Department of Health
and
Institute for Employment Research
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Spatial Variations in Labour Costs:

2001 Review of the Staff Market Forces Factor

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The responsibility for the views expressed and for any remaining errors lies solely with the authors.

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Executive Summary

Background

This document summarises the results of the 2001 Review of the Staff Market Forces Factor carried out by the Warwick Institute for Employment Research on behalf of the Department of Health. This work has involved an extensive review of related research, as well as new econometric and related analysis. The approach used to develop the Staff Market Forces Factor for the period 1996-2000 has been based on what have been termed standardised spatial wage differentials (SSWDs). The present research focuses on the estimation of SSWDs. These have been estimated for a range of different geographical areas. The SSWDs are intended to measure the disamenities associated with working in a particular geographical location, as well as differences in the balance of supply and demand in the locality, taking everything else into account. They measure the amount that employers need to pay to attract and retain staff in that location. The current method uses data from the New Earnings Survey (NES). This has been compared to alternative estimates based on the Labour Force Survey (LFS). The data used are for those in the private sector only to avoid problems of circularity.

Main Conclusions

1. It is recommended that the SSWDs calculations should continue, for the present round, to be based on the cross-sectional analysis, using ordinary least squares (OLS) methods. However, various refinements are proposed as set out below. These include the use of the full spatial detail available now in the NESPSD and more industry controls, as well as the use of some smoothing adjustments.

2. The review has reconsidered the choice of geographical areas. While some experiments have been conducted with the use of broader areas, it is considered that this is too crude an approach, which does not reflect the complexities of the pattern of SSWDs. The recommended approach is to use the full level of detail available in the NES data set (subject to a few reservations about sample sizes in the smallest area).

3. The review suggests that some type of smoothing mechanism can provide a useful refinement of the SSWD estimates, especially in the context of the introduction of Primary Care Trusts (PCTs). Such adjustments can avoid some of the "cliff edge" discontinuities, which were a major criticism of the previous MFF calculation. A variety of methods have been assessed. The recommended approach is based on a weighted averaging of own and neighbouring areas' SSWDs. The weights depend upon population size and the distance between areas.

4. The second main criticism of the previous method was concerned with the econometric method used to estimate the SSWDs. The OLS cross-sectional analysis is theoretically inferior to more sophisticated methods, which take advantage of the panel nature of the NES dataset. In principle, so called "fixed effects" and other methods can provide better and more accurate estimates of SSWDs. These alternative approaches have been explored in some detail and have shown some promise. However, there are a number of reservations about the precise values obtained. These will require further work to be fully resolved. Moreover there are some concerns about the practicalities of implementing such models in future years. These need to be sorted out before such an alternative approach can be recommended as the best way forward. In particular, the maintenance and improvement of the panel aspects of the NES dataset need to be put on a firmer footing.

5. Despite these reservations, the NES remains the preferred data set.

   - The analysis suggests that the LFS has no real advantage over the NES, as a result of its inclusion of data on human capital variables such as qualifications, etc, which are not available in the NES.
   - Despite recent increases in sample size, the LFS sample remains much smaller than that in the NES, so that it is not possible to get such detailed spatial results as is possible from using the NES.
   - Potential errors due to proxy reporting in the LFS, as well as small sample problems, remain a serious concern, especially for many of the smaller geographical areas.

6. A number of additional refinements have been recommended for further consideration:
   - Further analysis of fixed effects as well as other methods such as multi-level modelling
   - Further refinements of the controls used in the regression analysis, including the use of selected interaction effects between industry and space.
   - Use of finer geographical detail based on developing an enhanced version of the NESPD incorporating postcode information for individual cases
   - Further exploration of surfacing techniques, also using individual postcodes
   - Exploration of more sophisticated smoothing mechanisms based on use of additional data such as commuting flows.

Econometric Analysis

The previous set of SSWDs were based on an OLS cross-sectional analysis of data from the NES panel dataset (NESPD). The final estimates used in the previous MFF calculations were averages, over a three year period, using data for 1997-1999.

The previous estimation made use of detailed occupational controls (78 categories). However, industry controls were limited to some 18 sectors. This may fail to pick up some of the detailed differences in industrial structure in certain areas. The present analysis has explored the use of more detailed industry controls (50). While, in general, this does not make a huge difference, it does lead to a few significant changes in certain areas. For example, in Teeside the use of refined control distinguishing pharmaceuticals from other chemicals, results in changes to the SSWDs in that area. These refinements are regarded as small but significant improvements and it is recommended that they should be used in future SSWDs estimation.

Some further experiments with selected interactive industry/spatial dummies, in order to refine the "financial services/City of London" effect is probably desirable but it was not possible to cover all these possibilities within the current programme of work.

In addition to updating the OLS cross-sectional estimates to include data for 2000, the analysis explored a range of alternative methods. These have included the following:

- Fixed effects
- Random effects
- *Ex ante* Surfacing (OLS)

The latter is essentially an alternative technique for smoothing out discontinuities. It is therefore discussed below under the heading of smoothing techniques

The previous econometric analysis was based on some 79 areas. These reflected the greatest level of geographical detail available when this work was first undertaken. Subsequently, the Office for National Statistics has modified the NESPD to distinguish some 119 areas. It was agreed that the use of the more detailed areas available in the NESPD should be explored. This analysis suggested that the most detailed areas available were the most useful basis for the final round of econometric and *ex post* smoothing work. Initially, all 119 areas were used, but there were some concerns about sample sizes. The latter suggest that just one area (Rutland) be aggregated because of its small size. The results suggest that, subject to these reservations about some very small areas, this greater level of detail should be used in future estimates.

Much of the current econometric analysis has been conducted using the old 79 areas (to facilitate comparisons with the previous estimates) or with much more aggregated zonal categories (to facilitate comparisons with earlier work conducted by Bell (1998)). Much of the analysis of different methods for smoothing and avoiding cliff edges has also used the 79 zones. This choice was purely for analytical convenience. The use of these areas or zones was not intended to prejudge the issue of the optimal choice of zones to be used in the final calculations. The final results are all based on the more detailed 119 spatial areas (subject to the reservations already expressed).

Using the finally agreed areas, plus the most detailed set of industry dummies, a revised set of OLS/cross-sectional estimates have been produced, covering 1998-2000. A three year average of these form the basis for the new SSWDs. Results are presented which also give comparisons with the previous estimates. Further refinements to avoid cliff edges are discussed below.

The use of fixed effects (or random effects) methods offers a number of theoretical advantages over the OLS analysis. The NESPD enables such methods to be employed. In principle, these methods avoid potential bias to the SSWDs caused by the omission of certain key factors which may influence individual earnings. These include things such as ability, motivation, effort etc. If such effects can be regarded as fixed over time, then the panel nature of the NESPD (which tracks individuals over time) can be used to factor out such effects and avoid this source of bias.

A number of Fixed effects models have been estimated and the results compared with the conventional estimates. Comparisons have also been made with earlier research conducted by Bell. These results, while promising, need further refinement before they can be regarded as a practical alternative to the more conventional methods. They suggest a much attenuated range of SSWDs.

However, there are problems with the fixed effects results:

- There are still some quite large differences between slightly different specifications. The results currently are not, therefore, regarded as robust enough to be used for the MFF calculations. The standard errors are high on many coefficients and the results not always plausible.
- Moreover, there are difficulties surrounding the maintenance and upgrading of the panel aspects of NESPD. These counsel against major changes this time around. These problems are likely to affect the fixed effects results especially. In particular, prospective changes in occupational classification in the NESPD will need to be properly addressed.
- ONS are intending to devote more time and resources to developing and maintaining the NESPD but probably need encouragement from users such as the NHS to give this work a high priority.

Random effects models have also been explored, but there have been technical problems in finalising these estimates. The Academic Technical Steering Group has also expressed reservations about their value in this context.

The *ex ante* surfacing technique has been applied to the OLS based cross-sectional analysis. The results lead to sharply attenuated SSWDs, especially in the London area. The analysis has so far failed to pick up a real Central London effect, despite use of a large number of power terms in the polynomials fitted. This problem is regarded as primarily due to the lack of geographical variation in the spatial co-ordinates used in the Central London area. The general approach is regarded as having some promise but only if more refined geographical information, on individual cases, can be added to the NESPD. These results and conclusions are discussed in more detail below.

Smoothing and other techniques to avoid "cliff edges"

One of the main criticisms of the previous method for calculating SSWDs has been that this has resulted in some sharp discontinuities or "cliff edges" between neighbouring areas. This refers to the situation where adjoining HAs, which are perceived to have similar local labour market pressures (unemployment rates, housing costs, etc), have sharply different SSWDs, which do not appear to be related to labour market pressures. This section presents a brief review of the methods and approaches used to avoid such cliff edges between adjacent zones.

A review of previous work suggests that there are a number of techniques available for smoothing out such discontinuities. A number of these alternative methods have been considered here. They fall into two main categories. The first involves changes to the econometric estimation method in order to build space in explicitly. These are referred to as *ex ante* methods. The second approach adopts various means of smoothing the area SSWDs which emerge from the standard econometric analysis, after the econometric estimation is completed (*ex post*).

Ex ante smoothing

Ex ante methods, involve the estimation of more complex surfaces as an integral part of the econometric analysis, instead of simply using area dummy variables. This includes the approach referred to as *ex ante* surfacing above.

"*Ex ante* surfacing" involves incorporating space explicitly into the regression analysis. The area dummy variables used in the conventional analysis are replaced by information on the geographical co-ordinates of the area. These are measured at the geographical centre of the area, weighted by population in different wards. This location is referred to as a centroid. The geographical co-ordinates of the centroids are then used to fit a complex surface representing the pattern of SSWDs across space.

This general approach is founded on the assumption that SSWDs should differ gradually from one area to another, rather like undulating countryside. It involves the construction of a contour wage map of the country, with heights representing wage levels. From this, a smoothed SSWD for any particular area can be read off, in the same way that height above sea level can be read off an ordinary contour map.

"Space" is represented by the Ordnance Survey national grid co-ordinates for the data observation (with x representing distance east and y representing distance north from the origin of the national grid).

The co-ordinates alone would only permit a linear 'plane' to be estimated covering the entire country. In order to represent the curvature of the earnings surface, polynomial terms (the co-ordinates raised to successively higher powers) are added. SSWDs can then be calculated for any location by simply calculating the "height" of the surface above the appropriate x and y co-ordinates. In principle, by including successively higher powers of the geographical co-ordinates it should be possible to produce any required shape.

However, while intuitively appealing, the analysis suggests that the approach seems to be unable to pick up the complexities of the pattern of SSWDs in areas such as London. In particular, the results lead to much attenuated SSWDs in the London area. This probably reflects the fact that the co-ordinates are based on the limited number of NES areas rather than the precise location of the individual's work place. This means that the values of the geographical co-ordinates in London in particular, may be too imprecise to enable a good fit to be obtained.

In principle, it is possible to attach detailed postcode information to each individual record in the NESPD. Were this to be done it might facilitate a more successful application of this method. However, for such data to be made available ONS would need to enhance the current NESPD. This would also raise issues of confidentiality in the context of the 1947 Statistics of Trade Act. These matters are under consideration by ONS for possible future work.

Ex post smoothing

There are also a number of methods of smoothing out the estimated SSWDs derived from a more conventional regression analysis, using area dummy variable. Since this is carried out after the regression analysis has been completed it is referred to as *ex post* smoothing. The *ex post* methods include

- *Moving Windows*
- *Surfacing* (including contouring, trend surfaces and earnings potential surfaces)

***Moving Windows* –** is an *ex post* method of averaging SSWDs for neighbouring authorities in a systematic way. For each NES area, its SSWD can be converted into a "spatial average" of SSWDs for contiguous areas. These can be a straight average or weighted according to factors such as the distance between the geographical centres of each pair of areas or by the length of their common boundary. These areas are described as being in a "window". The procedure is repeated for each area in turn using a different set of neighbours (hence "moving windows"). The analysis conducted on behalf of DETR, suggested that this approach is able to smooth out most of the "cliff edges" between adjoining areas. However, the exact form of spatial weighting system adopted requires experimentation. A series of estimates based on alternative methods have been generated.

These include variants based on weighting using the size of area (as measured, for example by population or employment), distance between areas, and length of common boundaries. The recommended approach uses weights based on both population and distance although each alternative has its merits. The use of distance has been successful in other contexts and is accepted as a fairly standard technique.

Surfacing *of SSWDs yielded by the regression model.* This is essentially the same idea as the *ex ante* surfacing technique, except that the analysis is conducted on the 79 observations of SSWDs emerging from the standard regression model, rather than being estimated using the individual cases in the NESPD. There are a number of related *ex post* estimation techniques that have been considered. These include contouring, trend surfaces and earnings potential surfaces.

In the *Trend Surfaces* approach, the surface is estimated by treating space as the explanatory variable and SSWDs as the dependent variable in a regression equation. Trend surfaces have been fixed to the SSWDs using various powered terms. These show some promise. However the linear and quadratic variants are too restrictive to be useful (the former implying a simple linear North-West – South-East gradient, while the latter leads to a dome centred on the South-East corner of England. The cubic formulation is less restrictive but examination of high order powers begins to run into problems of the limited sample size (just 79 observations).

Various other methods of smoothing have also been explored. These require considerably more information on commuting patterns and the like. Most of these require further research and/or access to data, such as those from the Census of Population 2001, which will only be possible in 2002/3. They are possibilities for the future rather than practical options for the current round of MFF calculations.

The main report presents these alternatives in the form of a series of figures and maps which illustrate the key findings. The notes below each map or figure highlight the key points. The main conclusion is that some form of smoothing to avoid cliff edges is desirable. The differences between the methods are relatively modest. On balance the authors recommend a population weighted approach using distance between centroids (squared).

1. Introduction

In April 2001, the Department of Health commissioned the University of Warwick, Institute for Employment Research (IER) to carry out a new Review of the methods used to calculate the so called Market Forces Factor (MFF). The MFF forms a key element in the methods used to allocate resources within the NHS to different geographical areas.

This research updates earlier work, dating back to 1996, when the IER was first asked to undertake a general review of the procedures used to assess the impact of labour market factors on staffing costs. The results of the IER research were published in Wilson *et al* (1996)[1]. The IER study took place in parallel with an extensive review of the Area Cost Adjustment, which was being undertaken by a number of organisations on behalf of the (then) Department of the Environment (DoE)[2]. The basic MFF calculations have also been updated annually by IER since 1996. These results have formed the basis for the estimates of the staff Market Forces Factor (MFF) used by the NHS in allocating funds to Health Authorities (HAs).

The main recommendations of the original IER study (in common with the research undertaken on behalf of the DoE) were that a general labour market approach was the most reliable and robust approach. Specific cost methods, while superficially attractive were, in practice, fraught with difficulties and impracticable to implement in a non-controversial manner.

Since the earlier work was undertaken by IER, the Department of the Environment and Transport (DETR) has continued to undertake extensive technical research in this area as part of its own Area Cost Adjustment (ACA) review[3]. This work and other research has been reviewed as part of the current exercise, with a view to establishing what changes, if any, are needed to the present approach used within the NHS. The present report sets out the findings from this review.

In order to guide the research team, an external steering group of academics and other interested parties was set up to advise and monitor the new research. This is referred to below as the Academic Technical Steering Group (ATSG). This group was intended to be able to contribute to the research process and to ensure, as far as possible, that a consensus might be reached about the best approach to be followed. The role of the ATSG was to act as a sounding board and to offer critical advice as the research proceeded. This report reflects the discussion in the ATSG meetings[4].

The present research can be regarded as comprising two main elements, undertaken in parallel although there are many links between the two parts. ***Task 1*** focuses on the issue of the most appropriate geographical zones and the feasibility of various smoothing mechanisms designed to deal with the cliff edge problems. This includes the production of some new alternative estimates as well as recommendations as to the best approach to be adopted in

1 Wilson, R.A., A. Assefa, G. Briscoe, P. Elias, A. E. Green, A. McKnight, and J. Stilwell (1996). *Labour Market Forces and NHS Provider Costs:Final Report.* ISBN 0-9515763-3X Coventry: IER, University of Warwick.

2 This work is reviewed below. This area of research is now the responsibility of the Department of Environment, Transport and the Regions (DETR).

3 See in particular Local Government Finance Settlement Working Group Report for 1999/2000 – August 1998.

4 The membership of this group was agreed in advance with the Department of Health. It included Professor David Bell (Strathclyde), Professor Ian Diamond (Southampton) and Nigel Rice (York). The authors are grateful for the input of the ATSG. However, the authors alone are responsible for the views expressed and any remaining errors.

future. It also covers work on more radical alternatives, although these are limited to outlining the possibilities and setting out a plan for further research. This is mainly covered in Section 8 of the present document. ***Task 2*** focuses on the criticisms of the underlying estimation techniques used in the present procedures. This is dealt with primarily in Sections 3-7.

Following this introduction, the present document begins in earnest in Section 2, with a brief overview of the rationale and existing methodology used for calculating the staff MFF. This is intended to set the context for the remaining discussion and to act as a useful guide to those readers who may be unfamiliar with the concept of the MFF. It includes a summary of some of the main criticisms of the existing approach. This leads to suggestions for refining and improving the methods used to calculate the Standardised Spatial Wage Differential (SSWDs), which lie at the heart of the estimation of the staff MFF. Sections 3-7 present the new econometric analysis. Section 8 focuses on issues to do with choice of zones and the use of smoothing mechanisms to avoid cliff edges. Finally, Section 9 sets out recommendations for further research. These include further exploration of more sophisticated estimation methods, including fixed effects and possibly multi-level modelling. Development and use of spatially coded individual data is another possibility discussed, as well as the further exploration of surfacing and contouring techniques.

2. The MFF Calculation: 1996-2000

2.1 The current approach

The essential purpose of the staff MFF is to equalise purchasing power of HAs by adjusting for spatial differences in provider costs. The key issue is how to measure and adjust for unavoidable variations in such costs. In principle, two main methods of estimating these extra costs have been proposed:

- Specific Cost Approach (SCA);
- General Labour Market (GLM) Approach.

Although the SCA has considerable intuitive appeal, extensive technical research, including that in the original IER study, suggests that it is extremely difficult to separate avoidable costs from unavoidable costs. Several reports for the more recent DETR ACA review confirm that the SCA is very difficult, if not impossible, to put into practice, given current data limitations.

The alternative, (as currently used for the DETR ACA, as well as the NHS's own MFF), is the General Labour Market (GLM) approach. This uses measures of spatial differentials in earnings in the wider labour market as an estimate of the external labour market pressures facing HAs in different locations.

The rationale for this approach is based on the theory of 'compensating wage differentials'. Differences in wage rates, which employers are forced to offer in order to be able to attract and retain labour, can be partly explained by geographical differences in the amenities or disamenities associated with each area and with regional differences in the cost of living. In essence, the MFF measures the additional earnings an employee requires to compensate them for the relative amenities and disamenities of working in a particular area.

The key issue is how to calculate these wage differentials. Crude wage differentials are not appropriate, since like would not be compared with like. It is crucial to take account of all other factors which influence pay, including differences in employment structure, in order that in the geographical wage differentials calculated only reflect the relative amenities and disamenities of working in a particular area.

The method used to calculate the MFF during the period 1996-2000 has been based upon a quite sophisticated statistical technique, which attempts to 'control' for the influence of other factors which affect wage levels in different geographical areas (e.g. occupational/industrial composition)[5]. This analysis is conducted on the New Earnings Survey (NES) panel data set, which includes information on the earnings of a large sample of individual employees (working full-time) in 79 geographical zones.

The amount individuals have to be compensated to work in a particular area or NES zone is derived from a multivariate, cross-sectional regression analysis of the earnings of the individuals in the NES sample at a particular point in time[6]. Using this approach, a set of

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5 A more detailed description of the current estimation method is given in Annex A.

6 The choice of the NES was made in the original IER study because of concerns about the sample size and consequent reliability of estimates based on the only real alternative data source, the Labour Force Survey. The latter has now been

Standardised Spatial Wage Differentials (SSWDs) are calculated, which form the basis for the MFF calculations.

2.2 Main criticisms of the existing methodology

Although the case for having a staff MFF is generally accepted, there has been considerable debate over its estimated size (particularly between neighbouring areas) and the methodology used in its calculation.

The main criticisms of the existing methodology relate to:

- ***Geographical Zones*** **–** there has been much debate about the optimal size and number of zones;
- ***'Cliff-edge' issues*** – there are concerns about sharp differences in values between neighbouring zones or areas;
- ***Estimation techniques*** **–** some have advocated the use of more sophisticated estimation techniques such as "fixed-effects" methods.

These are now considered in turn.

Geography **–** a key issue is the number and size of zones or areas used. This was a matter that the original IER 1996 study considered in some detail. Over a dozen schemes were examined there. These ranged from the 4 aggregate zones used before 1996, to a full disaggregation to the (then) maximum level of 79 areas allowed by the NES. In its 1996 report IER recommended that the underlying estimates should be based on the most disaggregated analysis possible.

The spatial zones used in the NES are based on administrative areas (e.g. unitary authorities) rather than functional geographical areas such as 'travel-to-work-areas'. In London each borough is separately identifiable, whereas elsewhere the zones tend to be larger – thus potentially grouping together quite heterogeneous areas. This is somewhat arbitrary from a labour market perspective. In the approach, based on the 79 areas, some of the NES spatial areas used map directly into HAs on a one-to-one basis. Others subsume two or more HAs, which may have different local labour market pressures. In London, on the other hand, most HAs overlap a number of NES zones. The basic approach is for the MFF value calculated for each separate NES zone to then be applied as the MFF value for all those trusts which are located (by postal address) within that zone.

Statistical tests indicate that the differences in the SSWDs are often not significant for individual districts and boroughs[7]. This problem can be circumvented by grouping authorities/areas or by 'pooling' years of data[8]. But if there are, in fact, genuine material differences among HAs within a NES zone, such grouping may have an undesirable averaging effect, which would give some HAs/trusts too large an MFF and others too small a factor.

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increased in sample size and now offers a more serious alternative source of data. Detailed comparisons of results based on both sources are presented below.

7 Statistical significance is measured using so called '*t*-tests' on the individual coefficients. It is important to note that even though individual coefficients may not be statistically significant, it is often the case that the differences between two such coefficients is statistically significant.

8 Generally, it is the London NES zones that tend to have the smallest sample sizes.

'Cliff-edges' A particularly strong criticism of the present methodology has been the phenomenon of "cliff edges". This refers to the situation where adjoining HAs, which are perceived to have similar local labour market pressures (unemployment rates, housing costs, etc), have sharply different SSWDs.

Grouping may exaggerate the differences between the MFFs of neighbouring authorities/trusts on the geographical 'edges' of the larger zones. This conflicts with the expectation that there should be a relatively gradual geographical transition between higher and lower MFFs. The relatively smooth gradient that occurs between a succession of adjacent areas can be transformed by the grouping so that it becomes something of a 'cliff-edge', many small contrasts between adjacent areas being transformed into a single large step between neighbouring zones.

There is normally a 'trade-off' between maximising the number of zones and statistical reliability of results. Too many zones may not have sufficiently large individual sample sizes for statistically robust results. On the other hand, too small a number of zones may produce implausibly high 'cliff-edges' between neighbouring zones and also results in genuine local NHS labour market differences being 'averaged away'.

The cliff edge problem has also taxed the DETR. In its own review of the ACA, DETR has considered a number of potential smoothing mechanisms, including:

- Moving Windows
- Surfacing (including contouring and earnings potential surfaces)

These and other approaches are considered in detail in Section 8 below.

Estimation techniques – A major analytical issue involved in estimating the MFF is how to calculate the SSWDs, taking proper account of variations in earnings which derive from systematic differences in the personal and employment characteristics of individuals in the sample. The current method of calculating the staff MFF uses data on the earnings and characteristics of many thousands of individuals in the NES, from a cross-section at a point in time. The approach involves the application of the well established statistical technique of multiple regression (ordinary least squares) to work out the difference in earnings between areas, once the characteristics of the individuals in the sample (such as their occupation, age, etc) have been taken into account[9].

Such estimates of area earning differentials may not be ideal. In particular, they may be biased because the technique used in the calculations does not take account of all of the relevant individual characteristics which influence earnings, some of which may be unmeasured and unobserved.

However, there are techniques available which, in principle, allow this bias to be minimised. This involves combining together data from different cross-sectional samples where there is information on the same individuals, forming a so called panel data set. Such a panel data set

9 The estimated MFFs are based on a cross-section for a particular point in time, (i.e. the results for each year are deemed to be independent of the others (although in practice, the results from 3 consecutive cross-sections have been used to smooth any discontinuities from one year to the next).

enables the influence of certain unobserved effects to be captured by using so called "fixed-effects" or "random effects" models[10]. These are explained in Section 5 below.

Much of the present analysis focuses on the use of the New Earnings Survey panel data set. However, another key issue is what difference (if any) it would make if a different data source such as the Labour Force Survey (LFS) were to be was used. The LFS has been used in some of the DETR's ACA calculations. However, these calculations are based on a much smaller number of geographical areas than are used in the MFF calculations. The more limited sample size of the LFS does pose difficulties here. Nevertheless, it is important to consider the nature of such differences.

One important argument that has been advanced in favour of the use of the LFS (as opposed to the NES), is that the former includes measures of human capital formulation that are not available in the NES. For example, one key variable which is missing from the NES data set is the formal qualifications an individual possesses. From other research it is well known that earnings depend upon qualifications (amongst other things). If information about qualifications is not included in the estimation technique, it cannot be properly allowed for in the calculation and this omission may bias the results (although, as argued in the original IER report, the use of detailed occupational variables does act, in part, as a proxy for qualifications). Their omission could, in principle, bias the SSWDs calsulated using NES data. These and the related issues are also considered in Section 7.

A more important argument, however, is that MFFs based on ordinary least squares analysis of cross-sectional data may be subject to bias due to their failure to properly account for any unobserved characteristics of workers, including such things as ability and motivation which may vary across space. Models that utilise panel data can draw upon a useful fact about individuals – that many of their characteristics, which correlate with their earnings, stay the same over time. They can effectively be allowed for in the calculation implicitly, even when information on those characteristics themselves is not available in the data set.

A panel data set, following the same individual over time and collecting information at different points in time can be used, therefore, to standardise for unobservable characteristics which do not change over time, as well as for certain characteristics (which could, in principle, be observed) but where, in practice, data are not directly collected), such as qualifications.[11]

The differences in results between results of calculating SSWDs using single cross-sectional samples and fixed effects estimates based on a panel data set[12] would give a measure of the influence of unmeasured attributes of workers. Some previous research[13] suggests that such fixed-effects can have a substantial impact. In Section 5 below, a detailed comparison is undertaken to evaluate the difference between cross-sectional and fixed effects models in calculating the SSWDs and MFF using NES data.

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[10] "Fixed effects" estimators are also known in the literature in various contexts as "least squares dummy variables", "first differences", the "covariance estimator" and "within groups estimator". The other possible approach is called "random effects". Both methods are considered here.

[11] Assuming that these are also fixed over time.

[12] Differences between cross sectional and fixed effects models imply that unobserved characteristics (eg. motivation, ability) vary between geographical areas.

[13] Bell (1998) *Further Research on the Area Cost Adjustment: A Report for SIGOMA.*

3. New Econometric Evidence

3.1 Introduction

This part of the report presents new econometric evidence. It begins in Sections 3.2 – 3.5 with a brief discussion of the problems involved in setting up the latest version of NESPD for this purpose.

This is followed by the presentation of a new set of OLS cross-sectional results based on the latest data. These are presented for both the old 79 areas, the new 119 areas available since 1998 and some more aggregate zones.

3.2 Premature ageing within the NESPD2000

The latest version of the New Earnings Survey Panel Dataset (NESPD) was delivered to Warwick IER during July 2001. In setting up the data set for analysis, an error became apparent in the age variable for those who were in the panel for both the years 1999 and 2000. Given that information collected by the NES refers to the same week in April, then one would expect age to increase by one year between 1999 and 2000. However, more than half of those who are in the panel within each of these years register an increase in age of two years.

In using the panel element of the NES, it is possible to correct for this inconsistency by subtracting a year off the current age of this group of 'premature agers' (see Annex E below). This adjustment is however only possible for those who also appeared in the panel data set during earlier years and therefore have earlier age observations. The problem may however extend to those who have entered the panel for the first time during 2000. However, until it is established why the mis-recording has taken place it is not possible to know which cases are incorrect.

This premature ageing problem is not expected to have a significant impact upon the estimates of Standardised Spatial Wage Differentials (SSWDs) based upon the current cross sectional methodology. Within the specification currently used to estimate SSWDs, age is incorporated as an explanatory variable via set of age range dummies. For a majority of cases, the age problem will not effect which age band an individual is allocated to. However, checks using the cross sectional wage equation based upon the 2000 data have been undertaken to consider the potential impact of this premature ageing upon the SSWDs. These suggest that any impact is trivial. As noted earlier, fixed effects estimates based upon panel data will not be affected as adjustments can be made to the age data based upon earlier observations within the panel.

3.3 Criteria for inclusion within estimation sample

In the estimation of SSWDs based upon cross sectional data, a number of criteria have to be met for observations from the NES to be included in the multivariate analysis. Most significantly, the analysis is currently restricted to full time employees in the private sector who were aged between 16 and 70, and whose pay was unaffected by absence during the survey period of the NES[14]. These criteria have also been implemented in the construction of

[14] Aside from the exclusion of cases that include missing values for variables to be included in the multivariate analysis.

the panel data sets used upon the estimation of SSWDs. Therefore, whilst an individual may be observed within the NESPD over a number of consecutive years, if a record for any single year fails to meet any of the above criteria then the record for that year is excluded from the construction of the panel data set.

3.4 Derivation of a public/private sector marker

To avoid problems of circularity, previous estimates of the SSWDs have been restricted to private sector employees (see Wilson *et al* 1996, pp.65-66)[15]. Previous versions of the NESPD contained a variable that recorded whether an employee worked within the private sector, public corporations, central government or local government. However, the latest NESPD for 2000 (in common with that for 1999), as supplied by the Office for National Statistics, did not contain the information relating to the public and private sector classification of employees.

To achieve consistency with previous estimates of SSWDs, a public-private sector marker for the 1999 update was derived using information from the NESPD for 1998. This marker was derived by a cross-classification of industry codes at the 5-digit ‘subclass’ level of SIC92 against the sector code variable. In instances where it was not clear whether a particular SIC code should be allocated to the private or public sector, an additional cross-classification of SOC90 occupation codes at the major group level with the public sector marker was undertaken to enhance matching accuracy.

Cross-classification indicated that a majority of 5 digit SIC92 codes could be easily allocated to the public or private sector, i.e. all or nearly all employees within a subclass were classified to one sector. The additional cross-classification by occupation was undertaken for 26 subclasses where less than 95 per cent of employees were classified as public or private and where the number of cases classified to the less populated sector exceeded 30.

Table 3.1 outlines the accuracy of the derived public-private sector marker for full time employees in England utilising data from the NESPD98. Two types of classification error may occur; either (a) incorrectly classifying a public sector employee as a private sector employee or (b) incorrectly classifying a private sector employee as a public sector employee. The overall accuracy rate of the derived public sector marker is estimated as approximately 95 per cent.

