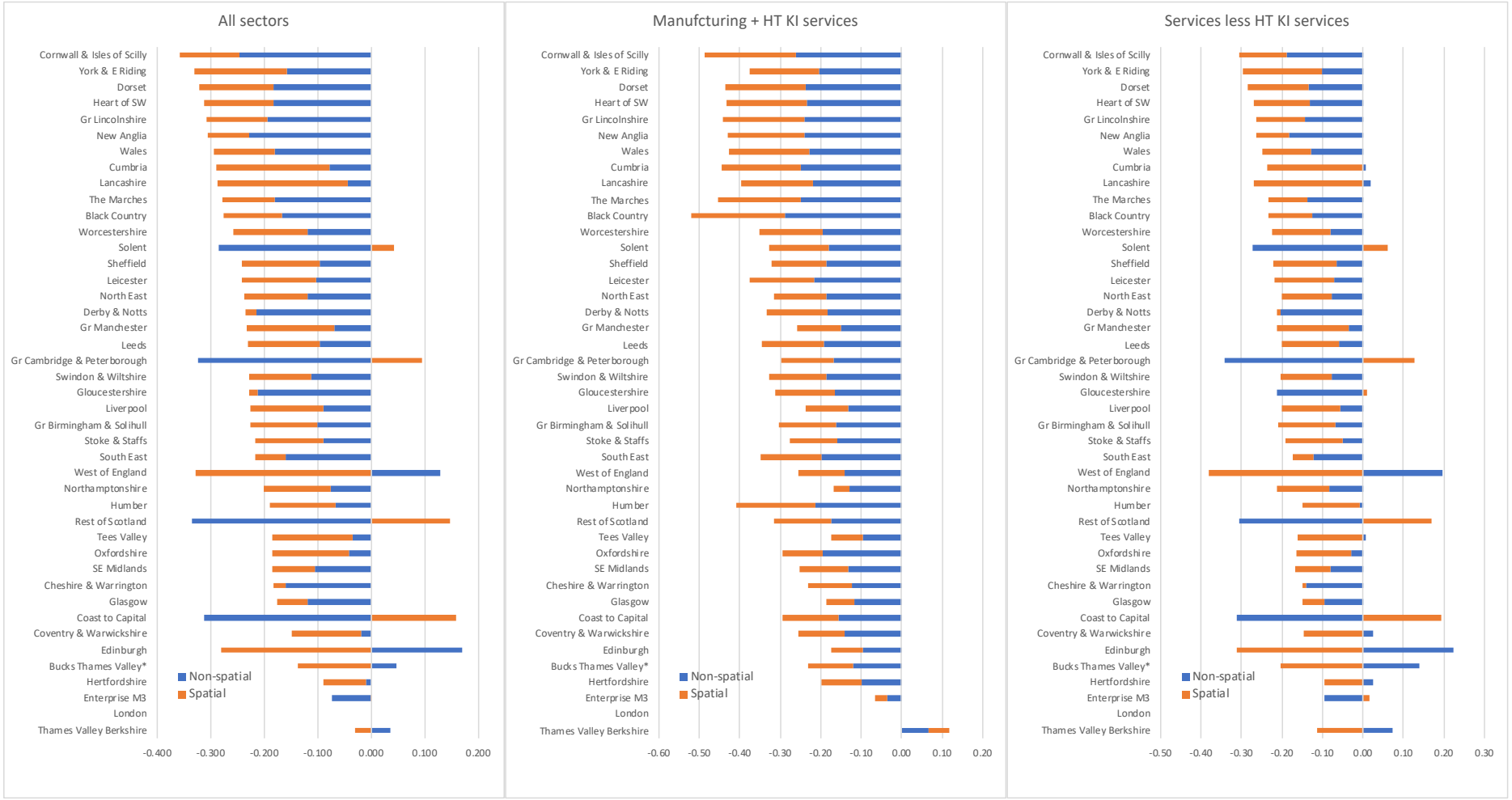


(c) Services minus high-tech KI market services



Source: Table U.5

Figure 2: Differences compared to London of mean ln TFP 2010-16 by LEP in England and Scotland and Wales: contribution of spatial and non-spatial factors



Source: Table U.6

APPENDIX

Table A.1 Definitions of variables used (weighted) all sectors, 2010-2016

Variable	Definition	Mean	Std. Dev.	Source
ln gross output	*ln* real gross output (£m 2000 prices)	5.336	1.967	ABS
ln Intermediate Inputs	*ln* intermediate inputs (gross output - GVA) (£m 2000 prices)	4.361	2.356	ABS
ln Employment	*ln* numbers employed in plant	1.594	1.320	ABS
ln Capital	*ln* plant and machinery capital stock (£m 1995 prices) plus real value of plant & machinery hires. Source HARRIS and DRINKWATER (2000, updated)	-3.568	4.033	ABS
ln Age	*ln* number of years since year of opening	1.925	0.938	ABS
Single-Plant Enterprise	Dummy coded 1 if plant comprises a single-plant enterprise	0.685	0.465	ABS
Multi-Region Enterprise	Dummy coded 1 if plant belongs to an enterprise operating plants in more than one UK region	0.291	0.454	ABS
Outward FDI	Dummy coded 1 if plant belongs to a GB or GB-registered foreign-owned firm involved in outward FDI	0.114	0.318	AFDI
GB outward FDI	Dummy coded 1 if plant belongs to a GB foreign-owned firm involved in outward FDI	0.099	0.299	AFDI
Brown-USA	Dummy coded 1 if plant is US-owned and not newly opened during 2010-2016	0.018	0.132	ABS
Brown-EU	Dummy coded 1 if plant is EU-owned and not newly opened during 2010-2016	0.032	0.177	ABS
Brown-OFO	Dummy coded 1 if plant is other country foreign-owned and not newly opened during 2010-2016	0.017	0.128	ABS
Green-USA	Dummy coded 1 if plant is US-owned and newly opened during 2010-2016	0.007	0.081	ABS
Green-EU	Dummy coded 1 if plant is EU-owned and newly opened during 2010-2016	0.014	0.117	ABS
Green-OFO	Dummy coded 1 if plant is other country foreign-owned and newly opened during 2010-2016	0.006	0.076	ABS
R&D	Dummy coded 1 if plant has positive R&D stock[a]	0.019	0.137	BERD
R&D rest enterprise	Dummy coded 1 for rest of enterprise which owns a plant with positive R&D stock	0.065	0.247	BERD
Export only	Dummy coded 1 if plant exports goods and/or services but does not import	0.049	0.217	ABS
Import only	Dummy coded 1 if plant imports goods and/or services but does not export	0.076	0.266	ABS
Export & import	Dummy coded 1 if plant both exports and imports	0.172	0.377	ABS
Assisted area	Dummy coded 1 if plant is located in an area eligible for EU structural funds assistance	0.272	0.445	ABS
Subsidy	Dummy coded 1 if plant received a subsidy to reduce the price of products sold into a market environment	0.193	0.395	ABS
Urbanisation	Percentage of 5-digit industries located in travel-to-work (TTWA) area in which plant is located – Jacobian spillovers	-0.227	2.283	ABS
Agglomeration	Percentage of industry output (at 5-digit SIC level) located in TTWA in which plant is located – MAR spillovers	-0.462	0.223	ABS
Herfindahl Index	Herfindahl index of industry concentration (3-digit level)	-2.939	0.866	ABS
Cities	Dummy coded 1 if plant is located in major city (defined by NUTS3 code)[b]	0.244	0.429	ABS
LEP	Dummies coded 1 if plant is located in particular LEP			
Industry	Dummies coded 1 if plant is in particular 4-digit standard industrial classification industry			
Unweighted N		1,681,652		

[a] R&D stocks are computed using the perpetual inventory method comprising adding together 1/3rd gross stock (assuming length of life of an R&D investment is 5 years) and 2/3rd net stock (assuming 20% straight-line depreciation rate)

[b] These are London, Manchester, Birmingham, Glasgow, Edinburgh, Cardiff, Tyneside, Liverpool, Bristol, Nottingham, Leicester and Coventry. Note in estimated model, separate dummies were entered for each city.

