Winners and Losers: Spatial variations in labour productivity in England and Wales

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Abstract

This paper presents an investigation into the static and dynamic spatial pattern of aggregate labour productivity across England and Wales at the district and unit authority level. This analysis is complemented by plant-level regressions to identify the contribution of industrial sectors to each NUTS1 region's average labour productivity. Using data for 1998 and 2005, our exploratory data analysis illustrates that there are stable spatial patterns in *levels* of labour productivity and that labour productivity *change* does not appear to be spatially dependent, at least not at this spatial scale. Furthermore the economic importance of different sectors to different regions evolves over time, which makes regional industrial policy formation problematic.

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Keywords: Labour productivity; districts and local authorities; sectors; spatial autocorrelation

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1. Introduction

Significant and persistent differences in labour productivity are known to exist across most countries and at different regional definitions (recent examples include Enflo and Hjertstrand (2009), Byrne *et al*., (2009) and Basile (2008)). This has spawned much academic and policy concern with some arguing that policy should be directed towards specific industries or towards the encouragement and retention of foreign direct investment, in spite of their effect being more localised than initially thought (Driffield, 2006). Whilst this stance is nothing new, what may be surprising is the degree of similarity of regional spatial strategies across regions of the UK. If all regions are affected equally by the growth of specific industries then it is entirely rational for regions to compete with each other to attract the best industries to their region. However, when regions possess a comparative advantage in the production of certain types of goods or services (and this comparative advantage might be due to, for example, variations in supply chains, communication infrastructures, industrial compositions or available labour supply quality) then regional economic and spatial strategies should be distinct, focused and specific to the needs of people within their region.

The objectives of this paper are twofold: first to present an exploratory spatial analysis of labour productivity in an attempt to identify whether there is an important spatial component of labour productivity across England and Wales at the district and unitary authority level in and between 1998 and 2005, and second to empirically identify whether the enhancing effect of different industries on NUTS1 regions evolves over time. Although the time period is constrained by data availability, the choice of geographical level is as fine grain as is currently possible for labour productivity analysis using UK data and the NUTS1 geographical level corresponds to regional development agencies boundaries and is therefore conducive to effective policy formation. The NUTS1 spatial level is particularly salient as it is the level at which regional strategies emphasise the importance of specific industries to enhance their labour productivity.

This paper has the following structure. Section 2 reviews the literature. Section 3 details the data set. Section 4 presents an exploratory spatial analysis of labour productivity. Section 5 presents an econometric investigation into the enhancing effect of industries to specific regions. Section 6 presents some concluding remarks.

2. Literature review

Regional analysts frequently examine whether labour productivity differentials exist, how they move in relation to one another and what needs to be done to improve labour productivity; they do not *always* consider directly the impact of industry composition on spatial labour productivity differentials (see, for instance, Webber *et al*. (2005)). Similarly, industrial analysts frequently examine labour productivity within and across industries, but they do not *always* consider the region in which the plant or industry is located (see, for instance, Griffith *et al*., 2006). Both approaches may be inappropriate, especially when the focus of attention is on variations in labour productivity at small geographical scales, because plants will compete predominantly with other plants in the same industry and within the same geographically defined market area making each market different and distinct.

Similar to many market economies, the composition of UK industry is dominated by small and medium-sized enterprises (SMEs)[1] which typically lack scale economies and tend to have geographically defined markets. Differences in industrial composition between geographically defined markets will influence the ability of consumers to substitute between goods and shape their consumptions patterns (Webber and Horswell, 2009); this will make each market distinct with the repercussion being that appropriate policy formulation will be complex and necessarily specific.

Just like many national-level policy makers, regional policy makers frequently seek to increase the labour productivity rates of their economies in order to stay ahead of or to catch up with other economies against which they compare themselves. For example, policy makers in the South West region of England could be seen to be attempting to increase their labour productivity to achieve labour productivity convergence with the South East region of England. The London region may seek to stay ahead of other regions of the UK and compete on the world stage with global cities of New York, Frankfurt of Tokyo. Regional Development Agencies can be seen to be competing with each other and seek to stimulate economic growth through the attraction and stimulation of different (though typically similar) industries that can increase area-based labour productivity measures.

Governments are increasingly recognising the importance of the regional dimension of our economies. This is especially noticeable in the UK economy after the demotion of regional policies in the 1970s and subsequent advancement in the mid and late 1990s as exemplified by documents published by the UK's Department of Trade and Industry (2004) and HM Treasury (2001, 2001, 2004). The predecessor of the DTI's (2004) document was the *Regional Competitiveness Indicators* that presented statistical information to illustrate the factors that contribute to regional competitiveness. Although these documents were not intended to measure the performance of the Government Offices or the devolved administrations, and were instead designed to assist those responsible for developing regional economic strategies (BERR, 2009, p. 2), it is difficult not to interpret them in a competitive and comparative manner. Their current supersedents, called the *State of the Region' Core Indicators*, were originally designed to measure progress towards sustainable economic development, skills and social regeneration and to provide monitoring and evaluation guidance for the RDAs (BERR, 2009, p. 2), but again can be seen to contain measures that emphasise and embellish the successfulness of a region's policy and paint a positive picture of a region that must entice economic activity and FDI to the region at the potential cost to other regions. This is often the case even though detailed empirical evidence is not typically provided to support arguments based on comparative advantage.

Nevertheless the HM Treasury (2000, 2001) usefully outlines five 'drivers' of productivity and productivity differentials: competition, skills, innovation, investment and enterprise. This outline does offer some rationale for policy progress because it focuses attention on a few areas, but these areas are noticeably vague because i) levels and asymmetries in competition are very difficult to measure, ii) workers (and therefore skills) are inter-regionally mobile through commuting behaviour, iii) investment and innovation are strongly influenced by the aspirations of SME owner-managers, while iv) enterprise is difficult to fully, accurately and usefully define. Such factors will vary in importance across industries and across regions. It is important to understand how these vary across regions and an attempt, based upon a number of restrictive assumptions, has been made by Webber *et al.* (2009).[2] However two pieces of information are important before such information can be of

[1] The company-size composition of an economy is an important dimension; for instance, Continental Research (2009, p.1) shows that SMEs have not been profitable since quarter 2 of 2008 or earlier.

[2] One factor that should be borne in mind is whether there is productive defragmentation, i.e. where there is the splitting of production processes into separate parts that can be done in different locations (Jones and

use to local and regional policy makers: first, how does labour productivity evolve spatially across regions and small-areas and second, do industries contribute to labour productivity to different extents in different regions? The first is necessary to fully understand the spatial labour productivity divide, while the second informs us about areas of comparative advantage. The remainder of this paper sets out to provide these two pieces of information.

3. Data

Factors influencing productivity ultimately act by influencing the operational performance of firms. Analysing business performance at the firm level overcomes the shortcomings of working with aggregate data, in particular by providing an unambiguous association between output and the workforce responsible for generating it. In the analysis below we use plant-level data corresponding to the years 2005 and 1998 held by the Office of National Statistics in the Annual Respondents Database (ARD) which brings together a wide range of data relating to individual business units (ONS, 2002).[3] This database brings together a wide range of data relating to individual business units, including the Annual Business Inquiry (ONS, 2002; Barnes and Martin, 2002). One major advantage of this data source is that it allows for the examination of labour productivity based on microeconomic data.[4] The database provides a full survey of larger firms but firms with fewer than 250 employees are sampled on a random basis and hence are not surveyed every year. Most data are available at the plant level (often referred to as the 'local unit') and there may be more than one plant within a firm. Given the large amount of noise which would be incurred when comparing firm-level data in a time series or panel data format, it is felt that the best way to investigate spatial variations in labour productivity is to compare and contrast area-aggregates of cross-sections for the longest possible time period while retaining the maximum spread of plants across sectors. The ARD data set contains observations for all industries back to 1998 with the latest available data being for the year 2005. It is therefore decided to consider the longest time period possible and hence our analysis below is of data for the years 1998 and 2005. Due to the randomness employed in the sampling technique, we avoid making year-on-year comparisons in our regression estimates.

We use plant-level data for GVA at factor cost per employee as the measure of labour productivity. In addition to variables on the number of employees and on ownership (public or *private*), labour characteristic variables need to be included in the estimations. This is done by using data on skill levels in the local authority district in which the plant is located, often seen as a key target for policy intervention at local, regional or national level. In line with some other analyses, we merge in NOMIS education data to create two classifications: *High qualifications* (the proportion of the labour force with NVQ 4 and above) and *Low/no qualifications* (the proportion of the labour force with lower than NVQ4 or with no certifications). These variables are responsive to long term policy initiatives to improve educational attainment.

Kierzkowski, 1990) and that supply chains in one region may well influence the structure of industry and supply chains in another.

[3] One issue with the ARD is the level at which the data are collected: we use the plant. Different establishments have different numbers of plants and to control for this we employ a variable called *llunit* which is the log of the number of plants within the establishment. If the establishment is a single plant establishment then this is equal to one. Plants are identified by postcode in the ARD and this allows the flexibility to consider the productivity determinants at various geographical levels from national down to local level.

[4] Some public sector organizations are included but Standard Industrial Classification 100 (agriculture, forestry and fishing) firms are omitted. Although coverage is incomplete, the response rate is virtually 100% as there is a statutory requirement to participate in these surveys.

Data on firm-specific capital stock is obtainable from the ONS and is matched with plant-specific data within the ARD. Although this is not identical to the Treasury investment productivity driver, it represents the result of past investment and is appropriate in modelling based on the Cobb-Douglas production function.

Competition is proxied in our estimations by economic potential: *gravity*. This measures the potential interaction between one area and every other area in the set of areas, defined for each area, i, as the average (for all other areas) of $p_i * p_j / d_{ij}^2$, where p_i is the population at area i, p_j, that at area j, and d_{ij} is the distance between area i and area j. Population (p_i) is measured at the level of the administrative area in which each establishment is located; p_j is the population of every other administrative area in Great Britain; d_{ij} is represented by the straight-line distance between the centroids of each administrative area. This provides an index of economic potential for each administrative area, which is then linked to plants. We also include industry and regional dummies in our regression modelling in Section 5.