Table 3.1: Accuracy of derived private-public sector marker

Public sector marker	Constructed Marker		
(TPUB4)	Private	Public	Total
Private	111790	3885	115675
Public	3497	35674	39171
Total	115287	39559	154846

Source: NESPD98

15 See Wilson *et al* (1996) pp.65-66 for a discussion of circularity.

3.5 Inconsistency in individual records

Previous estimates of SSWDs have only utilised the most recent set of cross sectional observations. The utilisation of the panel element introduces a further complication in the use of the NESPD. Inconsistencies emerge in the NESPD due to the re-issue of National Insurance Numbers. These inconsistencies are evident where a person may appear to change sex or show age inconsistencies. Analysis of the NESPD 2000 indicates that approximately 2-3 per cent of those people who were in the panel during 1999 and 2000 show a change in age that clearly indicates that the National Insurance number has been reissued.

Even by specifying age and sex constraints, there is no fool-proof way of removing these people from the data (a National Insurance number could be re-issued to somebody of the same sex and who was a year older than the previous recipient). However, given the size of the NESPD, the reissue of National Insurance numbers should not cause a problem and can be attributable to 'noise' in any modelling work[16].

[16] However, the reader should be aware that the re-issue of national insurance numbers can lead to the seemingly odd result of gender appearing in some of the preliminary results from the fixed effects models. Within such models all time invariant characteristics, like gender, should be absorbed into the individual specific constant term.

4. New Cross-sectional results

4.1 Introduction

The new cross-sectional econometric results are presented in 2 stages. The first stage (Sections 4.2 – 4.4) considers the effects upon the estimates of the Standardised Spatial Wage Differentials (SSWDs) of increasing the level of industrial controls used within the econometric model. The second stage (Section 4.5) presents an updated set of revised econometric estimates of the SSWDs using the cross-sectional data and using the more detailed spatial information available since 1998. Adjusted estimates for 2000 to control for inconsistencies introduced in the differentials arising due to the utilisation of the derived public sector marker are presented. The previous results for 1995 to 1999 are also compared, along with three-year moving average values for this period. The 1998-2000 average is estimated using the adjusted 2000 spatial wage differentials.

4.2 Industrial controls

Previous estimates of the SSWDs have been based upon models that have incorporated 18 dummy variables to control for industry group. These industry groups are presented in Table 4.1. The use of 18 industry dummies is in contrast to the utilisation of the more detailed 77 dummy variables used to control for occupation. These occupational dummy variables are based upon the minor groups of the 1990 Standard Occupational Classification (i.e. the 2-digit level). Increasing the resolution of the industry dummies is therefore one area where possible improvements could be made in the estimation of the SSWDs. One area where the lack of detail within the industry dummies may be particularly important is within London, where the industry dummies currently used may not be sharp enough, for example, to pick up the effects upon earnings of the presence of financial services employment.

The results presented in this section therefore focus upon 2 sets of estimations. The first set are based upon models that incorporate the 18 industry group dummy variables. The second set of estimations are based upon models that incorporate 50 industry dummy variables.

Table 4.1: Industry controls

	Industry Group	Industry
1.	Agriculture	1. Agriculture
2.	Mining etc.	2. Coal etc.
		3. Oil & Gas
		4. Other Mining
9.	Utilities	27. Electricity
		28. Gas Supply
		29. Water Supply
3.	Food, drink and tobacco	5. Food
		6. Drink
		7. Tobacco
4.	Textiles and clothing	8. Textiles
		9. Clothing & Leather
5.	Chemicals	12. Manufactured Fuels
		13. Pharmaceuticals
		14. Chemicals nes
		15. Rubber & Plastics
6.	Metals, and mineral products	16. Non-Metallic Mineral Products
		17. Basic Metals
7.	Engineering	18. Metal Goods
		19. Mechanical Engineering
		20. Electronics
		21. Electrical Engineering
		22. Instruments
		23. Motor Vehicles
		24. Aerospace
		25. Other Transport Equipment
8.	Other manufacturing	10. Wood & Wood Products
		11. Paper, Printing & Publishing
		26. Manufacturing nes & Recycling
10.	Construction	30. Construction
11.	Distribution, hotels etc.	31. Retailing
		32. Distribution nes
		33. Hotels & Catering
12.	Transport and communication	34. Rail Transport
		35. Other Land Transport
		36. Water Transport
		37. Air Transport
		38. Other Transport Services
		39. Communications
13.	Banking and business services	40. Banking & Finance
		41. Insurance
		44. Other Business Services
14.	Professional services	42. Professional Services
		43. Computing Services
15.	Other services	48. Waste Treatment
		49. Other Service Activities
16.	Health and education services	46. Education
		47. Health & Social Work
17.	Public administration and defence	45. Public Administration & Defence
18.	Industry not specified	50. Industry not specified

4.3 Geographical classification

Current estimates of SSWDs are based upon 79 areas for England. These 79 areas are based upon the most detailed areas available within the NES during 1996. The number of areas subsequently expanded to 101 in 1997 and 119 in 1998. NESPD spatial codes have remained unchanged since the 1998 revision. Current NESPD area codes are shown in the Annex. Despite the availability of more detailed codes, to maintain consistency with previous years the estimates of SSWDs retain the NES areas, based upon the 1996 definitions. The mapping between the 1996 (old), 1997 and 1998 codes to Scheme I as discussed in McKnight (1999) is also presented in Annex F. As with all previous updates, the City of London is excluded from the analysis due to the very special factors that operate within this area and which are not adequately controlled for by the set of explanatory variables contained within the NES.

Estimates of SSWDs are also presented based upon very broad area definitions. These definitions are referred to as Scheme A in the original report (Wilson *et al*, 1996) and are defined as Inner London, Outer London, Rest of South East (RoSE) and the Rest of England (RoE). The aggregation of the 79 Scheme I areas into these 4 broad areas are presented in the Annex. The presentation of results for these 4 broad areas does not prejudge the issue of the optimal choice of areas. The use of the smaller number of areas is to assist in the ease of exposition when considering the effects of different estimation techniques upon the size of SSWDs in subsequent sections.

4.4 Results

Table 4.2 presents estimates based upon cross sectional estimates of the NESPD 2000. Estimates based upon the Scheme A areas are shown at the top of the table. The reference category for these estimates is Area 1: Inner London. The detailed Scheme I estimates are presented below. The reference category for these estimates is Area 2: Barking and Dagenham. The table shows the estimated coefficients and estimates of SSWDs[17].

When comparing the broad Scheme A areas, it can be seen that the introduction of the more detailed industry control variables does not have a large impact upon the size of estimated the SSWDs. Compared to Inner London earnings in Outer London are 12.2 per cent lower, 16.6 per cent lower in ROSE and 23.7 per cent lower in ROE. Upon the inclusion of the more detailed industry dummies, the absolute size of the SSWDs increases. However, the increase in the absolute size of each SSWD is less than 1 percentage point in each instance.

The results for Scheme I areas, as presented in Table 4.2, have been arranged in descending order of their SSWDs (using the standard industrial specification). As above, it can be seen that the inclusion of more detailed industry dummy variables does not generally have a large impact upon the size of the estimated SSWDs. The size of the estimated SSWDs generally change by less than 1 per cent.

However, the inclusion of the more detailed industry specification does appear to have an impact upon the size of the SSWDs estimated for some of the Scheme I areas that fall within London. This supports the view that the previous industry classification did not adequately capture the effect of the industrial composition of employment within London. With the exception of West Sussex, all of the SSWDs that show a change of more than 1 percentage

[17] Estimated by taking the exponential, subtracting 1 and multiplying by 100.

point upon the inclusion of the more detailed industry specification fall within either Inner or Outer London as defined by the Scheme A area specification. In particular, significant changes are observed for Tower Hamlets (SSWD falls from 24.4 per cent to 22.2 per cent), Kensington and Chelsea (9.3 per cent to 11.8 per cent) and Hillingdon (5.3 per cent to 2.0 per cent).

Although the inclusion of the more detailed industry dummy variables does lead to some significant changes within London, it should also be noted that the inclusion of extra industry detail does not lead to any dampening down in the size of the area coefficients and SSWDs.

Table 4.2: Standard results, cross-sectional data for 2000

		Standard Industry Dummies			Detailed Industry Dummies			Difference in SSWDs
	Area	Coefficient	P-value	SSWD	Coefficient	P-value	SSWD	
Outer London		-0.13	0.0000	-12.2824	-0.14	0.00	-12.8925	-0.6101
Rest of South East		-0.18	0.0000	-16.6269	-0.19	0.00	-17.1806	-0.5537
Rest of England		-0.27	0.0000	-23.6654	-0.27	0.00	-24.0254	-0.3601
Tower Hamlets	30	0.2180	0.0000	24.3551	0.2002	0.0000	22.1608	-2.1943
City of Westminster	33	0.1861	0.0000	20.4506	0.1976	0.0000	21.8473	1.3966
Islington	19	0.1288	0.0000	13.7518	0.1146	0.0001	12.1462	-1.6056
Camden	7	0.1178	0.0000	12.4984	0.1251	0.0000	13.3222	0.8238
Lambeth	22	0.1079	0.0007	11.3883	0.1122	0.0004	11.8744	0.4861
Southwark	28	0.0898	0.0039	9.3957	0.0828	0.0071	8.6288	-0.7670
Kensington & Chelsea	20	0.0886	0.0065	9.2626	0.1118	0.0005	11.8243	2.5617
Hackney	12	0.0716	0.0493	7.4213	0.0730	0.0423	7.5728	0.1515
Hounslow	18	0.0522	0.0897	5.3599	0.0567	0.0620	5.8289	0.4690
Hillingdon	17	0.0518	0.0720	5.3172	0.0194	0.5001	1.9583	-3.3589
Hammersmith	13	0.0509	0.1324	5.2252	0.0639	0.0557	6.6026	1.3774
Ealing	9	0.0344	0.2821	3.5011	0.0416	0.1879	4.2457	0.7446
Surrey	44	0.0253	0.3566	2.5588	0.0202	0.4555	2.0393	-0.5195
Berkshire	35	0.0191	0.4829	1.9332	0.0171	0.5251	1.7268	-0.2064
Richmond-on-Thames	27	0.0080	0.8278	0.8032	0.0223	0.5388	2.2564	1.4532
Barnet	3	-0.0111	0.7394	-1.1074	-0.0034	0.9188	-0.3364	0.7710
Brent	5	-0.0129	0.6984	-1.2795	-0.0129	0.6932	-1.2859	-0.0064
Enfield	10	-0.0153	0.6555	-1.5204	-0.0263	0.4385	-2.5924	-1.0721
Greenwich	11	-0.0165	0.6842	-1.6327	-0.0124	0.7565	-1.2310	0.4017
Newham	25	-0.0185	0.6041	-1.8371	-0.0206	0.5589	-2.0415	-0.2044
Kingston-on-Thames	21	-0.0188	0.5933	-1.8622	-0.0057	0.8695	-0.5690	1.2932
Wandsworth	32	-0.0215	0.5272	-2.1266	-0.0111	0.7403	-1.1060	1.0206
Croydon	8	-0.0255	0.4114	-2.5217	-0.0354	0.2486	-3.4797	-0.9580
Hertfordshire	40	-0.0267	0.3269	-2.6383	-0.0272	0.3118	-2.6852	-0.0468
Sutton	29	-0.0290	0.4271	-2.8572	-0.0222	0.5387	-2.1912	0.6660
Redbridge	26	-0.0389	0.3213	-3.8155	-0.0276	0.4752	-2.7258	1.0897
Oxfordshire	43	-0.0417	0.1385	-4.0803	-0.0395	0.1547	-3.8736	0.2067
Lewisham	23	-0.0478	0.2590	-4.6638	-0.0410	0.3265	-4.0139	0.6499
Bromley	6	-0.0501	0.1026	-4.8863	-0.0458	0.1310	-4.4801	0.4062
Waltham Forest	31	-0.0534	0.1846	-5.2012	-0.0491	0.2166	-4.7913	0.4100
Buckinghamshire	36	-0.0538	0.0529	-5.2356	-0.0567	0.0388	-5.5082	-0.2726
Merton	24	-0.0558	0.1237	-5.4240	-0.0461	0.1972	-4.5048	0.9191
Harrow	15	-0.0725	0.0518	-6.9926	-0.0783	0.0333	-7.5316	-0.5390
Bexley	4	-0.0815	0.0236	-7.8276	-0.0872	0.0142	-8.3513	-0.5236
West Sussex	45	-0.0835	0.0027	-8.0122	-0.0956	0.0005	-9.1153	-1.1031
Haringey	14	-0.0860	0.0276	-8.2422	-0.0800	0.0379	-7.6885	0.5537
Avon	49	-0.0938	0.0008	-8.9576	-0.1034	0.0002	-9.8207	-0.8631
Hampshire	39	-0.0947	0.0004	-9.0341	-0.0962	0.0003	-9.1711	-0.1370
Wiltshire	55	-0.0962	0.0006	-9.1708	-0.0968	0.0005	-9.2227	-0.0518
Cambridgeshire	46	-0.0972	0.0004	-9.2586	-0.1014	0.0002	-9.6465	-0.3879
Essex	38	-0.0978	0.0003	-9.3135	-0.0989	0.0002	-9.4171	-0.1035
Kent	42	-0.1006	0.0002	-9.5723	-0.1033	0.0001	-9.8122	-0.2399
Bedfordshire	34	-0.1029	0.0003	-9.7780	-0.1016	0.0003	-9.6572	0.1208
Northamptonshire	65	-0.1048	0.0002	-9.9536	-0.1016	0.0002	-9.6597	0.2938
Gloucestershire	53	-0.1093	0.0001	-10.3571	-0.1130	0.0000	-10.6817	-0.3246
Havering	16	-0.1114	0.0007	-10.5431	-0.1040	0.0014	-9.8788	0.6643

Table 4.2: Standard results, cross-sectional data for 2000 (continued)

		Standard Industry Dummies			Detailed Industry Dummies			Difference in SSWDs
	Area	Coefficient	P-value	SSWD	Coefficient	P-value	SSWD	
Warwickshire	60	-0.1136	0.0001	-10.7407	-0.1058	0.0002	-10.0369	0.7038
Cleveland	76	-0.1226	0.0000	-11.5350	-0.1188	0.0000	-11.2038	0.3312
West Midlands	56	-0.1336	0.0000	-12.5086	-0.1311	0.0000	-12.2841	0.2244
Greater Manchester	71	-0.1341	0.0000	-12.5536	-0.1363	0.0000	-12.7441	-0.1905
Cheshire	73	-0.1355	0.0000	-12.6678	-0.1356	0.0000	-12.6782	-0.0104
Tyne & Wear	75	-0.1429	0.0000	-13.3174	-0.1529	0.0000	-14.1770	-0.8596
West Yorkshire	68	-0.1430	0.0000	-13.3281	-0.1472	0.0000	-13.6881	-0.3600
Merseyside	72	-0.1453	0.0000	-13.5239	-0.1461	0.0000	-13.5946	-0.0706
North Yorkshire	70	-0.1519	0.0000	-14.0886	-0.1547	0.0000	-14.3339	-0.2453
Dorset	52	-0.1542	0.0000	-14.2857	-0.1636	0.0000	-15.0918	-0.8061
East Sussex	37	-0.1566	0.0000	-14.4912	-0.1566	0.0000	-14.4980	-0.0068
Suffolk	48	-0.1605	0.0000	-14.8316	-0.1581	0.0000	-14.6205	0.2110
Norfolk	47	-0.1624	0.0000	-14.9931	-0.1711	0.0000	-15.7234	-0.7302
Hereford & Worcester	57	-0.1650	0.0000	-15.2090	-0.1599	0.0000	-14.7776	0.4314
Leicestershire	63	-0.1709	0.0000	-15.7092	-0.1653	0.0000	-15.2341	0.4751
Derbyshire	62	-0.1736	0.0000	-15.9372	-0.1675	0.0000	-15.4199	0.5174
Humberside	69	-0.1750	0.0000	-16.0520	-0.1713	0.0000	-15.7447	0.3073
Somerset	54	-0.1755	0.0000	-16.0983	-0.1772	0.0000	-16.2356	-0.1374
South Yorkshire	67	-0.1776	0.0000	-16.2711	-0.1776	0.0000	-16.2729	-0.0018
Northumberland	79	-0.1777	0.0000	-16.2773	-0.1752	0.0000	-16.0698	0.2075
Nottinghamshire	66	-0.1786	0.0000	-16.3542	-0.1707	0.0000	-15.6924	0.6619
Cumbria	77	-0.1829	0.0000	-16.7185	-0.1755	0.0000	-16.0987	0.6199
Isle of Wight	41	-0.1861	0.0000	-16.9812	-0.1823	0.0000	-16.6622	0.3190
Staffordshire	59	-0.1862	0.0000	-16.9912	-0.1859	0.0000	-16.9673	0.0239
Shropshire	58	-0.1891	0.0000	-17.2285	-0.1920	0.0000	-17.4717	-0.2432
Lancashire	74	-0.1910	0.0000	-17.3873	-0.1907	0.0000	-17.3634	0.0239
Lincolnshire	64	-0.1976	0.0000	-17.9329	-0.1982	0.0000	-17.9770	-0.0441
Durham	78	-0.2246	0.0000	-20.1203	-0.2241	0.0000	-20.0762	0.0441
Devon	51	-0.2266	0.0000	-20.2721	-0.2203	0.0000	-19.7683	0.5038
Cornwall	50	-0.2585	0.0000	-22.7814	-0.2561	0.0000	-22.5956	0.1858

4.5 Annual update of standardised spatial wage differentials based upon Scheme I areas

This section presents revised econometric estimates of the Standardised Spatial Wage Differentials (SSWDs). These are comparable with those initially presented in Wilson *et al* (1996) and updated in Wilson (1997, 1998), McKnight (1999) and Davies (2000). The previous estimates used data from earlier versions of the NESPD containing data up to 1994 (NESPD 1994) and subsequently extended to 1996 (NESPD 1996), 1997 (NESPD 1997), 1998 (NESPD98) and, finally, 1999 (NESPD 1999). The earnings equations used to estimate the SSWDs have now been re-estimated for 2000 as described in the previous section. The specification adopted and the methodological approach are essentially unchanged from those reported in the main report (Wilson *et al* 1996) and in the subsequent updates.

The derivation of the public-private sector marker for use within the 1999 estimates lead to a discontinuity in the spatial wage differential series between 1998 and 1999. By re-estimating results for 1998 using the derived private-public sector marker, it was possible to estimate adjusted spatial wage differentials for 1999 that control for this inconsistency.

Consistent 1999 estimates were estimated as:

$$SSWD99_{ADJ} = SSWD98_{OLD} + (SSWD99_{NEW} - SSWD98_{NEW})$$

where:

$SSWD99_{ADJ}$	=	adjusted 1999 differential.
$SSWD98_{OLD}$	=	original 1998 differential
$SSWD99_{NEW}$	=	unadjusted 1999 differential
$SSWD98_{NEW}$	=	re-estimated 1998 differential based upon derived private-public sector marker.

A similar adjustment process is also required for the 2000 estimates therefore control for inconsistencies introduced in the differentials arising due to the utilisation of the derived public sector marker.

Consistent 2000 estimates can therefore be estimated as:

$$SSWD00_{ADJ} = SSWD98_{OLD} + (SSWD00_{NEW} - SSWD98_{NEW})$$

Where:

$SSWD99_{ADJ}$	=	adjusted 2000 differential.
$SSWD98_{OLD}$	=	original 1998 differential
$SSWD99_{NEW}$	=	unadjusted 2000 differential
$SSWD98_{NEW}$	=	re-estimated 1998 differential based upon derived private-public sector marker.

The current set of SSWD results are presented in Table 4.3. Previous estimates covering the period 1995 to 1999 are shown in columns 2 to 6. Current estimates based upon the NESPD 2000 are presented in columns 7 and 8. Column 7 presents the unadjusted SSWDs. Column 8 presents estimates adjusted for inconsistencies arising from the use of the derived public sector marker from 1999 onwards. The final 4 columns present three-year moving averages for the period 1995/7 to 1998/00.

The results for 2000 are broadly similar to those for previous years. Although there is some changes to rankings and the overall size of the SSWDs, these are modest. The 3-year moving averages show a steady progression for most areas some gaining and some losing ground, but all at a very modest pace.

Table 4.3: Standardised spatial wage differentials, Scheme I (excluding City of London)

NESArea	Previous Estimate					Current Estimates		Three Year Averages			
	1995	1996	1997	1998	1999	2000 Unadj	2000 Adj	1995/7	1996/8	1997/9	1998/00
3 Barnet	-7.94	-5.33	-3.12	0.30	-5.59	-1.11	0.38	-5.46	-2.72	-2.80	-1.64
4 Bexley	-3.15	-4.05	-9.07	-5.35	-8.04	-7.83	-7.44	-5.42	-6.16	-7.49	-6.94
5 Brent	3.59	1.13	-3.32	-4.15	-0.50	-1.28	-3.99	0.47	-2.11	-2.65	-2.88
6 Bromley	-1.65	-0.67	-5.40	-2.53	-6.59	-4.89	-5.19	-2.57	-2.87	-4.84	-4.77
7 Camden	19.85	16.31	15.61	18.69	16.58	12.50	12.54	17.26	16.87	16.96	15.94
8 Croydon	-0.70	-1.26	-5.34	-4.51	-4.52	-2.52	-2.66	-2.43	-3.70	-4.79	-3.90
9 Ealing	6.59	3.91	0.47	2.76	-0.96	3.50	3.15	3.65	2.38	0.75	1.65
10 Enfield	0.95	-2.00	-5.95	-1.59	-7.54	-1.52	-1.83	-2.33	-3.18	-5.03	-3.65
11 Greenwich	-1.78	-0.26	-8.96	-4.78	-6.14	-1.63	-3.64	-3.67	-4.67	-6.62	-4.85
12 Hackney	29.31	25.10	25.98	24.05	22.58	7.42	7.61	26.80	25.05	24.20	18.08
13 Hammersmith	12.82	10.26	12.90	16.59	12.46	5.23	5.05	11.99	13.25	13.98	11.36
14 Haringey	-1.54	-1.78	-6.54	-2.23	-5.51	-8.24	-6.90	-3.29	-3.52	-4.76	-4.88
15 Harrow	3.74	-0.08	-3.27	0.42	-2.89	-6.99	-7.07	0.13	-0.98	-1.92	-3.18
16 Havering	0.94	-1.81	-3.64	-3.71	-10.32	-10.54	-10.63	-1.50	-3.05	-5.89	-8.22
17 Hillingdon	12.31	13.43	10.54	15.18	8.53	5.32	5.93	12.10	13.05	11.42	9.88
18 Hounslow	5.61	6.50	4.34	6.85	6.56	5.36	5.45	5.48	5.90	5.92	6.29
19 Islington	19.40	16.71	15.92	17.12	11.88	13.75	14.45	17.34	16.58	14.97	14.48
20 Kensington & Chelsea	17.37	15.53	12.05	15.69	15.69	9.26	9.00	14.98	14.42	14.48	13.46
21 Kingston-on-Thames	7.93	5.80	3.36	3.56	-3.92	-1.86	0.47	5.70	4.24	1.00	0.04
22 Lambeth	20.12	13.97	16.41	18.82	14.10	11.39	12.62	16.83	16.40	16.44	15.18
23 Lewisham	4.62	4.48	-10.50	-8.46	-0.59	-4.66	-4.57	-0.47	-4.83	-6.52	-4.54
24 Merton	-3.56	-2.83	-1.01	1.34	-8.54	-5.42	-5.65	-2.47	-0.83	-2.74	-4.28
25 Newham	3.47	-1.21	1.76	-1.42	-2.99	-1.84	-1.23	1.34	-0.29	-0.88	-1.88
26 Redbridge	-2.73	-4.54	-4.95	-10.47	-4.25	-3.82	-3.96	-4.07	-6.65	-6.55	-6.22
27 Richmond-on-Thames	1.02	8.35	-0.96	2.02	7.04	0.80	2.42	2.80	3.13	2.70	3.83
28 Southwark	19.17	17.04	17.06	12.97	11.18	9.40	10.18	17.76	15.69	13.74	11.44
29 Sutton	2.38	0.78	-5.40	-4.62	-0.89	-2.86	-2.97	-0.75	-3.08	-3.63	-2.82
30 Tower Hamlets	28.85	22.93	23.91	29.44	28.80	24.36	26.03	25.23	25.43	27.39	28.09
31 Waltham Forest	-4.39	-4.78	-8.53	-7.12	-3.72	-5.20	-5.04	-5.90	-6.81	-6.46	-5.29
32 Wandsworth	9.31	5.30	-0.53	5.76	2.56	-2.13	-0.82	4.69	3.51	2.60	2.50
33 City of Westminster	30.24	25.47	24.10	27.57	23.32	20.45	20.64	26.60	25.71	25.00	23.84
34 Bedfordshire	-4.71	-3.39	-5.83	-3.97	-7.83	-9.78	-9.56	-4.64	-4.39	-5.87	-7.12
35 Berkshire	3.82	4.31	0.26	4.44	4.23	1.93	2.28	2.80	3.00	2.98	3.65
36 Buckinghamshire	-0.39	-0.56	-2.91	-0.01	-1.89	-5.24	-4.83	-1.29	-1.16	-1.60	-2.24
37 East Sussex	-12.39	-11.58	-13.25	-13.69	-12.22	-14.49	-13.99	-12.41	-12.84	-13.05	-13.30
38 Essex	-6.16	-7.61	-10.11	-9.16	-10.08	-9.31	-9.34	-7.96	-8.96	-9.78	-9.53
39 Hampshire	-6.92	-7.83	-9.23	-6.40	-7.42	-9.03	-8.63	-7.99	-7.82	-7.68	-7.48
40 Hertfordshire	-2.47	-2.57	-2.15	0.76	-0.98	-2.64	-2.24	-2.40	-1.32	-0.79	-0.82
41 Isle of Wight	-16.15	-17.17	-17.80	-16.57	-16.82	-16.98	-15.51	-17.04	-17.18	-17.06	-16.30
42 Kent	-8.10	-8.94	-10.71	-9.45	-10.26	-9.57	-9.33	-9.25	-9.70	-10.14	-9.68
43 Oxfordshire	-4.59	-5.16	-6.64	-3.88	-5.61	-4.08	-3.81	-5.46	-5.22	-5.38	-4.43
44 Surrey	3.32	1.95	1.40	3.83	2.21	2.56	2.36	2.22	2.39	2.48	2.80
45 West Sussex	-3.09	-2.66	-5.63	-3.64	-6.55	-8.01	-8.11	-3.79	-3.98	-5.27	-6.10

Source: Regression Analysis of NESPD. See text for technical details.

Notes: (a.) City of London is exclude, see main text for details.
(b.) Area 2 is the comparator.
(c.) There is no area 61 in the NES spatial coding system.
(d.) Values for 1995/7, 1996/8, 1997/9 and 1998/00 are arithmetic averages.
(e.) 1997/9 and 1998/00 calculated using adjusted figures for 1999 and 2000.

Table 4.3: Standardised spatial wage differentials, Scheme I (excluding City of London) (continued)

NES Area	Previous Estimate					Current Estimates		Three Year Averages			
	1995	1996	1997	1998	1999	2000 Unadj	2000 Adj	1995/7	1996/8	1997/9	1998/00
46 Cambridgeshire	-6.00	-7.51	-6.44	-5.55	-8.58	-9.26	-9.33	-6.65	-6.50	-6.86	-7.82
47 Norfolk	-14.60	-14.72	-16.98	-15.34	-16.02	-14.99	-15.38	-15.43	-15.68	-16.12	-15.58
48 Suffolk	-11.06	-11.31	-14.31	-14.76	-16.03	-14.83	-14.90	-12.22	-13.46	-15.03	-15.23
49 Avon	-6.30	-8.77	-7.48	-6.48	-7.54	-8.96	-8.75	-7.52	-7.58	-7.17	-7.59
50 Cornwall	-19.60	-20.58	-19.58	-19.96	-22.78	-22.78	-22.44	-19.92	-20.04	-20.77	-21.73
51 Devon	-16.25	-17.93	-18.32	-18.90	-20.74	-20.27	-19.99	-17.50	-18.38	-19.32	-19.87
52 Dorset	-13.83	-11.30	-14.87	-9.16	-14.50	-14.29	-13.75	-13.33	-11.78	-12.84	-12.47
53 Gloucestershire	-7.75	-9.29	-11.65	-9.63	-11.44	-10.36	-10.67	-9.56	-10.19	-10.91	-10.58
54 Somerset	-14.60	-15.59	-16.47	-15.60	-17.61	-16.10	-16.41	-15.55	-15.89	-16.56	-16.54
55 Wiltshire	-9.32	-6.67	-7.81	-6.29	-8.99	-9.17	-9.26	-7.93	-6.92	-7.69	-8.18
56 West Midlands	-11.46	-11.17	-12.66	-11.10	-11.45	-12.51	-12.30	-11.76	-11.64	-11.73	-11.61
57 Hereford & Worcester	-14.86	-14.83	-16.78	-14.95	-16.30	-15.21	-15.04	-15.49	-15.52	-16.01	-15.43
58 Shropshire	-18.42	-16.58	-19.17	-17.14	-18.37	-17.23	-17.23	-18.05	-17.63	-18.23	-17.58
59 Staffordshire	-15.19	-15.07	-17.26	-15.63	-17.72	-16.99	-16.91	-15.84	-15.99	-16.87	-16.75
60 Warwickshire	-12.23	-10.92	-12.03	-8.55	-11.26	-10.74	-10.51	-11.73	-10.50	-10.61	-10.11
61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
62 Derbyshire	-15.06	-14.57	-16.10	-16.61	-15.19	-15.94	-15.74	-15.24	-15.76	-15.97	-15.85
63 Leicestershire	-12.94	-11.61	-12.08	-12.16	-13.20	-15.71	-15.50	-12.21	-11.95	-12.48	-13.62
64 Lincolnshire	-13.79	-14.61	-15.62	-14.41	-17.02	-17.93	-17.98	-14.67	-14.88	-15.68	-16.47
65 Northamptonshire	-8.17	-8.86	-10.93	-8.62	-9.22	-9.95	-9.88	-9.32	-9.47	-9.59	-9.24
66 Nottinghamshire	-14.22	-15.32	-16.60	-15.24	-15.66	-16.35	-16.22	-15.38	-15.72	-15.83	-15.71
67 South Yorkshire	-13.46	-14.87	-15.75	-14.87	-16.38	-16.27	-15.93	-14.70	-15.16	-15.67	-15.73
68 West Yorkshire	-11.53	-11.96	-13.65	-11.37	-12.77	-13.33	-12.86	-12.38	-12.33	-12.60	-12.33
69 Humberside	-15.35	-15.81	-16.64	-16.76	-17.34	-16.05	-16.67	-15.93	-16.40	-16.91	-16.93
70 North Yorkshire	-14.73	-12.26	-15.85	-13.49	-14.69	-14.09	-13.73	-14.28	-13.87	-14.68	-13.97
71 Greater Manchester	-10.43	-11.02	-12.30	-10.51	-11.84	-12.55	-12.56	-11.25	-11.28	-11.55	-11.63
72 Merseyside	-9.10	-11.07	-11.16	-9.27	-13.15	-13.52	-13.09	-10.45	-10.50	-11.19	-11.84
73 Cheshire	-4.28	-7.22	-9.29	-9.29	-11.43	-12.67	-12.35	-6.93	-8.60	-10.00	-11.02
74 Lancashire	-14.01	-14.74	-15.73	-13.99	-15.77	-17.39	-17.11	-14.82	-14.82	-15.16	-15.62
75 Tyne & Wear	-11.90	-12.83	-14.45	-12.62	-13.14	-13.32	-12.70	-13.06	-13.30	-13.40	-12.82
76 Cleveland	-9.13	-9.59	-12.55	-12.08	-12.60	-11.54	-11.60	-10.42	-11.40	-12.41	-12.09
77 Cumbria	-11.07	-14.29	-15.37	-15.64	-17.24	-16.72	-16.98	-13.58	-15.10	-16.08	-16.62
78 Durham	-11.78	-13.40	-16.04	-14.57	-17.25	-20.12	-19.57	-13.74	-14.67	-15.95	-17.13
79 Northumberland	-14.86	-16.60	-15.98	-18.50	-19.47	-16.28	-15.68	-15.81	-17.03	-17.98	-17.88

Source: Regression Analysis of NESPD. See text for technical details.