Source: OFFICE FOR NATIONAL STATISTICS (2018a, b, c)

UNPUBLISHED APPENDIX

Table U.1: Technology definitions (SIC 1992 codes)

Sector	SIC code
High-tech manufacturing	Pharmaceuticals (SIC244); Office machinery & computers (SIC30); Radio, TV & communications equipment (SIC32); Medical & precision instruments (SIC33); Aircraft & spacecraft (SIC353).
Medium high-tech manufacturing	Chemicals (SIC24 exc. Pharmaceuticals, SIC244); Machinery & equipment (SIC29); Electrical machinery (SIC31); Motor vehicles (SIC34); Other transport equipment (SIC 35 exc. Ships & boats, SIC351, and Aircraft & spacecraft, SIC353)
Medium low-tech manufacturing	Coke & petroleum (SIC23); Rubber & plastics (SIC25); Other non-metallic (SIC26); Basic metals (SIC 27); Fabricated metals (SIC28); Ships & boats (SIC351)
Low-tech manufacturing	Food & beverages (SIC15); Tobacco (SIC16); Textiles (SIC17); Clothing (SIC18); Leather goods (SIC 19); Wood products (SIC 20); Paper products (SIC21); Publishing, printing (SIC22); Furniture and other manufacturing (SIC36); recycling (SIC37)
High-tech knowledge intensive (KI) services	Telecoms (SIC642); Computer & related (SIC72 exc. Maintenance & repair, SIC725); R&D (SIC73); Photographic activities (SIC7481); Motion pictures (SIC 921); Radio & TV activities (SIC922); Artistic & literary creation (SIC9231)
KI services	Water transport (SIC61); Air transport (SIC62); Legal, accountancy & consultancy (SIC741 exc. Management activities of holding companies, SIC7415); Architecture & engineering (SIC742); Technical testing (SIC 743); Advertising (SIC744)
Low KI services	Repairs (SIC50); Land transport (SIC60); Support for transport (SIC63); real estate (SIC70); Renting machinery (SIC 71); Maintenance & repair of office machines (SIC725); Management activities of holding companies (SIC7415); Labour recruitment (SIC745); Investigation services (SIC746); Industrial cleaning (SIC747); Packaging (SIC7482); Secretarial services (SIC7483); Other business services (SIC7484); Sewage & refuse (SIC90)
Other low KI services	Postal services (SIC641); Membership organisations (SIC91); Other entertainment services (SIC923 exc. Artistic & literary creation, SIC9231); News agencies (SIC924); Sporting activities (SIC926); Other recreational activities (SIC927); Other services (SIC93).
Wholesale[a]	SIC51
Specialist retail[a]	SIC522-4
Retail (part)[a]	Rest of SIC52 excluding specialist retail
Hotels & restaurants[a]	SIC55

[a] Usually included in 'low KI services' but estimates of equation (1) uses these separate sub-groups as the numbers of observations is otherwise very large and estimation is problematic.

Table U.2: Long-run parameter estimates of production function using System-GMM (1980 SIC), 2010-2016 – dependent variable ln gross output

	High-tech Manufacturing	Medium High-tech Manufacturing	Medium Low-tech Manufacturing	Low-tech Manufacturing	High-tech KI Services	KI Market Services
ln Intermediate Inputs	0.826***	0.205***	0.375***	0.713***	0.622***	0.247*
ln Employment	0.277***	0.851***	0.604***	0.288***	0.458***	0.576**
ln Capital	0.111*	0.192**	0.282**	0.270***	0.181*	0.229*
Time trend	-0.015**	0.013***	0.010	0.005	0.032***	0.029***
ln Age	-0.040	-0.223***	-0.279**	-0.366***	-0.371***	-0.302*
Single-Plant Enterprise	0.169**	-0.064	0.085*	0.209***	0.330***	0.085*
Multi-Region Enterprise	0.062	0.099***	0.114	0.030	0.022	-0.111
Outward FDI	-0.181***	-0.083	-0.017	-0.035	-0.039	-0.213**
GB outward FDI	0.208***	0.172**	0.121	0.022	0.073	0.502***
Brown-USA	0.038	0.291***	0.010	-0.119**	0.245***	0.643**
Brown-EU	0.043	0.367***	0.189***	-0.181**	0.349***	0.316**
Brown-OFO	0.001	0.203**	0.159***	-0.096	0.004	0.636***
Green-USA	-0.042	0.246*	0.404***	0.207***	0.487***	0.272*
Green-EU	0.133**	0.301***	0.112**	-0.111**	0.205***	0.111
Green-OFO	0.096	0.423***	0.044	0.207	0.113	0.284**
R&D	-0.015	-0.150**	-0.105	-0.172***	0.156*	-0.198**
R&D rest enterprise	0.051*	0.009	0.037*	0.036*	0.234***	0.071**
Export only	0.042	0.033	0.170***	0.027	-0.099	0.127***
Import only	0.121**	0.125***	0.013	-0.037	-0.079**	0.217**
Export & import	0.029	0.113***	-0.041	0.149***	-0.037	0.250**
Assisted area	-0.013	0.021	-0.031	-0.071*	-0.044	-0.002
Subsidies	-0.029	0.007	0.032	0.004	0.067***	0.096*
ln Urbanisation	0.173	-0.050	0.049	0.051	-0.448***	-0.596***
ln Agglomeration	0.020	0.087***	-0.005	-0.019	0.038*	0.094***
ln Herfindahl Index	0.135***	0.048***	0.004	0.045**	0.083***	0.093**
Mark up $(\frac{\sigma}{\sigma-1})$	1.115**	1.042***	1.065***	1.031	1.086***	1.013
City dummies	Yes	Yes	Yes	Yes	Yes	Yes
LEP dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.943	0.850	0.931	0.944	0.734	0.878
Observations	3,551	9,514	11,990	17,335	36,586	25,650
Number of plants	1,348	3,687	4,580	6,090	10,178	9,798
AR(1) z-statistic	-4.137***	-1.425	-3.615***	-1.993**	2.906***	-3.503***
AR(2) z-statistic	-1.492	0.102	-1.590	-0.490	0.882	-0.481
Hansen test	8.294	1.519	7.871	11.310	5.368	1.336
Returns-to-scale	1.214**	1.248***	1.261***	1.271***	1.261***	1.052

***/**/* statistically significant at 1%/5%/10% levels.

Table U.2: (cont.)

	Low KI Market Services	Other Low KI Services	Wholesale	Retail (part)	Specialist retail	Hotels & restaurants
ln Intermediate Inputs	0.374***	0.785***	0.540***	0.336***	0.588***	0.337**
ln Employment	0.697***	0.127*	0.487***	0.562***	0.365***	0.566***
ln Capital	0.126*	0.136**	0.094***	0.240***	0.087***	0.126**
Time trend	0.022***	0.002	0.027***	0.017***	0.021***	-0.019**
ln Age	0.014	-0.437***	-0.057**	-0.330***	-0.118***	-0.153*
Single-Plant Enterprise	0.032	0.429***	0.141***	0.038	0.039**	-0.136***
Multi-Region Enterprise	-0.019	-0.062	-0.026	0.222***	0.052***	0.068
Outward FDI	-0.158***	-0.128**	-0.156***	0.092	0.052***	0.088**
GB outward FDI	0.284***	0.268***	0.256***	-0.169	-0.029***	-0.018
Brown-USA	0.198***	0.473***	0.030*	-0.206	0.064***	0.123
Brown-EU	0.261***	-0.213***	0.094***	0.428***	0.041***	-0.038
Brown-OFO	0.497***	-0.097	0.330***	-0.119	-0.007	0.205***
Green-USA	0.574***	0.314***	-0.033	-0.088	0.087***	-0.197***
Green-EU	0.047	-0.439***	0.069**	0.322***	0.055***	-0.102***
Green-OFO	0.745***	-0.391***	0.086*	0.026	0.081***	-0.167***
R&D	-0.071	0.052	-0.062	-0.069	0.188***	-0.068
R&D rest enterprise	0.109**	0.093***	0.052***	-0.012	0.004	0.027
Export only	0.296***	0.129***	0.109***	0.239***	-0.012**	-0.051
Import only	0.070	0.151***	0.045***	0.016	-0.008**	0.025
Export & import	0.194***	0.211***	0.084***	-0.077**	-0.006*	0.104***
Assisted area	0.013	-0.017	-0.013	0.015	0.010*	-0.054
Subsidies	0.139***	0.009	-0.073***	-0.072	-0.043***	0.072
ln Urbanisation	-0.303***	-0.352***	-0.085***	-0.086**	0.017	0.159
ln Agglomeration	0.072***	0.033***	0.014***	0.013*	0.001	0.016
ln Herfindahl Index	0.244***	-0.014	0.075***	0.295***	-0.028***	0.056
Mark up ($\frac{\sigma}{\sigma-1}$)	1.122***	1.078**	1.021	0.907**	0.975***	1.002
City dummies	Yes	Yes	Yes	Yes	Yes	Yes
LEP dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.930	0.920	0.947	0.990	0.793	0.943
Observations	242,901	117,406	80,277	144,015	250,332	146,743
Number of plants	76,527	27,613	22,130	31,534	61,698	38,994
AR(1) z-statistic	-7.054***	-6.293***	-1.314	-15.560***	-11.012***	-6.351***
AR(2) z-statistic	1.693*	1.100	-1.611	1.482	-1.640	-1.441
Hansen test	3.159	9.013	2.873	1.773	16.21	1.436
Returns-to-scale	1.197***	1.048*	1.121**	1.138**	1.040	1.029