4. Exploratory spatial analysis

The labour productivity measure used here is formed by dividing gross value added at factor cost by the number of workers within each plant. In this section we aggregate the plant-level values for labour productivity to form an average value for each district or unitary authority within England and Wales. The sample size is equal to 48,100 plants. Although there is unevenness in the number of observation within each geographical area, the sample sizes (median=97; mean 116; SD=86) within each area are sufficiently large to maintain confidentiality and pass disclosure controls, and the data are not heavily biased by the presence of one or several plants.

Area based labour productivity, 2005

Figure 1 is a standard deviation map of labour productivity. Several observations can be made here. First, there are many areas which do not differ substantially from the national average. Second, there are very few areas where labour productivity is very high, this being greater than two standard deviations away from the sample mean; these areas can be found in London and the South West. Third, all regions except for Wales and Yorkshire and Humberside have at least one district or unitary authority that lies one standard deviation above the sample mean. Fourth, there are many areas where the area's average labour productivity is greater than one standard deviation below the mean and these areas are spread across all regions. Wales and the South West appear to have a particularly high incidence of low average labour productivity areas. Fifth, areas with low average labour productivity occur in the expected areas, such as much of Wales that lies north of the Cardiff-Newport industrial area and the relatively inaccessible areas of West Somerset, North Devon and North Cornwall. Sixth, areas of significantly low labour productivity are not contiguous to areas of high labour productivity.

{Figure 1 about here}

A further way to examine this data is via a Moran's I scatter plot. This is presented in Figure 2. As the data are standardised the units on the graph are expressed in standard deviations from the mean. The upper right quadrant of the Moran's I scatter plot shows those districts and unitary authorities with above average labour productivity which share area boundaries with neighbouring districts and unitary authorities that also have above average

values of labour productivity (high-high). The bottom left quadrant shows districts and unitary authorities with below average labour productivity with neighbouring districts and unitary authorities also with below average labour productivity values (low-low). The bottom right quadrant displays districts and unitary authorities with above average labour productivity values surrounded by districts and unitary authorities that have below average labour productivity values (high-low) and the upper left quadrant showing the opposite. The slope of the regression line through these points expresses the global Moran's I value and is equal to 0.4276, and therefore illustrating the presence of positive and statistically significant spatial autocorrelation (Anselin, 1996).

{Figure 2 about here}

Area based labour productivity, 1998

The same exploratory spatial data analysis is now carried out for 1998 and these results are presented in Figures 3 and 4. Figure 3 illustrates a similar pattern to that which is found for the 2005 sample. Nevertheless a few important comparison points can be made. First, the 1998 labour productivity value are higher in 1998 than for 2005 along the M4 corridor within the South East region, suggesting some convergence towards the sample mean value. Second, the labour productivity gap for the South West is widening slightly with the rest of England and Wales, as shown by more and larger negative standard deviation values. This is not the case with all South West areas because the productivity gap is increasingly a north-south divide within the region. Third, Wales is increasingly becoming a Cardiff-Newport relatively productive zone with the rest of Wales having lower labour productivity values, except for the extreme north-east of the country where spillovers may be accruing from Manchester and Liverpool. This global picture is supported by the corresponding Moran's I scatter plot in Figure 4 which illustrates positive and statistically significant spatial autocorrelation, as shown by the Moran's I static value of 0.4330.

{Figure 3 about here}

{Figure 4 about here}

Labour productivity change over time

Although the focus of attention for this paper is the medium-term change in the spatial pattern of labour productivity, which will be achieved by comparing data for 1998 and 2005, attention is first directed to the evolution of these statistics over time. Figure 5 presents a graph that shows the evolution of the mean and standard deviation of labour productivity at the district and unitary authority level, based on clustered plant-level data. Of particular interest is the relatively stable variance and the consistently positive trend in labour productivity; both of these are concordant with *a priori* expectations.

{Figure 5 about here}

Figure 6 presents a scatter plot of labour productivity in two years: 2005 and 1998. The line of best fit illustrates a positive trend, which illustrates persistence in labour productivity at this geographical scale over time and suggests that, on average, those areas that have high labour productivity values at one point in time will also have high labour productivity values seven years later. There are, of course, some areas which appear to

diverge from the fairly tight distribution of points around the line-of-best-fit, and these include West Somerset, Teesdale and Bracknell Forest below the line and Westminster, North Shropshire and the City of London above the line.

{Figure 6 about here}

A map showing the change in labour productivity between 1998 and 2005 is presented in Figure 7. It illustrates that there is an absence of any clear spatial pattern of labour productivity change over this time period and at this level of geography. All NUTS1 areas have districts and unitary authorities that are improving and all NUTS1 areas have districts and unitary authorities (except Yorkshire and Humberside and East Midlands) that are deteriorating based in this performance measure. The lack of clear global spatial autocorrelation is supported by the accompanying Moran's I scatterplot presented in Figure 8, where the regression line is insignificantly different from zero with a value of 0.0258.

{Figure 7 about here}

{Figure 8 about here}

This part of the exploratory data analysis can be strengthened with reference to Figures 9-11. Figure 9 presents a scatter plot of 1998 values and their subsequent change over the 1998-2005 time period. There are clear outliers corresponding to the aforementioned areas of West Somerset, Teesdale and Bracknell Forest, Westminster, North Shropshire and the City of London as highlighted on the graph. The plots in the quadrant where both the X and Y axes are positive correspond to areas which had labour productivity in 1998 that is greater than the average and moved away from the average; hence these areas, which include Westminster, the City of London and Bracknell Forest, are performing relatively well and are improving further. The plots in the quadrant where both the X and Y axes are negative correspond to areas that had labour productivity in 1998 which was below the average and moved away from the average and so are deteriorating further relative to the average for the sample. The plots in the bottom right quadrant where the X axis is positive and Y axis is negative correspond to areas which had labour productivity in 1998 that was greater than the average and deteriorated over time such that they are converging with the sample average; these areas include North Shropshire. The plots in the top left quadrant where the X axis is negative and Y axis is positive correspond to areas which had labour productivity in 1998 that was less than the average and improved over time such that they are converging with the sample average; these areas include Teesdale and West Somerset. West Somerset is a particularly interesting example, particularly given that its labour productivity started in 1998 at such a low level, but even though it has experienced a very small positive change this change is not resulting in any significant convergence. Indeed the shape of the whole distribution is evolving; with that it appears that the relative position of West Somerset is deteriorating.

{Figure 9 about here}

Of interest is whether there is convergence towards the mean in the sense of Galtonian fallacy. Figure 10 highlights that most of the movement is towards the average, but that there are also clear and strong groups of districts and unitary authorities in our sample that are diverging away (either positively or negatively) from the mean. These four categories of districts and unitary authorities are mapped in Figure 11. There is no clear spatial pattern of

convergence or divergence for labour productivity at this geographical level over this time period; the accompanying Moran's I scatterplot is excluded for brevity, which has a Moran's I statistics of 0.025. All NUTS1 regions have at least one district or unitary authority from each of these four classifications; the only exception is Wales which does not have an area that can be classified as "good and getting better"

{Figure 10 about here}

{Figure 11 about here}

Although there is no clear global spatial autocorrelation in the pattern of change in labour productivity there are local patterns present in Figure 11; for example, the West of England area is comprised of South Gloucestershire and Bristol, which are converging towards the mean from above, and North Somerset which is converging towards the mean from below. This might be representing spatial spillover effects to North Somerset from South Gloucestershire and Bristol Unitary Authority. The other member of the West of England area is Bath and North East Somerset which is diverging away from the mean from above, and on closer inspection of the data it can be seen that the value for BANES is converging marginally with South Gloucestershire and Bristol.

5. Econometric investigation

Although we have been able to analyse the spatial variation and the change in labour productivity at a very disaggregated geographical level our ability to empirically investigate the importance of industry affiliation of plants within these geographical areas is constrained by data availability and the need to avoid the reporting of potentially disclosive results. Nevertheless a picture of the importance and any change in the importance of specific industries can be observed at a more aggregated geographical level. The level of geography we chose for this paper's subsequent analysis is arguably the level of most frequent and important policy formation: NUTS1 regions. Across the UK there are Regional Development Agencies which formulate their own spatial economic strategy, which is based on their knowledge of their regional economies and the effectiveness and appropriateness of policy.

For our plant-level econometric modelling procedure we assume, as commonly used, a Cobb-Douglas production function in the form:

$$Y = AK^{\beta 1}L^{\beta 2} \tag{1}$$

where K is capital stock, Y gross value added at factor cost (GVAFC) and L is labour force. We divide both sides by L, take natural logs and then augment the model to include our selection of important explanatory variables, such that:

$$\ln(y/l)_i = \beta_0 + \beta_1 \ln(k)_i + \beta_2 \ln(l)_i + \beta_3 (X)_i + \text{industry}_i + \text{region}_i + u_i \tag{2}$$

where $\ln(y/l)_i$ is the log of output per employee for each firm, i, k is the firm specific capital, l is the number of employees within the plant, X is a group of explanatory variables and u is an error term which we assume is normally distributed and well behaved. Also included in the econometric model are industry and region (NUTS1) dummy variables. In later estimations we compound the region and industry dummies to identify the relative contributory effect of industry-region dummy variables. The results were generated using

maximisation of the likelihood function by means of OLS estimation methods using STATA version 9.0 and log-likelihood ratio tests are employed throughout to test for collective deletion of region and/or industry dummies.