Notes: (a.) City of London is exclude, see main text for details.
(b.) Area 2 is the comparator.
(c.) There is no area 61 in the NES spatial coding system.
(d.) Values for 1995/7, 1996/8, 1997/9 and 1998/00 are arithmetic averages.
(e.) 1997/9 and 1998/00 calculated using adjusted figures for 1999 and 2000.

4.6 Standardised spatial wage differentials using 1998 areas

The Scheme I area definition that has been utilised in annual estimates of the SSWDs is based upon 79 area codes that constituted the most disaggregated area definitions that were available within the 1996 NESPD. Since this time the level of geographical detail utilised within the NESPD has increased due to the definition of new unitary authorities in some areas. The number of areas available increased to 101 in 1997 and 119 in 1998. The formation of these new unitary authorities did not lead to changes in geographical boundaries. The aggregation of the new 1997 and 1998 area codes to those used in 1996 was therefore straightforward and the original Scheme I area definitions could be retained.

However, the availability of the more detailed area definitions available within the NES could be exploited in the production of SSWDs. The earnings used to estimate the SSWDs have been therefore been re-estimated for the period 1998 to 2000, utilising the more detailed area definitions available over this period. It was decided that the full level of detail available within the NES spatial codes over this period should be incorporated into the model, subject to concerns about small sample sizes in some areas. In practice, the only problem area was the case of Rutland (area 29), which, due to the small sample size associated with this region, was merged with Leicestershire (area 30). As noted earlier, the City of London (area 68) is excluded from the results due to the unusual characteristics of this area. Barking and Dagenham (area 69) is retained as the reference area. The estimation of these more detailed SSWDs is also based upon a model that incorporates the more detailed set of industry dummy variables. Otherwise, the specification of the earnings equation remains unchanged.

Table 4.4 provides cross sectional estimates of Standardised Spatial Wage Differentials utilising more detailed area definitions. New estimates for 1998 and 1999 are shown in columns 2 to 3. Current estimates based upon the NESPD 2000 are presented in columns 4 and 5. Column 4 presents the unadjusted SSWDs. Column 5 presents estimates adjusted for inconsistencies arising from the use of the derived public sector marker from 1999 onwards. The final column shows the three-year moving average for the period 1998/00.

The importance of additional geographical detail can be seen by looking at SSWDs for new unitary authorities that have evolved from a single Scheme I area. For example, Berkshire (area 35 within the Scheme I definitions) has been replaced by Bracknell Forest (area 101), Newbury (102), Reading (103), Slough (104), Windsor and Maidenhead (105) and Wokingham (106). The adjusted SSWD estimated for Berkshire as presented in Table 4.3 is 2.28. The SSWDs for the 1998 NES areas that originally formed Berkshire range from –2.3 in Wokingham to 11.7 in Bracknall Forest (see Table 4.4). Similarly, *Cleveland* (area 76 within the Scheme I definitions) has been replaced by Hartlepool (area 4), Middlesborough (5), Redcar and Cleveland (7) and Stockton-on-Tees (8). The adjusted SSWD estimated for *Cleveland* as presented in Table 2.4 is –11.60. The SSWDs for the 1998 NES areas that originally formed Cleveland range from –1.3 in Redcar and Cleveland to –23.4 in Hartlepool (see Table 4.4).[18]

[18] Note that Redcar and Cleveland is now an area within what was referred to as *Cleveland*.

Table 4.4: Standardised spatial wage differentials for 1998 areas

NES Area	1998	1999	2000 Unadjusted	2000 Adjusted	Three Year Average
1 Tyne and Wear MC	-12.1546	-13.6586	-14.2427	-13.7372	-13.1834
2 Darlington	-18.6107	-17.0944	-20.4097	-20.0212	-18.5754
3 Durham	-13.0717	-17.6259	-20.0918	-19.6043	-16.7673
4 Hartlepool	-15.1606	-17.1836	-22.8256	-23.3692	-18.5712
5 Middlesbrough	-17.2951	-11.9539	-12.4263	-12.3668	-13.8720
6 Northumberland	-18.0212	-19.3994	-16.1819	-15.5848	-17.6685
7 Redcar and Cleveland	-6.0466	-4.7671	-0.9147	-1.3349	-4.0495
8 Stockton-on-Tees	-8.4645	-15.5156	-10.8487	-10.8197	-11.5999
9 Greater Manchester MC	-10.4117	-12.3374	-12.8151	-12.9025	-11.8838
10 Halton	-8.3686	-12.7722	-11.6492	-10.7499	-10.6302
11 Warrington	-8.8769	-14.6182	-14.5470	-14.6645	-12.7199
12 Cheshire	-9.1071	-10.5499	-12.4292	-12.2333	-10.6301
13 Cumbria	-14.8086	-16.9402	-16.1819	-16.4809	-16.0766
14 Blackburn with Darwen	-14.1546	-17.8005	-18.6753	-18.2128	-16.7226
15 Blackpool	-17.7133	-16.5954	-19.6534	-18.3366	-17.5484
16 Lancashire	-13.4040	-15.8764	-17.0589	-16.9202	-15.4002
17 Merseyside	-9.1453	-13.7655	-13.6678	-13.3249	-12.0786
18 South Yorkshire MC	-14.2230	-16.6634	-16.3228	-16.0488	-15.6450
19 West Yorkshire MC	-11.2370	-13.5488	-13.7719	-13.3732	-12.7197
20 East Riding of Yorkshire	-16.8257	-17.6673	-15.2355	-15.3586	-16.6172
21 Kingston upon Hull	-15.7911	-17.0917	-16.2883	-17.2783	-16.7204
22 North East Lincolnshire	-10.6712	-13.4736	-16.5250	-16.3198	-13.4882
23 North Lincolnshire	-6.6455	-12.1458	-12.6098	-12.4426	-10.4113
24 York	-7.6998	-9.5984	-7.1015	-6.4236	-7.9072
25 North Yorkshire	-15.8298	-17.8201	-17.7225	-17.5699	-17.0732
26 Derby	-12.7860	-12.1680	-11.5649	-11.4073	-12.1204
27 Derbyshire	-17.1935	-16.8311	-17.1612	-17.0723	-17.0323
28 Leicester	-13.0776	-13.4941	-16.3267	-16.0914	-14.2211
30 Leicestershire (including Rutland)	-10.1096	-12.8985	-14.7368	-14.6646	-12.5576
31 Lincolnshire	-18.1112	-20.6076	-20.0125	-20.3642	-19.6943
32 Northamptonshire	-8.0740	-9.6845	-9.7396	-9.7069	-9.1551
33 Nottingham	-13.7943	-12.6503	-13.7774	-13.7754	-13.4067
34 Nottinghamshire	-15.2631	-17.7337	-17.0872	-17.0266	-16.6745
35 West Midlands MC	-10.4387	-11.6676	-12.3302	-12.1979	-11.4347
36 Herefordshire	-15.8281	-20.6163	-17.5031	-17.7733	-18.0726
37 Worcestershire	-13.5237	-15.0156	-14.1635	-13.9809	-14.1734
38 Telford and Wrekin	-14.8522	-18.2673	-15.7036	-15.7251	-16.2815
39 Shropshire	-18.3962	-18.7133	-19.0897	-19.0788	-18.7295
40 Stoke-on-Trent	-17.7150	-22.5009	-20.0241	-19.4949	-19.9036
41 Staffordshire	-13.8946	-15.8096	-15.9539	-16.0840	-15.2627
42 Warwickshire	-7.5930	-11.1367	-10.1012	-9.9557	-9.5618
43 Bath and North East Somerset	-10.0829	-12.1380	-13.5234	-13.3855	-11.8688
44 Bristol, City of	-6.6782	-8.4436	-8.8168	-8.8371	-7.9863
45 North Somerset	-13.9676	-16.3526	-13.7265	-14.2815	-14.8672
46 South Gloucestershire	-7.2633	-10.8791	-10.4724	-10.2043	-9.4489
47 Cornwall	-19.8666	-23.2332	-22.6741	-22.3591	-21.8196
48 Plymouth	-17.1321	-18.3452	-16.9654	-16.8613	-17.4462
49 Torbay	-20.1032	-24.8508	-24.2459	-23.7063	-22.8868
50 Devon	-18.8200	-21.1025	-20.3082	-20.1051	-20.0092
51 Bournemouth	-11.8465	-15.5009	-13.4360	-13.3363	-13.5612
52 Poole	-2.7792	-12.2545	-13.7156	-13.5829	-9.5389
53 Dorset	-15.0524	-17.4198	-16.8452	-16.1896	-16.2206

Table 4.4: Standardised spatial wage differentials for 1998 areas (continued)

NES Area	1998	1999	2000 Unadjusted	2000 Adjusted	Three Year Average
54 Gloucestershire	-10.9325	-12.8308	-10.8873	-11.5076	-11.7569
55 Somerset	-15.5367	-18.3922	-17.0213	-17.3820	-17.1036
56 Swindon	-1.2651	-3.6688	-5.3568	-5.1705	-3.3681
57 Wiltshire	-10.3563	-14.0976	-12.4600	-12.8835	-12.4458
58 Luton	1.8572	-4.8423	-9.3811	-9.1172	-4.0341
59 Bedfordshire	-6.9856	-9.6013	-9.9082	-9.7856	-8.7909
60 Peterborough	-7.2672	-11.6793	-14.3702	-14.5109	-11.1524
61 Cambridgeshire	-4.8031	-8.4704	-7.7366	-7.9227	-7.0654
62 Southend-on-Sea	-10.8042	-15.7297	-15.9871	-15.2655	-13.9331
63 Thurrock	0.9939	-3.0190	0.1320	0.0720	-0.6511
64 Essex	-9.6225	-10.9573	-9.7918	-9.9861	-10.1886
65 Hertfordshire	1.3050	-1.2448	-2.7423	-2.3844	-0.7747
66 Norfolk	-15.9715	-17.2127	-15.8044	-16.2853	-16.4898
67 Suffolk	-14.4109	-16.5223	-14.7090	-14.8179	-15.2504
69 Barking and Dagenham	0.0000	0.0000	0.0000	0.0000	0.0000
70 Barnet	1.0874	-5.9651	-0.4383	0.7803	-1.3658
71 Bexley	-5.9407	-9.4442	-8.4477	-7.9946	-7.7932
72 Brent	-3.6830	-1.2854	-1.3872	-4.2673	-3.0786
73 Bromley	-1.6101	-6.3784	-4.5649	-5.0170	-4.3352
74 Camden	19.6377	17.1192	13.2928	13.2333	16.6634
75 Croydon	-5.0008	-5.4087	-3.5270	-3.5881	-4.6659
76 Ealing	3.7153	-0.9165	4.1839	3.5270	2.1086
77 Enfield	-1.8433	-8.8636	-2.6496	-3.0335	-4.5801
78 Greenwich	-3.9526	-6.3722	-1.3040	-3.2184	-4.5144
79 Hackney	19.9744	19.8693	7.5071	7.7326	15.8588
80 Hammersmith and Fulham	17.9354	11.7285	6.5508	6.2222	11.9620
81 Haringey	-0.4906	-5.0511	-7.7677	-6.3429	-3.9615
82 Harrow	0.2039	-3.8241	-7.5663	-7.7895	-3.8032
83 Havering	-2.8675	-10.2179	-9.9753	-10.0168	-7.7008
84 Hillingdon	9.8811	3.8900	1.8888	2.2977	5.3563
85 Hounslow	7.6246	6.8991	5.7881	5.7966	6.7734
86 Islington	16.8465	10.3029	12.1226	12.8064	13.3186
87 Kensington and Chelsea	17.4644	16.5577	11.7460	11.2970	15.1064
88 Kingston upon Thames	4.6415	-2.1492	-0.6455	1.5498	1.3474
89 Lambeth	19.8042	14.3171	11.8228	12.9649	15.6954
90 Lewisham	-6.9951	-1.9143	-4.0720	-3.9819	-4.2971
91 Merton	2.6692	-7.7331	-4.5859	-4.9350	-3.3330
92 Newham	-1.2386	-3.8168	-2.1134	-1.6418	-2.2324
93 Redbridge	-9.6785	-3.6502	-2.7409	-2.9371	-5.4219
94 Richmond upon Thames	3.4269	8.3206	2.1982	3.6692	5.1389
95 Southwark	12.8945	9.2506	8.5552	9.2338	10.4597
96 Sutton	-3.9223	-1.6014	-2.2653	-2.3706	-2.6314
97 Tower Hamlets	27.5149	25.8155	22.1164	23.8699	25.7334
98 Waltham Forest	-5.9660	-3.9572	-4.8887	-4.6893	-4.8708
99 Wandsworth	7.4983	3.0527	-1.1915	-0.0106	3.5135
100 City of Westminister	29.0845	23.8721	21.8101	21.7937	24.9168
101 Bracknell Forest	14.9786	10.9194	11.2330	11.6724	12.5235
102 Newbury	-1.7988	-3.6041	-1.7014	-1.8834	-2.4287
103 Reading	6.2376	8.0823	-0.9757	-0.4668	4.6177
104 Slough	10.1301	4.0127	3.0028	3.8487	5.9972
105 Windsor and Maidenhead	2.7492	9.8003	4.3662	4.8162	5.7886
106 Wokingham	1.5747	-3.0048	-2.4617	-2.3398	-1.2566
107 Brighton and Hove	-10.6814	-12.6174	-12.4282	-11.9439	-11.7476

Table 4.4: Standardised spatial wage differentials for 1998 areas (continued)

NES Area	1998	1999	2000 Unadjusted	2000 Adjusted	Three Year Average
108 East Sussex	-16.3106	-12.9806	-16.1059	-15.6310	-14.9740
109 Milton Keynes	-1.6580	-6.0065	-7.6358	-7.3638	-5.0094
110 Buckinghamshire	1.6140	0.6108	-3.9318	-3.6527	-0.4760
111 Portsmouth	-5.0756	-7.8493	-9.6382	-8.9550	-7.2933
112 Southampton	-4.8554	-9.0681	-9.6817	-9.1337	-7.6857
113 Hampshire	-6.4722	-7.9239	-9.0688	-8.7619	-7.7194
114 Isle of Wight	-16.5995	-16.8756	-16.6577	-15.4765	-16.3172
115 Medway Towns	-7.1196	-11.7114	-11.4466	-10.3208	-9.7173
116 Kent	-9.7601	-10.8100	-9.6488	-9.5086	-10.0262
117 Oxfordshire	-3.4854	-6.0695	-3.9367	-3.7733	-4.4427
118 Surrey	3.6985	1.3188	1.9821	1.7148	2.2441
119 West Sussex	-5.1889	-8.4074	-9.1946	-9.3585	-7.6516

Table 4.5: Alternative estimates of standardised spatial wage differentials

1996 NES Area Codes		Three Year Averages[1]		Smoothed Results[2]	1998 Area Codes		Three Year Averages[3]
		1997/9	1998/00	1998/00			1998/00
3	Barnet	-2.8	-1.64	-0.60	70	Barnet	-1.3658
4	Bexley	-7.49	-6.94	-6.54	71	Bexley	-7.7932
5	Brent	-2.65	-2.88	1.27	72	Brent	-3.0786
6	Bromley	-4.84	-4.77	-4.14	73	Bromley	-4.3352
7	Camden	16.96	15.94	16.86	74	Camden	16.6634
8	Croydon	-4.79	-3.9	-3.55	75	Croydon	-4.6659
9	Ealing	0.75	1.65	1.59	76	Ealing	2.1086
10	Enfield	-5.03	-3.65	-4.17	77	Enfield	-4.5801
11	Greenwich	-6.62	-4.85	-5.48	78	Greenwich	-4.5144
12	Hackney	24.2	18.08	24.07	79	Hackney	15.8588
13	Hammersmith	13.98	11.36	11.76	80	Hammersmith	11.962
14	Haringey	-4.76	-4.88	-0.04	81	Haringey	-3.9615
15	Harrow	-1.92	-3.18	-1.34	82	Harrow	-3.8032
16	Havering	-5.89	-8.22	-7.30	83	Havering	-7.7008
17	Hillingdon	11.42	9.88	9.53	84	Hillingdon	5.3563
18	Hounslow	5.92	6.29	5.89	85	Hounslow	6.7734
19	Islington	14.97	14.48	14.19	86	Islington	13.3186
20	Kensington & Chelsea	14.48	13.46	16.63	87	Kensington & Chelsea	15.1064
21	Kingston-on-Thames	1	0.04	0.16	88	Kingston-on- Thames	1.3474
22	Lambeth	16.44	15.18	14.32	89	Lambeth	15.6954
23	Lewisham	-6.52	-4.54	-2.81	90	Lewisham	-4.2971
24	Merton	-2.74	-4.28	-2.90	91	Merton	-3.333
25	Newham	-0.88	-1.88	0.37	92	Newham	-2.2324
26	Redbridge	-6.55	-6.22	-6.22	93	Redbridge	-5.4219
27	Richmond-on-Thames	2.7	3.83	4.75	94	Richmond-on- Thames	5.1389
28	Southwark	13.74	11.44	11.27	95	Southwark	10.4597
29	Sutton	-3.63	-2.82	-2.70	96	Sutton	-2.6314
30	Tower Hamlets	27.39	28.09	27.80	97	Tower Hamlets	25.7334
31	Waltham Forest	-6.46	-5.29	-5.12	98	Waltham Forest	-4.8708
32	Wandsworth	2.6	2.5	3.42	99	Wandsworth	3.5135
33	City of Westminster	25	23.84	23.32	100	City of Westminister	24.9168
34	Bedfordshire	-5.87	-7.12	-6.20	58	Luton	-4.0341
					59	Bedfordshire	-8.7909
35	Berkshire	2.98	3.65	3.13	101	Bracknell Forest	12.5235
					102	Newbury	-2.4287
					103	Reading	4.6177
					104	Slough	5.9972
					105	Windsor and Maidenhead	5.7886
					106	Wokingham	-1.2566
36	Buckinghamshire	-1.6	-2.24	-1.55	109	Milton Keynes	-5.0094
					110	Buckinghamshire	-0.476
37	East Sussex	-13.05	-13.3	-12.38	107	Brighton and Hove	-11.7476
					108	East Sussex	-14.974
38	Essex	-9.78	-9.53	-9.24	62	Southend-on-Sea	-13.9331
					63	Thurrock	-0.6511
					64	Essex	-10.1886

Table 4.5: Alternative estimates of standardised spatial wage differentials (continued)

1996 NES Area Codes		Three Year Smoothed Averages[1] 1997/9	Three Year Smoothed Averages[1] 1998/00	Results[2] 1998/00	1998 Area Codes		Three Year Averages[3] 1998/00
39	Hampshire	-7.68	-7.48	-7.02	111	Portsmouth	-7.2933
					112	Southampton	-7.6857
					113	Hampshire	-7.7194
40	Hertfordshire	-0.79	-0.82	-1.11	65	Hertfordshire	-0.7747
41	Isle of Wight	-17.06	-16.3	-14.92	114	Isle of Wight	-16.3172
42	Kent	-10.14	-9.68	-9.51	115	Medway Towns	-9.7173
					116	Kent	-10.0262
43	Oxfordshire	-5.38	-4.43	-4.55	117	Oxfordshire	-4.4427
44	Surrey	2.48	2.8	1.88	118	Surrey	2.2441
45	West Sussex	-5.27	-6.1	-5.81	119	West Sussex	-7.6516
46	Cambridgeshire	-6.86	-7.82	-7.88	60	Peterborough	-11.1524
					61	Cambridgeshire	-7.0654
47	Norfolk	-16.12	-15.58	-15.46	66	Norfolk	-16.4898
48	Suffolk	-15.03	-15.23	-14.83	67	Suffolk	-15.2504
49	Avon	-7.17	-7.59	-7.71	43	Bath and North East Somerset	-11.8688
					44	Bristol, City of	-7.9863
50	Cornwall	-20.77	-21.73	-21.61	47	Cornwall	-21.8196
51	Devon	-19.32	-19.87	-19.75	48	Plymouth	-17.4462
					49	Torbay	-22.8868
					50	Devon	-20.0092
52	Dorset	-12.84	-12.47	-12.18	51	Bournemouth	-13.5612
					52	Poole	-9.5389
					53	Dorset	-16.2206
53	Gloucestershire	-10.91	-10.58	-10.52	46	South Gloucestershire	-9.4489
					54	Gloucestershire	-11.7569
54	Somerset	-16.56	-16.54	-15.50	45	North Somerset	-14.8672
					55	Somerset	-17.1036
55	Wiltshire	-7.69	-8.18	-7.95	56	Swindon	-3.3681
					57	Wiltshire	-12.4458
56	West Midlands	-11.73	-11.61	-11.67	35	West Midlands MC	-11.4347
57	Hereford & Worcester	-16.01	-15.43	-14.51	36	Herefordshire	-18.0726
					37	Worcestershire	-14.1734
58	Shropshire	-18.23	-17.58	-17.18	38	Telford and Wrekin	-16.2815
					39	Shropshire	-18.7295
59	Staffordshire	-16.87	-16.75	-15.94	40	Stoke-on-Trent	-19.9036
					41	Staffordshire	-15.2627
60	Warwickshire	-10.61	-10.11	-10.92	42	Warwickshire	-9.5618
62	Derbyshire	-15.97	-15.85	-15.68	26	Derby	-12.1204
					27	Derbyshire	-17.0323
63	Leicestershire	-12.48	-13.62	-13.39	28	Leicester	-14.2211
					30	Leicestershire (including Rutland)	-12.5576
64	Lincolnshire	-15.68	-16.47	-15.61	22	North East Lincolnshire	-13.4882
					23	North Lincolnshire	-10.4113
					31	Lincolnshire	-19.6943

Table 4.5: Alternative estimates of standardised spatial wage differentials (continued)

1996 NES Area Codes		Three Year Averages[1]		Smoothed Results[2]	1998 Area Codes		Three Year Averages[3]
		1997/9	1998/00	1998/00			1998/00
65	Northamptonshire	-9.59	-9.24	-9.36	32	Northamptonshire	-9.1551
66	Nottinghamshire	-15.83	-15.71	-15.65	33	Nottingham	-13.4067
					34	Nottinghamshire	-16.6745
67	South Yorkshire	-15.67	-15.73	-15.56	18	South Yorkshire MC	-15.645
68	West Yorkshire	-12.6	-12.33	-12.45	19	West Yorkshire MC	-12.7197
69	Humberside	-16.91	-16.93	-16.93	20	East Riding of Yorkshire	-16.6172
					21	Kingston upon Hull	-16.7204
70	North Yorkshire	-14.68	-13.97	-14.14	24	York	-7.9072
					25	North Yorkshire	-17.0732
71	Greater Manchester	-11.55	-11.63	-11.69	9	Greater Manchester MC	-11.8838
72	Merseyside	-11.19	-11.84	-11.84	17	Merseyside	-12.0786
73	Cheshire	-10	-11.02	-11.19	10	Halton	-10.6302
					11	Warrington	-12.7199
					12	Cheshire	-10.6301
74	Lancashire	-15.16	-15.62	-14.76	14	Blackburn with Darwen	-16.7226
					15	Blackpool	-17.5484
					16	Lancashire	-15.4002
75	Tyne & Wear	-13.4	-12.82	-12.94	1	Tyne and Wear MC	-13.1834
76	Cleveland	-12.41	-12.09	-12.38	4	Hartlepool	-18.5712
					5	Middlesbrough	-13.872
					7	Redcar and Cleveland	-4.0495
					8	Stockton-on-Tees	-11.5999
77	Cumbria	-16.08	-16.62	-16.68	13	Cumbria	-16.0766
78	Durham	-15.95	-17.13	-15.00	2	Darlington	-18.5754
					3	Durham	-16.7673
79	Northumberland	-17.98	-17.88	-16.61	6	Northumberland	-17.6685

Notes:

1. Estimates based upon conventional equation specification containing broad industry specification.
2. Original post estimation smoothing techniques based upon 2000 estimates of SSWDs as opposed to three-year average. Smoothed estimates based upon application of these results to 1998/00 three-year average using the following transformation:

$SSWD98/00_{SMOOTH} = SSWD98/00 + (SSWD00 – SSWD00_{SMOOTH})$

$SSWD98/00_{SMOOTH}$ = Smoothed 1998/00 average of SSWDs.
SSWD98/00 = 1998/00 average of SSWDs.
SSWD00 = 2000 estimates of SSWDs.
$SSWD_{SMOOTH}$ = Smoothed 2000 estimates of SSWDs.

3. Estimates based upon equation specification containing detailed industry specification.

5. Fixed Effect Results

5.1 Construction of panel data sets

Three panel data sets were constructed to consider the use of fixed effects techniques upon the estimation of the SSWDs. These data sets comprise 5 period panels. The 5 period panels contain information on the 5 year period, 1996-2000. The choice of time span for the panel data sets was guided by changes in the method of industrial classification utilised by the NESPD between 1995 and 1996. Between 1982 and 1995, industrial classification was based upon the four digit code of SIC80. Since 1996, industrial classification has been based upon the five-digit code of SIC92.

A) Five Period Balanced Panel
This panel data set contains information on those individuals who appeared continuously in the NESPD during the period 1996 to 2000 inclusive. After excluding those people that failed to meet the inclusion criteria outlined in Section 3.3 for each of the time periods; this panel data set contains information on 22,236 people for 5 time periods. The total number of observations available for analysis is therefore 111,180.

B) Five Period Partial Unbalanced Panel
This panel data set contains information on those individuals who appeared in the NESPD during 2000 and at least on one other occasion during the period 1996 to 1999 inclusive. The panel is unbalanced in so far as the timing of the earliest observation is allowed to vary across individuals. Furthermore, individuals may not have a complete set of records between 2000 and the occurrence of their earliest observation (i.e. an individual may appear in 1998 and 2000 but be missing from the panel during 1999).

After excluding those people that failed to meet the inclusion criteria outlined in Section 3.3 for each of the time periods; this panel data set contains information on 56,217 people. The average number of occurrences within the panel for each individual is 3.9. By definition, the minimum number of observations per individual is 2 and the maximum is 5. The total number of observations available for analysis is 218,424. Note that this panel contains many more observations than the balanced panel described above.

C) Five Period 'Full' Unbalanced Panel
This panel data set contains information on those individuals who appeared in the NESPD on at least two occasions between the period 1996 and 2000. The panel is unbalanced in so far as the timing of both the earliest and latest observation can vary across individuals. As with the unbalanced panel described in B, individuals may not have a complete set of records between the occurrence of their earliest and latest observation.

After excluding those people that failed to meet the inclusion criteria outlined in Section 3.3 for each of the time periods; this panel data set contains information on 88,291 people. The average number of occurrences within the panel for each individual is 3.5. By definition, the minimum number of observations per individual is 2 and the maximum is 5. The total number of observations available for analysis is 306,083. This 'full' unbalanced panel contains approximately 90,000 more observations than the partial unbalanced panel described above.

All fixed effects estimations were conducted using the xtreg command within STATA econometric package.

5.2 Model specification

Details of the fixed effects approach are given in Annex A. In other respects the model specifications used for the analysis (utilising panel data techniques) correspond to those utilised within the cross sectional analysis presented in Section 4.

The importance of the level of detail incorporated within the models to control for the industrial composition of employment is considered through the estimation of 2 sets of models; the first incorporating the 18 industry category variables and the second incorporating the 50 industry dummy variables.

To assist comparisons with cross sectional results, SSWDs are again estimated for both the Scheme A and Scheme I geographies.

There is one other difference in the specification of the fixed effects models compared to those used within the cross sectional estimates. The eight age dummy variables used within the cross sectional estimates are replaced by a single continuous age measure. As no attempt has been made to deflate the earnings information to control for inflation, the age variable can be expected to capture both the effects of (a) experience upon real wage growth and (b) inflation upon nominal wage growth. Apart from the age variable, the specification of the models used within the fixed effects estimates remain unchanged.

5.3 Results

Table 5.1 and Table 5.2 present estimates of Standardised Spatial Wage Differentials based upon the 5 period balanced and unbalanced panel data sets derived from the NESPD 2000. These estimates are compared with the SSWDs produced from the cross sectional analysis as outlined in Section 4. Table 5.1 presents estimates of the SSWDs that are derived from OLS and fixed effects models that incorporate the broad industry category variables. Table 5.2 presents estimates of SSWDs derived from models that incorporate the more detailed industrial specification. Estimates based upon the Scheme A areas are shown at the top of each table. The reference category for these estimates is Area 1: Inner London. The detailed Scheme I estimates are presented beneath. The reference category for these estimates is Area 2: Barking and Dagenham. As before, the tables show both the estimated coefficients and estimates of SSWDs.

When comparing the broad Scheme A areas, it can be seen that the utilisation of fixed effects estimates have a large impact upon the size of estimated the SSWDs. Considering results from Table 5.2, cross sectional estimates indicate that compared to Inner London, earnings in Outer London are 12.9 per cent lower, 17.1 per cent lower in ROSE and 24 per cent lower in ROE. The utilisation of fixed effects estimates leads to a large reduction in the size of the Scheme A SSWDs. Considering results based upon the 'full' unbalanced 5 year panel data set presented within Table 5.2, it can be seen that compared to Inner London, earnings are 4.8 per cent lower in outer London, 7.3 per cent lower in ROSE and 9 per cent lower in ROE.

The SSWDs based upon the 5 year balanced panel data set are much smaller than those based upon both of the unbalanced panels. Considering results based upon the partial unbalanced panel presented within Table 5.2, it can be seen that compared to Inner London, earnings are 2.3 per cent lower in Outer London, 4.2 per cent lower in ROSE and 5.3 per cent lower in ROE. It would seem that providing people the opportunity to enter the panel at different points and perhaps also leave the panel for a period may capture more information about geographical variations in wages and increases the size of the area coefficients. Comparing the size of the coefficients estimated using the two unbalanced panels further supports this view. The size of the scheme A area coefficients are slightly larger for the estimates based upon the larger of the 2 unbalanced panel data sets. If this is what is happening then the problem seems to be that estimates depend upon the somewhat arbitrary decision of what type of panel data set to use to use.

It should be noted that, the balanced panel is not a random sample it contains people with some stability in their careers – the NES information generally will include pay increases due to career progression (promotion, incremental salary schemes etc). This may cause a bias in the fixed effect type estimates because some unmeasured influences associated with the passage of time are *not* fixed.