***/**/* statistically significant at 1%/5%/10% levels.

Table U.3: Means and 80th and 90th percentiles of ln TFP 2010-16 by sector

Sectors[a]	Mean	p80	p90
High-tech Manufacturing	1.114	1.608	1.934
Medium High-tech manufacturing	0.973	1.590	2.016
Medium Low-tech manufacturing	0.454	0.973	1.367
Low-tech Manufacturing	0.522	0.968	1.386
High-tech KI Market Services	0.921	1.900	2.526
KI Market Services	0.667	1.695	2.348
Low KI Services[b]	0.249	0.790	1.188
Other low KI Services	0.222	1.051	1.273

[a] See Table U.1 Source: based on estimates using equation (2a)

[b] includes wholesale, retail and hotels & restaurants

Table U.4: Mean ln TFP 2010-16 by LEP – average across plants and average weighted by real gross output

	All Sectors		Manufacturing + High-tech KI Market Services		Services – High-tech KI Market Services	
LEP	Mean[a]	Weighted Mean[b]	Mean[a]	Weighted Mean[b]	Mean[a]	Weighted Mean[b]
Black Country	0.285	0.368	0.507	0.580	0.233	0.311
Bucks Thames Valley	0.470	0.638	0.796	1.094	0.401	0.539
Cheshire & Warrington	0.378	0.495	0.797	1.050	0.316	0.408
Coast to Capital	0.406	0.527	0.732	1.010	0.346	0.440
Cornwall & Isles of Scilly	0.204	0.275	0.539	0.697	0.162	0.221
Coventry & Warwickshire	0.413	0.539	0.770	0.976	0.346	0.451
Cumbria	0.272	0.373	0.581	0.689	0.237	0.334
Derby & Notts	0.326	0.429	0.692	0.862	0.253	0.332
Dorset	0.240	0.361	0.592	0.805	0.183	0.284
Enterprise M3	0.489	0.655	0.962	1.341	0.390	0.511
Gloucestershire	0.333	0.451	0.714	0.920	0.263	0.358
Gr Birmingham & Solihull	0.335	0.447	0.722	0.886	0.258	0.353
Gr Cambridge & Peterborough	0.331	0.468	0.728	1.034	0.253	0.349
Gr Lincolnshire	0.253	0.335	0.585	0.689	0.202	0.275
Gr Manchester	0.328	0.434	0.767	0.946	0.253	0.341
Heart of SW	0.249	0.331	0.595	0.778	0.197	0.261
Hertfordshire	0.471	0.624	0.829	1.138	0.398	0.518
Humber	0.372	0.418	0.619	0.698	0.318	0.351
Lancashire	0.273	0.391	0.630	0.765	0.218	0.323
Leeds	0.330	0.433	0.682	0.819	0.267	0.356
Leicester	0.320	0.416	0.650	0.800	0.248	0.324
Liverpool	0.335	0.423	0.790	0.947	0.266	0.336
London	0.566	0.770	1.035	1.516	0.472	0.628
New Anglia	0.256	0.382	0.598	0.798	0.203	0.313
North East	0.323	0.400	0.710	0.846	0.265	0.325
Northamptonshire	0.360	0.484	0.860	0.948	0.255	0.370
Oxfordshire	0.376	0.505	0.732	1.007	0.302	0.398
Solent	0.318	0.451	0.698	0.949	0.255	0.363
South East	0.345	0.479	0.678	0.917	0.292	0.407
SE Midlands	0.377	0.503	0.775	0.981	0.299	0.404
Stoke & Staffs	0.345	0.437	0.749	0.837	0.274	0.359
Swindon & Wiltshire	0.333	0.463	0.699	0.913	0.264	0.375
Tees Valley	0.376	0.446	0.854	1.009	0.312	0.361

	All Sectors		Manufacturing + High-tech KI Market Services		Services – High-tech KI Market Services	
LEP	Mean[a]	Weighted Mean[b]	Mean[a]	Weighted Mean[b]	Mean[a]	Weighted Mean[b]
Thames Valley Berkshire	0.567	0.741	1.144	1.618	0.428	0.522
The Marches	0.284	0.384	0.574	0.711	0.232	0.320
West of England	0.360	0.448	0.772	1.018	0.283	0.339
Worcestershire	0.303	0.411	0.675	0.858	0.242	0.331
York & E Riding	0.230	0.340	0.651	0.761	0.169	0.271
Sheffield	0.319	0.397	0.705	0.817	0.245	0.308
Glasgow	0.386	0.470	0.841	0.992	0.318	0.386
Edinburgh	0.450	0.550	0.853	1.116	0.379	0.450
Rest of Scotland	0.375	0.462	0.712	0.838	0.332	0.408
Wales	0.267	0.347	0.601	0.793	0.218	0.276
Correlation	0.972		0.946		0.961	

[a] Source Table U.5 (below)

[b] $(\sum_{it} (lnTFP_{it} \times gross\ output_{it}) / \sum gross\ output_{it})$

Table U.5: Mean ln TFP 2010-16 by LEP

LEP[a]	All Sectors			Manufacturing + High-tech KI Market Services			Services – High-tech KI Market Services		
	Mean[b]	p80	p90	Mean[b]	p80	p90	Mean[b]	p80	p90
Thames Valley Berkshire	0.567*	1.242	1.857	1.144*	1.951	2.746	0.428*	1.066	1.619
London	0.561	1.280	1.951	1.027	2.000	2.736	0.467	1.159	1.710
Enterprise M3	0.489	1.212	1.806	0.962*	1.919	2.555	0.390	1.074	1.624
Hertfordshire	0.471	1.156	1.722	0.829	1.687	2.244	0.398	1.049	1.566
Bucks Thames Valley	0.470	1.159	1.743	0.796	1.597	2.326	0.401*	1.071	1.593
Edinburgh	0.450	1.100	1.627	0.853	1.699	2.263	0.379	0.992	1.482
Coventry & Warwickshire	0.413	1.086	1.550	0.770	1.560	2.202	0.346	0.996	1.432
Coast to Capital	0.406	1.082	1.581	0.732	1.573	2.046	0.346	0.975	1.440
Glasgow	0.386	1.033	1.500	0.841	1.571	2.126	0.318	0.918	1.373
Cheshire & Warrington	0.378	1.076	1.546	0.797	1.636	2.163	0.316	0.972	1.443
SE Midlands	0.377	1.044	1.524	0.775	1.553	2.019	0.299	0.935	1.375
Oxfordshire	0.376	1.101	1.592	0.732	1.572	2.032	0.302	0.984	1.457
Tees Valley	0.376	1.069	1.501	0.854	1.683	2.315	0.312	1.013	1.406
Rest of Scotland	0.375	1.029	1.545	0.712	1.403	1.994	0.332	0.970	1.479
Humber	0.372	0.966	1.385	0.619	1.286	1.806	0.318	0.888	1.268
Northamptonshire	0.360	1.012	1.441	0.860	1.532	1.844	0.255	0.859	1.283
West of England	0.360	1.027	1.505	0.772	1.586	2.180	0.283	0.910	1.343
South East	0.345	0.980	1.469	0.678	1.410	1.956	0.292	0.897	1.374
Stoke & Staffs	0.345	0.939	1.432	0.749	1.456	2.001	0.274	0.848	1.276
Gr Birmingham & Solihull	0.335	0.989	1.437	0.722	1.418	1.948	0.258	0.891	1.312
Liverpool	0.335	1.002	1.382	0.790	1.468	2.014	0.266	0.917	1.280
Gloucestershire	0.333	0.924	1.412	0.714	1.441	1.930	0.263	0.835	1.258
Swindon & Wiltshire	0.333	1.000	1.453	0.699	1.429	1.973	0.264	0.904	1.338
Gr Cambridge & Peterborough	0.331	1.006	1.463	0.728	1.494	2.125	0.253	0.869	1.300
Leeds	0.330	0.965	1.416	0.682	1.427	1.923	0.267	0.880	1.293
Gr Manchester	0.328	1.002	1.427	0.767	1.476	2.052	0.253	0.916	1.300
Derby & Notts	0.326	0.965	1.396	0.692	1.417	2.002	0.253	0.830	1.265
North East	0.323	0.939	1.342	0.710	1.395	2.008	0.265	0.872	1.271
Leicester	0.320	0.928	1.341	0.650	1.336	1.866	0.248	0.835	1.232
Sheffield	0.319	0.931	1.343	0.705	1.435	2.059	0.245	0.814	1.214
Solent	0.318	0.957	1.419	0.698	1.448	1.953	0.255	0.860	1.318
Worcestershire	0.303	0.910	1.323	0.675	1.346	1.947	0.242	0.811	1.237
Black Country	0.285	0.849	1.293	0.507	1.104	1.551	0.233	0.791	1.220