The results of our plant-level econometric regressions for 2005 are presented in four columns in Table 1. In column 1 we present estimates of a model of labour productivity which includes a variable that captures the number of plants that make up the overall enterprise (which we argue captures the (dis-)economies of scale associated with larger enterprises) (*#plants*), the amount of capital-stock per worker available to the plant within the enterprise (*Capital per worker*), and the number of workers within the plant (*Employees*). The results suggest that greater capital stocks per worker and employee numbers increase labour productivity and that there are diseconomies of scale that are experienced with managing large, multi-plant organisations. Of particular interest is the productivity gap that can be observed for all English and Welsh regions relative to the London region; the London region control is consistently the region with the highest labour productivity so we expect all region coefficients to be negative and with coefficients being larger in absolute magnitude for some regions (e.g. Wales) than for other regions (e.g. SE). These *a priori* expectations are borne out in the results. Also of interest is the result of a collective variable deletion test of all regional dummy variables: we conclude that these regional dummy variables statistically significantly improve the model and should not be excluded.

{Table 1 about here}

Column 2 presents reestimates column 1 but instead of including the regional dummies (often included because regional geographers perceive that location is important) we include industry dummies (often included because industrial economists perceive that the industry is important). It can be seen that, relative to the hotels and catering sector, all other industries contribute statistically significantly more to labour productivity: hence plants operating in different industries have different effects on labour productivity levels. Worthy of note is that the standard error values suggest that construction coefficient is significantly larger than all other industry coefficients and that the wholesale and retail coefficient is significantly smaller than all other coefficients, although it is statistically larger than the hotels and catering control industry. We would expect that different industries have different effects on labour productivity values and that controlling for sector composition is important. These *a priori* expectations are borne out in the results and are supported by the collective variable deletion test for industry dummies which indicates that these industry controls statistically significantly improve the model and should not be excluded.

Column 3 provides the results of a regression that includes both sets of dummy variables: industry and region. Of interest is that, when relevant, most coefficients are relatively stable across these three columns. Note also that the separate collective variable deletion test for industry and regional dummies indicate that these industry and region controls statistically significantly improve the model and should not be excluded.

In column 4 we augment and then estimate the underlying model from column 3 to include our *qualifications*, *gravity* and *private* variables. Areas with greater proportions of high qualified workers have plants with higher labour productivity levels. Privately-owned plants are more productive than publicly owned plants. Note that the magnitudes of the industry dummies do not alter substantially and that the magnitude of the region dummies fall when columns 3 and 4 are compared, suggesting that the regional productivity gaps can be at least partly explained by differences in the availability of human capital, economic potential and whether the plant is privately-owned. Again, the collective variable deletion tests indicate that both groups of dummy variables cannot be excluded from the model.

Table 1 suggests that plant-level labour productivity is influenced by their regional location and the industry in which they operate. But do plants operating in specific industries have the same effect across all regions? Table 2 attempts to identify whether this is the case and shows that, relative to hotel and catering plants operating in the Yorkshire and Humberside region, there are distinct and statistically significant differences in the region-industry dummy variables in plant-level regressions.

The middle section of this regression table can be read along rows or down columns. Across the construction row we can see that the enhancing effect on labour productivity of operating in the construction industry varies across regions. The enhancing effect of operating in the construction industry in London is relatively small, which captures the early downturn in the housing market in the London region in 2005. The enhancing effect of operating in the construction industry was greatest in the West Midlands in 2005. The enhancing effect on labour productivity of operating in the manufacturing sector was greatest in London and smallest in Wales. Plants operating in the hotel and catering sector outside London were most productive in Yorkshire and Humberside and least productive in the East Midlands.

{Table 2 about here}

Down the South West column we can observe that plants operating in the construction industry appear to have the greatest enhancing effect on South West labour productivity and those plants operating in the hotels and catering sector have the least enhancing effect on South West labour productivity. On closer inspection, even though plants operating in the construction industry have the greatest enhancing industry effect on labour productivity in the South West, construction plants actually have greater enhancing effects in all other regions (excluding London). Although attracting plants operating in the construction industry might appear to be the best way of increasing the absolute level of productivity in the South West, it should be clear that such firms actually do better in all other regions. Therefore, in order to enhance the overall level of labour productivity in the UK, construction plants should not necessarily be encouraged to locate to the South West region. Such differences may be due to variations in infrastructure and supply chains as well as consumer tastes and preferences.

Similarly, although the enhancing effect on labour productivity of plants in the hotel and catering sector is not the greatest of all industries in the South West, there are only four regions for which the enhancing effect of plants operating in that industry is greater: Wales (which arguable does and should increasingly compete with the South West in this sector), and London, the East Midlands and Yorkshire and Humberside, all of which have a much higher number of large conurbations. This larger enhancing effect could simply reflect greater proportions of city-centre hotels focused on the business accommodation part of the sector. Therefore in order to increase the nation's labour productivity Table 2 tentatively suggests that regions should specialise in the sector in which they have a comparative advantage rather than competing with each other over attracting and retaining firms in specific enhancing sectors.[5]

There are some regions which appear to be very good across a range of sectors. Other than London, a prime example of this is the South East where the enhancing effects on labour productivity are particularly strong in the *wholesale and retail*, *transport*, *manufacturing* and *all other sectors*. Although there are only three regions where the hotel and catering sector

[5] This is a discussion about the relative strengths of discussing in absolute or relative terms, and both have very important and distinct implications.

have a more enhancing effect on labour productivity, Wales does experience relatively low enhancing effects from plants operating in *all other sectors*, *transport* and *manufacturing*.

Table 3 replicates Table 1 using data for the year 1998.The results are qualitatively similar, but a number of points are worthy of note. First the regional labour productivity gap between all regions with London was much smaller in 1998, suggesting that between 1998 and 2005 labour productivity in London grew much faster than in the rest of England and Wales; this is reflected in the smaller magnitudes of the region coefficients in the 1998 results. A similar effect may have occurred for plants operating in the *hotels and catering* sector which seems to have deteriorated in labour productivity relative to plants in the other sector groupings. Nevertheless the importance of region and industry dummies remain, suggesting it is neither an industry nor a regional perspective that is important, but instead there should be a region-industry (two-dimensional) perspective. These results remain after we include all of the extra explanatory variables, although the productivity gaps between London, the South East and the East are now no longer statistically different from zero.

{Table 3 about here}

Table 4 presents a reestimation of the underlying model used to generate the results of Table 2 but this time we use data corresponding to the year 1998. Plants operating in the construction sector were most labour productivity enhancing in London, the North East and Yorkshire and Humberside. Plants operating in the wholesale and retail sector were least labour productivity enhancing in the North East, East Midlands and in Wales. The South West and Wales are similar in that their labour productivity were most enhanced by the construction, manufacturing and wholesale and retail sectors and least by plants operating in the hotel and catering and all other sectors. These results are similar to those presented in Table 2, but are also different in a few important ways.

{Table 4 about here}

First, although the relative importance of industries within regions has not altered substantially, there are important characteristics concerning the change in the rankings of sectors across regions. For example, plants operating in the construction sector enhanced labour productivity most in the East Midlands in 2005 but in 1998 construction plants enhanced labour productivity relatively more in 7 other regions (all but the West Midlands and the East). In 1998 plants operating in the hotel and catering sector contributed more to labour productivity in all regions relative to Wales, but by 2005 hotel and catering plants only contributed more to labour productivity in Yorkshire and Humberside, the West Midlands and London. In 1998 only Wales gained less contribution to labour productivity from manufacturing relative to Yorkshire and Humberside, however by 2005 only London and the South East gained more. This picture illustrates an evolving relative importance of industry to regions, and essentially captures the evolving importance of industrial composition to the comparative advantage of regions.

Second, if a region specialises in the production of a small range of goods within a specific sector and if the growth of that sector is smaller than that of other sectors, then the overall growth of that region will be stunted. However, if a region is able to diversify its sector base such that it can gain the benefit of growth from a variety of sectors then that region is likely to be insulated from the low growth rates of specific sectors. Alternatively, if a region specialises in the production of a small range of goods within a specific sector and if the growth of that sector is much greater than that of other sectors, then the overall growth of that region will be greatly enhanced. If a region is able to reduce its sector base such that it

can gain the benefit of growth from a smaller range of high growth sectors then that region is likely to have a higher rate of growth. Note, however, that the importance of an industry to a region, relative to other regions, will change over time. This makes the identification of the industry to support over time problematic.

Third, the evolving contribution of different sectors to a region's labour productivity can result in an increase or a decrease in comparative advantage, and perhaps even kaleidoscopic comparative advantage (Bhagwati and Dehejia, 1994) which may have important implications for labour markets at the national (Traca, 2005) and regional level given the potential for workers to migrate to find work. Regional Development Agencies may incorrectly be accredited or scorned for changes in performance measures which are a 'natural' evolutionary property for their region rather than a direct result of policy.

The results presented above have an important message. First, within regions, all districts and unitary authorities are not equally wealthy and are not growing in a unified manner. Second, there are spatial patterns whereby the labour productivity of a district or unitary authority will be correlated with its neighbours' labour productivity. Third, there is persistence in the relative position of a district or unitary authority for labour productivity. Fourth, a district or unitary authority's growth rate is not necessarily strongly related to its neighbouring district or unitary authority's growth rate, at least not at this spatial scale. Fifth, and perhaps most importantly, the growth rate of a region will be driven by the growth rate of its industries, but plants in the same industry will enhance different regions to different extents. When policy is formulated to stimulate an area's labour productivity, care should be taken to ensure that relative and absolute labour productivity are enhanced within and across areas.

6. Conclusion

The objectives of this paper were to investigate whether a) there is a spatial component of labour productivity at the district and unitary authority level within England and Wales between 1998 and 2005 using exploratory spatial data analysis and b) the enhancing effect of different industries is similar across NUTS1 regions and whether their contributory effect evolves over time. Although the time period was constrained by data availability, the choice of geographical level was as fine grain as was currently possible for labour productivity analysis using UK data and the NUTS1 geographical level corresponds to regional development agencies boundaries and is therefore conducive to effective policy formation.

The results from the exploratory data analysis suggest that there is a strong spatial component of labour productivity at the district and unitary authority spatial scale. The spatial pattern of labour productivity did not change substantially between 1998 and 2005. Our results also suggest that there is not a clear global pattern of labour productivity change, at least not over this time period and at this spatial scale, although there are signs that there are local patterns which may be associated with local convergence; further analysis is recommended here.