Table 5.1: Comparisons of SSWDs between OLS and fixed effects estimates: broad industry categories

Cross Sectional Estimates		Balanced Five Year Panel			Partial Unbalanced Five Year Plan			'Full' Unbalanced Five Year Panel		
	SSWD		Coefficient	SSWD		Coefficient	SSWD		Coefficient	SSWDs
Outer London	-12.2824		-0.0233	-2.3010		-0.0422	-4.1331		-0.0491	-4.7930
Rest of South East	-16.6269		-0.0429	-4.1981		-0.0709	-6.8447		-0.0760	-7.3156
Rest of England	-23.6654		-0.0548	-5.3311		-0.0934	-8.9208		-0.0947	-9.0359
Tower Hamlets	24.3551	Greenwich	0.1190	12.6381	City of Westminster	0.1203	12.7873	Hackney	0.1284	13.7036
City of Westminster	20.4506	Richmond-on-Thames	0.1023	10.7756	Tower Hamlets	0.1158	12.2793	Islington	0.1071	11.3100
Islington	13.7518	City of Westminster	0.1021	10.7474	Waltham Forest	0.1158	12.2728	City of Westminster	0.1070	11.2886
Camden	12.4984	Camden	0.0960	10.0721	Islington	0.1046	11.0229	Richmond-on-Thames	0.0955	10.0154
Lambeth	11.3883	Norfolk	0.0938	9.8314	Hackney	0.0987	10.3694	Tower Hamlets	0.0915	9.5854
Southwark	9.3957	Lewisham	0.0923	9.6685	Kensington & Chelsea	0.0977	10.2660	Camden	0.0912	9.5529
Kensington & Chelsea	9.2626	Ealing	0.0865	9.0339	Lewisham	0.0974	10.2353	Lewisham	0.0825	8.5985
Hackney	7.4213	Tower Hamlets	0.0864	9.0252	Richmond-on-Thames	0.0952	9.9884	Hounslow	0.0819	8.5302
Hounslow	5.3599	Islington	0.0805	8.3817	Camden	0.0951	9.9801	Kensington & Chelsea	0.0805	8.3839
Hillingdon	5.3172	Newham	0.0789	8.2055	Southwark	0.0922	9.6627	Southwark	0.0802	8.3550
Hammersmith	5.2252	Enfield	0.0774	8.0489	Hounslow	0.0883	9.2317	Waltham Forest	0.0787	8.1849
Ealing	3.5011	Hounslow	0.0730	7.5685	Hammersmith	0.0861	8.9868	Newham	0.0767	7.9695
Surrey	2.5588	Hertfordshire	0.0708	7.3398	Brent	0.0833	8.6913	Lambeth	0.0694	7.1855
Berkshire	1.9332	Waltham Forest	0.0701	7.2656	Ealing	0.0729	7.5600	Hammersmith	0.0684	7.0770
Richmond-on-Thames	0.8032	Barnet	0.0685	7.0892	Newham	0.0710	7.3548	Haringey	0.0612	6.3135
Barnet	-1.1074	Lambeth	0.0615	6.3391	Lambeth	0.0693	7.1748	Brent	0.0516	5.2963
Brent	-1.2795	Croydon	0.0613	6.3188	Hillingdon	0.0688	7.1225	Hillingdon	0.0474	4.8493
Enfield	-1.5204	Southwark	0.0602	6.2085	Barnet	0.0661	6.8319	Surrey	0.0427	4.3660
Greenwich	-1.6327	Hammersmith	0.0590	6.0745	Haringey	0.0632	6.5206	Enfield	0.0423	4.3237
Newham	-1.8371	Kensington & Chelsea	0.0586	6.0335	Croydon	0.0617	6.3611	Ealing	0.0422	4.3142
Kingston-on-Thames	-1.8622	Haringey	0.0575	5.9192	Enfield	0.0585	6.0204	Croydon	0.0381	3.8857
Wandsworth	-2.1266	Harrow	0.0561	5.7709	Berkshire	0.0559	5.7495	Berkshire	0.0349	3.5530
Croydon	-2.5217	Isle of Wight	0.0538	5.5325	Hertfordshire	0.0486	4.9830	Barnet	0.0344	3.5000
Hertfordshire	-2.6383	Surrey	0.0470	4.8149	Surrey	0.0477	4.8806	Hertfordshire	0.0328	3.3312
Sutton	-2.8572	Sutton	0.0456	4.6663	Kingston-on-Thames	0.0471	4.8268	Wandsworth	0.0315	3.2046
Redbridge	-3.8155	Northumberland	0.0444	4.5397	Greenwich	0.0467	4.7800	Buckinghamshire	0.0285	2.8884

Table 5.1: Comparisons of SSWDs between OLS and fixed effects estimates: broad industry categories (continued)

Cross Sectional Estimates		Balanced Five Year Panel			Partial Unbalanced Five Year Plan			'Full' Unbalanced Five Year Panel		
	SSWD		Coefficient	SSWD		Coefficient	SSWD		Coefficient	SSWDs
Oxfordshire	-4.0803	Brent	0.0442	4.5169	Buckinghamshire	0.0419	4.2749	Bexley	0.0272	2.7588
Lewisham	-4.6638	Kingston-on-Thames	0.0436	4.4612	Redbridge	0.0409	4.1734	Merton	0.0270	2.7325
Bromley	-4.8863	Warwickshire	0.0422	4.3104	Sutton	0.0366	3.7307	Greenwich	0.0240	2.4282
Waltham Forest	-5.2012	Hillingdon	0.0396	4.0408	Merton	0.0335	3.4053	Bromley	0.0239	2.4165
Buckinghamshire	-5.2356	Cambridgeshire	0.0356	3.6285	Oxfordshire	0.0300	3.0404	Kingston-on-Thames	0.0225	2.2782
Merton	-5.424	Cheshire	0.0356	3.6273	Wiltshire	0.0267	2.7106	Sutton	0.0220	2.2224
Harrow	-6.9926	Merton	0.0352	3.5839	West Midlands	0.0258	2.6101	Harrow	0.0210	2.1211
Bexley	-7.8276	Bexley	0.0336	3.4123	Wandsworth	0.0251	2.5380	Oxfordshire	0.0194	1.9594
West Sussex	-8.0122	Havering	0.0332	3.3766	Bromley	0.0208	2.0992	Wiltshire	0.0146	1.4694
Haringey	-8.2422	Wandsworth	0.0326	3.3119	Northumberland	0.0182	1.8331	Havering	0.0132	1.3292
Avon	-8.9576	Essex	0.0317	3.2239	Cheshire	0.0180	1.8196	West Midlands	0.0111	1.1130
Hampshire	-9.0341	Berkshire	0.0317	3.2180	Havering	0.0169	1.7085	Cleveland	0.0097	0.9705
Wiltshire	-9.1708	West Midlands	0.0315	3.2003	Shropshire	0.0160	1.6117	Northumberland	0.0070	0.6996
Cambridgeshire	-9.2586	Hereford & Worcester	0.0292	2.9649	Essex	0.0140	1.4109	Warwickshire	0.0067	0.6680
Essex	-9.3135	Oxfordshire	0.0256	2.5907	Northamptonshire	0.0125	1.2590	Cambridgeshire	0.0064	0.6379
Kent	-9.5723	Shropshire	0.0245	2.4805	Warwickshire	0.0125	1.2528	Redbridge	0.0038	0.3769
Bedfordshire	-9.778	Bromley	0.0240	2.4337	Tyne & Wear	0.0110	1.1031	Tyne & Wear	0.0036	0.3642
Northamptonshire	-9.9536	Dorset	0.0235	2.3822	Harrow	0.0101	1.0185	Hereford & Worcester	0.0020	0.2041
Gloucestershire	-10.3571	Tyne & Wear	0.0228	2.3082	Hampshire	0.0087	0.8738	Gloucestershire	-0.0002	-0.0182
Havering	-10.5431	Cumbria	0.0228	2.3019	Staffordshire	0.0083	0.8300	Bedfordshire	-0.0014	-0.1395
Warwickshire	-10.7407	Staffordshire	0.0207	2.0887	Hereford & Worcester	0.0081	0.8084	Staffordshire	-0.0020	-0.1950
Cleveland	-11.535	Buckinghamshire	0.0187	1.8827	Norfolk	0.0063	0.6333	Cheshire	-0.0030	-0.3013
West Midlands	-12.5086	Hackney	0.0175	1.7667	Bexley	0.0058	0.5825	West Yorkshire	-0.0036	-0.3583
Greater Manchester	-12.5536	West Yorkshire	0.0174	1.7564	Greater Manchester	0.0054	0.5396	Avon	-0.0051	-0.5040
Cheshire	-12.6678	Northamptonshire	0.0173	1.7472	West Yorkshire	0.0053	0.5323	Northamptonshire	-0.0059	-0.5897
Tyne & Wear	-13.3174	Cleveland	0.0159	1.6030	Cleveland	0.0040	0.4047	Greater Manchester	-0.0065	-0.6510
West Yorkshire	-13.3281	Greater Manchester	0.0151	1.5170	Avon	0.0026	0.2637	West Sussex	-0.0076	-0.7527
Merseyside	-13.5239	Wiltshire	0.0147	1.4790	Cambridgeshire	0.0012	0.1232	North Yorkshire	-0.0097	-0.9674
North Yorkshire	-14.0886	Nottinghamshire	0.0140	1.4113	Merseyside	0.0011	0.1060	Essex	-0.0103	-1.0204
Dorset	-14.2857	Hampshire	0.0126	1.2633	Bedfordshire	0.0002	0.0184	Dorset	-0.0105	-1.0442
East Sussex	-14.4912	Lincolnshire	0.0117	1.1783	North Yorkshire	-0.0004	-0.0403	Hampshire	-0.0107	-1.0683

Table 5.1: Comparisons of SSWDs between OLS and fixed effects estimates: broad industry categories (continued)

Cross Sectional Estimates		Balanced Five Year Panel			Partial Unbalanced Five Year Plan			'Full' Unbalanced Five Year Panel		
	SSWD		Coefficient	SSWD		Coefficient	SSWD		Coefficient	SSWDs
Suffolk	-14.8316	West Sussex	0.0111	1.1157	Gloucestershire	-0.0011	-0.1065	Norfolk	-0.0123	-1.2197
Norfolk	-14.9931	Suffolk	0.0083	0.8371	Suffolk	-0.0013	-0.1290	Merseyside	-0.0140	-1.3926
Hereford & Worcester	-15.209	Merseyside	0.0078	0.7829	Dorset	-0.0055	-0.5507	Lincolnshire	-0.0157	-1.5573
Leicestershire	-15.7092	Gloucestershire	0.0073	0.7307	West Sussex	-0.0109	-1.0825	Kent	-0.0182	-1.8005
Derbyshire	-15.9372	East Sussex	0.0070	0.7034	Lancashire	-0.0112	-1.1127	Nottinghamshire	-0.0183	-1.8140
Humberside	-16.052	Humberside	0.0055	0.5549	Nottinghamshire	-0.0132	-1.3125	Leicestershire	-0.0188	-1.8588
Somerset	-16.0983	Derbyshire	0.0053	0.5305	East Sussex	-0.0146	-1.4525	Shropshire	-0.0193	-1.9131
South Yorkshire	-16.2711	North Yorkshire	0.0053	0.5272	Kent	-0.0148	-1.4673	Humberside	-0.0223	-2.2069
Northumberland	-16.2773	Lancashire	0.0002	0.0235	Leicestershire	-0.0174	-1.7233	Somerset	-0.0230	-2.2771
Nottinghamshire	-16.3542	Kent	-0.0005	-0.0489	Derbyshire	-0.0203	-2.0066	Durham	-0.0254	-2.5066
Cumbria	-16.7185	Redbridge	-0.0042	-0.4194	Lincolnshire	-0.0206	-2.0432	Lancashire	-0.0290	-2.8570
Isle of Wight	-16.9812	Leicestershire	-0.0054	-0.5401	Somerset	-0.0302	-2.9728	Suffolk	-0.0296	-2.9127
Staffordshire	-16.9912	Avon	-0.0080	-0.7978	South Yorkshire	-0.0313	-3.0778	East Sussex	-0.0302	-2.9774
Shropshire	-17.2285	South Yorkshire	-0.0122	-1.2089	Durham	-0.0337	-3.3104	Derbyshire	-0.0363	-3.5686
Lancashire	-17.3873	Bedfordshire	-0.0161	-1.5933	Humberside	-0.0347	-3.4083	South Yorkshire	-0.0371	-3.6427
Lincolnshire	-17.9329	Durham	-0.0212	-2.0997	Cumbria	-0.0476	-4.6526	Cumbria	-0.0503	-4.9041
Durham	-20.1203	Somerset	-0.0257	-2.5370	Devon	-0.0588	-5.7129	Devon	-0.0583	-5.6618
Devon	-20.2721	Devon	-0.0310	-3.0500	Isle of Wight	-0.0732	-7.0624	Isle of Wight	-0.0890	-8.5134
Cornwall	-22.7814	Cornwall	-0.1703	-15.6557	Cornwall	-0.1502	-13.9436	Cornwall	-0.1151	-10.8748

Table 5.2: Comparisons of SSWDs between OLS and fixed effects estimates: detailed industry categories

Cross Sectional Estimates			Balanced Five Year Panel			Partial Unbalanced Five Year Panel			'Full' Unbalanced Five Year Panel		
		SSWD		Coefficient	SSWDs		Coefficient	SSWDs		Coefficient	SSWDs
Outer London		-12.8925		-0.0236	-2.3314		-0.0438	-4.2867		-0.0494	-4.8184
Rest of South East		-17.1806		-0.0432	-4.2251		-0.0719	-6.9390		-0.0759	-7.3120
Rest of Engalnd		-24.0254		-0.0547	-5.3214		-0.0940	-8.9682		-0.0948	-9.0412
Tower Hamlets	30	22.1608	Greenwich	0.1136	12.0251	City of Westminster	0.1213	12.8908	Hackney	0.1222	12.9980
City of Westminster	33	21.8473	City of Westminster	0.0989	10.3912	Tower Hamlets	0.1176	12.4739	City of Westminster	0.1076	11.3616
Camden	7	13.3222	Richmond-on-Thames	0.0967	10.1578	Waltham Forest	0.1159	12.2924	Islington	0.1049	11.0602
Islington	19	12.1462	Camden	0.0923	9.6721	Islington	0.1033	10.8816	Richmond-on-Thames	0.0941	9.8632
Lambeth	22	11.8744	Norfolk	0.0923	9.6654	Lewisham	0.0984	10.3356	Camden	0.0922	9.6569
Kensington & Chelsea	20	11.8243	Lewisham	0.0890	9.3076	Kensington & Chelsea	0.0983	10.3344	Tower Hamlets	0.0904	9.4618
Southwark	28	8.6288	Tower Hamlets	0.0852	8.8938	Camden	0.0961	10.0850	Lewisham	0.0827	8.6173
Hackney	12	7.5728	Ealing	0.0846	8.8262	Hackney	0.0946	9.9168	Hounslow	0.0820	8.5495
Hammersmith	13	6.6026	Islington	0.0778	8.0912	Richmond-on-Thames	0.0927	9.7141	Waltham Forest	0.0811	8.4472
Hounslow	18	5.8289	Newham	0.0767	7.9681	Southwark	0.0909	9.5181	Kensington & Chelsea	0.0807	8.4096
Ealing	9	4.2457	Enfield	0.0746	7.7503	Hammersmith	0.0895	9.3631	Southwark	0.0794	8.2676
Richmond-on-Thames	27	2.2564	Hounslow	0.0708	7.3396	Hounslow	0.0874	9.1281	Newham	0.0771	8.0189
Surrey	44	2.0393	Hertfordshire	0.0682	7.0568	Brent	0.0811	8.4439	Hammersmith	0.0700	7.2548
Hillingdon	17	1.9583	Waltham Forest	0.0667	6.9019	Ealing	0.0726	7.5292	Lambeth	0.0694	7.1879
Berkshire	35	1.7268	Barnet	0.0662	6.8442	Newham	0.0721	7.4783	Haringey	0.0593	6.1070
Barnet	3	-0.3364	Croydon	0.0594	6.1177	Lambeth	0.0695	7.1978	Brent	0.0511	5.2384
Kingston-on-Thames	21	-0.5690	Hammersmith	0.0576	5.9298	Barnet	0.0686	7.1029	Hillingdon	0.0467	4.7829
Wandsworth	32	-1.1060	Southwark	0.0575	5.9207	Hillingdon	0.0662	6.8403	Ealing	0.0427	4.3666
Greenwich	11	-1.2310	Lambeth	0.0566	5.8249	Haringey	0.0621	6.4083	Surrey	0.0416	4.2488
Brent	5	-1.2859	Kensington & Chelsea	0.0553	5.6830	Enfield	0.0573	5.8934	Enfield	0.0403	4.1075
Newham	25	-2.0415	Harrow	0.0544	5.5923	Croydon	0.0565	5.8102	Croydon	0.0356	3.6250
Sutton	29	-2.1912	Haringey	0.0543	5.5759	Berkshire	0.0561	5.7732	Berkshire	0.0354	3.6067
Enfield	10	-2.5924	Isle of Wight	0.0517	5.3105	Kingston-on-Thames	0.0484	4.9638	Barnet	0.0353	3.5879
Hertfordshire	40	-2.6852	Sutton	0.0453	4.6311	Hertfordshire	0.0483	4.9435	Wandsworth	0.0331	3.3684
Redbridge	26	-2.7258	Surrey	0.0431	4.4057	Greenwich	0.0471	4.8259	Hertfordshire	0.0327	3.3290
Croydon	8	-3.4797	Warwickshire	0.0414	4.2245	Surrey	0.0464	4.7445	Bexley	0.0296	3.0015
Oxfordshire	43	-3.8736	Brent	0.0408	4.1653	Buckinghamshire	0.0425	4.3449	Buckinghamshire	0.0292	2.9598

Table 5.2: Comparisons of SSWDs between OLS and fixed effects estimates: detailed industry categories (continued)

Cross Sectional Estimates			Balanced Five Year Panel			Partial Unbalanced Five Year Panel			'Full' Unbalanced Five Year Panel		
		SSWD		Coefficient	SSWDs		Coefficient	SSWDs		Coefficient	SSWDs
Lewisham	23	-4.0139	Northumberland	0.0403	4.1125	Redbridge	0.0372	3.7915	Merton	0.0281	2.8548
Bromley	6	-4.4801	Kingston-on-Thames	0.0389	3.9638	Sutton	0.0347	3.5289	Greenwich	0.0250	2.5318
Merton	24	-4.5048	Hillingdon	0.0379	3.8581	Merton	0.0340	3.4575	Kingston-on-Thames	0.0244	2.4697
Waltham Forest	31	-4.7913	Bexley	0.0359	3.6533	Oxfordshire	0.0303	3.0757	Bromley	0.0233	2.3531
Buckinghamshire	36	-5.5082	Merton	0.0342	3.4742	Wiltshire	0.0272	2.7613	Sutton	0.0217	2.1957
Harrow	15	-7.5316	Cheshire	0.0340	3.4578	Wandsworth	0.0268	2.7152	Harrow	0.0205	2.0678
Haringey	14	-7.6885	Cambridgeshire	0.0323	3.2779	West Midlands	0.0260	2.6312	Oxfordshire	0.0196	1.9770
Bexley	4	-8.3513	Wandsworth	0.0319	3.2378	Bromley	0.0196	1.9750	Wiltshire	0.0131	1.3167
West Sussex	45	-9.1153	Essex	0.0299	3.0351	Cheshire	0.0186	1.8818	Havering	0.0128	1.2925
Hampshire	39	-9.1711	West Midlands	0.0297	3.0195	Northumberland	0.0178	1.7954	Cleveland	0.0117	1.1776
Wiltshire	55	-9.2227	Hereford & Worcester	0.0288	2.9221	Shropshire	0.0172	1.7387	West Midlands	0.0116	1.1679
Essex	38	-9.4171	Berkshire	0.0286	2.8963	Havering	0.0156	1.5686	Northumberland	0.0090	0.9050
Cambridgeshire	46	-9.6465	Havering	0.0283	2.8709	Northamptonshire	0.0145	1.4613	Warwickshire	0.0076	0.7625
Bedfordshire	34	-9.6572	Shropshire	0.0233	2.3533	Warwickshire	0.0134	1.3473	Cambridgeshire	0.0061	0.6139
Northamptonshire	65	-9.6597	Cumbria	0.0225	2.2722	Essex	0.0132	1.3327	Tyne & Wear	0.0050	0.5040
Kent	42	-9.8122	Oxfordshire	0.0207	2.0883	Tyne & Wear	0.0106	1.0670	Hereford & Worcester	0.0029	0.2937
Avon	49	-9.8207	Staffordshire	0.0200	2.0239	Bexley	0.0101	1.0159	Redbridge	0.0003	0.0317
Havering	16	-9.8788	Tyne & Wear	0.0199	2.0052	Hereford & Worcester	0.0094	0.9431	Gloucestershire	-0.0002	-0.0233
Warwickshire	60	-10.0369	Dorset	0.0186	1.8724	Harrow	0.0087	0.8759	Bedfordshire	-0.0014	-0.1349
Gloucestershire	53	-10.6817	Bromley	0.0171	1.7281	Staffordshire	0.0081	0.8180	Staffordshire	-0.0020	-0.2033
Cleveland	76	-11.2038	Nottinghamshire	0.0164	1.6548	Hampshire	0.0081	0.8147	Cheshire	-0.0028	-0.2820
West Midlands	56	-12.2841	Buckinghamshire	0.0157	1.5850	Norfolk	0.0060	0.6030	West Yorkshire	-0.0043	-0.4272
Cheshire	73	-12.6782	Northamptonshire	0.0156	1.5742	Greater Manchester	0.0051	0.5158	Northamptonshire	-0.0055	-0.5465
Greater Manchester	71	-12.7441	West Yorkshire	0.0135	1.3560	Cleveland	0.0050	0.4993	Avon	-0.0056	-0.5553
Merseyside	72	-13.5946	Cleveland	0.0125	1.2543	West Yorkshire	0.0038	0.3828	West Sussex	-0.0065	-0.6457
West Yorkshire	68	-13.6881	Greater Manchester	0.0123	1.2331	Merseyside	0.0022	0.2252	Greater Manchester	-0.0071	-0.7068
Tyne & Wear	75	-14.1770	Wiltshire	0.0114	1.1422	Avon	0.0018	0.1844	North Yorkshire	-0.0098	-0.9798
North Yorkshire	70	-14.3339	Hampshire	0.0104	1.0469	Cambridgeshire	0.0004	0.0414	Essex	-0.0100	-0.9993
East Sussex	37	-14.4980	Lincolnshire	0.0103	1.0317	Bedfordshire	0.0000	0.0021	Hampshire	-0.0105	-1.0398
Suffolk	48	-14.6205	Hackney	0.0096	0.9638	Suffolk	0.0000	-0.0014	Norfolk	-0.0123	-1.2183
Hereford & Worcester	57	-14.7776	Merseyside	0.0085	0.8489	Gloucestershire	-0.0013	-0.1250	Dorset	-0.0127	-1.2586

Table 5.2: Comparisons of SSWDs between OLS and fixed effects estimates: detailed industry categories (continued)

Cross Sectional Estimates			Balanced Five Year Panel			Partial Unbalanced Five Year Panel			'Full' Unbalanced Five Year Panel		
		SSWD		Coefficient	SSWDs		Coefficient	SSWDs		Coefficient	SSWDs
Dorset	52	-15.0918	West Sussex	0.0083	0.8384	North Yorkshire	-0.0027	-0.2728	Merseyside	-0.0137	-1.3574
Leicestershire	63	-15.2341	Suffolk	0.0053	0.5330	Dorset	-0.0072	-0.7169	Lincolnshire	-0.0148	-1.4675
Derbyshire	62	-15.4199	East Sussex	0.0043	0.4346	Nottinghamshire	-0.0098	-0.9717	Nottinghamshire	-0.0155	-1.5373
Nottinghamshire	66	-15.6924	Derbyshire	0.0042	0.4258	Lancashire	-0.0107	-1.0675	Kent	-0.0188	-1.8659
Norfolk	47	-15.7234	Gloucestershire	0.0042	0.4208	West Sussex	-0.0109	-1.0885	Leicestershire	-0.0189	-1.8758
Humberside	69	-15.7447	Humberside	0.0029	0.2934	Kent	-0.0160	-1.5847	Shropshire	-0.0191	-1.8889
Northumberland	79	-16.0698	North Yorkshire	0.0011	0.1143	Leicestershire	-0.0166	-1.6509	Humberside	-0.0214	-2.1192
Cumbria	77	-16.0987	Lancashire	-0.0021	-0.2061	East Sussex	-0.0175	-1.7329	Durham	-0.0228	-2.2499
Somerset	54	-16.2356	Kent	-0.0044	-0.4405	Derbyshire	-0.0184	-1.8251	Somerset	-0.0244	-2.4138
South Yorkshire	67	-16.2729	Leicestershire	-0.0077	-0.7648	Lincolnshire	-0.0200	-1.9778	Suffolk	-0.0284	-2.7990
Isle of Wight	41	-16.6622	Avon	-0.0109	-1.0888	South Yorkshire	-0.0310	-3.0501	Lancashire	-0.0290	-2.8565
Staffordshire	59	-16.9673	South Yorkshire	-0.0133	-1.3248	Somerset	-0.0323	-3.1762	East Sussex	-0.0316	-3.1089
Lancashire	74	-17.3634	Redbridge	-0.0148	-1.4699	Durham	-0.0328	-3.2238	Derbyshire	-0.0351	-3.4511
Shropshire	58	-17.4717	Bedfordshire	-0.0178	-1.7655	Humberside	-0.0353	-3.4666	South Yorkshire	-0.0372	-3.6557
Lincolnshire	64	-17.9770	Durham	-0.0251	-2.4796	Cumbria	-0.0478	-4.6710	Cumbria	-0.0504	-4.9145
Devon	51	-19.7683	Somerset	-0.0299	-2.9442	Devon	-0.0593	-5.7596	Devon	-0.0585	-5.6835
Durham	78	-20.0762	Devon	-0.0358	-3.5161	Isle of Wight	-0.0654	-6.3307	Isle of Wight	-0.0828	-7.9498
Cornwall	50	-22.5956	Cornwall	-0.1772	-16.2381	Cornwall	-0.1524	-14.1398	Cornwall	-0.1184	-11.1687

Considering the estimates of SSWDs for the detailed NES areas that fall within Scheme I, it can be seen that the fixed effects techniques act to dampen down the geographical variations observed in the OLS estimates of the SSWDs. To observe this more clearly, the frequency distributions of estimated SSWDs are presented graphically within Figures 5.1 and 5.2. It can be seen that the slope of the frequency distributions based upon the fixed effects models are much shallower than that of the frequency distribution representing the conventional OLS estimates.

It can also be seen that the frequency distribution derived from the balanced panel estimates is slightly shallower than those derived from both of the unbalanced panels. This coincides with the earlier comparisons based upon the broad Scheme A areas made between the balanced and unbalanced panel estimates. However, the difference in the slopes of these 2 frequency distributions is perhaps not as great as what may have been expected given the large reduction in the size of the Scheme A SSWDs when comparing results from the balanced and unbalanced panels.