LEP[a]	All Sectors			Manufacturing + High-tech KI Market Services			Services – High-tech KI Market Services		
	Mean[b]	p80	p90	Mean[b]	p80	p90	Mean[b]	p80	p90
The Marches	0.284	0.884	1.294	0.574	1.189	1.702	0.232	0.803	1.217
Lancashire	0.273	0.910	1.310	0.630	1.327	1.933	0.218	0.835	1.228
Cumbria	0.272	0.879	1.253	0.581	1.196	1.823	0.237	0.820	1.207
Wales	0.267	0.871	1.285	0.601	1.368	1.885	0.218	0.788	1.184
New Anglia	0.256	0.896	1.320	0.598	1.268	1.900	0.203	0.821	1.220
Gr Lincolnshire	0.253	0.825	1.218	0.585	1.226	1.674	0.202	0.750	1.150
Heart of SW	0.249	0.840	1.284	0.595	1.293	1.820	0.197	0.754	1.192
Dorset	0.240	0.880	1.289	0.592	1.403	1.844	0.183	0.752	1.175
York & E Riding	0.230	0.844	1.224	0.651	1.210	1.690	0.169	0.784	1.152
Cornwall & Isles of Scilly	0.204	0.781	1.179	0.539	1.174	1.804	0.162	0.728	1.124

[a] Figure U.1 shows the LEPs

[b] based on a *t*-test, mean values are all significantly less (at the 1% level) than that of London except those marked *

Table U.6: Differences compared to London of mean ln TFP 2010-16 by LEP: contribution of spatial and non-spatial factors

LEP	All Sectors			Manufacturing + High-tech KI Market Services			Services – High-tech KI Market Services		
	Non-spatial[a]	Spatial[b]	*ln* TFP[c]	Non-spatial	Spatial	*ln* TFP	Non-spatial	Spatial	*ln* TFP
Thames Valley Berkshire	0.036	-0.030	0.006	0.067	0.050	0.117	0.074	-0.113	-0.039
London	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Enterprise M3	-0.073	0.001	-0.072	-0.036	-0.029	-0.065	-0.094	0.017	-0.077
Hertfordshire	-0.009	-0.081	-0.090	-0.099	-0.099	-0.198	0.026	-0.095	-0.069
Bucks Thames Valley*	0.047	-0.138	-0.091	-0.120	-0.111	-0.231	0.139	-0.205	-0.066
Edinburgh	0.170	-0.281	-0.111	-0.097	-0.077	-0.174	0.223	-0.311	-0.088
Coventry & Warwickshire	-0.020	-0.128	-0.148	-0.140	-0.117	-0.257	0.025	-0.146	-0.121
Coast to Capital	-0.313	0.158	-0.155	-0.155	-0.140	-0.295	-0.313	0.192	-0.121
Glasgow	-0.120	-0.055	-0.175	-0.118	-0.068	-0.186	-0.094	-0.055	-0.149
Cheshire & Warrington	-0.160	-0.023	-0.183	-0.122	-0.108	-0.230	-0.141	-0.010	-0.151
SE Midlands	-0.105	-0.079	-0.184	-0.133	-0.119	-0.252	-0.081	-0.087	-0.168
Oxfordshire	-0.042	-0.143	-0.185	-0.196	-0.099	-0.295	-0.029	-0.136	-0.165
Tees Valley	-0.035	-0.150	-0.185	-0.096	-0.077	-0.173	0.006	-0.161	-0.155
Rest of Scotland	-0.334	0.148	-0.186	-0.173	-0.142	-0.315	-0.305	0.170	-0.135
Humber	-0.067	-0.122	-0.189	-0.214	-0.194	-0.408	-0.009	-0.140	-0.149
Northamptonshire	-0.075	-0.126	-0.201	-0.128	-0.039	-0.167	-0.084	-0.128	-0.212
West of England	0.128	-0.329	-0.201	-0.140	-0.115	-0.255	0.197	-0.381	-0.184
South East	-0.161	-0.055	-0.216	-0.198	-0.151	-0.349	-0.122	-0.053	-0.175
Stoke & Staffs	-0.090	-0.126	-0.216	-0.159	-0.119	-0.278	-0.051	-0.142	-0.193
Gr Birmingham & Solihull	-0.100	-0.126	-0.226	-0.163	-0.142	-0.305	-0.069	-0.140	-0.209
Liverpool	-0.090	-0.136	-0.226	-0.133	-0.104	-0.237	-0.057	-0.144	-0.201
Gloucestershire	-0.212	-0.016	-0.228	-0.165	-0.148	-0.313	-0.213	0.009	-0.204
Swindon & Wiltshire	-0.113	-0.115	-0.228	-0.186	-0.142	-0.328	-0.078	-0.125	-0.203
Gr Cambridge & Peterborough	-0.324	0.094	-0.230	-0.168	-0.131	-0.299	-0.341	0.127	-0.214
Leeds	-0.096	-0.135	-0.231	-0.192	-0.153	-0.345	-0.059	-0.141	-0.200
Gr Manchester	-0.070	-0.163	-0.233	-0.151	-0.109	-0.260	-0.035	-0.179	-0.214
Derby & Notts	-0.215	-0.020	-0.235	-0.183	-0.152	-0.335	-0.203	-0.011	-0.214
North East	-0.119	-0.119	-0.238	-0.187	-0.130	-0.317	-0.078	-0.124	-0.202
Leicester	-0.103	-0.138	-0.241	-0.215	-0.162	-0.377	-0.070	-0.149	-0.219
Sheffield	-0.096	-0.146	-0.242	-0.185	-0.137	-0.322	-0.064	-0.158	-0.222
Solent	-0.286	0.043	-0.243	-0.180	-0.149	-0.329	-0.272	0.060	-0.212
Worcestershire	-0.120	-0.138	-0.258	-0.195	-0.157	-0.352	-0.079	-0.146	-0.225

LEP	All Sectors			Manufacturing + High-tech KI Market Services			Services – High-tech KI Market Services		
	Non-spatial[a]	Spatial[b]	*ln* TFP[c]	Non-spatial	Spatial	*ln* TFP	Non-spatial	Spatial	*ln* TFP
Black Country	-0.167	-0.109	-0.276	-0.288	-0.232	-0.520	-0.124	-0.110	-0.234
The Marches	-0.181	-0.096	-0.277	-0.250	-0.203	-0.453	-0.138	-0.097	-0.235
Lancashire	-0.045	-0.243	-0.288	-0.218	-0.179	-0.397	0.020	-0.269	-0.249
Cumbria	-0.077	-0.212	-0.289	-0.250	-0.196	-0.446	0.007	-0.237	-0.230
Wales	-0.180	-0.114	-0.294	-0.228	-0.198	-0.426	-0.128	-0.121	-0.249
New Anglia	-0.227	-0.078	-0.305	-0.239	-0.190	-0.429	-0.184	-0.080	-0.264
Gr Lincolnshire	-0.195	-0.113	-0.308	-0.241	-0.201	-0.442	-0.145	-0.120	-0.265
Heart of SW	-0.183	-0.129	-0.312	-0.235	-0.197	-0.432	-0.132	-0.138	-0.270
Dorset	-0.182	-0.139	-0.321	-0.237	-0.198	-0.435	-0.133	-0.151	-0.284
York & E Riding	-0.158	-0.173	-0.331	-0.203	-0.173	-0.376	-0.100	-0.198	-0.298
Cornwall & Isles of Scilly	-0.247	-0.110	-0.357	-0.262	-0.226	-0.488	-0.189	-0.116	-0.305
London[d]	0.408	0.153	0.561	0.933	0.095	1.028	0.303	0.164	0.467

[a] $\sum_{it} \hat{\alpha}_X(\bar{X}_{it}^r - \bar{X}_{it}^L)$ where $X \in$ non-spatial determinants (e.g., *ln* age, ownership, R&D, trade) listed in Table A.1; r refers to LEP and L to London.

[b] $\sum_{it} \hat{\alpha}_X(\bar{X}_{it}^r - \bar{X}_{it}^L)$ where $X \in$ spatial determinants (i.e.., assisted area, urbanisation, agglomeration, LEP and city dummies) listed in Table A.1; *r* refers to LEP and *L* to London.

[c] (weighted) mean for LEP minus London value – source Table U.5.