The econometric results indicate that there are statistically significant effects on labour productivity patterns of i) industries, ii) regions, and iii) industries within regions. Industries contribute different amounts to each region's observable labour productivity values, and these patterns evolve over time. Our results have ramifications for regional policy formation and should encourage regional development agencies to move away from the production of qualitatively identical regional spatial and regional economic strategies.

References

Basile, R. (2008) **"**Regional economic growth in Europe: A semiparametric spatial dependence approach**",** *Papers in Regional Science* 87(4), 527-544

Bhagwati, J. N. and Dehejia, V. H. (1994) "Freer Trade and Wages of the Unskilled - Is Marx Striking Again?" in Bhagwati, J. N. and Kosters, M. (eds.), *Trade and Wages: Levelling Wages Down?*, Washington D.C.: American Enterprise Institute, pp. 36-75

Boddy, M., Hudson, J., Plumridge, A. and Webber, D. (2005) *Meeting the Productivity Challenge: final report on a study carried out for the South West of England Regional Development Agency*, SWRDA, Exeter.

Byrne, J. P., Fazio, G. and Piacentino , D. (2009) "Total Factor Productivity Convergence among Italian Regions: Some Evidence from Panel Unit Root Tests", *Regional Studies*, 43(1), 63–76

Department of Business Enterprise and Regulatory Reform (BERR) (2009) *Regional Economic Performance Indicators*, Downloaded from http://www.dtistats.net/sd/rci/ on 22 June 2009 at 06.19 GMT

Department of Trade and Industry (2004) *Regional Competitiveness and the State of the Regions* Department of Trade and Industry, London

Driffield , N. (2006) "On the search for spillovers from foreign direct investment (FDI) with spatial dependency" *Regional Studies* 40(1), 107–119

Enflo, K. and Hjertstrand , P. (2009) "Relative Sources of European Regional Productivity Convergence: A Bootstrap Frontier Approach", *Regional Studies* 43(5), 643 – 659

Griffith, R., Haskel, J. And Neely, A. (2006) "Why is productivity so dispersed?", *Oxford Review of Economic Policy* **22**(4), 513-525

H M Treasury (2000) *Productivity in the UK: 1 – The Evidence and the Government's Approach,* HMSO, London

H M Treasury (2001) *Productivity in the UK: 3 – The Regional Dimension*, H M Treasury, London

H M Treasury (2004) Public Spending Review 2004: Public Service Agreements 2005-2008, HM Treasury, London.

Jones, R. W. and Kierzkowski, H. (1990) "The Role of Services in Production and International Trade: A Theoretical Framework', in Jones, R. W. and Krueger, A. O. (eds.), *The Political Economy of International Trade: Essays in Honor of Robert E. Baldwin*, Cambridge, MA: Blackwell, pp. 31-48.

Traca, D. A. (2005) "Labour Markets and Kaleidoscopic Comparative Advantage", *Review of International Economics* **13**(3), 431-444

Webber, D. J. and Horswell, M. (2009) "Microeconomic foundations of geographical variations in labour productivity", unpublished manuscript

Webber, D. J., Hudson, J., Boddy, M. And Plumridge, A. (2009) "*Regional productivity differentials: Explaining the gap*", *Papers in Regional Science* (forthcoming)

Webber, D. J.; White, P. and Allen, D. O. (2005) "Income convergence across US states: An analysis using measures of concordance and discordance", *Journal of Regional Science* **45**(3), 565-589