Figure 5.1: Frequency distributions of SSWD estimates for NES areas: broad industry categories

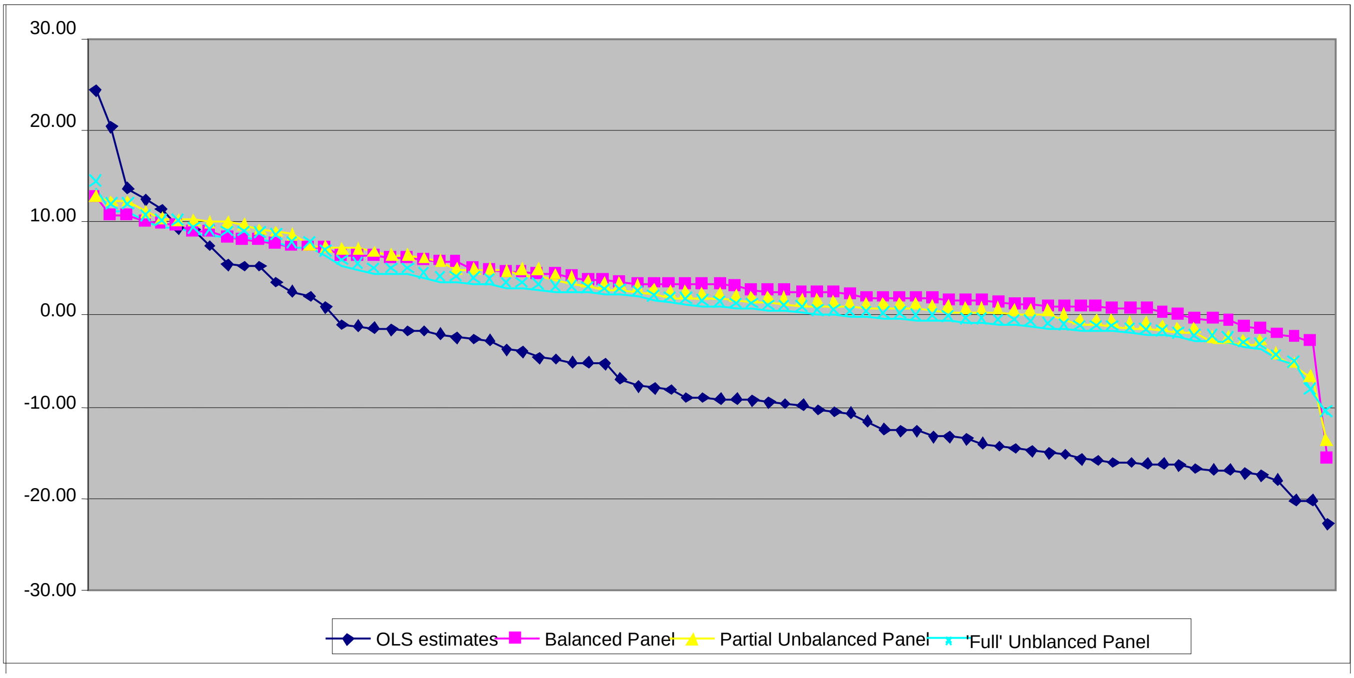


Figure 5.2: Frequency distributions of SSWD estimates for NES areas: detailed industry categories

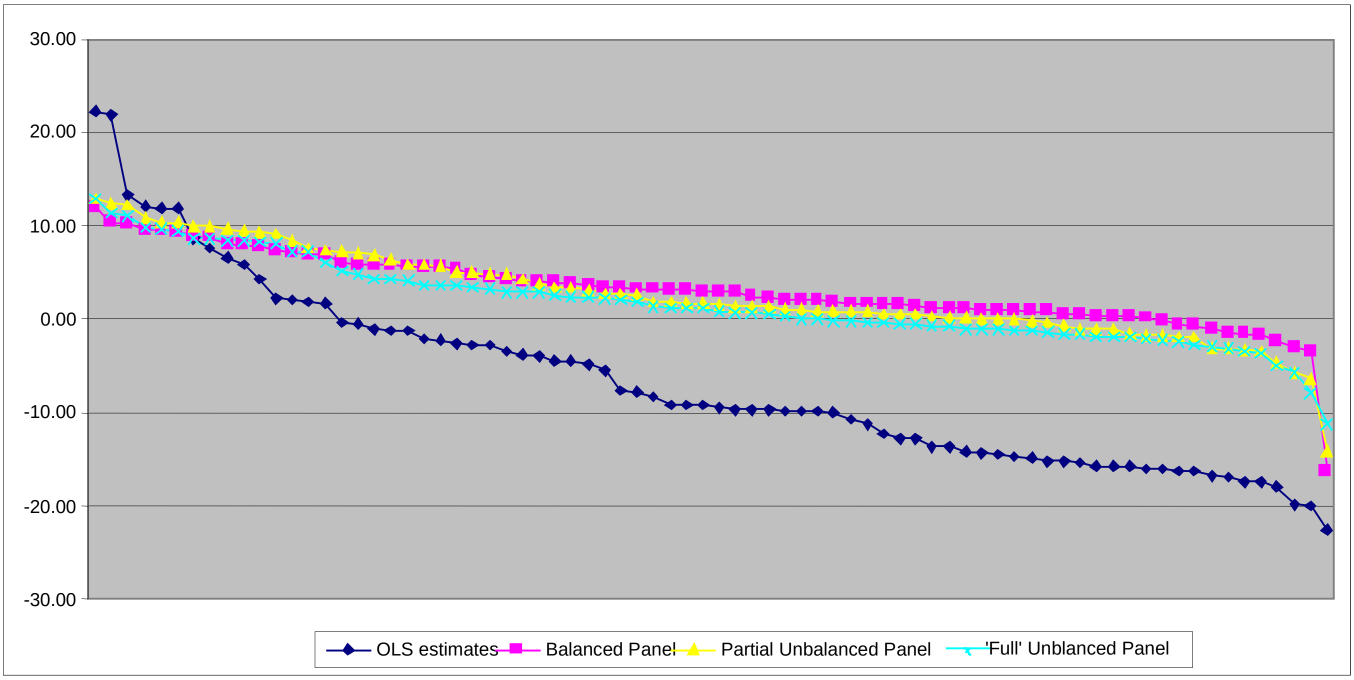


Figure 5.3: Comparing the ordering of SSWDs based upon OLS and fixed effects estimates (partial balanced panel)

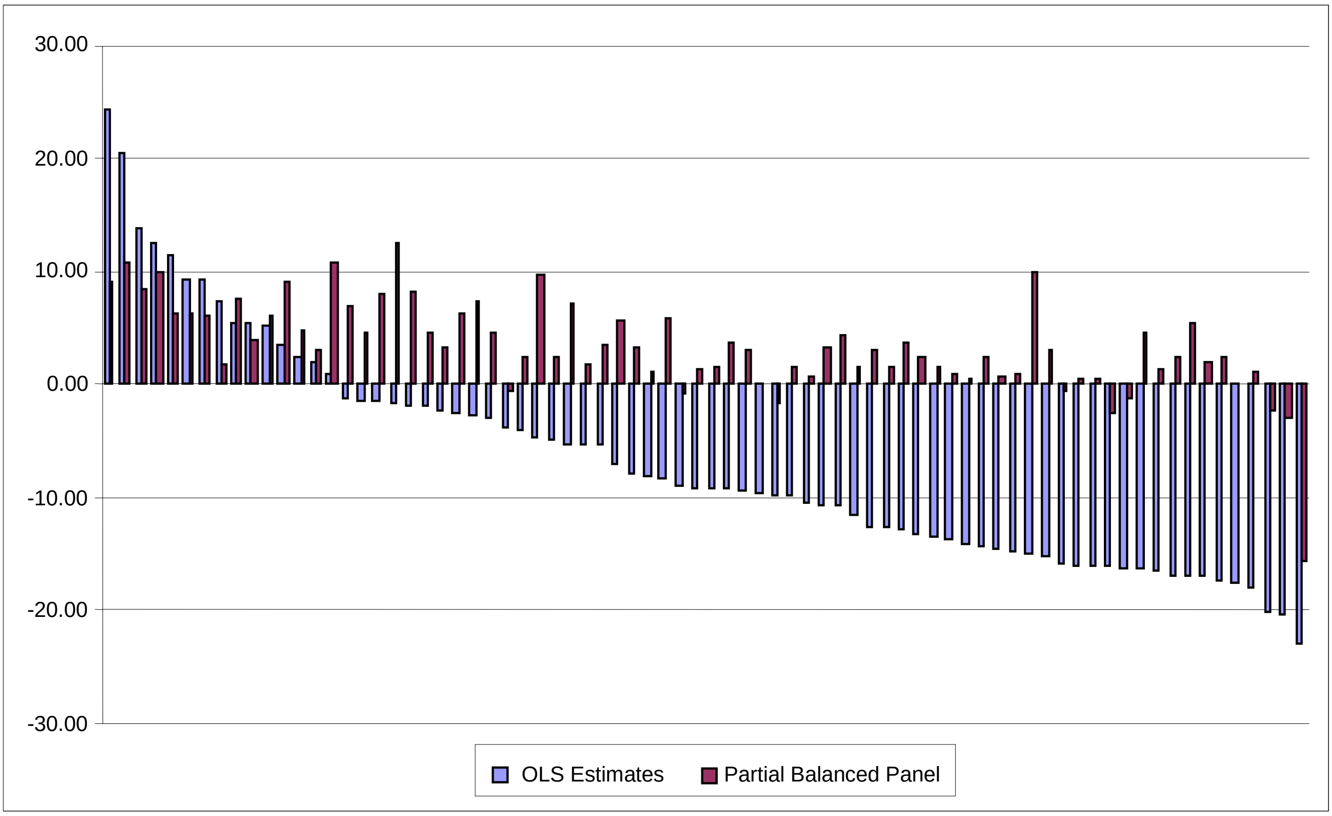


Figure 5.4: Comparing the ordering of SSWDs based upon OLS and fixed effects estimates (partial unbalanced panel)

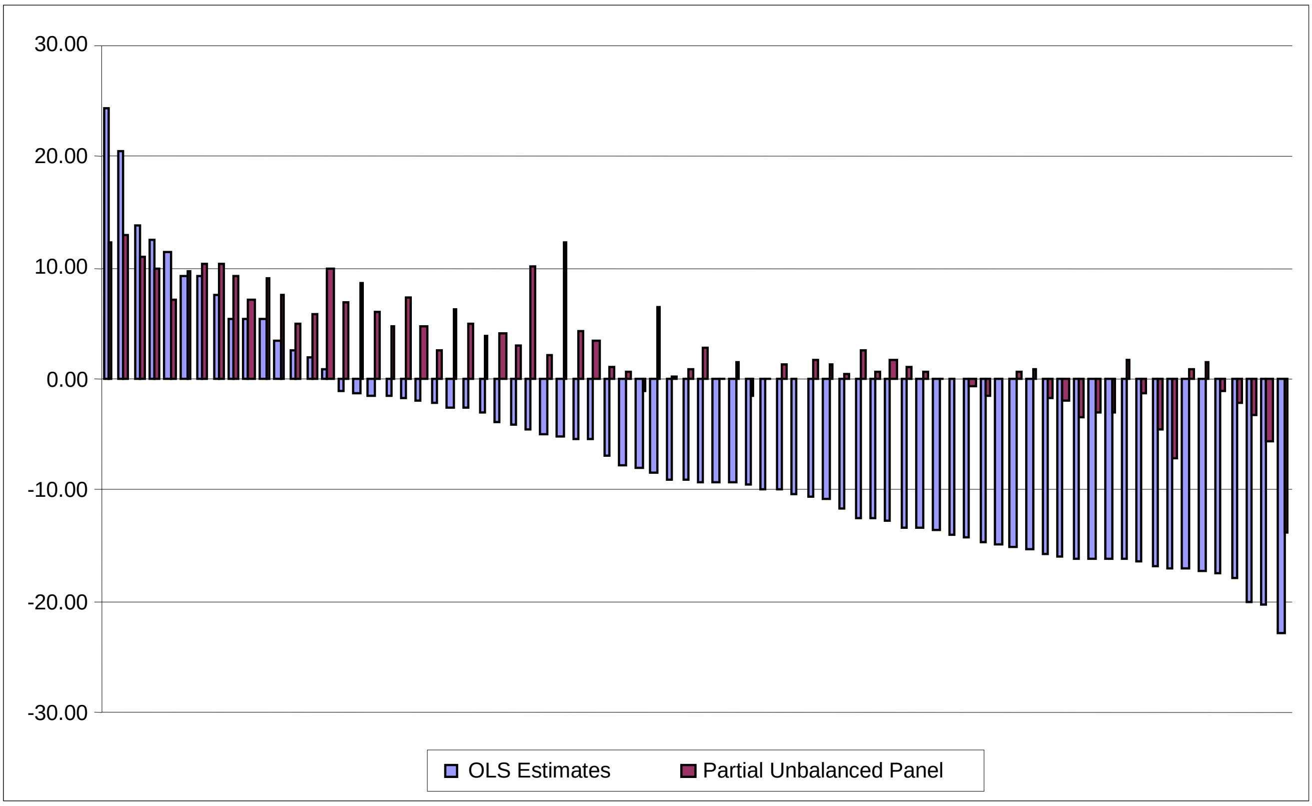
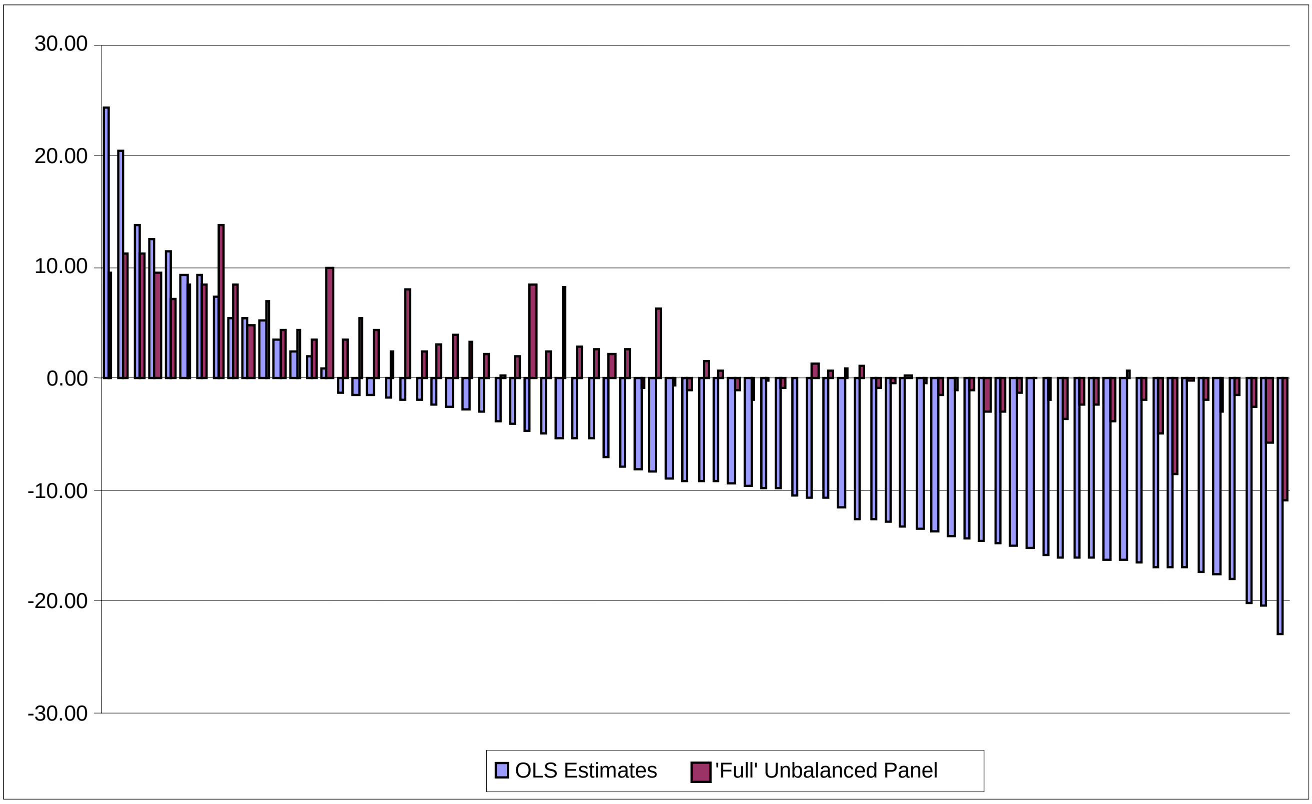


Figure 5.5: Comparing the ordering of SSWDs based upon OLS and fixed effects estimates (full unbalanced panel)



Figures 5.1 and 5.2 highlight the importance of fixed effects estimates in dampening the size of SSWDs when compared to conventional estimates based upon OLS techniques. However, these charts do not highlight the changes in the rank ordering of Scheme I areas that occurs in moving towards estimates of SSWDs based upon fixed effects techniques. Individual examples of areas that exhibit a significant change in their rank ordering can be observed within Tables 5.3 and 5.4. For examples, comparing results between OLS estimates and fixed effects estimates based upon the unbalanced panel within Table 5.2, it can be seen that the area Waltham Forest moves upwards from 31st position to 3rd. Similarly, Lewisham moves from 29th position to 5th. Examples of areas that experience a decline in their ranking include Surrey (13th to 24th), Wandsworth (22nd to 34th) and Bexley (34th to 49th).

The overall impact of moving towards fixed effects upon the relative rankings of Scheme I areas can be seen in Figures 5.3, 5.4 and 5.5. These grouped bar charts present estimated SSWDs based upon (a) OLS estimates and (b) respective fixed effects estimates. Figure 5.3 presents fixed effects estimates based upon the balanced panel, Figure 5.4 presents fixed effects estimates based upon the partial unbalanced panel and Figure 5.5 presents fixed effects estimates based upon the 'full' unbalanced panel. In each figure the Scheme I areas are arranged in descending order of their SSWDs based upon the OLS estimates. Within both charts it can be seen that the smooth downward progression of SSWDs based upon OLS estimates is not replicated by those estimated via fixed effects techniques. However, the overall degree of congruence with OLS estimates is observed to be greater when comparing with fixed effects estimates based upon both of the larger unbalanced panel data sets. This is particularly the case with the larger 'full' unbalanced panel data set.

5.4 Comparisons with earlier results

Another reason for incorporating results based upon the broad Scheme A areas was in order to make comparisons with earlier work conducted by Bell (1998) for SIGOMA. A summary of the results from these 2 pieces of work are presented in Table 5.3. The results presented below are based upon from Table 4.4 of Bell (1998). Note that Bell (1998) excludes the City to act as the reference category within his analysis. To maintain consistency with the earlier estimates (that take Inner London as the reference category), Bell's results Are transformed to provide differences from his estimates for Inner London. Also note that the results used are from Table 4.4 of Bell (1998), which refer to the private sector. Again, this is to achieve the highest possible level of consistency between the 2 sets of results. Finally, Bell (1998) uses a time varying fixed effects methodology. This means that separate coefficients are estimated for each year of data contained within his panel data set. The following comparisons are based on his 1996 estimates (the latest year available in Table 4.4).

It can be seen that the results of the present analysis produce consistently smaller SSWDs based upon the Scheme A areas compared to Bell (1998). The coefficients on the cross sectional estimates produced by IER are approximately 0.06 smaller (in absolute terms) than those of Bell (1998). Similarly, the fixed effect estimates are approximately 0.04 to 0.05 smaller than those produced by Bell. The impact of fixed effect techniques in reducing the size of the area coefficients is presented in terms of the ratio of fixed effects to cross sectional estimates. Within the present analysis it can be seen that the area coefficients based upon fixed effects techniques are approximately 0.32-0.38 the size of the cross sectional estimates. This is compared to the analysis of Bell where the area coefficients based upon the fixed effect estimates are approximately 0.43-0.48 of the cross sectional estimates.

Table 5.3: Comparisons with previous estimates

		IER	Bell
Cross Section	Outer London	-0.131	-0.184
	Rest of South East	-0.182	-0.243
	Rest of England	-0.270	-0.336
Fixed Effect	Outer London	-0.042	-0.085
	Rest of South East	-0.070	-0.108
	Rest of England	-0.093	-0.143
Ratio of Fixed Effects to Cross Section	Outer London	0.32	0.46
	Rest of South East	0.38	0.44
	Rest of England	0.34	0.43

A number of factors however mitigate against making consistent direct comparisons between the current estimates and those presented by Bell (1998):

- Period of Analysis: The data sets used within the respective analyses cover different periods (i.e. Bell: 1990 to 1997, IER: 1996 to 2000).
- Bell uses a deflated earnings variable
- Bell uses time varying parameters for the spatial dummies
- Model Specification: It is unlikely that the 2 analyses incorporated identical controls for occupation and industry (for example, at the same level of detail). Bell's model attempts to control for attrition and whether the individual was covered by collective agreement, which are not included within our estimates of the SSWDs.
- Sample Selection: The present estimates of SSWDs are based upon full time private sector employees aged 16-70 whose pay was unaffected by absence in the week covered by the survey. It is not clear if these or other selection criteria were employed in the analysis conducted by Bell (1998).

5.5 Time varying fixed effects estimates

Bell (1998) utilises a time varying fixed effects methodology. This methodology has the advantage that year on year estimates of SSWDs can be obtained and therefore trends in the size of SSWDs can be identified. Time varying fixed effects estimates can be obtained by including additional time dummy variables and interacting these with the area dummy variables[19]. Given that there is some overlap in the time span of the data utilised in the present analysis compared to that used by Bell (1998), the estimation of a time varying fixed effects model within the present analysis may help to explain the differences in the size of the coefficients produced by the respective analyses.

[19] One of the time effects must be dropped to avoid perfect collinearity.

Table 5.4: Time varying fixed effect estimates

Data Set	Region	Time varying coefficients					Time invariant coefficients
		1996	1997	1998	1999	2000	
Balanced Panel	Outer London	-0.0113	-0.0188	-0.0262	-0.0323	-0.0351	-0.0233
	Rest of South East	-0.0375	-0.0471	-0.0469	-0.0443	-0.0480	-0.0429
	Rest of England	-0.0449	-0.0499	-0.0550	-0.0615	-0.0695	-0.0548
Partial Unbalanced Panel	Outer London	-0.0175	-0.0356	-0.0403	-0.0521	-0.0604	-0.0422
	Rest of South East	-0.0542	-0.0720	-0.0709	-0.0719	-0.0839	-0.0709
	Rest of England	-0.0711	-0.0824	-0.0874	-0.0983	-0.1176	-0.0934
Full Unbalanced Panel	Outer London	-0.0251	-0.0453	-0.0550	-0.0650	-0.0644	-0.0491
	Rest of South East	-0.0590	-0.0781	-0.0842	-0.0820	-0.0866	-0.076
	Rest of England	-0.0703	-0.0891	-0.0973	-0.1083	-0.1167	-0.0947

Time varying fixed effects estimates of the SSWDs have been estimated for the broad areas incorporated within the Scheme A area definitions. These estimates of the SSWDs are based upon models that incorporate the 18 industry control variables. Estimates are provided for each of three panel data sets previously described. To aid comparison with earlier results, time invariant estimates of the area coefficients are presented in the final column of Table 5.4. These correspond to the area coefficients presented in Table 5.1.

It can be seen in Table 5.4 that the time invariant estimates of the area coefficients are approximately equal to the average of the five time varying coefficients estimated for each area. As noted by Bell (1998), the availability of a large number of observations within the NES results in a high degree of stability in the estimates of the time varying coefficients. However, a general trend is observed in the estimates of the area coefficients, with hourly earnings in all areas declining relative to those within Inner London between 1996 and 2000. These trends are observed for estimates based upon each of the three panel data sets and point towards the continued regional divergence in earnings estimated by Bell (1998) for the period 1990 to 1997.

However, it is noted that a significant difference is still observed in the size of the coefficients estimated for the years 1996 and 1997 within Table 5.4 and those estimated by Bell (1998). As noted above, the size of estimated SSWDs will depend upon the precise specification of the regression model. The omission of relevant explanatory variables will lead to biases in the estimation of SSWDs, as otherwise unobserved influences become attributed to geographical location. We conclude that the differences observed in the sizes of the estimated SSWDs reflect differences in model specification, sample selection and the utilisation by Bell (1998) of deflated earnings. Further research is needed to clarify the precise causes of these differences.

6. NES results incorporating spatial co-ordinates (*ex ante* surfacing)

6.1 Introduction

In order to incorporate space directly into the estimation process, the surfacing approach requires that spatial co-ordinates are defined for each geographical location. In principle, this could distinguish details of the individual's workplace location. In practice, the current analysis is restricted to the 79 NES zones[20].

In order to operationalise the approach, so called "centroids" are defined, representing the spatial co-ordinates of the population weighted centres of each NES area. These co-ordinates (eastings and northings) are then entered into the regression analysis in place of the spatial dummy variables. In order to allow for complex surfaces, various powered terms (e.g. squares, cubes) and interactions of the eastings and northings (and of their powered terms) are also used.

6.2 Methodology for calculating centroids

The centroids used in the analysis represent the 'population-weighted centre' of each NES zone; in other words the point most accessible to the population living within each area. If the entire population of an NES zone lived in a single town, this point would be the centre of that town. Thus, NES areas in which the population is most dispersed have a centroid closest to the geometric centre of the zone (e.g. Cambridgeshire; see Figure 6.1). In contrast, Dorset, Hampshire, East Sussex and West Sussex have centroids close to the coast, reflecting the concentration of the population in the coastal resorts and cities such as Southampton and Portsmouth. Similarly, the centroid for Northumberland is located in the more urbanised south-east of the county, away from the more rural areas of the north and west.

The centroid calculations use data from the 1991 Census of Population. This divides England into about 100 thousand areas for collection of the Census data (termed Enumeration Districts [EDs]), each of which contain about 250 households. The centre of each ED is assigned an Ordnance Survey National Grid co-ordinate[21] by the Office for National Statistics and the 1991 population of each ED is known.

Each ED is also given a code identifying which local authority district and which electoral ward within the district it falls within. Each NES zone is made up of local authority districts. It is thus possible to identify all the EDs within each NES zone.

The centroid is calculated as the mean of the easting (X_j) co-ordinate and the mean of the northing (Y_j) of each of the n EDs in the NES zone, each weighted by the population (P_j) of the ED. The calculation for the X co-ordinate of the centroid (X_{nes}) is as follows:

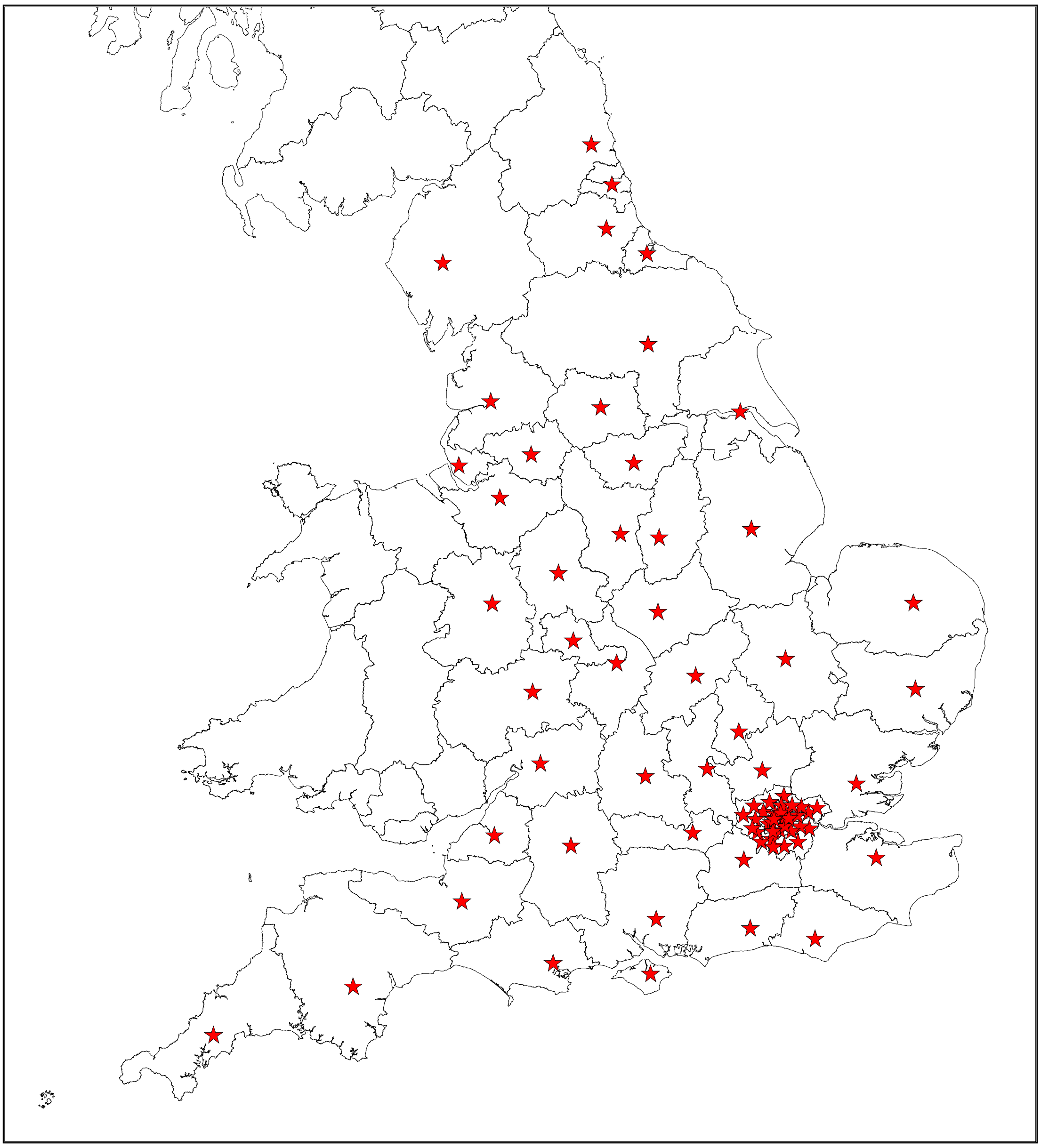
$$X_{nes} = \left(\sum_{j=1}^{n} \left[Xj \bullet Pj \right] \div \sum_{j=1}^{n} Pj \right)$$

The calculation is the same for the Y co-ordinate (simply substitute Y for X in the equation above).

20 Although 119 spatial areas are distinguished in the NESPD for years since 1998.

21 Derived from a rectangular grid laid over the land surface of Great Britain, from which the position of any point can be read off as an X (easting) and Y (northing) co-ordinate.

Figure 6.1: Location of population weighted centroids for NES zones



6.3 Incorporation of spatial co-ordinates in the regressions

The centroids have only been included in the cross-sectional regressions, although they can, in principle also be used in the fixed effects analysis.

A variety of different power terms have been tried, including squared, cubed and higher powers. Interactions between the northing and easting terms (and their powers) have also been incorporated as explanatory variables.

6.4 Results of incorporating the spatial co-ordinates in the regressions

The detailed results appear to be sensitive to the precise specification but, in general, the overall pattern seems appears to be reasonably stable and consistent.

The replacement of the area dummies by the centroids does not have a significant impact upon the size or statistical significance of the other coefficients (e.g. on age, gender, industry or occupational dummies).

The presence of multi-collinearity between the various polynomial and interaction terms included within the regressions makes it difficult to make an accurate judgement regarding their individual statistical significance. Indeed, low levels of tolerance between some polynomial terms resulted in these being excluded from the estimations due to the associated computational problems. Tolerance criteria were adjusted to minimise the number polynomial terms excluded from the models.

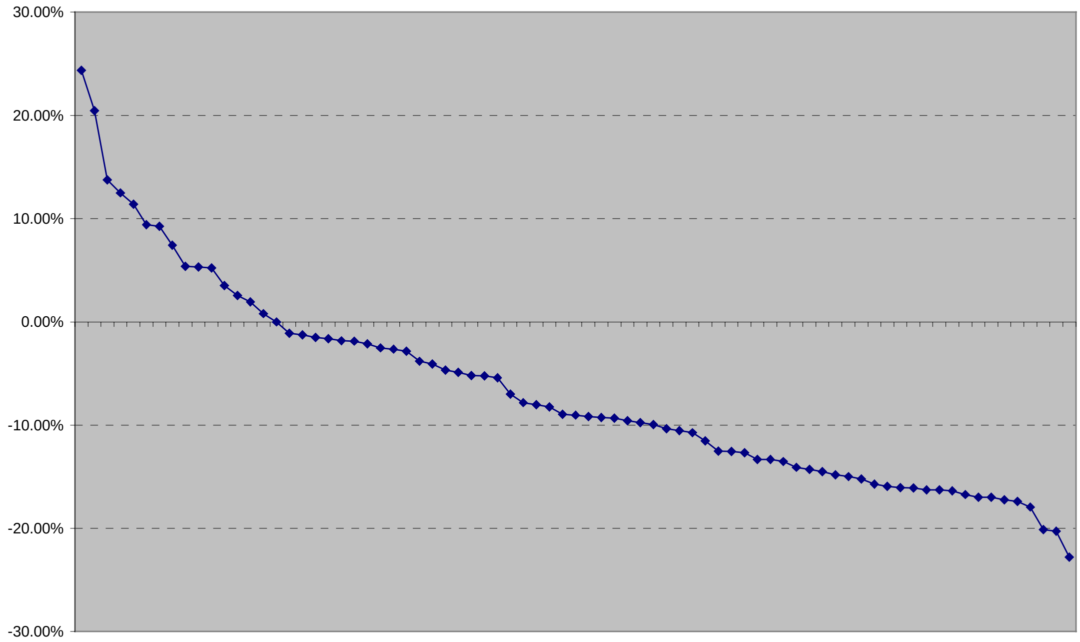
6.5 Implied SSWDs

Converting the results back into the form of implied SSWDs, the estimates suggest a generally stable pattern, with a clear distinction between London and the rest of England remaining.

However, the surfacing method dampens down the more extreme patterns of variation within London. The summary table (Table 6.1) shows comparisons with Barking and Dagenham, including the conventional estimates using area dummies. The frequency distributions of the estimates, providing insights into how the shape of the distribution changes as different power terms are introduced, are presented in Figures 6.2-6.6. All frequency distributions are presented together in Figure 6.7. Figures 6.8 – 6.12 present the information in the form of a series of maps, showing the pattern of SSWDs across the country.

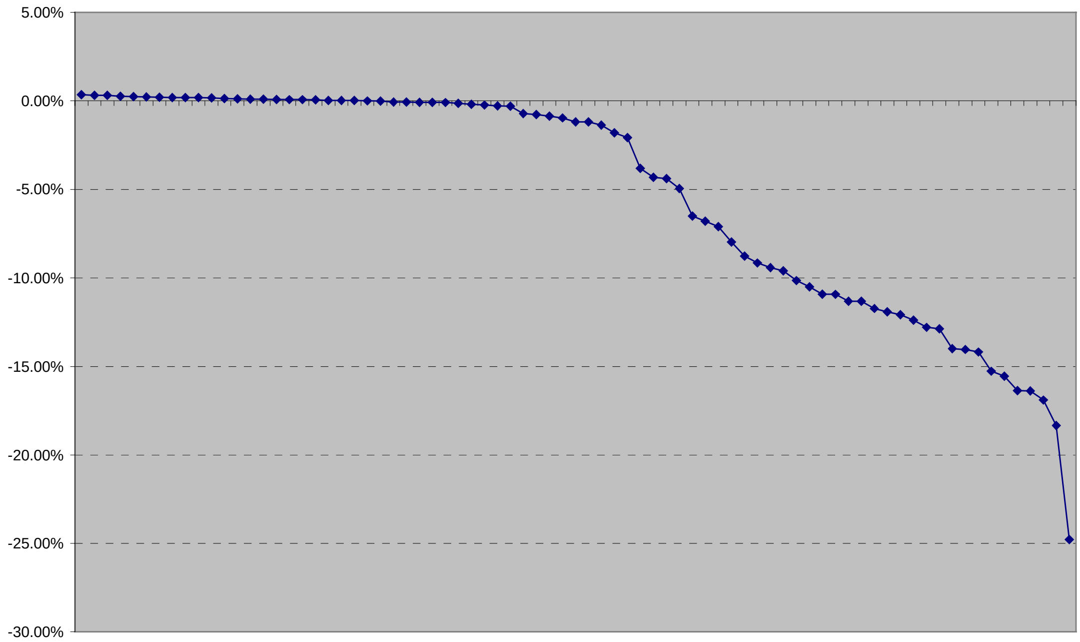
The conventional estimates, using area dummies (Figure 6.2) show wide disparities within London. Surrey and Berkshire are the only areas outside central, west and south London where the differentials are positive. The largest negative differentials are recorded in Cornwall, Devon and Durham.