[d] benchmark figures for London

Table U.7: Differences compared to London of mean ln TFP 2010-16 by region in Great Britain: contribution of spatial and non-spatial factors

Region	All Sectors			Manufacturing + High-tech KI Market Services			Services – High-tech KI Market Services		
	Non-spatial[a]	Spatial[b]	*ln* TFP[c]	Non-spatial	Spatial	*ln* TFP	Non-spatial	Spatial	*ln* TFP
North East	-0.097	-0.127	-0.224	-0.194	-0.089	-0.283	-0.057	-0.134	-0.191
Yorkshire-Humberside	-0.106	-0.142	-0.248	-0.266	-0.075	-0.341	-0.068	-0.153	-0.221
North West	0.090	-0.330	-0.240	-0.220	-0.074	-0.294	0.158	-0.369	-0.211
West Midlands	-0.109	-0.120	-0.229	-0.294	-0.064	-0.358	-0.072	-0.129	-0.201
East Midlands	-0.121	-0.119	-0.240	-0.292	-0.074	-0.366	-0.086	-0.128	-0.214
South West	-0.193	-0.081	-0.274	-0.305	-0.061	-0.366	-0.157	-0.086	-0.243
South East	0.024	-0.170	-0.146	-0.168	-0.042	-0.210	0.065	-0.195	-0.130
Eastern	-0.230	0.007	-0.223	-0.262	-0.051	-0.313	-0.214	0.017	-0.197
London	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Scotland	-0.187	0.017	-0.170	-0.182	-0.067	-0.249	-0.158	0.026	-0.132
Wales	-0.181	-0.113	-0.294	-0.346	-0.081	-0.427	-0.130	-0.120	-0.250
London[d]	0.408	0.153	0.561	0.933	0.095	1.028	0.303	0.164	0.467

[a] $\sum_{it} \hat{\alpha}_X(\bar{X}_{it}^r - \bar{X}_{it}^L)$ where $X \in$ non-spatial determinants (e.g., *ln* age, ownership, R&D, trade) listed in Table A.1; r refers to region and L to London.

[b] $\sum_{it} \hat{\alpha}_X(\bar{X}_{it}^r - \bar{X}_{it}^L)$ where $X \in$ spatial determinants (i.e.., assisted area, urbanisation, agglomeration, LEP and city dummies) listed in Table A.1; *r* refers to region and *L* to London.

[c] (weighted) mean for region minus London value – source Table 5.

[d] benchmark figures for London

Table U.8: Differences compared to London of mean ln TFP 2010-16 by city in Great Britain: contribution of spatial and non-spatial factors

City	All Sectors			Manufacturing + High-tech KI Market Services			Services – High-tech KI Market Services		
	Non-spatial[a]	Spatial[b]	*ln* TFP[c]	Non-spatial[a]	Spatial[b]	*ln* TFP[c]	Non-spatial[a]	Spatial[b]	*ln* TFP[c]
London	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Edinburgh	0.170	-0.281	-0.111	-0.097	-0.077	-0.174	0.223	-0.311	-0.088
Glasgow	-0.120	-0.055	-0.175	-0.118	-0.068	-0.186	-0.094	-0.055	-0.149
Nottingham	-0.063	-0.124	-0.187	-0.051	-0.051	-0.102	-0.056	-0.134	-0.190
Liverpool	-0.060	-0.131	-0.191	-0.048	-0.149	-0.197	-0.026	-0.130	-0.156
Coventry	-0.123	-0.078	-0.201	-0.125	-0.053	-0.178	-0.119	-0.082	-0.201
Bristol	0.220	-0.422	-0.202	-0.204	-0.061	-0.265	0.297	-0.488	-0.191
Manchester	-0.090	-0.122	-0.212	0.075	-0.054	0.021	-0.087	-0.140	-0.227
Cardiff	-0.060	-0.153	-0.213	-0.187	-0.072	-0.259	-0.021	-0.164	-0.185
Birmingham	-0.075	-0.161	-0.236	-0.267	-0.076	-0.343	-0.034	-0.175	-0.209
Tyneside	-0.101	-0.136	-0.237	-0.062	-0.195	-0.257	-0.075	-0.131	-0.206
Leicester	-0.147	-0.116	-0.263	-0.239	-0.081	-0.320	-0.155	-0.124	-0.279
London	0.408	0.153	0.561	0.931	0.096	1.027	0.303	0.164	0.467

[a] $\sum_{it} \hat{\alpha}_X(\bar{X}_{it}^r - \bar{X}_{it}^L)$ where $X \in$ non-spatial determinants (e.g., *ln* age, ownership, R&D, trade) listed in Table A.1; r refers to city and L to London.

[b] $\sum_{it} \hat{\alpha}_X(\bar{X}_{it}^r - \bar{X}_{it}^L)$ where $X \in$ spatial determinants (i.e.., assisted area, urbanisation, agglomeration, LEP and city dummies) listed in Table A.1; *r* refers to city and *L* to London.

[c] (weighted) mean for city minus London value – source Table 6.

[d] benchmark figures for London

Table U.9: Definitions of Local Economic Partnerships

LEP	LA (District/Unitary) covered (spatially)	Post-2009 ONS LA (District/Unitary) Code
Black Country	Dudley	00CR
Black Country	Sandwell	00CS
Black Country	Walsall	00CU
Black Country	Wolverhampton	00CW
Buckinghamshire Thames Valley	Aylesbury Vale	11UB
Buckinghamshire Thames Valley	Chilten	11UC
Buckinghamshire Thames Valley	South Buckinghamshire	11UE
Buckinghamshire Thames Valley	Wycombe	11UF
Cheshire and Warrington	Cheshire East	00EQ
Cheshire and Warrington	Warrington	00EU
Cheshire and Warrington	Cheshire West and Chester	00EW
Coast to Capital	Croydon	00AH
Coast to Capital	Brighton and Hove	00ML
Coast to Capital	Mole Valley	43UE
Coast to Capital	Reigate and Banstead	43UF
Coast to Capital	Tandridge	43UK
Coast to Capital	Adur	45UB
Coast to Capital	Arun	45UC
Coast to Capital	Chichester	45UD
Coast to Capital	Crawley	45UE
Coast to Capital	Horsham	45UF
Coast to Capital	Mid Sussex	45UG
Coast to Capital	Worthing	45UH
Cornwall and the Isles of Scilly	Cornwall	00HE
Cornwall and the Isles of Scilly	Isles of Scilly	00HF
Coventry and Warwickshire	Coventry	00CQ
Coventry and Warwickshire	North Warwickshire	44UB
Coventry and Warwickshire	Nuneaton and Bedworth	44UC
Coventry and Warwickshire	Rugby	44UD
Coventry and Warwickshire	Stratford-on-Avon	44UE
Coventry and Warwickshire	Warwick	44UF
Cumbria	Allerdale	16UB
Cumbria	Barrow-in-Furness	16UC
Cumbria	Carlisle	16UD
Cumbria	Copeland	16UE
Cumbria	Eden	16UF
Cumbria	South Lakeland	16UG
Derby & Nottingham	Derby	00FK
Derby & Nottingham	Nottingham	00FY
Derby & Nottingham	Amber Valley	17UB
Derby & Nottingham	Bolsover	17UC
Derby & Nottingham	Chesterfield	17UD
Derby & Nottingham	Derbyshire Dales	17UF
Derby & Nottingham	Erewash	17UG
Derby & Nottingham	High Peak	17UH
Derby & Nottingham	North East Derbyshire	17UJ
Derby & Nottingham	South Derbyshire	17UK
Derby & Nottingham	Ashfield	37UB
Derby & Nottingham	Bassetlaw	37UC
Derby & Nottingham	Broxtowe	37UD
Derby & Nottingham	Gedling	37UE
Derby & Nottingham	Mansfield	37UF
Derby & Nottingham	Newark and Sherwood	37UG
Derby & Nottingham	Rushcliffe	37UJ
Dorset	Bournemouth	00HN

LEP	LA (District/Unitary) covered (spatially)	Post-2009 ONS LA (District/Unitary) Code
Dorset	Poole	00HP
Dorset	Christchurch	19UC
Dorset	East Dorset	19UD
Dorset	North Dorset	19UE
Dorset	Purbeck	19UG
Dorset	West Dorset	19UH
Dorset	Weymouth and Portland	19UJ
Enterprise M3	Basingstoke and Deane	24UB
Enterprise M3	East Hampshire	24UC
Enterprise M3	Hart	24UG
Enterprise M3	Rushmoor	24UL
Enterprise M3	Test Valley	24UN
Enterprise M3	Winchester	24UP
Enterprise M3	Guildford	43UD
Enterprise M3	Surrey Heath	43UJ
Enterprise M3	Waverley	43UL
Enterprise M3	Woking	43UM
Gloucestershire	Cheltenham	23UB
Gloucestershire	Cotswold	23UC
Gloucestershire	Forest of Dean	23UD
Gloucestershire	Gloucester	23UE
Gloucestershire	Stroud	23UF
Gloucestershire	Tewkesbury	23UG
Greater Birmingham and Solihull	Birmingham	00CN
Greater Birmingham and Solihull	Solihull	00CT
Greater Birmingham and Solihull	Cannock Chase	41UB
Greater Birmingham and Solihull	East Staffordshire	41UC
Greater Birmingham and Solihull	Lichfield	41UD
Greater Birmingham and Solihull	Tamworth	41UK
Greater Birmingham and Solihull	Bromsgrove	47UB
Greater Birmingham and Solihull	Redditch	47UD
Greater Birmingham and Solihull	Wyre Forest	47UG
Greater Cambridge & Greater Peterborough	Rutland	00FP
Greater Cambridge & Greater Peterborough	Peterborough	00JA
Greater Cambridge & Greater Peterborough	Cambridge	12UB
Greater Cambridge & Greater Peterborough	East Cambridgeshire	12UC
Greater Cambridge & Greater Peterborough	Fenland	12UD
Greater Cambridge & Greater Peterborough	Huntingdonshire	12UE
Greater Cambridge & Greater Peterborough	South Cambridgeshire	12UG
Greater Cambridge & Greater Peterborough	Uttlesford	22UQ
Greater Cambridge & Greater Peterborough	North Hertfordshire	26UF
Greater Cambridge & Greater Peterborough	King's Lynn and West Norfolk	33UE
Greater Manchester	Bolton	00BL
Greater Manchester	Bury	00BM
Greater Manchester	Manchester	00BN
Greater Manchester	Oldham	00BP
Greater Manchester	Rochdale	00BQ