Figure 1: Labour productivity in 2005

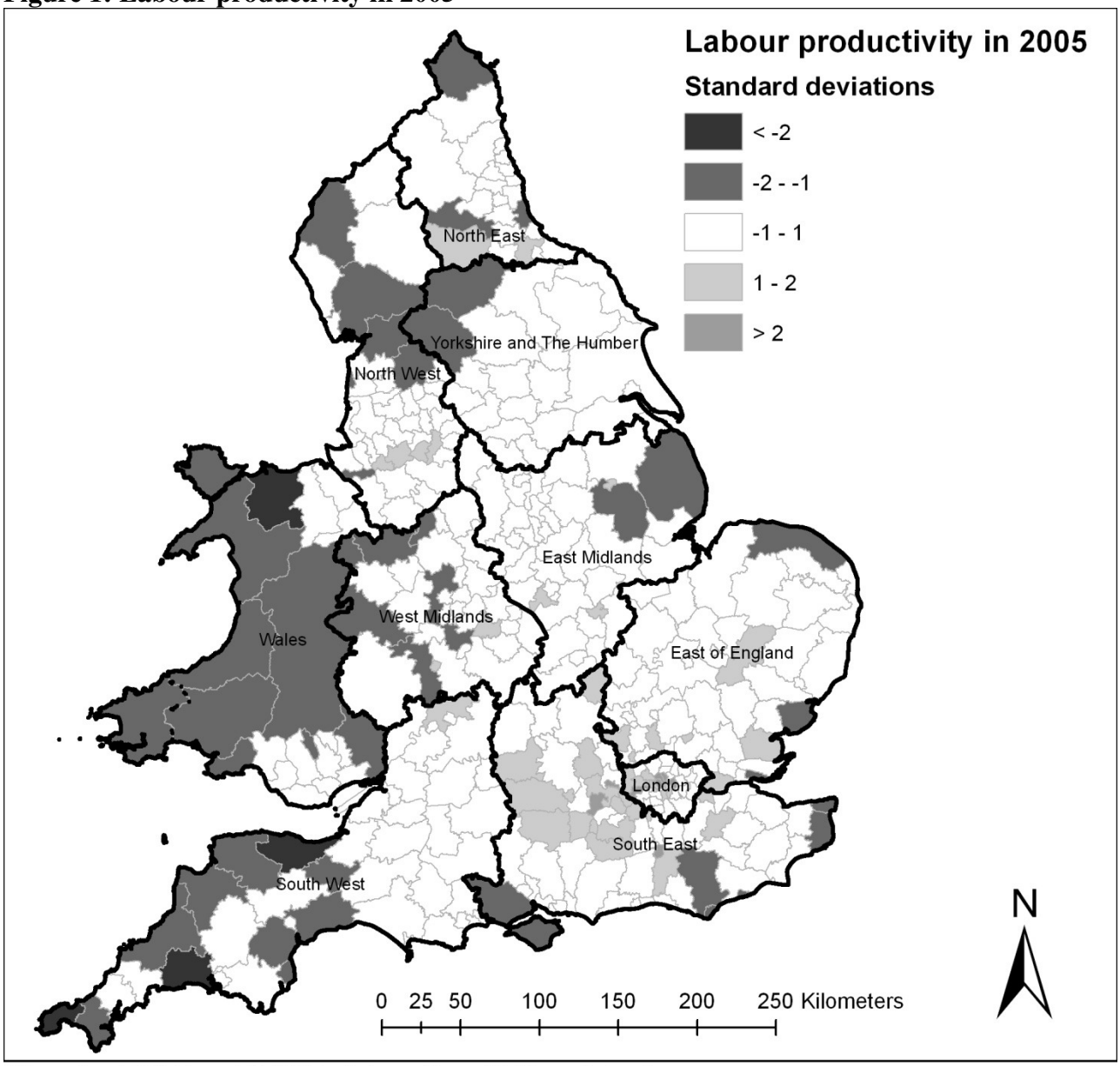

Figure 2: Moran's I scatter plot of labour productivity in 2005

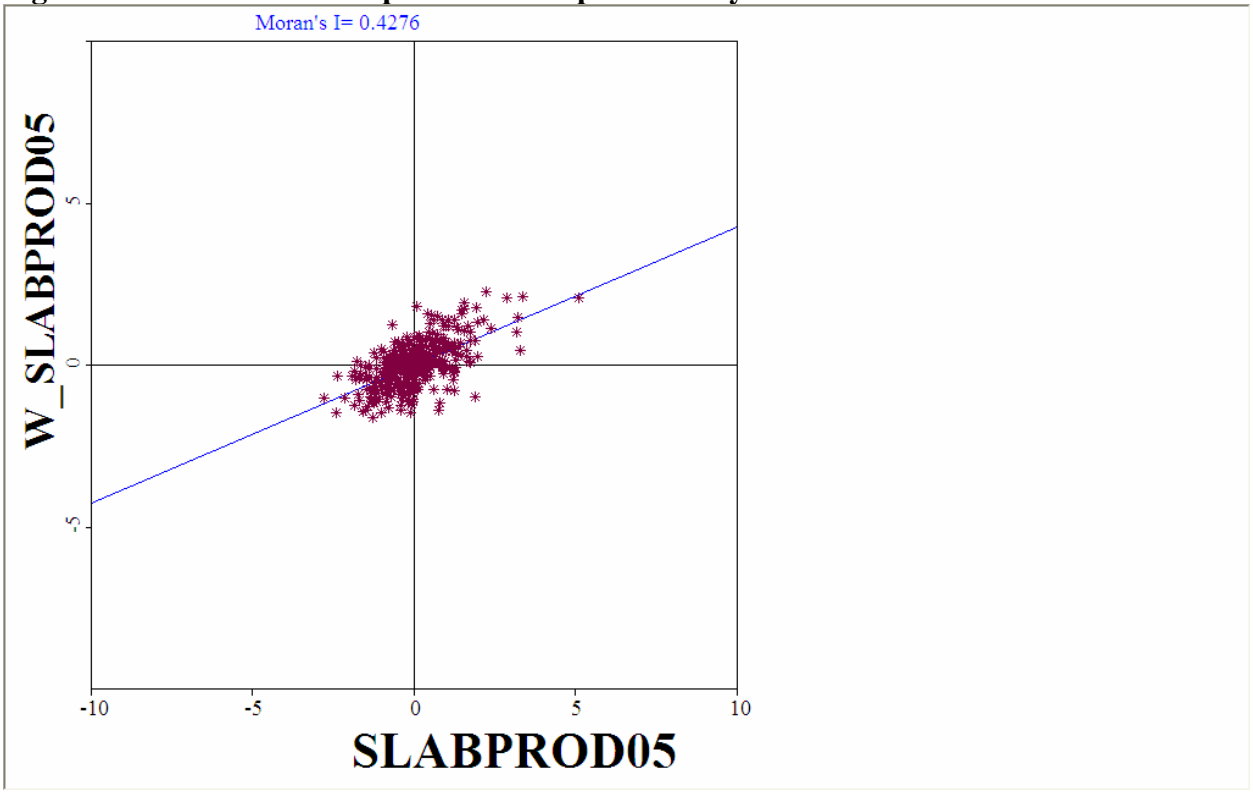

Figure 3: Labour productivity in 1998

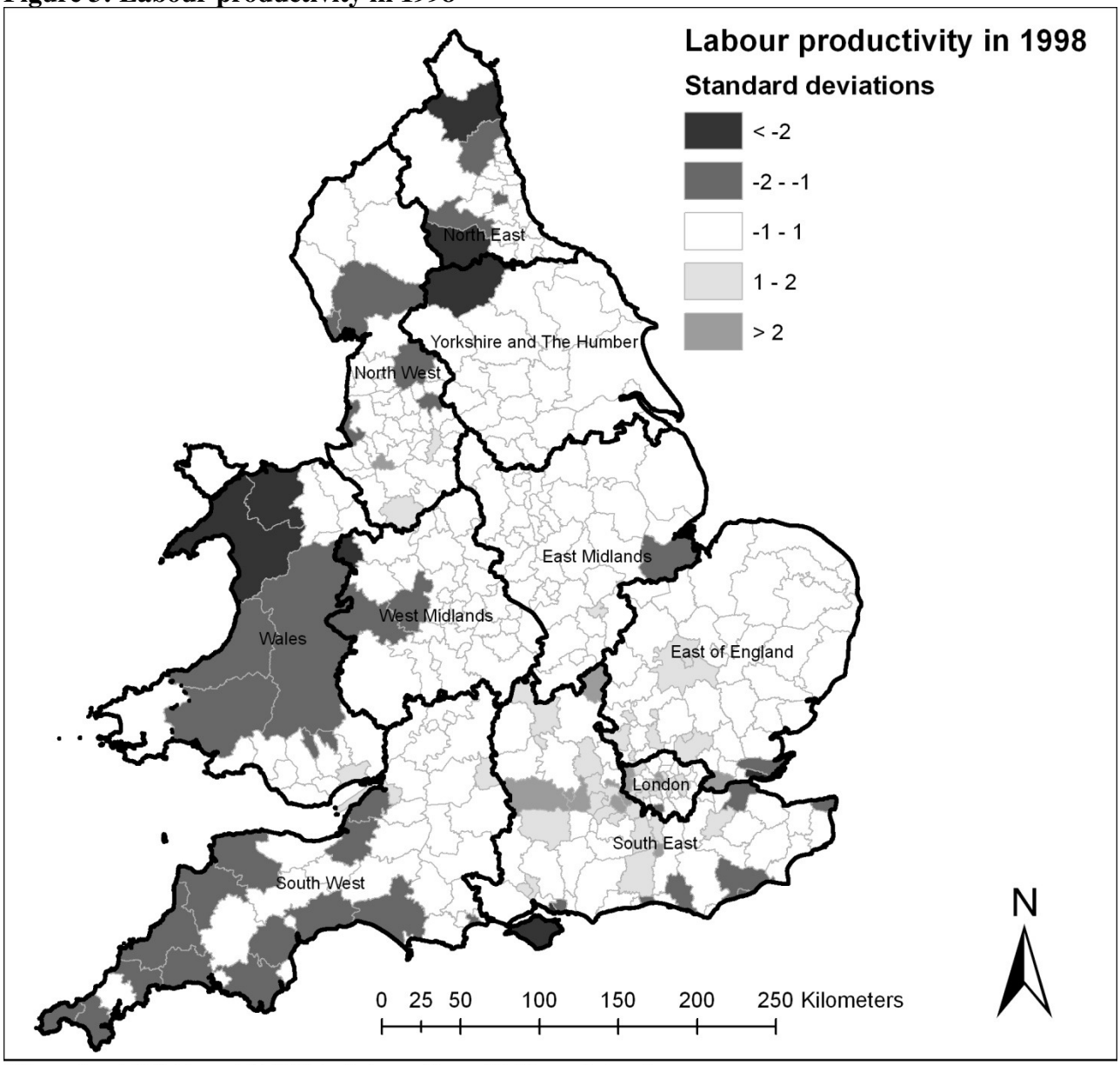

Figure 4: Moran's I scatter plot of labour productivity in 1998