Figure 6.2: Frequency distribution using area dummies



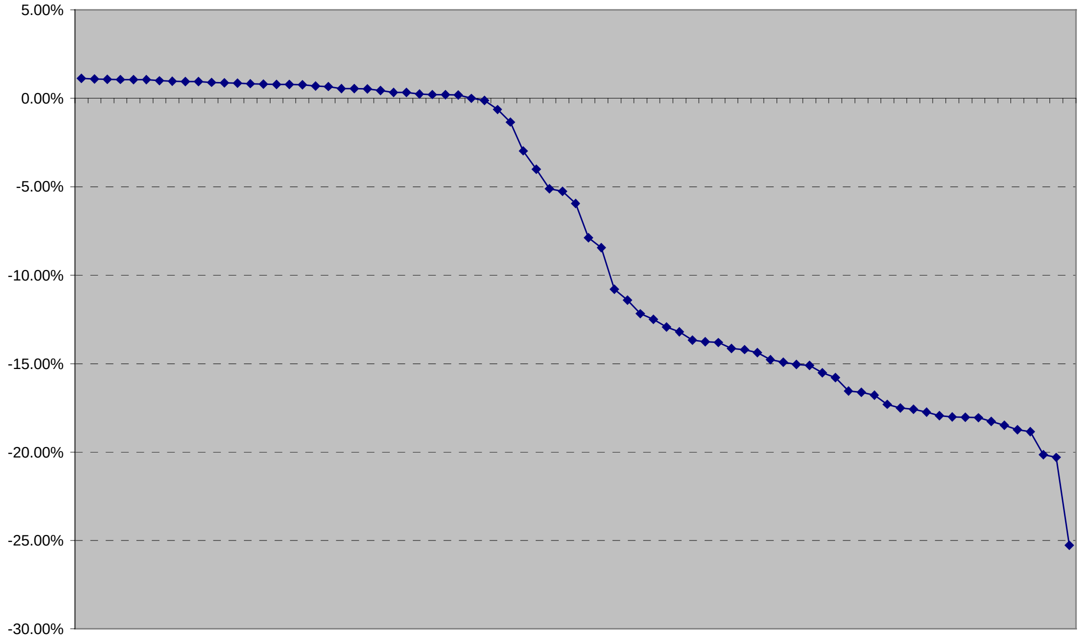
As the power terms (of different magnitudes) are introduced, the disparities within London are dampened down considerably. Moreover, there are changes in the rank order of the boroughs. For example, Tower Hamlets and the City of Westminster (formerly ranked 1 and 2) drop to rankings 13 and 17, as a group of south London boroughs record the largest positive differentials when the power term is raised to 2 (Figure 6.3). Outside London, Surrey and West Sussex record positive differentials, with a group of areas in south-eastern England – including East Sussex, Kent, Hertfordshire, the Isle of Wight, Essex, Berkshire, Hampshire, Buckinghamshire and Bedfordshire recording the next smallest negative differentials after the London boroughs. Next comes a group of neighbouring areas on the edge of south-eastern England, including Oxfordshire, Northamptonshire, Dorset and Cambridgeshire. Cornwall remains at the bottom of the rankings, with a negative differential significantly larger than the next area – Humberside.

Figure 6.3: Frequency distribution of estimates for NES areas with centroids to power 2



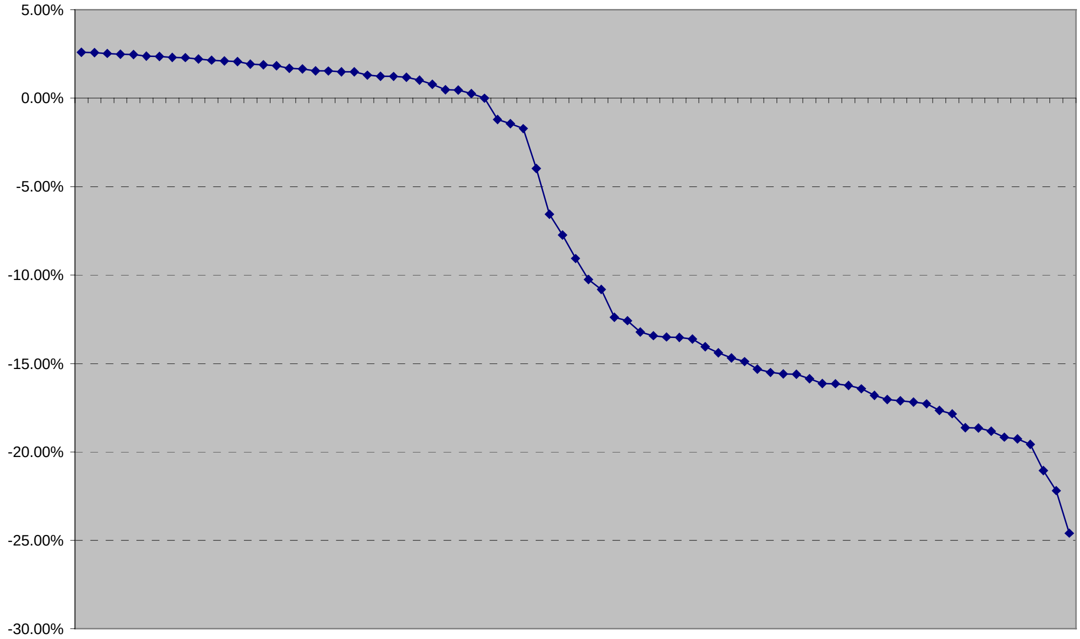
As the power term is raised to 3 (Figure 6.4) there are again some changes in the rank order of areas, although, in general terms, the geographical pattern emerging remains relatively consistent. Only Surrey has a higher rank than some of the London boroughs (Barking and Dagenham, Bexley and Havering). The steepest gradient in the distribution is from Hertfordshire (with a differential value of –1.34%) to Northamptonshire (with a differential value of –10.80%), and encompasses Berkshire, Buckinghamshire, Bedfordshire, Essex, West Sussex, Hampshire and Oxfordshire. This may be thought of in terms of a 'zone of transition' between London (and its immediate environs) and the rest of England. Cornwall remains firmly rooted at the foot of the distribution, with Lincolnshire and Devon displaying the next largest negative differentials.

Figure 6.4: Frequency distribution of estiJmates for NES areas with centroids to power 3



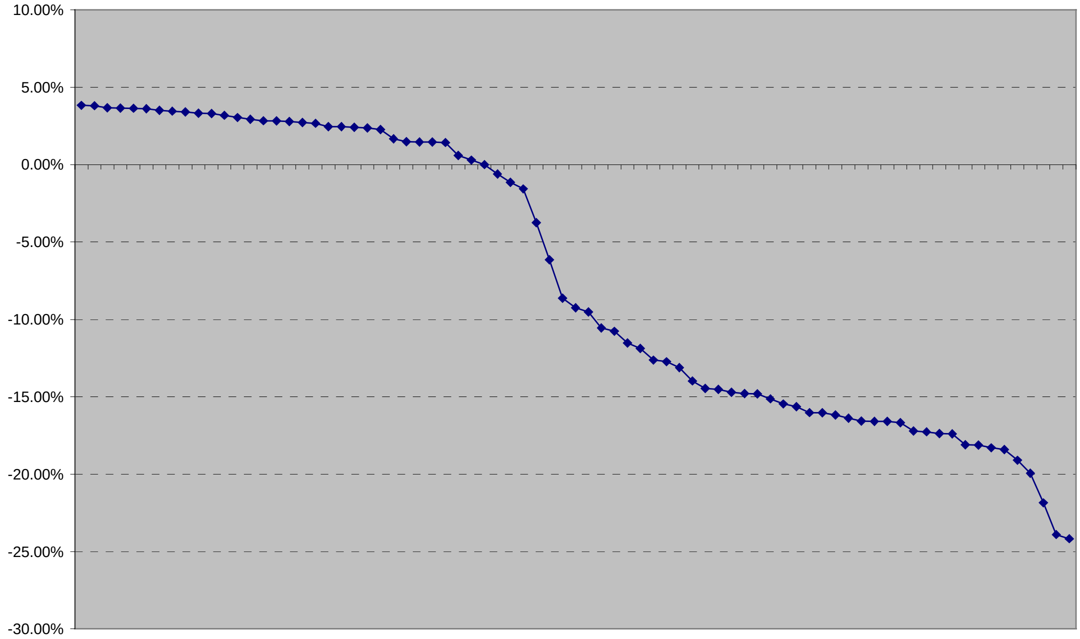
When the power term is raised to 4 (Figure 6.5), a similar 'steep' gradient in the frequency distribution is apparent, again extending from Hertfordshire (with a differential value of –1.72%) to Wiltshire (with a differential value of 12.39%). There is considerable similarity in the areas encompassed between these two points as noted for the previous case: the areas in question are Buckinghamshire, Bedfordshire, Oxfordshire, Essex, Hampshire and West Sussex. Cornwall, Devon and the Isle of Wight are at the foot of the rankings. (Cornwall is consistently at the foot of the rankings, but the position of the Isle of Wight is far more volatile.)

Figure 6.5: Frequency distribution of estimates for NES areas with centroids to power 4



As the power term is raised to 5 (Figure 6.6) the disparities within London and it immediate environs begin to emerge more clearly; (although in a considerably more dampened form than revealed by the conventional estimates). A group of outer boroughs on the eastern side of London – Bromley, Waltham Forest, Newham, Greenwich and Enfield – record slightly smaller positive differentials than boroughs in most of central and western London. Then comes another group of areas, including Redbridge, Bexley, Barking & Dagenham, Hertfordshire, Berkshire and Havering, before a steeper gradient is apparent through Buckinghamshire and Bedfordshire to Oxfordshire. Cornwall remains at the foot of the rankings, with the Isle of Wight and Devon recording slightly smaller negative differentials.

Figure 6.6: Frequency distribution of estimates for NES areas with centroids to power 5



Hence, although in general terms the geographical patterns emerging are similar, there are many detailed changing in rankings, depending upon the power terms employed in the regressions. Moreover, some areas – notably the Isle of Wight – are more 'volatile' than others. Figure 6.7 compares the various results.

This figure compares the unadjusted SSWDs from the OLS cross-sectional analysis shown in Figure 6.8 with results from the *ex ante* smoothing regressions. The latter are based on using the geographical co-ordinates of the centroids for each area rather than individual area dummy variables. Differentials in the London area, which constitute most of the high SSWDs in the conventional estimates, are greatly attenuated using the *ex ante* surfacing estimation technique. This result is obtained regardless of the number of power terms employed in the regressions.

The differences between the SSWDs using the quadratic and higher powered terms are quite marked for a broad swathe of areas outside London. The higher powered terms are probably essential to get a more precise picture, the quadratic being too crude a specification.

There are also notable differences for a number of areas outside London, which have small negative differentials using the dummy variable approach but which are brought close to zero using the surfacing method.

Figure 6.7: ***Ex Ante*** **Smoothing: comparisons of surfacing results with conventional estimates Frequency distribution of Centroid estimates for 79 NES areas**

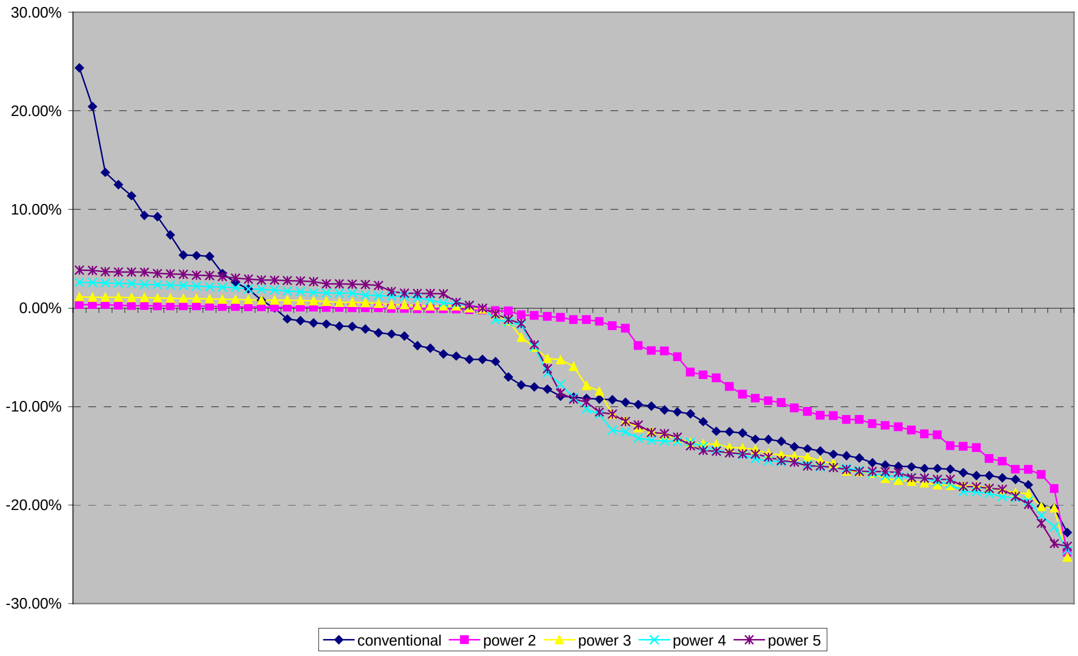


Table 6.1: SSWDs from cross-sectional results using area dummies and centroids

Conventional Estimates			Centroids to the power 2			Centroids to the power 3			Centroids to the power 4			Centroids to the power 5		
NES Area	SSWD	Standardised Wage Rate	NES Area	SSWD	Standardised Wage Rate	NES Area	SSWD	Standardised Wage Rate	NES Area	SSWD	Standardised Wage Rate	NES Area	SSWD	Standardised Wage Rate
Tower Hamlets	24.36%	21.8708	Croydon	0.35%	17.4613	Wandsworth	1.12%	18.2750	Merton	2.59%	18.5723	Richmond-on-Thames	3.83%	18.7160
City of Westminster	20.45%	21.1841	Bromley	0.32%	17.4565	Hammersmith	1.08%	18.2676	Kingston-on-Thames	2.57%	18.5689	Kingston-on-Thames	3.81%	18.7133
Islington	13.75%	20.0060	Sutton	0.32%	17.4561	Kensington & Chelsea	1.08%	18.2673	Wandsworth	2.53%	18.5607	Hounslow	3.68%	18.6896
Camden	12.50%	19.7855	Merton	0.26%	17.4458	Lambeth	1.07%	18.2648	Richmond-on-Thames	2.49%	18.5529	Merton	3.66%	18.6849
Lambeth	11.39%	19.5903	Lewisham	0.25%	17.4441	Merton	1.06%	18.2631	Sutton	2.47%	18.5501	Wandsworth	3.64%	18.6823
Southwark	9.40%	19.2398	Lambeth	0.22%	17.4395	City of Westminster	1.05%	18.2620	Hammersmith	2.37%	18.5325	Hammersmith	3.62%	18.6789
Kensington & Chelsea	9.26%	19.2164	Kingston-on-Thames	0.20%	17.4362	Southwark	0.99%	18.2514	Lambeth	2.37%	18.5316	Kensington & Chelsea	3.50%	18.6568
Hackney	7.42%	18.8926	Wandsworth	0.20%	17.4354	Kingston-on-Thames	0.98%	18.2483	Hounslow	2.31%	18.5205	Ealing	3.46%	18.6489
Hounslow	5.36%	18.5300	Greenwich	0.19%	17.4346	Camden	0.96%	18.2447	Kensington & Chelsea	2.29%	18.5182	Sutton	3.41%	18.6413
Hillingdon	5.32%	18.5225	Southwark	0.19%	17.4345	Richmond-on-Thames	0.96%	18.2446	Croydon	2.22%	18.5043	City of Westminster	3.32%	18.6252
Hammersmith	5.23%	18.5064	Bexley	0.18%	17.4319	Islington	0.91%	18.2358	City of Westminster	2.16%	18.4933	Lambeth	3.30%	18.6207
Ealing	3.50%	18.2031	Surrey	0.13%	17.4235	Sutton	0.87%	18.2299	Southwark	2.11%	18.4845	Brent	3.18%	18.5994
Surrey	2.56%	18.0374	Tower Hamlets	0.11%	17.4204	Tower Hamlets	0.87%	18.2283	Ealing	2.07%	18.4775	Camden	3.04%	18.5747
Berkshire	1.93%	17.9274	Hammersmith	0.09%	17.4170	Hackney	0.83%	18.2220	Lewisham	1.92%	18.4504	Southwark	2.93%	18.5540
Richmond-on-Thames	0.80%	17.7286	Kensington & Chelsea	0.09%	17.4170	Hounslow	0.81%	18.2179	Camden	1.88%	18.4439	Hillingdon	2.83%	18.5366
Barking and Dagenham	0.00%	17.5874	Richmond-on-Thames	0.08%	17.4146	Brent	0.79%	18.2146	Brent	1.83%	18.4347	Croydon	2.82%	18.5350
Barnet	-1.11%	17.3926	City of Westminster	0.08%	17.4140	Lewisham	0.78%	18.2130	Islington	1.70%	18.4100	Surrey	2.79%	18.5280
Brent	-1.28%	17.3623	Newham	0.07%	17.4132	Ealing	0.76%	18.2100	Tower Hamlets	1.66%	18.4039	Islington	2.73%	18.5183
Enfield	-1.52%	17.3200	West Sussex	0.06%	17.4115	Haringey	0.70%	18.1988	Bromley	1.55%	18.3828	Harrow	2.67%	18.5076
Greenwich	-1.63%	17.3002	Hackney	0.03%	17.4054	Croydon	0.67%	18.1929	Surrey	1.54%	18.3811	Lewisham	2.46%	18.4695
Newham	-1.84%	17.2643	Islington	0.02%	17.4047	Newham	0.56%	18.1728	Hillingdon	1.50%	18.3740	Barnet	2.46%	18.4692
Kingston-on-Thames	-1.86%	17.2599	Camden	0.02%	17.4036	Barnet	0.55%	18.1718	Hackney	1.49%	18.3726	Tower Hamlets	2.41%	18.4612
Wandsworth	-2.13%	17.2134	Barking and Dagenham	0.00%	17.4007	Waltham Forest	0.53%	18.1675	Harrow	1.30%	18.3378	Hackney	2.38%	18.4554
Croydon	-2.52%	17.1439	Hounslow	-0.01%	17.3988	Greenwich	0.45%	18.1526	Greenwich	1.24%	18.3272	Haringey	2.27%	18.4349
Hertfordshire	-2.64%	17.1234	Redbridge	-0.06%	17.3902	Harrow	0.34%	18.1336	Haringey	1.23%	18.3253	Bromley	1.67%	18.3263
Sutton	-2.86%	17.0849	Waltham Forest	-0.07%	17.3891	Enfield	0.32%	18.1306	Barnet	1.19%	18.3178	Waltham Forest	1.50%	18.2954
Redbridge	-3.82%	16.9163	Ealing	-0.08%	17.3864	Redbridge	0.24%	18.1156	Newham	1.02%	18.2882	Newham	1.47%	18.2911
Oxfordshire	-4.08%	16.8698	Haringey	-0.08%	17.3862	Bromley	0.22%	18.1112	Waltham Forest	0.79%	18.2453	Greenwich	1.47%	18.2902
Lewisham	-4.66%	16.7671	Brent	-0.09%	17.3844	Hillingdon	0.21%	18.1101	Bexley	0.49%	18.1910	Enfield	1.44%	18.2847
Bromley	-4.89%	16.7280	Havering	-0.13%	17.3784	Surrey	0.20%	18.1073	Enfield	0.46%	18.1861	Redbridge	0.59%	18.1317

Table 6.1: SSWDs from cross-sectional results using area dummies and centroids (continued)

Conventional Estimates			Centroids to the power 2			Centroids to the power 3			Centroids to the power 4			Centroids to the power 5		
Waltham Forest	-5.20%	16.6726	Barnet	-0.19%	17.3668	Barking and Dagenham	0.00%	18.0718	Redbridge	0.25%	18.1490	Bexley	0.29%	18.0782
Buckinghamshire	-5.24%	16.6666	Enfield	-0.23%	17.3603	Bexley	-0.13%	18.0491	Barking and Dagenham	0.00%	18.1029	Barking and Dagenham	0.00%	18.0259
Merton	-5.42%	16.6334	Harrow	-0.28%	17.3516	Havering	-0.63%	17.9573	Havering	-1.20%	17.8861	Hertfordshire	-0.60%	17.9177
Harrow	-6.99%	16.3576	Hillingdon	-0.29%	17.3493	Hertfordshire	-1.34%	17.8295	Berkshire	-1.43%	17.8445	Berkshire	-1.15%	17.8194
Bexley	-7.83%	16.2107	East Sussex	-0.72%	17.2762	Berkshire	-2.97%	17.5353	Hertfordshire	-1.72%	17.7914	Havering	-1.56%	17.7443
West Sussex	-8.01%	16.1782	Kent	-0.76%	17.2679	Buckinghamshire	-4.01%	17.3480	Buckinghamshire	-3.97%	17.3844	Buckinghamshire	-3.74%	17.3523
Haringey	-8.24%	16.1378	Hertfordshire	-0.86%	17.2511	Bedfordshire	-5.11%	17.1478	Bedfordshire	-6.56%	16.9145	Bedfordshire	-6.16%	16.9155
Avon	-8.96%	16.0120	Isle of Wight	-0.96%	17.2334	Essex	-5.26%	17.1206	Oxfordshire	-7.74%	16.7010	Oxfordshire	-8.62%	16.4720
Hampshire	-9.03%	15.9985	Essex	-1.18%	17.1945	West Sussex	-5.93%	16.9993	Essex	-9.07%	16.4613	Wiltshire	-9.26%	16.3567
Wiltshire	-9.17%	15.9745	Berkshire	-1.19%	17.1941	Hampshire	-7.87%	16.6493	Hampshire	-10.25%	16.2477	West Sussex	-9.53%	16.3086
Cambridgeshire	-9.26%	15.9590	Hampshire	-1.36%	17.1635	Oxfordshire	-8.44%	16.5475	West Sussex	-10.81%	16.1452	Hampshire	-10.55%	16.1235
Essex	-9.31%	15.9494	Buckinghamshire	-1.80%	17.0870	Northamptonshire	-10.80%	16.1202	Wiltshire	-12.39%	15.8606	Essex	-10.76%	16.0860
Kent	-9.57%	15.9039	Bedfordshire	-2.07%	17.0399	Isle of Wight	-11.41%	16.0107	Kent	-12.58%	15.8264	Kent	-11.51%	15.9507
Bedfordshire	-9.78%	15.8677	Oxfordshire	-3.81%	16.7378	Cambridgeshire	-12.18%	15.8709	Northamptonshire	-13.21%	15.7116	Cleveland	-11.88%	15.8853
Northamptonshire	-9.95%	15.8368	Northamptonshire	-4.32%	16.6491	Cleveland	-12.50%	15.8129	Cleveland	-13.42%	15.6731	Gloucestershire	-12.62%	15.7507
Gloucestershire	-10.36%	15.7658	Dorset	-4.38%	16.6385	Warwickshire	-12.93%	15.7345	Cambridgeshire	-13.50%	15.6589	Cambridgeshire	-12.74%	15.7296
Havering	-10.54%	15.7331	Cambridgeshire	-4.95%	16.5391	Kent	-13.20%	15.6861	North Yorkshire	-13.53%	15.6535	Avon	-13.11%	15.6626
Warwickshire	-10.74%	15.6984	Wiltshire	-6.51%	16.2686	West Midlands	-13.67%	15.6012	Gloucestershire	-13.61%	15.6394	Northamptonshire	-13.97%	15.5071
Cleveland	-11.54%	15.5587	Leicestershire	-6.79%	16.2196	Shropshire	-13.77%	15.5842	Hereford & Worcester	-14.05%	15.5599	Staffordshire	-14.46%	15.4191
West Midlands	-12.51%	15.3874	Warwickshire	-7.11%	16.1641	Hereford & Worcester	-13.81%	15.5761	Warwickshire	-14.40%	15.4958	Greater Manchester	-14.52%	15.4082
Greater Manchester	-12.55%	15.3795	Suffolk	-7.97%	16.0130	Staffordshire	-14.15%	15.5153	West Midlands	-14.69%	15.4438	Warwickshire	-14.72%	15.3731
Cheshire	-12.67%	15.3594	Nottinghamshire	-8.76%	15.8758	Wiltshire	-14.21%	15.5038	Avon	-14.89%	15.4076	West Midlands	-14.80%	15.3584
Tyne & Wear	-13.32%	15.2452	Derbyshire	-9.15%	15.8077	Gloucestershire	-14.37%	15.4740	Shropshire	-15.33%	15.3285	Merseyside	-14.81%	15.3559
West Yorkshire	-13.33%	15.2433	Cumbria	-9.43%	15.7605	Leicestershire	-14.77%	15.4026	Somerset	-15.50%	15.2966	Hereford & Worcester	-15.13%	15.2984
Merseyside	-13.52%	15.2089	West Midlands	-9.59%	15.7312	Cheshire	-14.92%	15.3749	Staffordshire	-15.59%	15.2810	West Yorkshire	-15.47%	15.2380
North Yorkshire	-14.09%	15.1096	Gloucestershire	-10.15%	15.6347	Tyne & Wear	-15.05%	15.3522	Durham	-15.61%	15.2767	Tyne & Wear	-15.64%	15.2072
Dorset	-14.29%	15.0749	South Yorkshire	-10.50%	15.5729	Greater Manchester	-15.11%	15.3415	Cheshire	-15.85%	15.2333	Somerset	-16.02%	15.1378
East Sussex	-14.49%	15.0388	West Yorkshire	-10.91%	15.5015	Humberside	-15.51%	15.2686	Lancashire	-16.13%	15.1829	Derbyshire	-16.04%	15.1351
Suffolk	-14.83%	14.9789	Staffordshire	-10.93%	15.4995	Avon	-15.80%	15.2173	East Sussex	-16.14%	15.1804	Dorset	-16.18%	15.1095
Norfolk	-14.99%	14.9505	Lincolnshire	-11.32%	15.4315	Derbyshire	-16.55%	15.0818	Norfolk	-16.23%	15.1647	North Yorkshire	-16.39%	15.0720
Hereford & Worcester	-15.21%	14.9125	Northumberland	-11.32%	15.4314	Lancashire	-16.62%	15.0680	Greater Manchester	-16.43%	15.1285	Norfolk	-16.57%	15.0396
Leicestershire	-15.71%	14.8245	Hereford & Worcester	-11.72%	15.3605	East Sussex	-16.78%	15.0402	Dorset	-16.80%	15.0623	Suffolk	-16.58%	15.0364

Table 6.1: SSWDs from cross-sectional results using area dummies and centroids (continued)

Conventional Estimates			Centroids to the power 2			Centroids to the power 3			Centroids to the power 4			Centroids to the power 5		
Derbyshire	-15.94%	14.7844	Greater Manchester	-11.92%	15.3273	Norfolk	-17.30%	14.9461	Leicestershire	-17.04%	15.0176	East Sussex	-16.60%	15.0338
Humberside	-16.05%	14.7643	Avon	-12.07%	15.2999	Durham	-17.50%	14.9089	West Yorkshire	-17.10%	15.0072	Cheshire	-16.67%	15.0204
Somerset	-16.10%	14.7561	Somerset	-12.39%	15.2446	Somerset	-17.58%	14.8955	Tyne & Wear	-17.18%	14.9923	South Yorkshire	-17.22%	14.9227
South Yorkshire	-16.27%	14.7257	Lancashire	-12.79%	15.1752	Northumberland	-17.74%	14.8666	Merseyside	-17.28%	14.9754	Shropshire	-17.26%	14.9149
Northumberland	-16.28%	14.7246	Durham	-12.87%	15.1612	Nottinghamshire	-17.95%	14.8286	South Yorkshire	-17.65%	14.9083	Northumberland	-17.37%	14.8946
Nottinghamshire	-16.35%	14.7111	Tyne & Wear	-13.99%	14.9656	Merseyside	-18.02%	14.8161	Derbyshire	-17.84%	14.8729	Leicestershire	-17.39%	14.8907
Cumbria	-16.72%	14.6470	Cheshire	-14.04%	14.9575	West Yorkshire	-18.04%	14.8122	Suffolk	-18.63%	14.7299	Lancashire	-18.10%	14.7628
Isle of Wight	-16.98%	14.6008	North Yorkshire	-14.18%	14.9327	Suffolk	-18.05%	14.8090	Nottinghamshire	-18.65%	14.7264	Humberside	-18.12%	14.7596
Staffordshire	-16.99%	14.5991	Shropshire	-15.27%	14.7434	North Yorkshire	-18.26%	14.7725	Northumberland	-18.83%	14.6947	Lincolnshire	-18.29%	14.7285
Shropshire	-17.23%	14.5573	Norfolk	-15.56%	14.6932	Dorset	-18.49%	14.7311	Cumbria	-19.16%	14.6339	Cumbria	-18.41%	14.7082
Lancashire	-17.39%	14.5294	Merseyside	-16.37%	14.5519	South Yorkshire	-18.73%	14.6863	Humberside	-19.25%	14.6179	Nottinghamshire	-19.10%	14.5835
Lincolnshire	-17.93%	14.4335	Devon	-16.39%	14.5487	Cumbria	-18.84%	14.6670	Lincolnshire	-19.56%	14.5620	Durham	-19.93%	14.4337
Durham	-20.12%	14.0487	Cleveland	-16.90%	14.4595	Devon	-20.14%	14.4320	Isle of Wight	-21.04%	14.2933	Devon	-21.85%	14.0875
Devon	-20.27%	14.0220	Humberside	-18.33%	14.2107	Lincolnshire	-20.30%	14.4041	Devon	-22.19%	14.0860	Isle of Wight	-23.90%	13.7184
Cornwall	-22.78%	13.5807	Cornwall	-24.78%	13.0882	Cornwall	-25.27%	13.5046	Cornwall	-24.59%	13.6519	Cornwall	-24.17%	13.6694

Differentials are relative to Barking and Dagenham
City of London is excluded from estimates

Figure 6.8: SSWDs: default: using 79 area dummies, unsmoothed (based on OLS cross-sectional results)

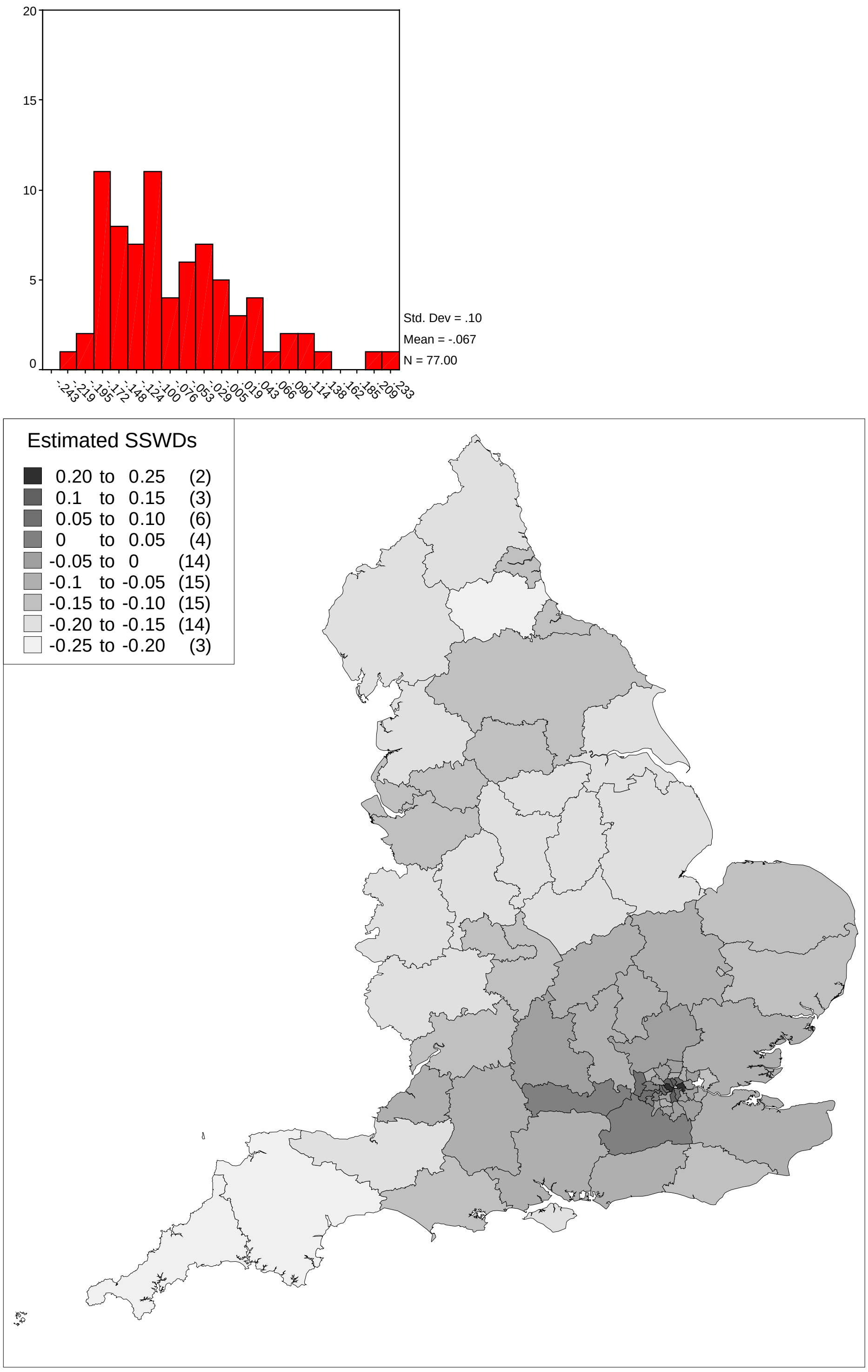
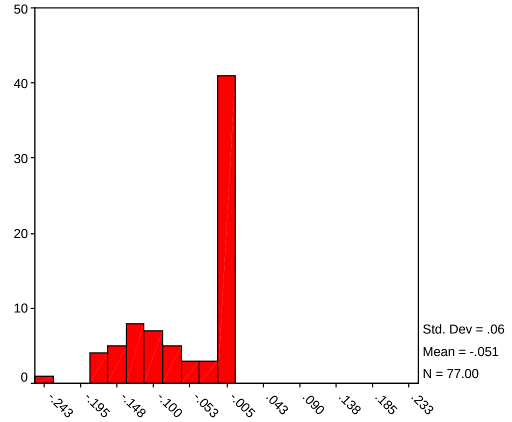


Figure 6.8 shows the spatial pattern of Standardised Spatial Wage Differentials (SSWDs) obtained from the latest econometric analysis without any further adjustment. Comparisons are with Barking and Dagenham (the blank area in north-east London on the map). High wage rates extend westwards from central London into Surrey and Berkshire, and decline with increasing distance from London, being lowest in the most peripheral rural areas. Higher SSWDs than in the surrounding rural areas are recorded across a band of urban areas in northern England, stretching from Cheshire to Tyne & Wear.