LEP	LA (District/Unitary) covered (spatially)	Post-2009 ONS LA (District/Unitary) Code
Greater Manchester	Salford	00BR
Greater Manchester	Stockport	00BS
Greater Manchester	Tameside	00BT
Greater Manchester	Trafford	00BU
Greater Manchester	Wigan	00BW
Heart of the South West	Plymouth	00HG
Heart of the South West	Torbay	00HH
Heart of the South West	East Devon	18UB
Heart of the South West	Exeter	18UC
Heart of the South West	Mid Devon	18UD
Heart of the South West	North Devon	18UE
Heart of the South West	South Hams	18UG
Heart of the South West	Teignbridge	18UH
Heart of the South West	Torridge	18UK
Heart of the South West	West Devon	18UL
Heart of the South West	Mendip	40UB
Heart of the South West	Sedgemoor	40UC
Heart of the South West	South Somerset	40UD
Heart of the South West	Taunton Deane	40UE
Heart of the South West	West Somerset	40UF
Hertfordshire	Broxbourne	26UB
Hertfordshire	Dacorum	26UC
Hertfordshire	East Hertfordshire	26UD
Hertfordshire	Hertsmere	26UE
Hertfordshire	St Albans	26UG
Hertfordshire	Stevenage	26UH
Hertfordshire	Three Rivers	26UJ
Hertfordshire	Watford	26UK
Hertfordshire	Welwyn Hatfield	26UL
Humber	Kingston upon Hull, city of	00FA
Humber	East Riding of Yorkshire	00FB
Humber	North East Lincolnshire	00FC
Humber	North Lincolnshire	00FD
Lancashire	Blackburn with Darwen	00EX
Lancashire	Blackpool	00EY
Lancashire	Burnley	30UD
Lancashire	Chorley	30UE
Lancashire	Fylde	30UF
Lancashire	Hyndburn	30UG
Lancashire	Lancaster	30UH
Lancashire	Pendle	30UJ
Lancashire	Preston	30UK
Lancashire	Ribble Valley	30UL
Lancashire	Rossendale	30UM
Lancashire	South Ribble	30UN
Lancashire	West Lancashire	30UP
Lancashire	Wyre	30UQ
Leeds City Region	Barnsley	00CC
Leeds City Region	Bradford	00CX
Leeds City Region	Calderdale	00CY
Leeds City Region	Kirklees	00CZ
Leeds City Region	Leeds	00DA
Leeds City Region	Wakefield	00DB
Leeds City Region	York	00FF
Leeds City Region	Craven	36UB
Leeds City Region	Harrogate	36UD
Leeds City Region	Selby	36UH

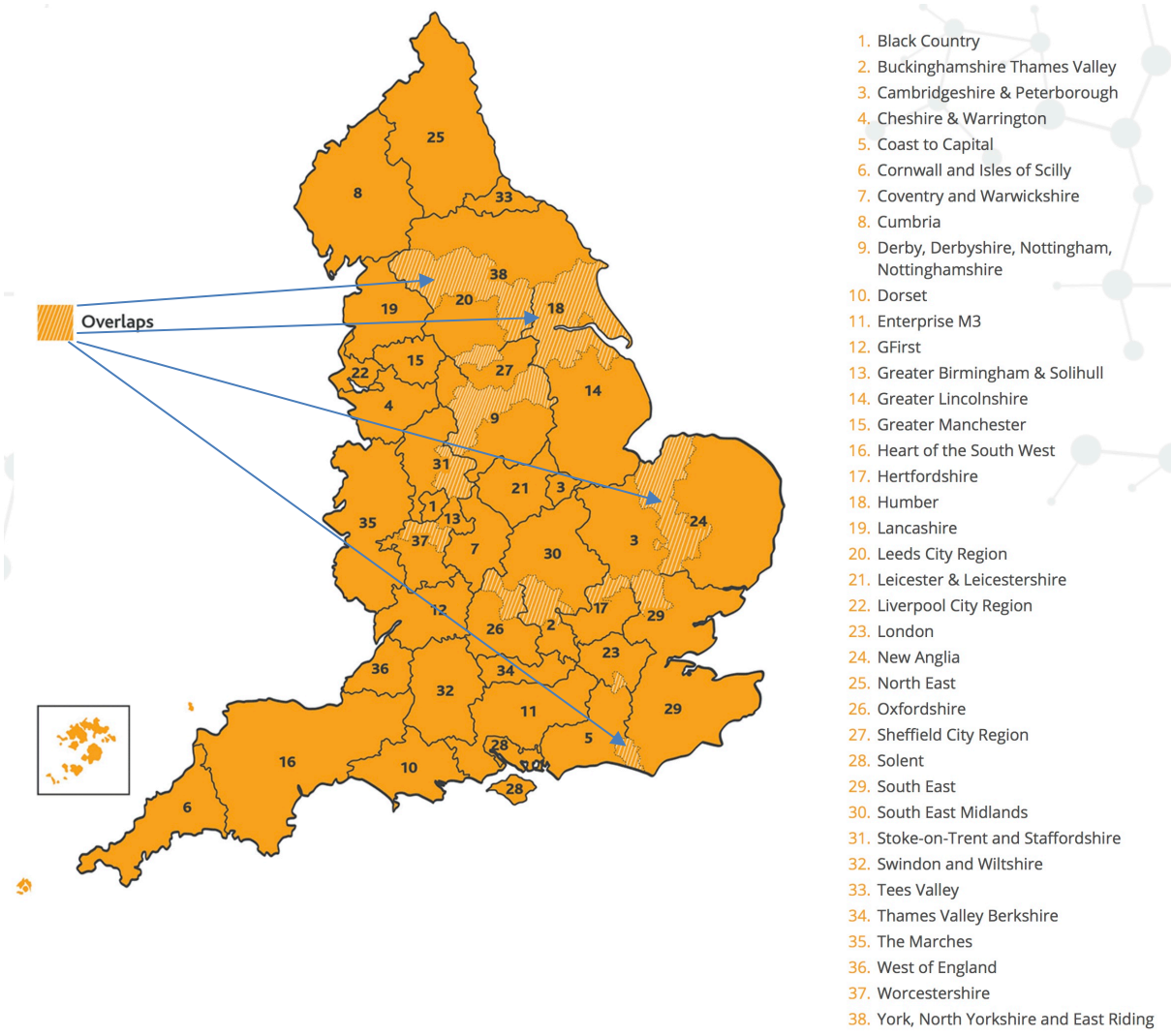
LEP	LA (District/Unitary) covered (spatially)	Post-2009 ONS LA (District/Unitary) Code
Leicester and Leicestershire	Leicester	00FN
Leicester and Leicestershire	Blaby	31UB
Leicester and Leicestershire	Charnwood	31UC
Leicester and Leicestershire	Harborough	31UD
Leicester and Leicestershire	Hinckley and Bosworth	31UE
Leicester and Leicestershire	Melton	31UG
Leicester and Leicestershire	North West Leicestershire	31UH
Leicester and Leicestershire	Oadby and Wigston	31UJ
Lincolnshire	Boston	32UB
Lincolnshire	East Lindsey	32UC
Lincolnshire	Lincoln	32UD
Lincolnshire	North Kesteven	32UE
Lincolnshire	South Holland	32UF
Lincolnshire	South Kesteven	32UG
Lincolnshire	West Lindsey	32UH
Liverpool City Region	Knowsley	00BX
Liverpool City Region	Liverpool	00BY
Liverpool City Region	St. Helens	00BZ
Liverpool City Region	Sefton	00CA
Liverpool City Region	Wirral	00CB
Liverpool City Region	Halton	00ET
London	City of London	00AA
London	Barking and Dagenham	00AB
London	Barnet	00AC
London	Bexley	00AD
London	Brent	00AE
London	Bromley	00AF
London	Camden	00AG
London	Ealing	00AJ
London	Enfield	00AK
London	Greenwich	00AL
London	Hackney	00AM
London	Hammersmith and Fulham	00AN
London	Haringey	00AP
London	Harrow	00AQ
London	Havering	00AR
London	Hillingdon	00AS
London	Hounslow	00AT
London	Islington	00AU
London	Kensington and Chelsea	00AW
London	Kingston upon Thames	00AX
London	Lambeth	00AY
London	Lewisham	00AZ
London	Merton	00BA
London	Newham	00BB
London	Redbridge	00BC
London	Richmond upon Thames	00BD
London	Southwark	00BE
London	Sutton	00BF
London	Tower Hamlets	00BG
London	Waltham Forest	00BH
London	Wandsworth	00BJ
London	Westminster	00BK
New Anglia	Breckland	33UB
New Anglia	Broadland	33UC
New Anglia	Great Yarmouth	33UD
New Anglia	North Norfolk	33UF