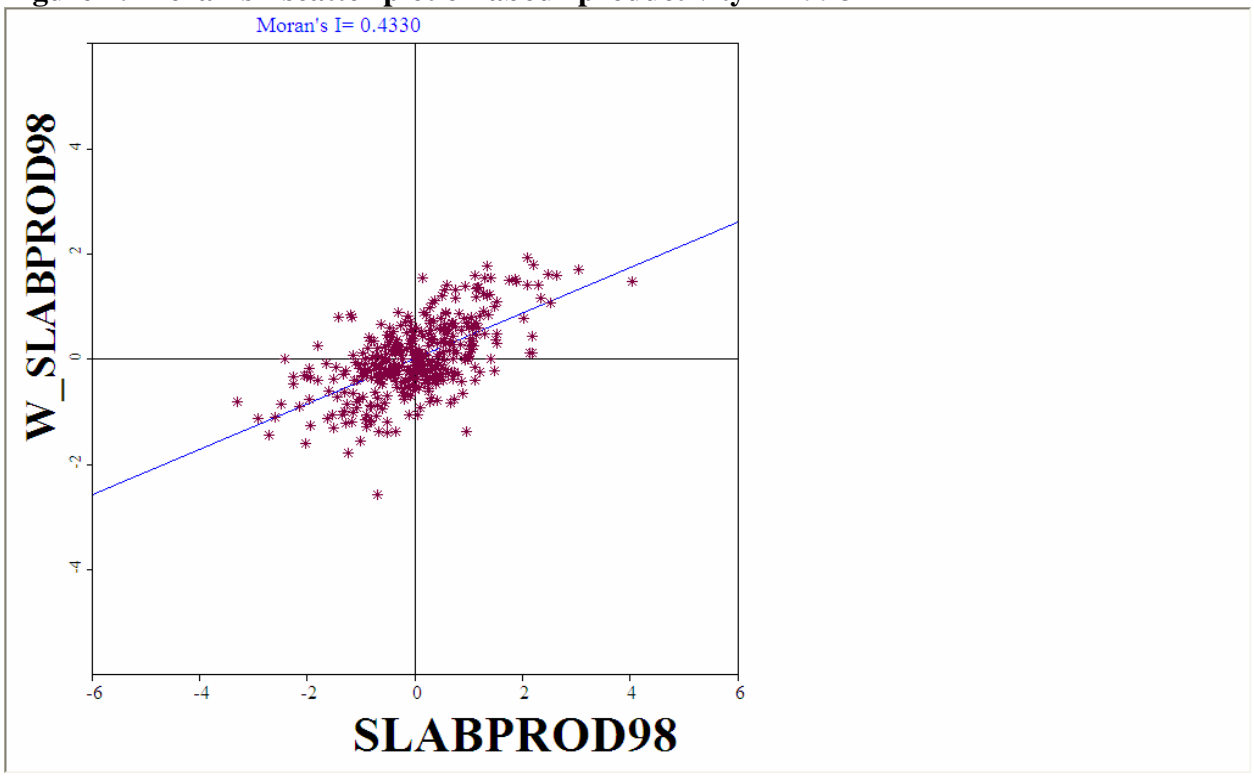

Figure 5: Mean and standard deviation of labour productivity

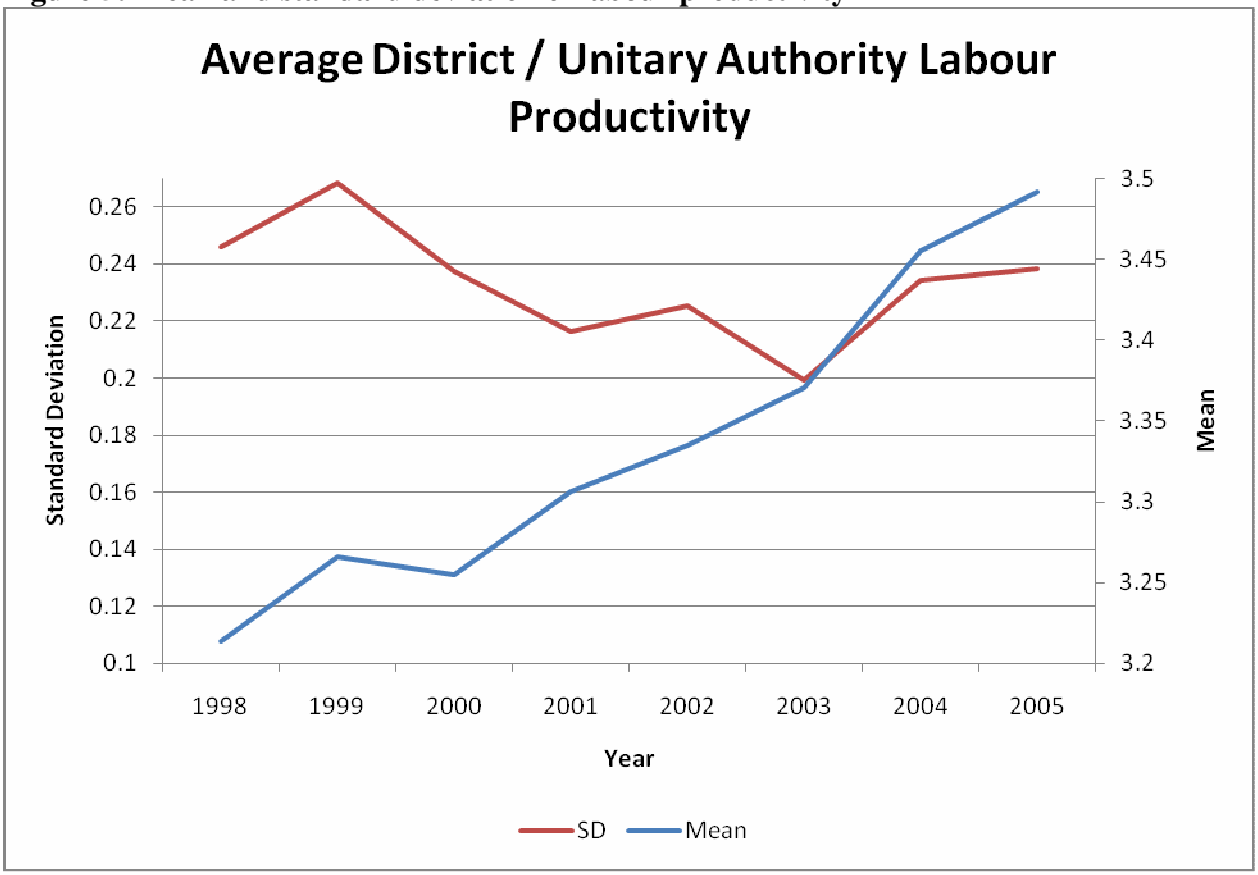

Figure 6: Scatterplot of change in labour productivity, 1998-2005

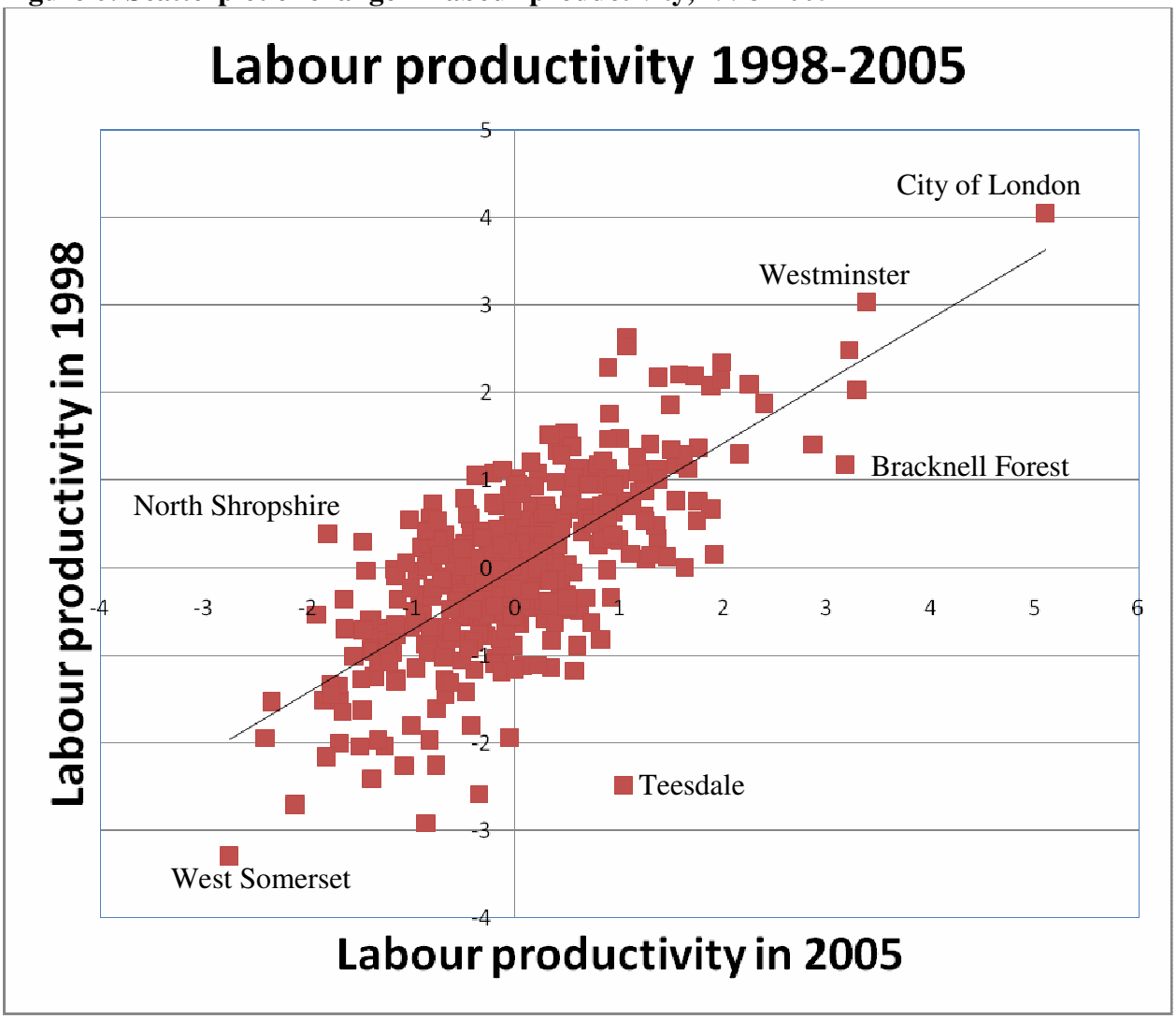

Figure 7: Change in labour productivity, 1998-2005

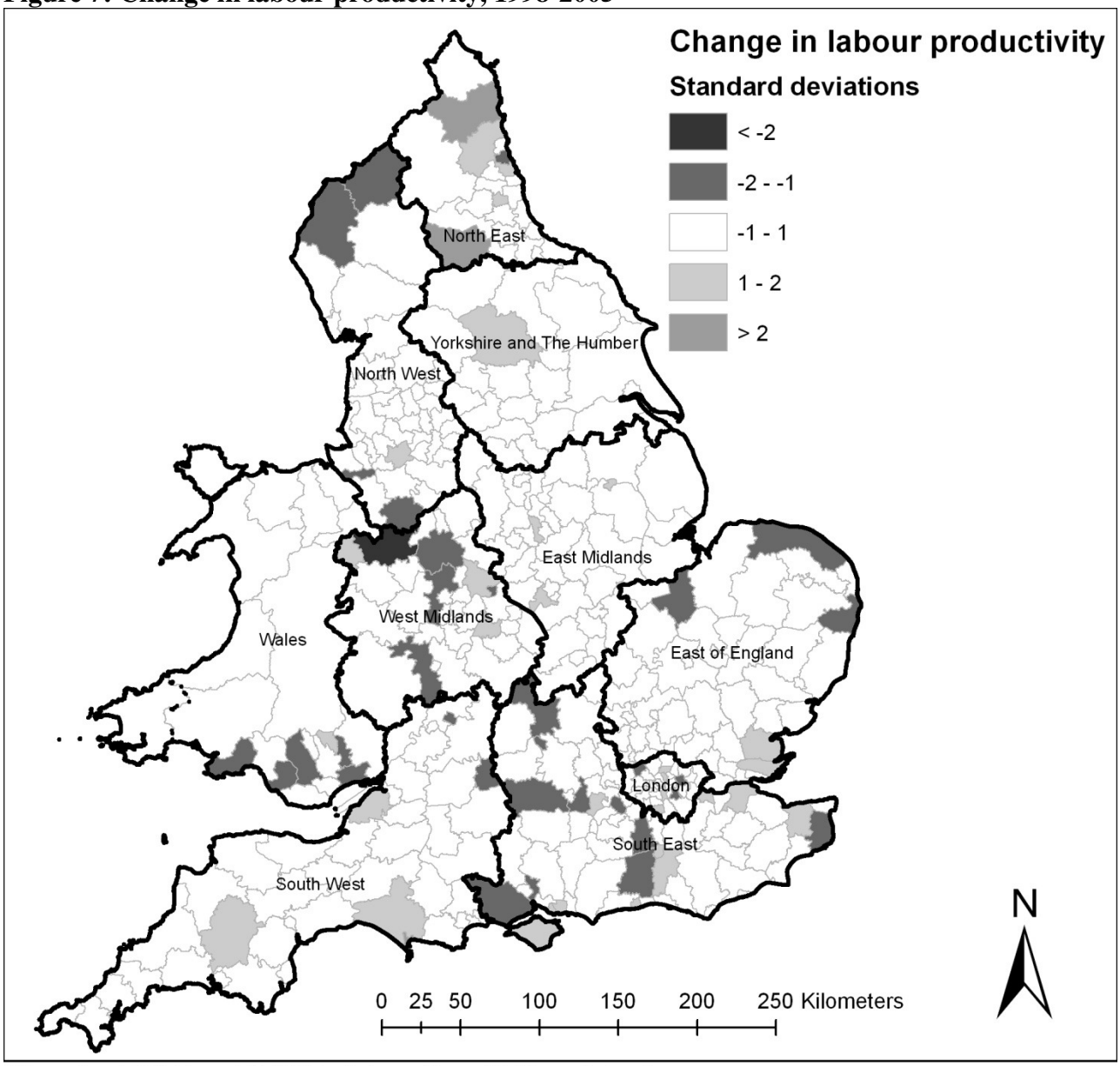