Figure 6.9: *Ex Ante* Surfacing: smoothing using centroids – quadratic version



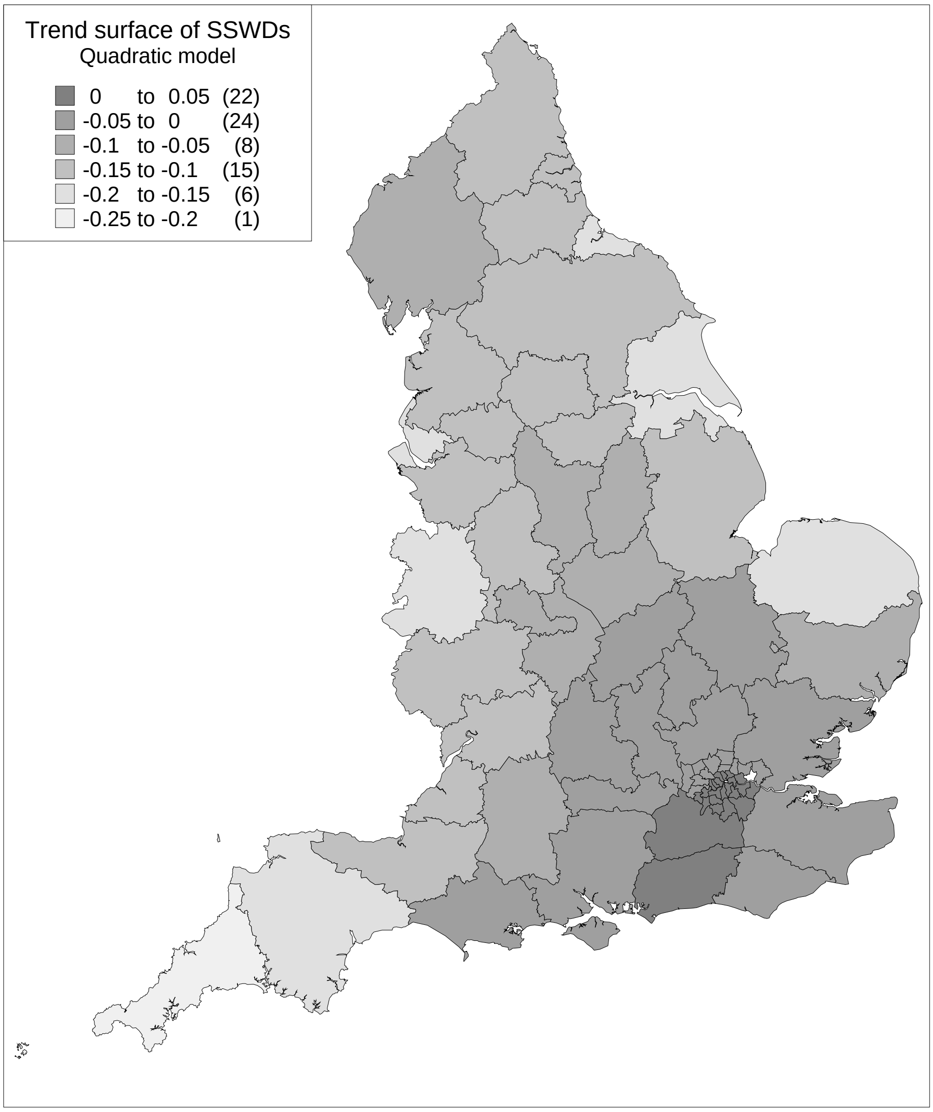
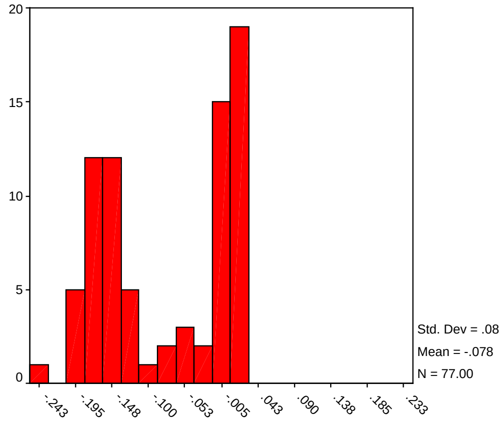
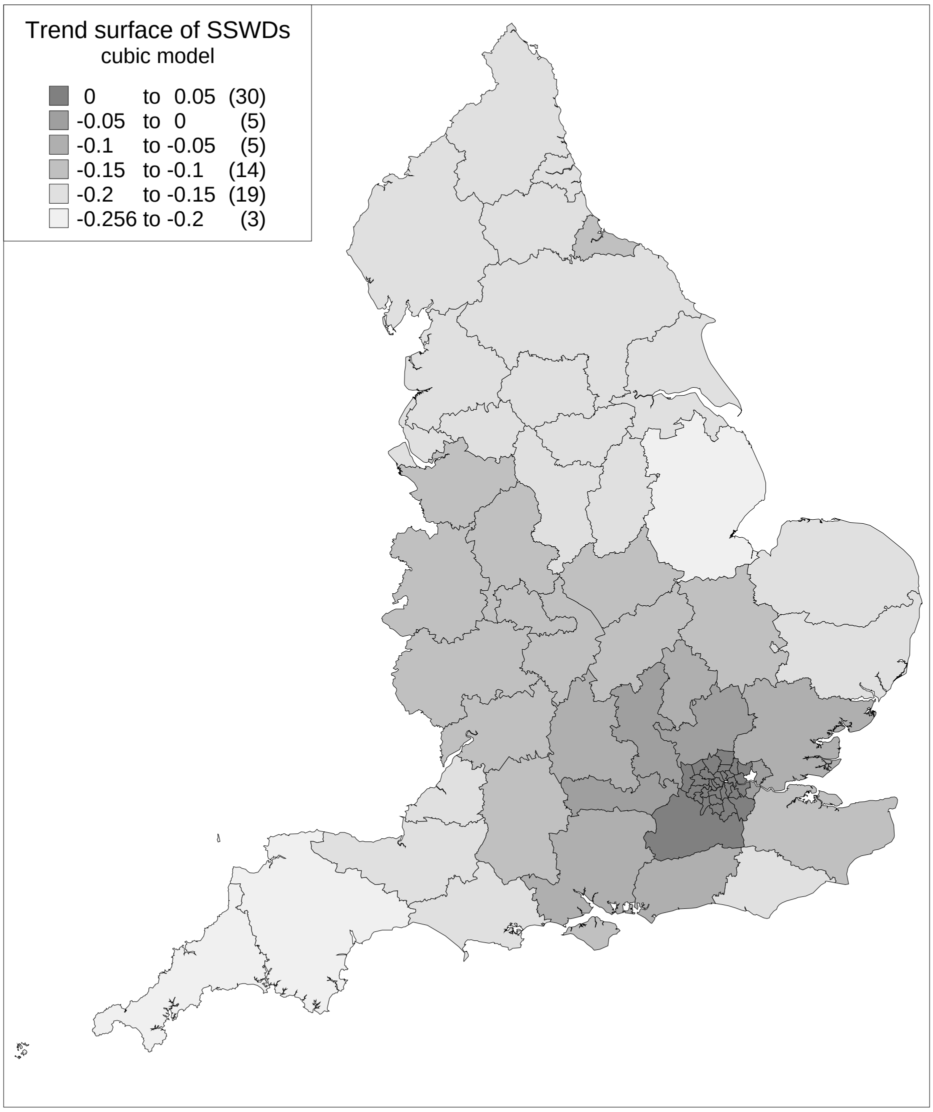


Figure 6.9 depicts SSWDs calculated using the geographical co-ordinates of the centroids for each area rather than individual area dummy variables. There is no *ex post* smoothing adjustment. The regression model includes co-ordinates raised to the power 2, in order to allow the 3-dimensional wage 'surface' to curve. The geographical pattern is rather different from Figure 6.8, with SSWDS declining more slowly with distance from London. The very high SSWDs in central London are not replicated, and the overall range of SSWDs is attenuated, with very few positive values.

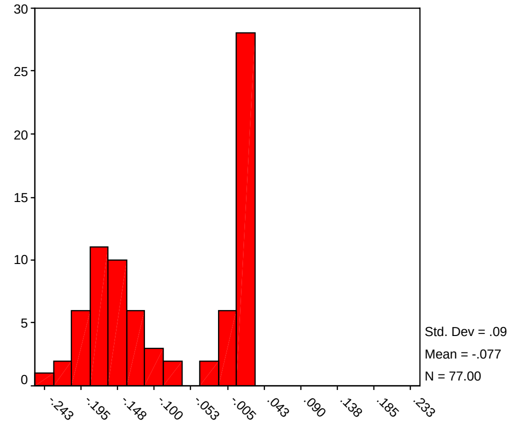
Figure 6.10: *Ex Ante* Surfacing: smoothing using centroids – cubic version

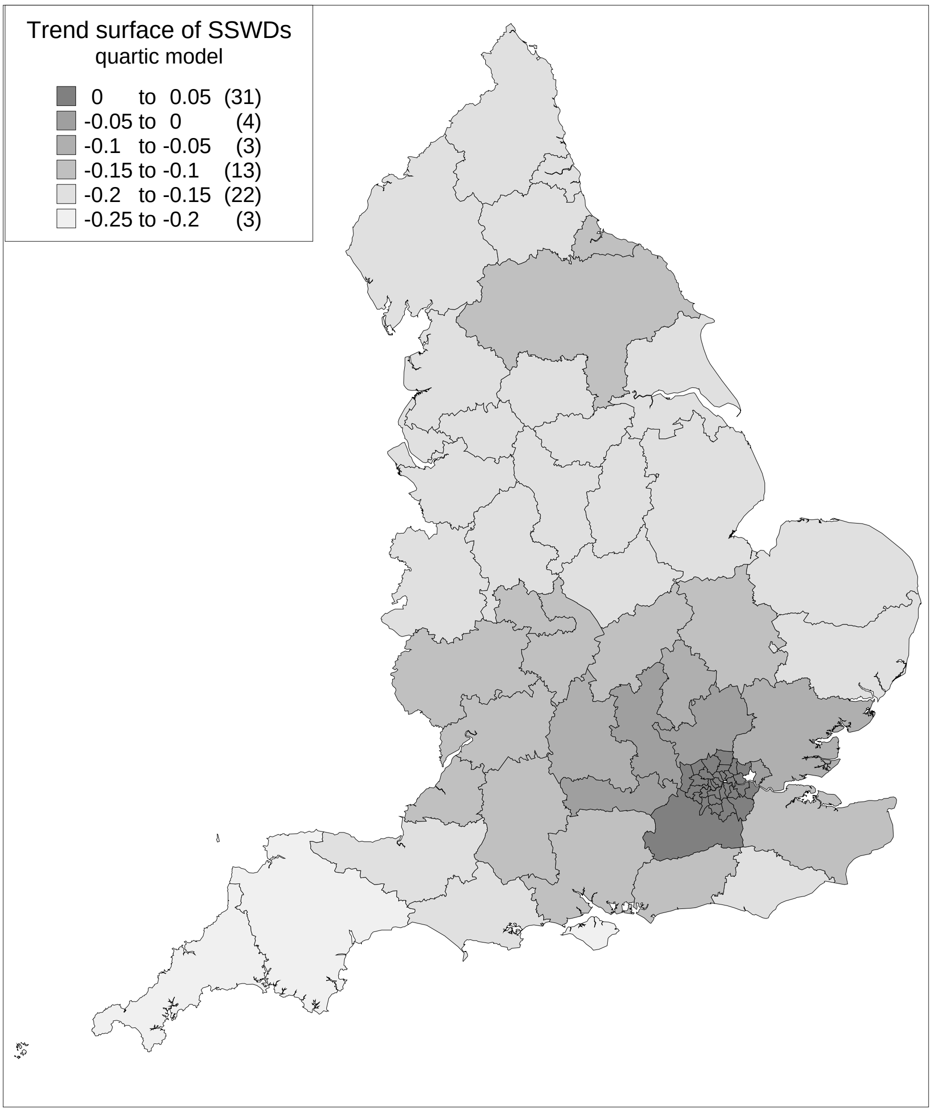




In *Figure 6.10*, SSWDs have been calculated using the same model as in Figure 6.9, with the addition of the geographical co-ordinates of centroids raised to the power 3, in order to make the estimated 3-dimensional surface more complex. These estimates produce a broad south-east / north-west axis of higher SSWDs, with lower SSWDs in rural areas. While estimated SSWDs for London are larger, it does not replicate the very high wage rates observed in the capital. Higher SSWDs also extend into Surrey, but not along the M4 corridor.

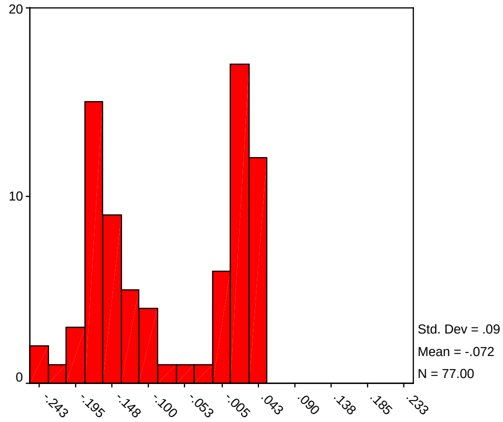
Figure 6.11: *Ex Ante* Surfacing: smoothing using centroids – quartic version

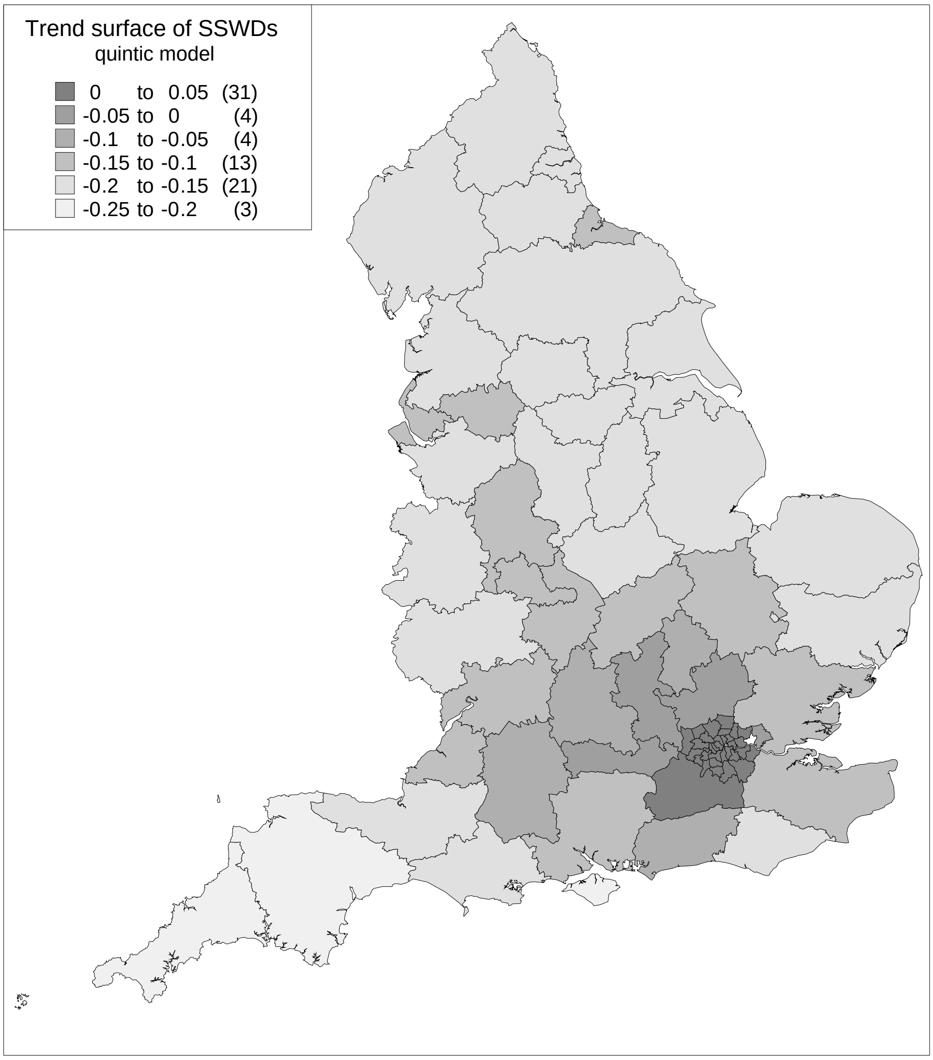




In *Figure 6.11*, SSWDs have been calculated using the same model as in 6.10, with the addition of the geographical co-ordinates of centroids raised to the power 4. These estimates produce a more circular disribution of higher SSWDs extending from London into the rest of the South East, the southern West Midlands, the western part of East Anglia and the eastern South West. There is little variation in SSWDs (except for higher SSWDs in North Yorkshire and Teesside) outside this area, though they are lowest in the far South West.

Figure 6.12: *Ex Ante* Surfacing: smoothing including centroids to the power 5





In *Figure 6.12*, SSWDs have been calculated using the same model as in Figure 6.11, with the addition of the geographical co-ordinates of centroids raised to the power 5. These estimates produce a more complex pattern of higher SSWDs extending from London westward along the M4 corridor and north-westwards towards Birmingham and Manchester, with higher SSWDs in Teesside. The lowest SSWDs are in the most peripheral areas. None of these variants of the regression model incorporating centroids are able to replicate the very high SSWDs of central London, and there are much fewer positive than negative SSWDs.

7. LFS results

7.1 Introduction

An important criticism of the utilisation of the NES for the estimation of SSWDs is that the NES does not contain information on the stock of human capital held by individuals. Previous research suggests that this is an important determinant of wages. Given that the level of formal qualifications, formal training and/or work experience required for the conduct of tasks will vary substantially across occupations, the approach of the previous analyses based upon the NES has been to incorporate detailed occupational information within the earnings regression. The results presented in Section 4 incorporate around 80 occupational dummy variables, representing each of the minor groups (2 digit level) of SOC 1990.

In contrast, the LFS incorporates information that could be considered to control for both the accumulation of general and firm specific human capital by the respondent. Firstly, the LFS asks detailed questions regarding the level of qualification held by the individual. A derived variable classifies the highest level of qualification attained by the individual to one of 41 categories. Secondly, the LFS asks of those in employment, how long they have been employed with their current employer.

The present analysis of the LFS therefore considers 2 issues. Firstly, are the area coefficients estimated using the LFS comparable to those based upon the NES. Secondly, what is the effect of including measures of work experience and educational attainment as additional explanatory variables upon the size of estimated area coefficients.

7.2 Criteria for inclusion within the analysis

The analysis of the LFS attempts to maintain the highest possible level of consistency with cross sectional analysis of the NES presented in Section 4. The analysis focuses upon full time private sector employees aged between 16 and 70 years old. It should be noted however that the definitions used to distinguish between both public and private sector employees and between full time and part time employees will differ between the analysis of the NES and the LFS. Firstly, the distinction between full time and part time employment within the LFS is based upon the respondent’s assessment. This is in contrast to the NES, where an individual is classified as part time if he/she works fewer than 30 hours a week (25 hours for teachers) excluding meal breaks and over-time.

Similarly, the distinction between the private and public sector within the LFS is based upon the respondent’s assessment as to whether he/she works in a private firm, business or limited company as opposed to some other kind of organisation. This is in contrast to the private/public sector marker that has been developed for the NES based upon the cross classification exercise outlined in Section 4.

The dependent variable is the natural logarithm of hourly earnings in the main job.

7.3 Data sets used

Analyses were undertaken on the 2 most recent quarters of the LFS available. These relate to LFS quarter March to May 2000 and June to August 2000. The sample sizes available from the LFS are much smaller than those available within the NES. After excluding those people that failed to meet the inclusion criteria outlined in Section 7.2, the data set for the LFS quarter March-May 2000 contains 7373 observations. Similarly, the data set for the LFS quarter June-August 2000 contains 7637 observations.

7.4 Model specification

As noted above, the focus of the current results is upon changes to the sign and statisitical significance of the area coefficients following the inclusion of additional explanatory variables within the regression model to control for (a) experience and (b) qualifications. To achieve the highest possible level of consistency with earlier estimates, the specification of the model otherwise remains unchanged from that utilised in the standard cross sectional analysis of the NES presented in Section 4.

7.5 Measuring employment tenure

Employment tenure is measured as the length of time with the current employer. Respondents are classified into one of the following categories:

1. Less than three months
2. Three months but less than six months
3. Six months but less than twelve months
4. One year but less than two years
5. Two years but less than five years
6. Five years but less than ten years
7. Ten years but less than twenty years
8. Twenty years or more

7.6 Measuring educational attainment

Two classification of educational attainment have been utilised within the analyses of earnings based upon the LFS. Both classifications are based upon NVQ equivalents. The first classification provides a more detailed breakdown of qualifications, expanding NVQ equivalents into academic and vocational categories. The highest level of educational attainment is classified to one of the following categories:

1.	NVQ 5	Higher Degree
2.	NVQ 4	First degree and equivalent
3.	NVQ 4	HE below degree level
4.	NVQ 4	HNC, BTEC, and RSA higher etc.
5.	NVQ 4	Nursing and Teaching
6.	NVQ 3	2+ A levels and Equivalent
7.	NVQ 3	GNVQ advanced
8.	NVQ 3	ONC, BTEC National
9.	NVQ 2	5+ GCSEs (grades A-C)
10.	NVQ 2	GNVQ Intermediate
11.	NVQ 2	BTEC First Diploma etc
12.	NVQ 1	GCSE (below grade C)
13.	NVQ 1	GNVQ foundation
14.	NVQ 1	BTEC First Certificate
15.	No qualification.	

The second qualification classification does not make the distinction between academic and vocational qualifications within NVQ equivalents. The highest level of educational attainment is therefore classified as follows:

1.	NVQ 5	Higher Degree
2.	NVQ 4	First degree and equivalent, HE below degree level, HNC, BTEC, and RSA higher etc. Nursing and Teaching qualifications
3.	NVQ 3	2+ A levels and Equivalent, GNVQ Advanced, ONC, BTEC National
4.	NVQ 2	5+ GCSEs (grades A-C), GNVQ Intermediate, BTEC First Diploma etc.
5.	NVQ 1	GCSE (below grade C), GNVQ foundation, BTEC First Certificate
	No qualification	

7.7 Geographical variables

The detailed area specification used within the analysis of the NES (previously referred to as Scheme I) is not available within the LFS. Two more aggregate geographical schemes are used instead. Both schemes consider the location of the place of work rather than residence. The first refers to Scheme A as utilised in previous results presented in Sections 4 and 5 (i.e., Inner London, Outer London, Rest of the South East and the Rest of England). As before, the Inner London is dropped from the regression to act as a reference category.

The second geographical scheme utilises the most detailed geographical breakdown available within the LFS. Place of work is classified to one of the following 17 regions:

1. Tyne and Wear
2. Rest of Northern Region
3. South Yorkshire
4. West Yorkshire
5. Rest of Yorkshire and Humberside
6. East Midlands
7. East Anglia
8. Central London
9. Inner London (not Central)
11. Outer London
12. Rest of South East
13. South West
14. West Midlands Metropolitan
15. Rest of West Midlands
16. Greater Manchester
17. Merseyside
18. Rest of North West

(There is no region 10).

To maintain consistency with the Scheme A geographical specification, Central London and Inner London are dropped from the regression and jointly act as a reference category representing Inner London in its entirety.

7.8 Discussion of results

Tables 7.1 and 7.2 present the coefficients estimated for the both sets of regional dummy variables estimated using the LFS. Table 5.1 corresponds to results estimated using data from the LFS quarter March-May 2000. Table 7.2 corresponds to results estimated using data from the LFS quarter June-August 2000.

Although not of primary concern at this point, it can be seen that the geographical differentials for the Scheme A areas based upon LFS data are larger than those estimated utilising the NES presented. Scheme A estimates based upon the cross sectional analysis of the NES presented in Section 1 were –0.13 for Outer London, -0.18 for the Rest of the South East and –0.27 for the Rest of England. However, as discussed earlier, it is difficult to make comparisons between the 2 data sources due to the different definitions of variables used to select cases for inclusion into the multivariate analysis (see discussion in Section 7.2). It is also worth noting that there is quite a significant variation in the size of the coefficients estimated utilising successive quarters of data. This is probably due to sampling variability given the relatively small size of the sample available for analysis within the LFS.

Tables 7.1 and 7.2 both indicate that the inclusion of explanatory variables to control for qualifications and employment tenure does have some impact on the size of the coefficients on the geographical variables. This can be seen in both the general and more detailed geographical specifications. However, the size of the reduction in the area coefficients is very small. This is more clearly illustrated when considering the reductions in the size of the Scheme A area coefficients. Analysis based upon LFS data for the period March to May

2000 indicates that the inclusion of controls for tenure and qualifications reduces the size of the area coefficients by approximately 0.01 to 0.02. It can also be seen that the movement from the broad qualification categories to the more detailed specification does not contribute to a significant further reduction in the size of the estimated area coefficients.

Given that the area coefficients do not change significantly in the presence of this extra information, it can be concluded that the detailed occupational dummies currently utilised within the analysis of the NES are adequately capturing the influences of education and experience upon earnings. The omission of information on education and experience within NES analysis is not contributing to significant biases in the current estimates of SSWDs.

Table 7.1: Coefficients on area dummies: LFS March-May 2000

Area	Basic Specification	Basic Specification + Employment Tenure + Qualifications	Basic Specification + Employment Tenure + Detailed Qualifications
Scheme A			
Inner London	Reference	Reference	Reference
Outer London	-0.185	-0.173	-0.169
Rest of South East	-0.241	-0.227	-0.223
Rest of England	-0.346	-0.335	-0.33
Detailed			
Tyne and Wear	-0.373	-0.375	-0.369
Rest of Northern Region	-0.344	-0.348	-0.342
South Yorkshire	-0.41	-0.393	-0.387
West Yorkshire	-0.318	-0.31	-0.305
Rest of Yorkshire and Humberside	-0.419	-0.409	-0.402
East Midlands	-0.351	-0.337	-0.333
East Anglia	-0.359	-0.342	-0.336
Inner London	Reference	Reference	Reference
Outer London	-0.186	-0.174	-0.17
Rest of South East	-0.242	-0.228	-0.224
South West	-0.321	-0.308	-0.306
West Midlands Metropolitan	-0.323	-0.305	-0.301
Rest of West Midlands	-0.36	-0.341	-0.337
Greater Manchester	-0.346	-0.339	-0.332
Merseyside	-0.295	-0.299	-0.291
Rest of North West	-0.364	-0.358	-0.353

Table 7.2: Coefficients on area dummies: LFS June-August 2000

Area	Basic Specification	Basic Specification + Employment Tenure + Qualifications	Basic Specification + Employment Tenure + Detailed Qualifications
	Coefficient	Coefficient	Coefficient
Scheme A			
Inner London	Reference	Reference	Reference
Outer London	-0.1560	-0.1560	-0.1520
Rest of South East	-0.2240	-0.2120	-0.2050
Rest of England	-0.3540	-0.3490	-0.3400
Detailed			
Tyne and Wear	-0.3380	-0.3400	-0.3290
Rest of Northern Region	-0.3990	-0.4020	-0.3910
South Yorkshire	-0.4170	-0.4050	-0.3920
West Yorkshire	-0.4150	-0.4100	-0.4010
Rest of Yorkshire and Humberside	-0.4190	-0.4090	-0.4020
East Midlands	-0.3500	-0.3380	-0.3300
East Anglia	-0.3250	-0.3190	-0.3120
Inner London	Reference	Reference	Reference
Outer London	-0.1570	-0.1560	-0.1530
Rest of South East	-0.2250	-0.2120	-0.2060
South West	-0.3170	-0.3180	-0.3090
West Midlands Metropolitan	-0.3380	-0.3210	-0.3140
Rest of West Midlands	-0.3700	-0.3680	-0.3610
Greater Manchester	-0.3350	-0.3280	-0.3190
Merseyside	-0.3660	-0.3690	-0.3620
Rest of North West	-0.3550	-0.3560	-0.3440

8. Geography, Choice of Zones, Smoothing and Cliff-edges

8.1 Introduction

The original review by Wilson *et al* (1996) discussed various geographical/zoning options, as well as the options for smoothing cliff edges. This review is updated and extended here.