LEP	LA (District/Unitary) covered (spatially)	Post-2009 ONS LA (District/Unitary) Code
New Anglia	Norwich	33UG
New Anglia	South Norfolk	33UH
New Anglia	Babergh	42UB
New Anglia	Forest Heath	42UC
New Anglia	Ipswich	42UD
New Anglia	Mid Suffolk	42UE
New Anglia	St Edmundsbury	42UF
New Anglia	Suffolk Coastal	42UG
New Anglia	Waveney	42UH
North East	Gateshead	00CH
North East	Newcastle upon Tyne	00CJ
North East	North Tyneside	00CK
North East	South Tyneside	00CL
North East	Sunderland	00CM
North East	County Durham	00EJ
North East	Northumberland	00EM
Northamptonshire	Corby	34UB
Northamptonshire	Daventry	34UC
Northamptonshire	East Northamptonshire	34UD
Northamptonshire	Kettering	34UE
Northamptonshire	Northampton	34UF
Northamptonshire	South Northamptonshire	34UG
Northamptonshire	Wellingborough	34UH
Oxfordshire	Cherwell	38UB
Oxfordshire	Oxford	38UC
Oxfordshire	South Oxfordshire	38UD
Oxfordshire	Vale of White Horse	38UE
Oxfordshire	West Oxfordshire	38UF
Sheffield City Region	Doncaster	00CE
Sheffield City Region	Rotherham	00CF
Sheffield City Region	Sheffield	00CG
Sheffield City Region	Bolsover	17UC
Solent	Portsmouth	00MR
Solent	Southampton	00MS
Solent	Isle of Wight	00MW
Solent	East Hampshire	24UC
Solent	Eastleigh	24UD
Solent	Fareham	24UE
Solent	Gosport	24UF
Solent	Havant	24UH
Solent	New Forest	24UJ
Solent	Test Valley	24UN
Solent	Winchester	24UP
South East Midlands	Luton	00KA
South East Midlands	Bedford	00KB
South East Midlands	Central Bedfordshire	00KC
South East Midlands	Milton Keynes	00MG
South Eastern	Southend-on-Sea	00KF
South Eastern	Thurrock	00KG
South Eastern	Medway	00LC
South Eastern	Eastbourne	21UC
South Eastern	Hastings	21UD
South Eastern	Lewes	21UF
South Eastern	Rother	21UG
South Eastern	Wealden	21UH
South Eastern	Basildon	22UB
South Eastern	Braintree	22UC

LEP	LA (District/Unitary) covered (spatially)	Post-2009 ONS LA (District/Unitary) Code
South Eastern	Brentwood	22UD
South Eastern	Castle Point	22UE
South Eastern	Chelmsford	22UF
South Eastern	Colchester	22UG
South Eastern	Epping Forest	22UH
South Eastern	Harlow	22UJ
South Eastern	Maldon	22UK
South Eastern	Rochford	22UL
South Eastern	Tendring	22UN
South Eastern	Ashford	29UB
South Eastern	Canterbury	29UC
South Eastern	Dartford	29UD
South Eastern	Dover	29UE
South Eastern	Gravesham	29UG
South Eastern	Maidstone	29UH
South Eastern	Sevenoaks	29UK
South Eastern	Shepway	29UL
South Eastern	Swale	29UM
South Eastern	Thanet	29UN
South Eastern	Tonbridge and Malling	29UP
South Eastern	Tunbridge Wells	29UQ
Stoke and Staffordshire	Stoke-on-trent	00GL
Stoke and Staffordshire	Newcastle-under-Lyme	41UE
Stoke and Staffordshire	South Staffordshire	41UF
Stoke and Staffordshire	Stafford	41UG
Stoke and Staffordshire	Staffordshire Moorlands	41UH
Swindon and Wiltshire	Swindon	00HX
Swindon and Wiltshire	Wiltshire	00HY
Tees Valley	Hartlepool	00EB
Tees Valley	Middlesbrough	00EC
Tees Valley	Redcar and Cleveland	00EE
Tees Valley	Stockton-on-Tees	00EF
Tees Valley	Darlington	00EH
Thames Valley Berkshire	Bracknell Forest	00MA
Thames Valley Berkshire	West Berkshire	00MB
Thames Valley Berkshire	Reading	00MC
Thames Valley Berkshire	Slough	00MD
Thames Valley Berkshire	Windsor and Maidenhead	00ME
Thames Valley Berkshire	Wokingham	00MF
The Marches Enterprise Partnership	Herefordshire, County of	00GA
The Marches Enterprise Partnership	Telford and Wrekin	00GF
The Marches Enterprise Partnership	Shropshire	00GG
West of England	Bath and North East Somerset	00HA
West of England	Bristol, City of	00HB
West of England	North Somerset	00HC
West of England	South Gloucestershire	00HD
Worcestershire	Malvern Hills	47UC
Worcestershire	Worcester	47UE
Worcestershire	Wychavon	47UF
York and North Yorkshire	Hambleton	36UC
York and North Yorkshire	Richmondshire	36UE
York and North Yorkshire	Ryedale	36UF
York and North Yorkshire	Scarborough	36UG

Note, local authorities in red belong to more than one LEP. We have assigned them uniquely to a single LEP, based on locations and other information (e.g., travel-to-work area to which they belong).