Figure 8: Moran's I scatter plot of change in labour productivity, 1998-2005

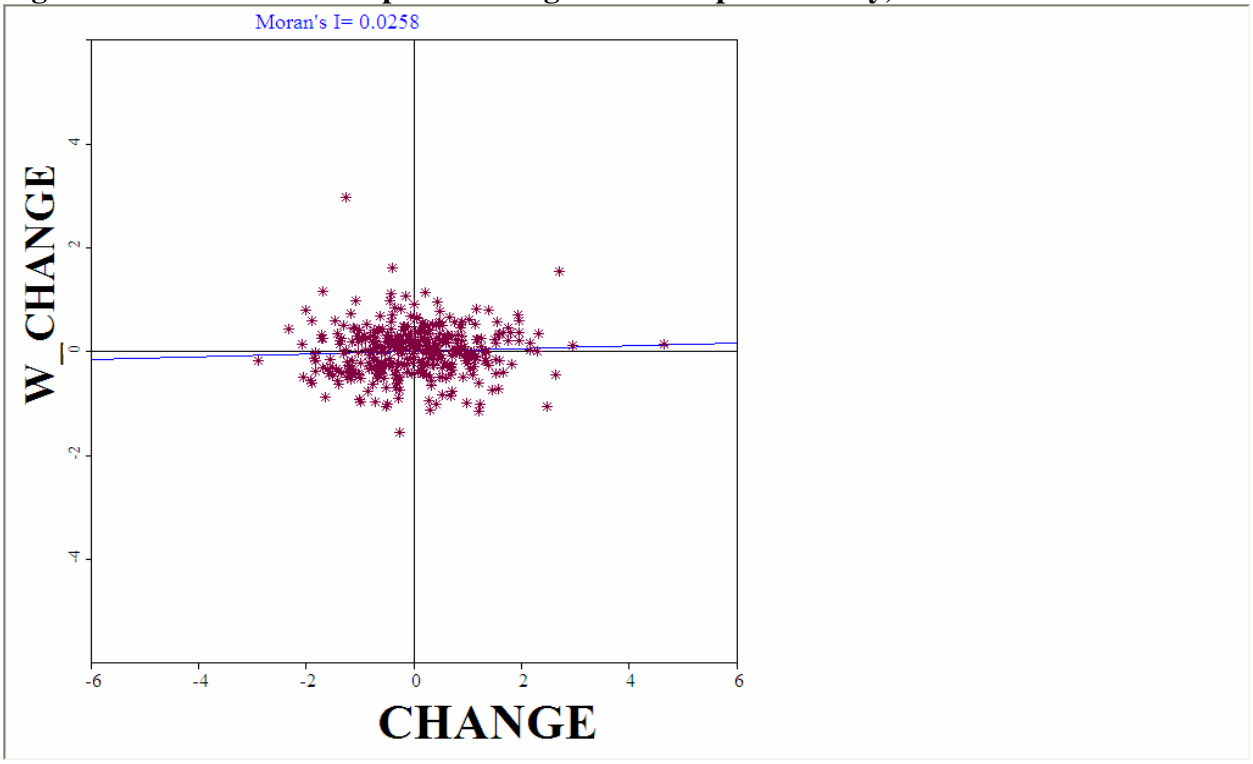

Figure 9: Scatterplot of change in labour productivity, 1998-2005

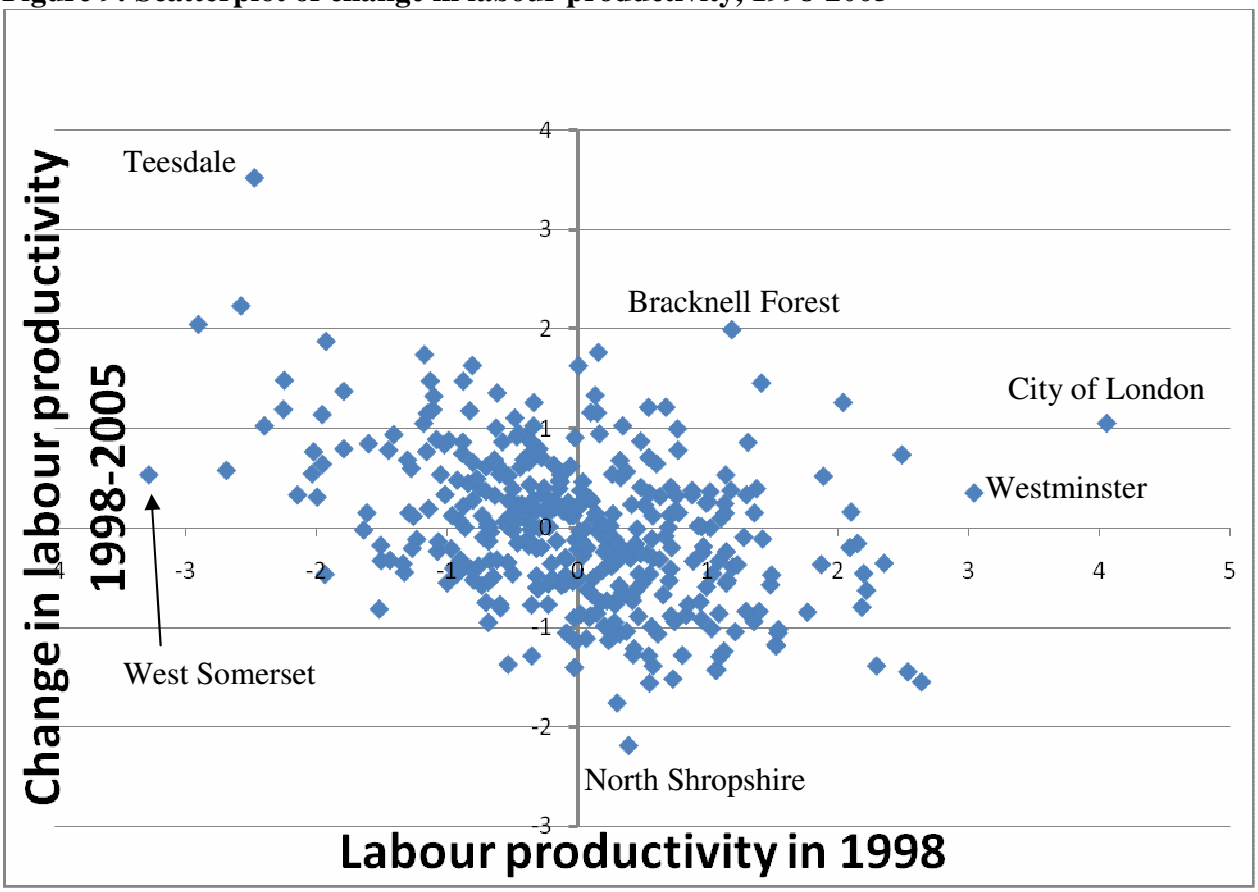

Figure 10: Percentage of districts and unitary authorities in performance classes