Figure U.1: Definitions of LEPs



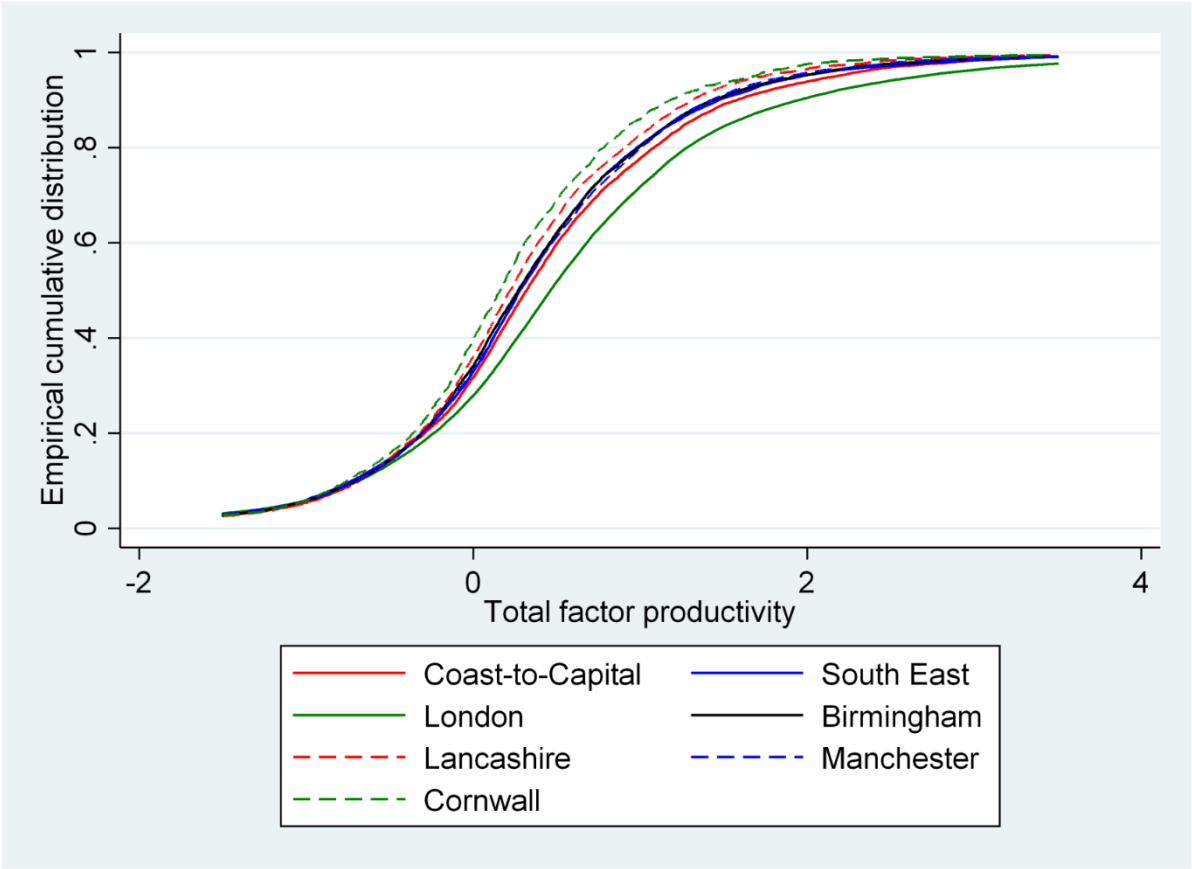
Source: lepnetwork.net

Note, the Northamptonshire and South East Midlands LEPs merged in 2016 (hence, area 30 in the above diagram covers both, although separate data is provided in this paper on the two LEPs). The Greater Cambridgeshire and Peterborough LEP was replaced by a business board on 1 April 2018.

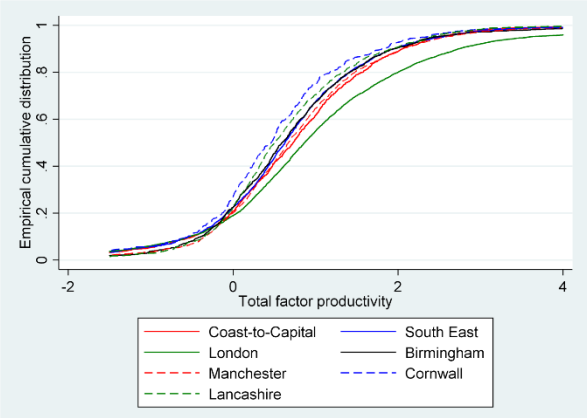
With regard to the LEPs that 'overlap' more than one local authority, Table U.9 sets out which overlapping LAs where assigned to each LEP (shown in red).

Figure U.2: Cumulative distribution of ln TFP across plants by certain LEPs 2010-16

(a) All sectors



(b) Manufacturing + high-tech KI market services



(c) Services minus high-tech KI market services

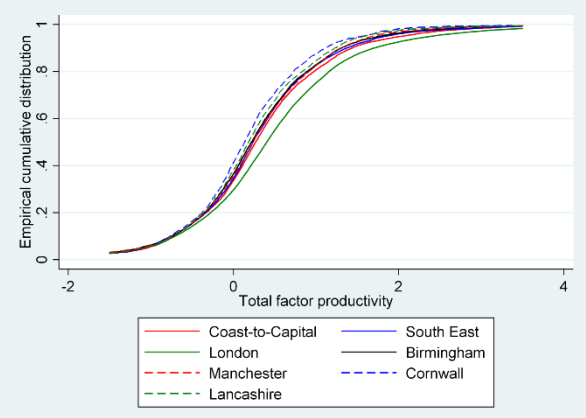
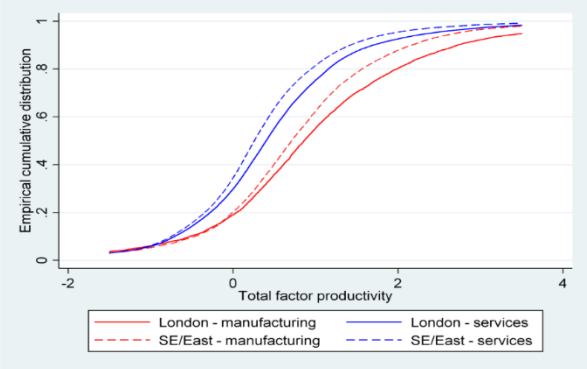
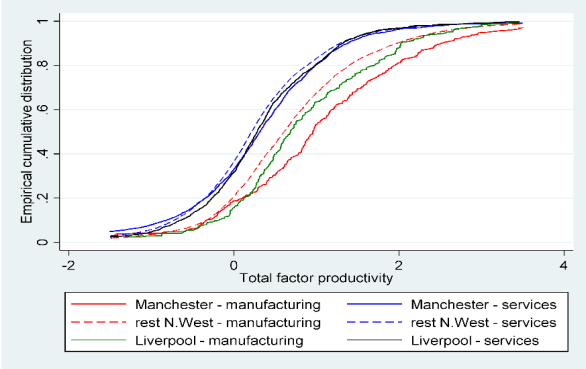


Figure U.3: Cumulative distribution of ln TFP across plants by main cities and their hinterlands

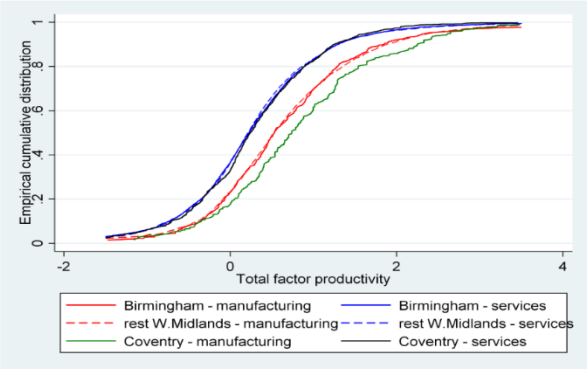
(a) London



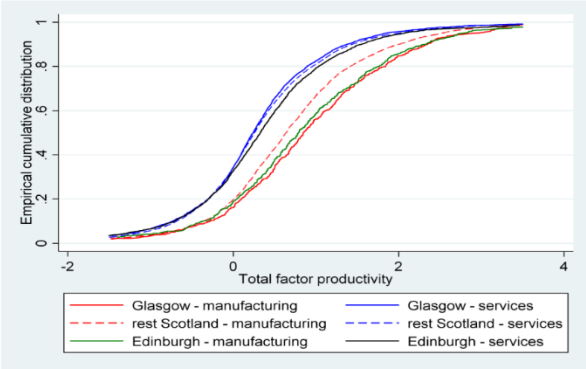
(b) Manchester & Liverpool



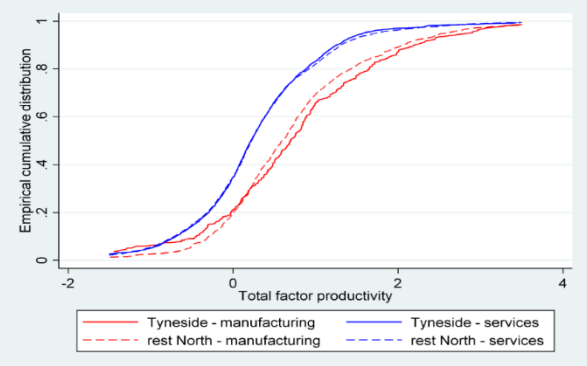
(c) Birmingham & Coventry



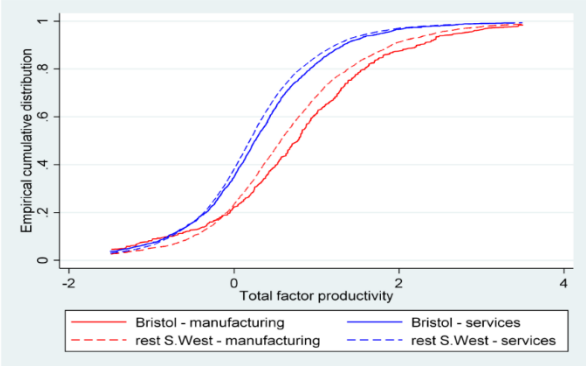
(d) Glasgow & Edinburgh



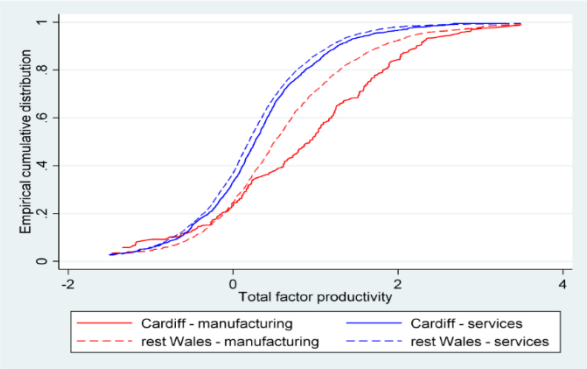
(e) Tyneside



(f) Bristol



(g) Cardiff



(h) Nottingham & Leicester