Source: ONS

Figure 11: Winners and losers: Labour productivity change, 1998-2005

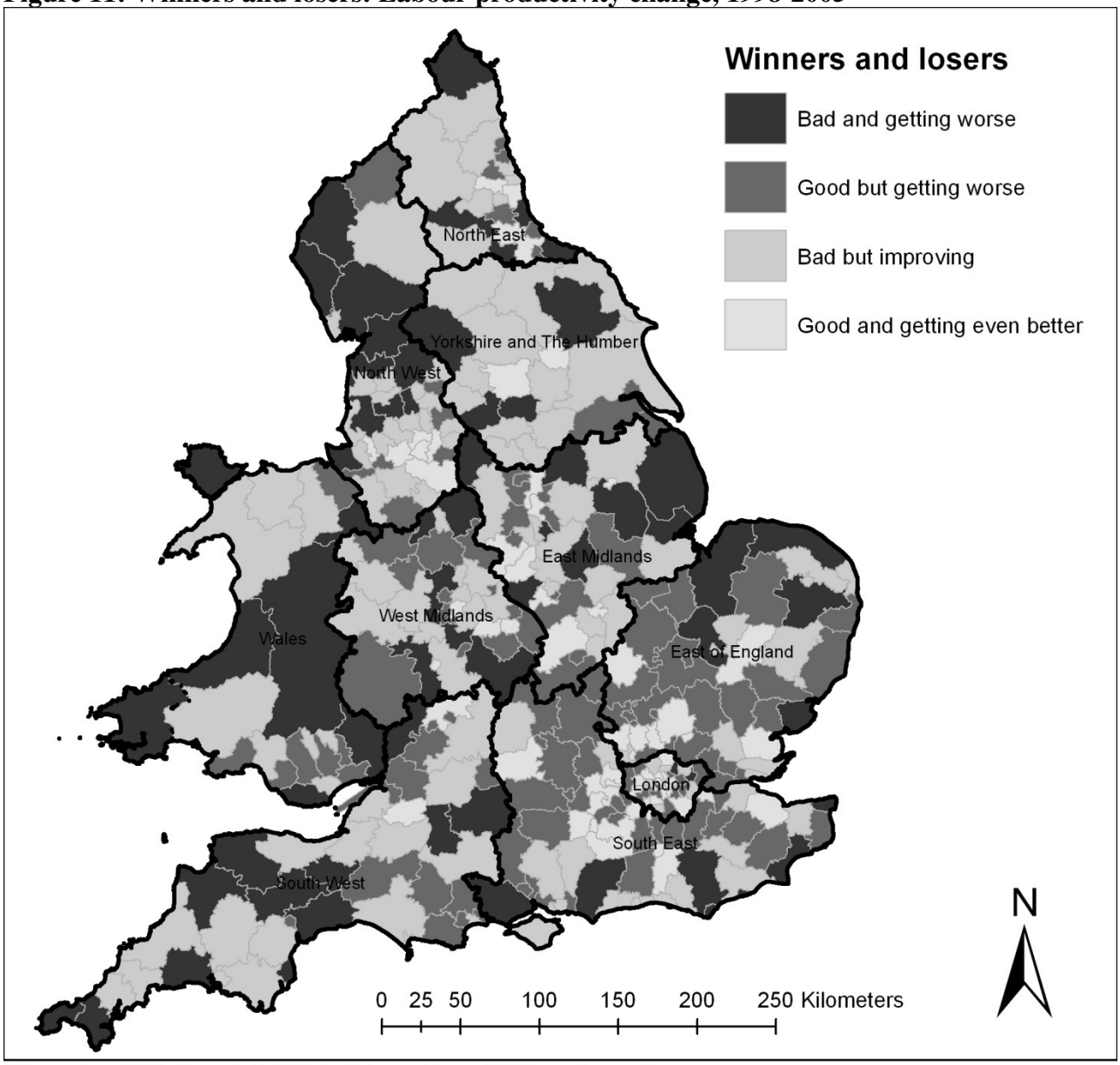

Table 1: Labour productivity differentials in 2005

	1	2	3	4
#plants	-0.050 (0.009)***	-0.018 (0.010)*	-0.020 (0.010)**	-0.020 (0.010)**
Employees	0.021 (0.006)***	0.006 (0.006)	0.005 (0.006)	0.011 (0.006)
Capital per worker	0.248 (0.006)***	0.261 (0.006)***	0.254 (0.006)***	0.251 (0.006)***
Low/no qualifications	*Control Variable*			
High qualifications				0.297 (0.033)***
Economic potential				0.011 (0.014)
Private				0.125 (0.025)***
London	*Control Variable*			
South East	-0.172 (0.034)***		-0.216 (0.033)***	-0.064 (0.038)*
South West	-0.311 (0.041)***		-0.330 (0.040)***	-0.154 (0.046)***
North West	-0.313 (0.040)***		-0.356 (0.039)***	-0.157 (0.045)***
East	-0.315 (0.053)***		-0.363 (0.052)***	-0.167 (0.058)***
Yorkshire & Humberside	-0.320 (0.041)***		-0.374 (0.040)***	-0.163 (0.046)***
West Midlands	-0.329 (0.040)***		-0.386 (0.040)***	-0.163 (0.046)***
North East	-0.338 (0.055)***		-0.394 (0.054)***	-0.143 (0.061)**
East Midlands	-0.371 (0.042)***		-0.435 (0.042)***	-0.211 (0.049)***
Wales	-0.491 (0.037)***		-0.499 (0.036)***	-0.298 (0.044)***
Hotels and catering	*Control Variable*			
Wholesale and retail		0.886 (0.048)***	0.881 (0.047)***	0.903 (0.047)***
All other sectors		0.991 (0.045)***	0.969 (0.045)***	0.988 (0.045)***
Transport		0.994 (0.058)***	1.002 (0.057)***	1.046 (0.057)***
Manufacturing		1.002 (0.047)***	1.050 (0.046)***	1.101 (0.047)***
Construction		1.332 (0.055)***	1.346 (0.055)***	1.394 (0.055)***
n	11306	11306	11306	11283
F test	178.65***	330.25***	173.49***	153.23***
R^2	0.160	0.190	0.207	0.214
LR test for collective variable deletion – regions	24.36***		27.68***	6.92***
LR test for collective variable deletion – industries		129.08***	135.54***	144.86***

Notes: Equations estimated using OLS. Standard errors are in parentheses and *, ** and *** denote the variable is significant at the 10%, 5% and 1% level respectively. The dependent variable in each regression is the log of gross value added per worker. Constant terms omitted. Source: ONS

Table 2: The enhancing and contracting effects of industry in regions on labour productivity in 2005

#Plants	-0.019 (0.010)*
Employees	0.010 (0.006)*
Capital	0.250 (0.006)***
Low / no qualifications	*Control Variable*
High qualifications	0.254 (0.034)***
Economic potential	-0.013 (0.014)
Private	0.128 (0.025)***

	London	South East	North West	West Midlands	East	Yorkshire & Humberside	South West	North East	East Midlands	Wales
Construction	-0.019 (0.143)***	1.007 (0.114)***	0.966 (0.138)***	1.097 (0.149)***	0.936 (0.198)***	1.107 (0.137)***	0.865 (0.145)***	1.108 (0.179)***	1.184 (0.142)***	1.003 (0.127)***
Wholesale and retail	0.797 (0.105)***	0.632 (0.095)***	0.498 (0.101)***	0.497 (0.106)*	0.365 (0.139)***	0.514 (0.112)***	0.408 (0.108)***	0.400 (0.141)***	0.525 (0.112)***	0.475 (0.110)***
All other sectors	0.876 (0.095)***	0.727 (0.089)***	0.671 (0.099)***	0.638 (0.100)***	0.598 (0.113)***	0.556 (0.102)***	0.664 (0.097)***	0.564 (0.120)***	0.444 (0.104)***	0.329 (0.091)***
Transport	0.713 (0.136)***	0.793 (0.117)***	0.625 (0.151)***	0.790 (0.172)***	0.778 (0.180)***	0.669 (0.150)***	0.573 (0.159)***	0.843 (0.242)***	0.589 (0.162)***	0.537 (0.135)***
Manufacturing	0.889 (0.117)***	0.811 (0.094)***	0.690 (0.097)***	0.652 (0.097)***	0.739 (0.115)***	0.767 (0.099)***	0.724 (0.101)***	0.749 (0.113)***	0.658 (0.098)***	0.591 (0.098)***
Hotels and catering	-0.127 (0.133)***	-0.494 (0.135)***	-0.359 (0.158)**	-0.217 (0.196)	-0.546 (0.236)**	*Control Variable*	-0.319 (0.144)**	-0.394 (0.236)*	-0.690 (0.201)***	-0.316 (0.124)**

n	11283
F test	48.01***
R^2	0.218
LR test for collective variable deletion of compound variables	13.86***

See notes on Table 1. Source: ONS

Table 3: Labour productivity differentials in 1998

	1	2	3	4
#plants	0.432 (0.011)***	0.422 (0.011)***	0.426 (0.011)***	0.417 (0.011)***
Employees	-0.287 (0.008)***	-0.265 (0.008)***	-0.272 (0.008)***	-0.292 (0.008)***
Capital per worker	0.445 (0.006)***	0.486 (0.007)***	0.478 (0.007)***	0.469 (0.007)***
Low/no qualifications	*Control Variable*			
High qualifications				0.161 (0.033)***
Economic potential				0.011 (0.015)
Private				-0.055 (0.021)***
London	*Control Variable*			
South East	-0.056 (0.036)		-0.112 (0.035)***	-0.053 (0.039)
South West	-0.106 (0.044)**		-0.165 (0.043)***	-0.086 (0.048)*
North West	-0.119 (0.043)***		-0.228 (0.042)***	-0.129 (0.046)***
East	-0.045 (0.055)		-0.128 (0.053)**	-0.035 (0.058)
Yorkshire and Humberside	-0.149 (0.042)***		-0.255 (0.041)***	-0.138 (0.046)***
West Midlands	-0.112 (0.041)***		-0.220 (0.040)***	-0.101 (0.045)**
North East	-0.094 (0.055)*		-0.237 (0.054)***	-0.115 (0.060)*
East Midlands	-0.099 (0.043)**		-0.206 (0.042)***	-0.110 (0.048)**
Wales	-0.335 (0.048)***		-0.395 (0.046)***	-0.299 (0.052)***
Hotels and catering	*Control Variable*			
Wholesale and retail		0.835 (0.070)***	0.833 (0.069)***	0.777 (0.070)***
All other sectors		0.329 (0.068)***	0.319 (0.068)***	0.224 (0.068)***
Transport		0.709 (0.079)***	0.701 (0.079)***	0.697 (0.080)***
Manufacturing		0.775 (0.067)***	0.808 (0.067)***	0.762 (0.068)***
Construction		1.201 (0.077)***	1.210 (0.077)***	1.126 (0.078)***
n	8594	8594	8594	8403
F test	2389.94***	3892.12***	1856.36***	1582.89***
R^2	0.770	0.784	0.786	0.791
LR test for collective variable deletion – regions	6.35***		10.90***	4.75***
LR test for collective variable deletion – industries		124.78***	133.37***	127.68***

See notes on Table 1. Source: ONS

Table 4: The enhancing and contracting effects of industry in regions on labour productivity in 1998

#Plants	0.359 (0.013)***
Employees	-0.296 (0.008)***
Capital	0.467 (0.007)***
Low/no qualifications	*Control Variable*
High qualifications	0.128 (0.036)***
Economic potential	0.007 (0.015)
Private	-0.052 (0.021)**

	London	South East	North West	West Midlands	East	Yorkshire & Humberside	South West	North East	East Midlands	Wales
Construction	0.614 (0.148)***	0.520 (0.112)***	0.526 (0.130)***	0.427 (0.142)***	0.267 (0.180)	0.698 (0.145)***	0.469 (0.156)***	0.753 (0.164)***	0.440 (0.143)***	0.517 (0.162)***
Wholesale and retail	0.330 (0.097)***	0.306 (0.081)***	0.142 (0.106)	0.166 (0.101)*	0.295 (0.135)**	0.149 (0.107)	0.147 (0.105)	-0.118 (0.150)	0.150 (0.104)	-0.093 (0.114)
All other sectors	-0.184 (0.082)**	-0.264 (0.074)***	-0.472 (0.096)***	-0.335 (0.091)***	-0.246 (0.110)**	-0.287 (0.096)***	-0.440 (0.089)***	-0.365 (0.131)***	-0.264 (0.096)***	-0.617 (0.102)***
Transport	0.256 (0.126)**	0.083 (0.108)	0.355 (0.168)**	0.149 (0.200)	0.157 (0.251)	-0.091 (0.166)	0.186 (0.166)	0.248 (0.236)	0.029 (0.183)	-0.230 (0.204)
Manufacturing	0.259 (0.089)***	0.188 (0.071)***	0.153 (0.075)**	0.162 (0.072)**	0.253 (0.089)***	0.082 (0.074)	0.257 (0.079)***	0.151 (0.086)*	0.148 (0.074)**	0.028 (0.081)
Hotels and catering	-0.126 (0.156)	-0.613 (0.168)***	-0.700 (0.213)***	-0.370 (0.261)	-0.742 (0.295)***	*Control Variable*	-0.467 (0.204)**	-0.924 (0.461)**	-1.073 (0.295)***	-1.146 (0.196)***

n	8403
F test	487.09***
R^2	0.792
LR test for collective variable deletion of compound variables	12.34***

See notes on Table 1. Source: ONS