Although the case for having a staff MFF is generally accepted, there has been considerable debate over its estimated size (particularly between neighbouring areas) and the methodology used in its calculation.

Some of the main criticisms of the existing methodology relate to:

- *Geography* – the choice, size and number of zones;
- *'Cliff-edge' issues* - sharp differences in values between neighbouring zones.

It is pertinent to note that in any zoning system the objective is to maximise internal homogeneity within a zone (i.e. the grouping together of areas sharing similar characteristics). As noted by Coombes (1997) the principle of internal homogeneity has an important corollary: that of drawing boundaries between zones in order to maximise differences, so creating sharp discontinuities, or 'cliff-edges'. Such 'exaggerated contrasts' are undesirable for the MFF, so the challenge is to mitigate the undesirable effects of 'cliff-edges'.

8.2 Geography

As noted above, a key issue is the choice of the number and size of the spatial zones. This was a matter that the original IER study considered in some detail, with respect to grouping of NES areas. Over a dozen schemes were examined there. These ranged from the 4 aggregate zones used prior to 1996, to a full disaggregation to the (then) maximum level of 79 areas[22] allowed by the NES. The original IER report (Wilson *et al*, 1996) recommended that the underlying estimates should be based on the most disaggregated analysis possible. In part this recommendation was made in order to achieve a smooth transition between areas and to avoid cliff edges.

A key focus of the current MFF review is to assess the most appropriate geographical zones, given the data currently available and the feasibility of the smoothing mechanisms available.

The review of previous research undertaken for DETR and others, and the new analyses undertaken here were intended to inform recommendations concerning the appropriate number of specific MFF zones[23]. Such recommendations need to take into account the statistical reliability of individual MFF zone estimates. Initially it was proposed to improve the statistical reliability of results by 'pooling' separate data for individual years. However, subsequent discussion by the ATSG recommended that the analysis should continue to focus on individual years, the results being averaged across the years to deal with any random elements.

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[22] Although there are now 119 separate areas identified in the NES, much of the analysis has been restricted to the 78 NES areas used formerly to facilitate comparison.

[23] In particular, the question of whether London NES zones should be 'aggregated' into larger entities (such as inner, outer, 'fringe', or broad geographical sectors such as North, South East and West)?

Number of zones: It must be recognised that a limiting factor is the relatively small number of areas identified in the NES data set. The current panel data set only includes information on which of the 119 zones an individual works in. The possibility of getting an enhanced version of the data set, where postcodes for individual cases might be available has been explored with ONS. However it was recognised that any analysis based on such data would not be feasible for the current round of calculations but might be worth serious consideration in the future.

Subsequent approaches to ONS on this issue initiated an internal debate within ONS about the feasibility and practicalities of doing this. The initial results of these discussions confirmed that this is indeed feasible. However, the terms of the Statistics of Trade Act, 1947, regarding confidentiality of individual data, raise concerns which will have to be need to be explored by the ONS legal department and discussed in more detail with the Department of Health.

It is, in principle, possible to extend the number of zones used, based on the current NESPD. However, although 119 NES zones are now available in the NESPD, some of these are quite small Unitary Authorities and it may probably not be appropriate to include them as separate SSWDs. In practice, only one area (Rutland) is particularly problematic in this regard.

It is worth noting in this context that NES (area aggregate) data have now been made available on NOMIS (as part of the progress towards the development of ONS's "Neighbourhood Statistics). The NES data have been made available at ward level (and for other standard geographies) enabling users to have the flexibility to aggregate areas dynamically. Thus, in theory, it should be possible to look at differentials between central cores of cities and outlying areas. The data placed on NOMIS in Summer 2001 are for 2000. The data are available for disaggregations of sex, full-time/part-time and occupation (SOC90 from Major Group [1 digit] down to 3 digit classification). However, unfortunately there is no industry disaggregation. A range of geographies is available, including 1991 wards, so it is possible to aggregate user-defined areas. To give a flavour of simple outputs from NOMIS NES data, a number of analyses of these data have been undertaken[24]. Although there are a range of breakdowns of earnings available, currently these are based on gross weekly pay or weekly pay excluding overtime; for all occupations aggregated together. Implicitly, therefore, they take account of differences in occupational structure. Selected results are presented in Annex F.

The spatial zones used in the NES are based on administrative areas (e.g. counties and unitary authorities) rather than functional geographical areas such as 'travel-to-work-areas'[25]. (In

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[24] The following analyses, in the form of Excel workbooks, were prepared:

- *nes0908.xls* - showing averages for all unitary and lower tier authorities in England. This illustrates that while data for just the Scilly Isles are suppressed, several areas have fewer than 30 cases, so these need to be treated with caution.
- *nesbrum.xls* - showing the data that are available at ward level, choosing Birmingham as an example. This contains some of the largest wards in England. Nevertheless, many wards have fewer than 30 cases. However, this example illustrates that it would be feasible to generate 'total' data for inner and outer parts of major cities
- *neswyorks.xls* - showing unitary authority disaggregation of average earnings in W Yorks. As expected, Leeds comes out highest.
- *nesgmanc.xls* - a similar example for Greater Manchester. Again an expected pattern emerges of highest values in the central authorities of Manchester and Trafford, and lowest values in Oldham.

[25] Note that Colin Wymer has investigated the feasibility of defining 'LALMAs' (Local Authority Labour Market Areas) using commuting data from the 1991 Census of Population at the University of Newcastle. 41 LALMAs were identified, using a version of the TTWA algorithm, in order to maximise the supply-side and demand-side self-containment of each LALMA created (Coombes and Raybould, 1997). Such regionalisation exercises are resource

London each borough is separately identifiable, whereas elsewhere the zones tend to be larger – thus potentially grouping together quite heterogeneous areas.) This is somewhat arbitrary from a labour market perspective. In the current NHS approach, some of the NES spatial areas used map directly into HAs on a one-to-one basis. Others subsume two or more HAs, which may have different local labour market pressures. In London, on the other hand, most HAs overlap a number of NES zones. The basic approach is for the MFF value calculated for each separate NES zone to then be applied as the MFF value for all those trusts which are located (by postal address) within that zone.

Statistical tests of the results from the regression analysis indicate that the differences in the SSWDs are often not significant[26] for individual districts and boroughs. However, in the absence of any other information these remain the best 'point' estimates available. Grouping authorities/areas or 'pooling' years of data can circumvent this problem[27]. But if there are, in fact, genuine, material differences among HAs within a NES zone, such grouping may have an undesirable averaging effect, which would give some HAs/trusts too large an MFF and others too small a factor.

Grouping may also tend to exaggerate the differences between the MFFs of neighbouring authorities/trusts on the geographical 'edges' of the larger zones. This conflicts with the expectation that there should be a relatively gradual geographical transition between higher and lower MFFs. The relatively smooth gradient that occurs between a succession of adjacent areas can be transformed by the grouping so that it becomes something of a 'cliff-edge' (as noted in Section 8.1), with many small contrasts between adjacent areas being transformed into a single large step between neighbouring zones.

In statistical terms, there is normally a 'trade-off' between maximising the number of zones and statistical reliability of results. Too many zones may not have sufficiently large individual sample sizes for statistically robust results. On the other hand, too small a number of zones may exaggerate differences between neighbouring zones (i.e. produce implausibly high 'cliff-edges') and at the same time obscure genuine local NHS labour market differences within the overall average for the grouped areas.

8.3 Cliff-edges

This phenomenon has been a particularly strong source of criticism of the present methodology. This refers to the situation where adjoining HAs, which are perceived to have similar local labour market pressures (unemployment rates, housing costs, etc), have sharply different SSWDs.

This problem has also taxed the DETR. In its own review of the ACA, DETR (1998) has considered a number of potential smoothing mechanisms, including:

- *Moving Windows*
- *Surfacing* (including contouring, trend surfaces and earnings potential surfaces)

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intensive, and are dependent on the availability of a matrix of commuting flow data at the micro area level (i.e. the decennial Census of Population).

26 Insignificant '*t*-tests'

27 It is the London NES zones that tend to have the smallest sample sizes.

Moving Windows – is an *ex post* method of averaging MFFs for neighbouring authorities in a systematic way. For each NES area, its MFF can be converted into a "spatial average" of MFFs for contiguous areas, weighted according to the distance between the geographical centres of each pair of areas and the length of their common boundary. These areas are described as being in a "window". The procedure is repeated for each area in turn using a different set of neighbours (hence "moving windows"). The analysis conducted on behalf of DETR, suggested that this approach is able to smooth out most of the "cliff edges" between adjoining areas. However, the exact form of spatial weighting system adopted requires experimentation. A series of estimates based on alternative methods are presented in Table 8.1 (old areas), and Table 8.2 (new areas).

***Surfacing** of MFFs yielded by the regression model* – this general approach is founded on the assumption that MFFs should differ gradually from one area to another, rather like undulating countryside. It involves the construction of a contour wage map of the country, with heights representing wage levels. From this, a smoothed MFF for any particular area can be read off, in the same way that height above sea level can be read off an ordinary contour map. There are a number of related estimation techniques that can be adopted, including contouring, trend surfaces and earnings potential surfaces which are now discussed in turn.

- *Contouring* – This approach involves the use of algorithms used in the geosciences for estimating surfaces of natural phenomena assumed to vary smoothly over space (e.g. physical height or magnetic fields) to fit a similar surface to the spatial distribution of wages. The "nearest neighbour" contouring algorithm estimates the value of a surface at each point on a grid from the mean of the nearest *n* neighbouring observations. Others techniques (such as "kriging") estimate the autocorrelation structure of the data in three dimensions in order to fit a descriptive model to the data. The shape of the contour map is strongly influenced by:
  - the spatial distribution of observations,
  - the number of neighbouring areas used in calculating the value for any point, and
  - the assumptions made about the effect each area has on every other area (which generally declines as the distance between them increases).
- *Trend Surfaces* – In this approach, the surface is estimated by treating space as the explanatory variable and wages as the dependent variable in a regression equation. "Space" is represented by the Ordnance Survey national grid co-ordinates for the data observation (with x representing distance east and y representing distance north from the origin of the national grid). The co-ordinates alone would only permit a linear 'plane' to be estimated covering the entire country. In order to represent the curvature of the earnings surface, polynomial terms (the co-ordinates raised to successively higher powers) are added. MFFs can then be calculated for any location by simply calculating the "height" of the surface above the appropriate x and y co-ordinates. Examples of fitting trend surfaces to MFFs are presented in Tables 8.1 and 8.2 and related maps.
- *Earnings potential surfaces* – are based upon the "population potential" model, derived from the gravity model of physics, using the population of a place as a measure of its "mass". The method measures the accessibility of a place to the population of all other places, given their relative sizes and the distance between them, (adjusted by the 'friction of distance'):

where Z_i represents potential, P_i is a measure of the "mass" of a place (in this case

$$Z_i = \sum_{j=1}^{n} \frac{P_i \times P_j}{d_{ij}^{\beta}}$$

measured by population), d_{ij} is the distance between each pair of the n places and beta is the 'friction of distance' parameter. Given that wages are measured as a rate per hour, they cannot be used directly in this equation. Rather, it is necessary to first disaggregate the wage rate into two "mass" variables; the total wage bill, and the number of employees. Each of these is then fed into the calculation to yield two sets of "potential" estimates. The first uses the total wage bill as the mass measure, yielding "wage cost potential". The second uses the number of employees as the measure of mass, yielding "employment potential". The "mean earnings potential" for any area is then its wage cost potential divided by its employment potential. This method effectively yields a spatially weighted average of wage rates for each location. The friction of distance parameter (beta) represents the influence of nearby places in the calculation. The larger this is, the more "peaked" the earnings surface, dominated by local maxima. The smaller it is, the flatter the surface, probably gradually declining with distance away from London and the South East. The surface can be represented in the form of a contour map. It would probably require considerable experimentation in order to identify an appropriate value for the friction of distance parameter. The gravity model of physics suggests an exponent of –2, but this is likely to be far too large for economic phenomena.

Trust based estimates: A more radical alternative would be to base the MFF estimates directly on Trust location/catchment areas. However, this would depend on the availability of NES data for small areas, such as postcode sectors[28]. It would not be possible using LFS data because the sample size is too small (the LFS sample design was never intended to yield such spatially detailed data and the number of households in the survey is too small for this purpose).

Since the full detail of the NES is not available at postcode sector/other micro area geographies, it is not regarded as a practical possibility within the present proposed programme of work. Nevertheless, the appeal behind this methodology is that it would attempt to capture quasi labour market size zones, and that it would give Trusts specific MFF values.

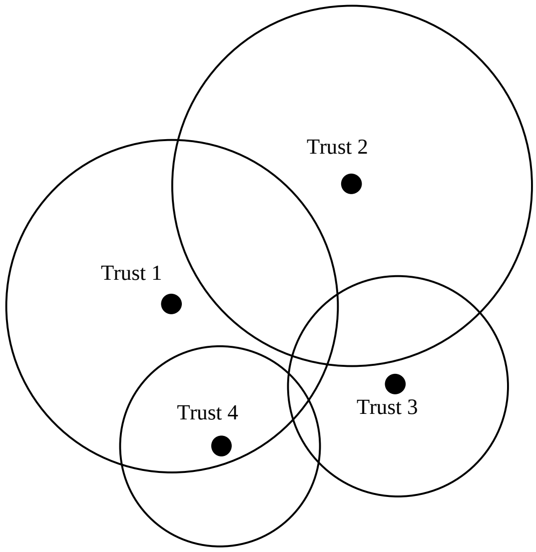
At present, Trusts are allocated MFF value of the NES zones in which they are located. This is then mapped back to Health Authorities using the Purchaser Provider Matrix (PPM). There are few problems with this methodology, except where Trusts are located close to the boundary between two zones, or when they are located in a high-cost 'hot spot' within a large zone. The first of these problems could be addressed to some extent if some form of smoothing methodology is adopted as discussed above, but the second would not.

If data were available on where employees of Trusts lived, the catchment area for labour for any given Trust could be determined from the commuting patterns of employees, using the postcode of their home (which can be translated into Ordnance Survey national grid co-ordinates). The most basic analysis would compare the grid co-ordinates of the Trust with that of each employee's home to calculate the distance (using Pythagoras' Theorem) within

[28] Although note that NES data (with an occupational disaggregation) for 1991 wards was made available on NOMIS in July 2001.

which a given percentage of the workforce resides (this distance can also be calculated separately for each grade of staff, if required). These catchment areas can be depicted in the form of circles of differing radii, centred upon the grid co-ordinate for the Trust, as in Figure 8.1. This also illustrates the overlapping catchment areas which would be yielded by this analysis. This overlap between catchment areas may reduce the problem of sample size, since the same postcoded NES data would contribute to the MFF calculations for different Trusts.

Figure 8.1



In general these catchment areas will not be circular, indeed it is likely that they will be quite irregular; defined by major road and rail links, topographic barriers such as rivers, hills and industrial development. It is possible to identify irregular shaped catchment areas, using the smallest geographical areas (electoral wards or postcode sectors) for which NES data are available. The simplest method would simply rank wards according to the number of employees resident in each, and use a "cut-off" value to identify those wards sending significant numbers of employees. More complex regionalisation methods could also be employed[29].

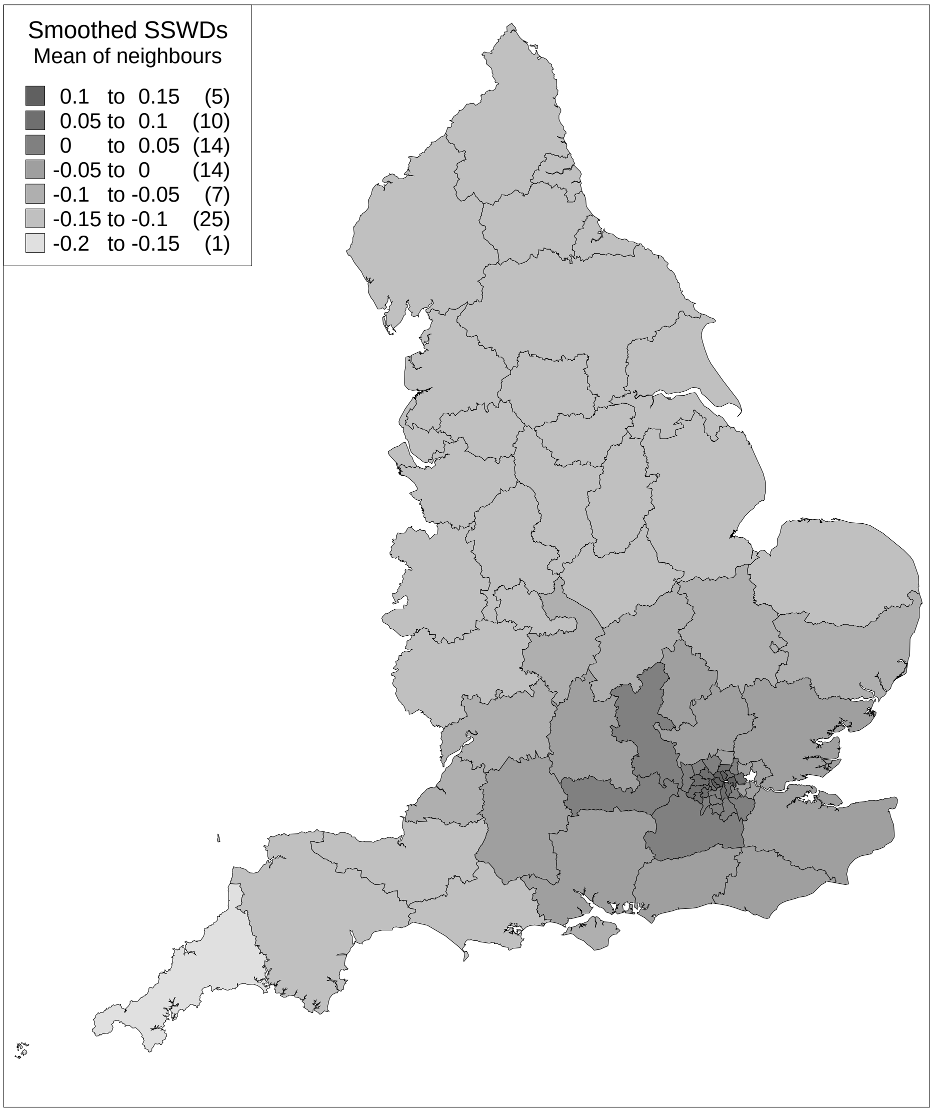
An approximation to the catchment area for each Trust can also be made using Census of Population data on commuting patterns into the ward in which the Trust is located, if employee level data specific to the Trusts were not available. However, the 1991 data is now ten years out of date and hence pre-dates much NHS re-organisation, while 2001 data will not be available until late 2003 at the earliest. Indicative estimates could be made based on 1991 data, but estimation of Trust-level MFFs is not possible in the immediate future.

8.4 Alternative Smoothing Adjustments to Avoid Cliff Edges

This section presents a range of alternative estimates obtained using the moving windows and *ex post* surfacing methods. These are presented in graphical form. These are all for the old NES, 79 areas

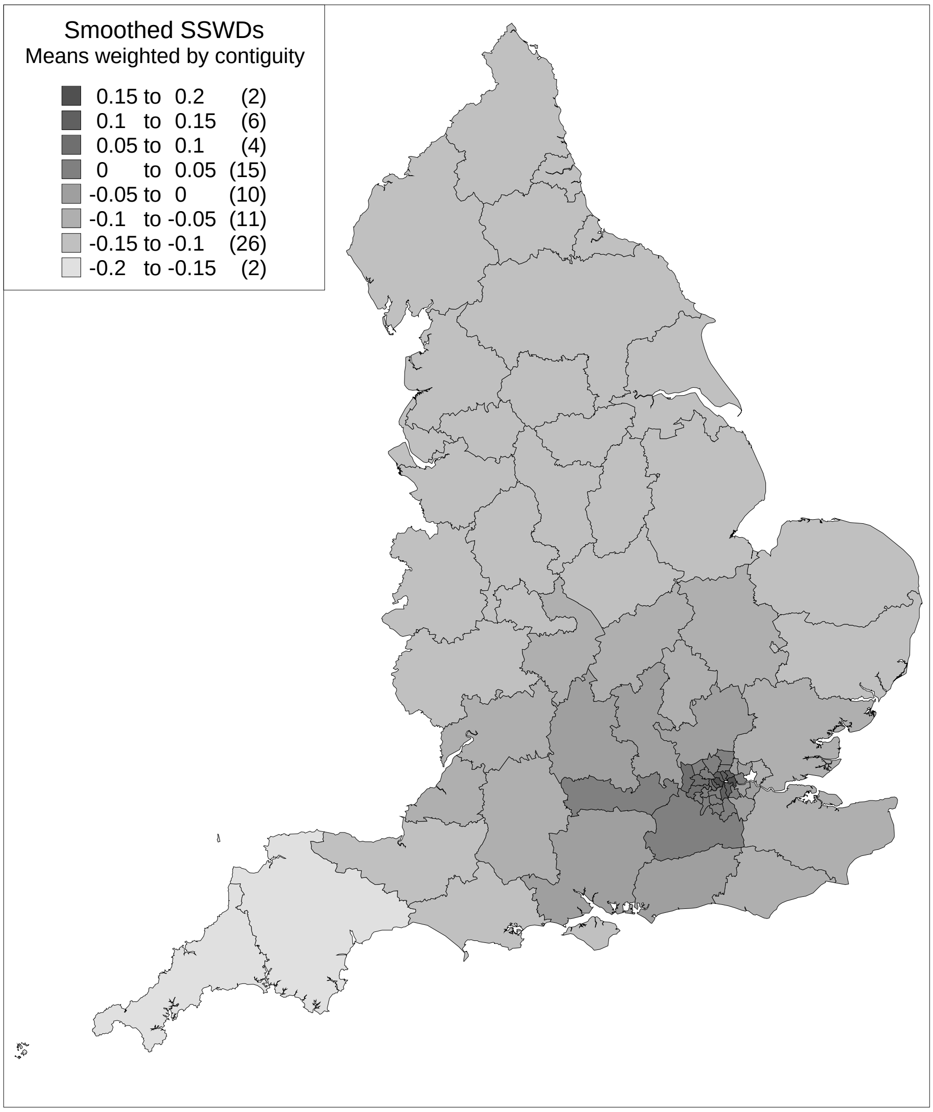
[29] As used to delineate the LALMAs referred to above.

Figure 8.2: ***Ex post*** **smoothing, Method 1: SSWDs averaged across neighbouring NES areas (old areas).**



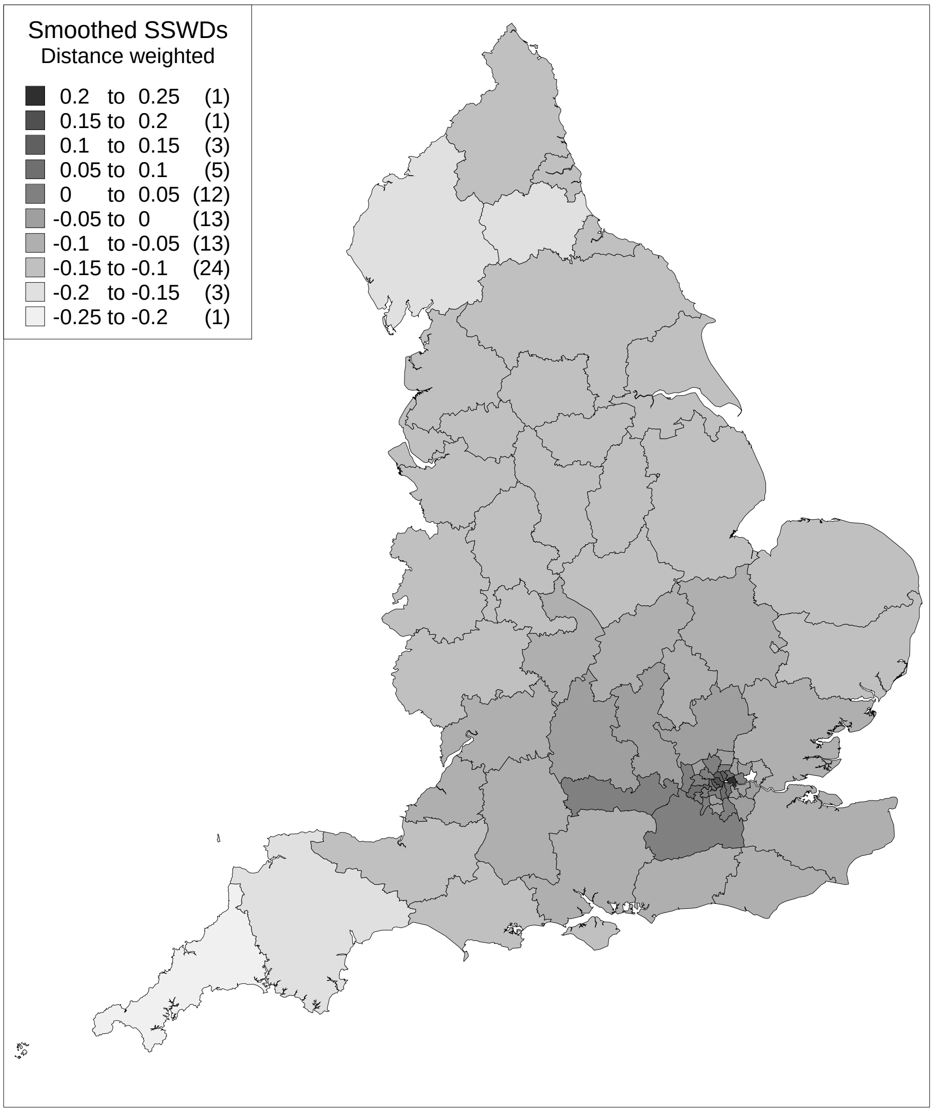
This method takes the estimated SSWD in each area and its immediate neighbours and calculates the average. The own area SSWD and those for each contiguous neighbour receive equal weighting. This produces a surface with highest values in central London, extending into surrounding counties, with higher values in Berkshire, Surrey and Buckinghamshire. Prosperous counties such as Cambridgeshire have a lower average, as higher wages to the south are counter-balanced by lower wages to the north and east. The overall effect of the smoothing adjustment on an individual area depends, in part, upon how many neighbours it has. The method has a dampening effect, with the extremes of SSWDs reduced.

Figure 8.3: *Ex post* smoothing, Method 2: SSWDs weighted using length of common boundary (old areas).



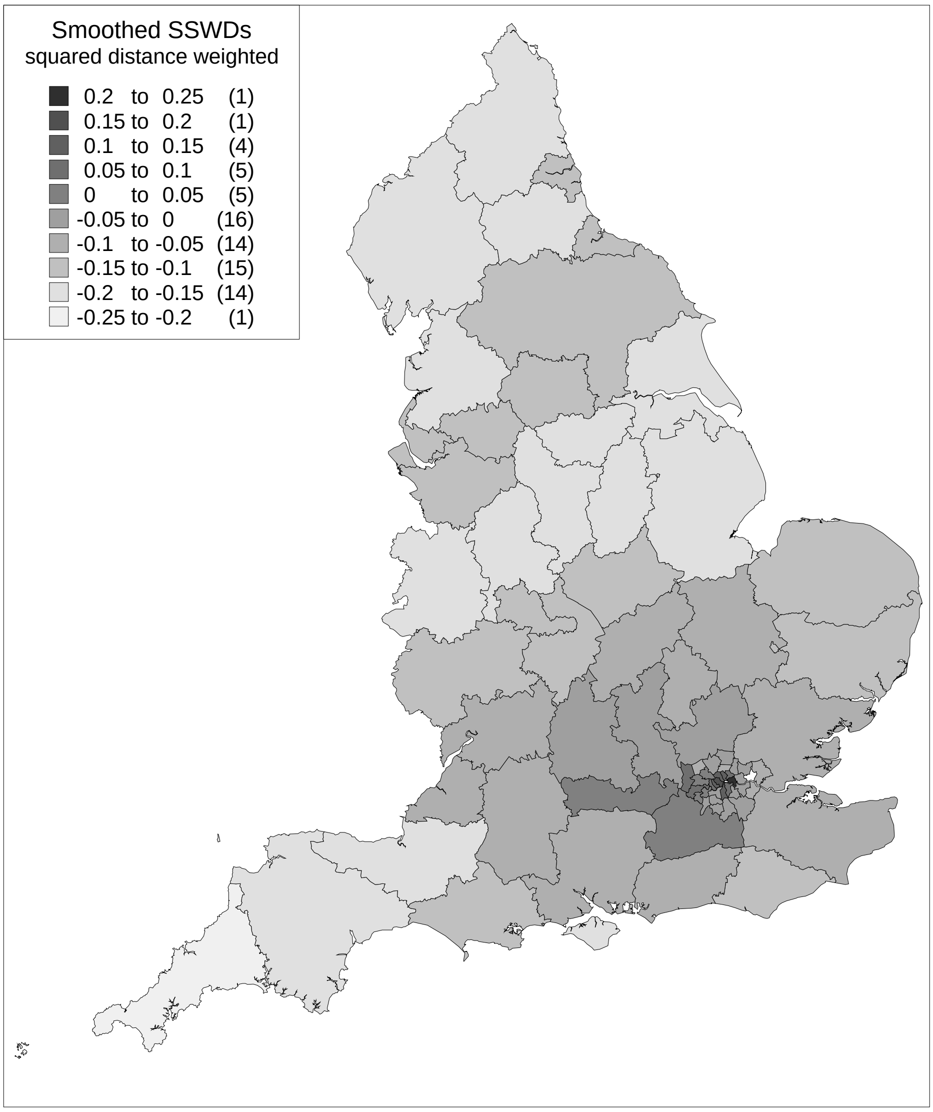
This method averages the SSWDs for each NES area and its immediate neighbours, but this time the contribution of each is weighted by the percentage of the boundary of each NES area common to that pair of neighbours. The own area has a weight of 50 per cent, the neighbours in total 50 per cent. The 50% rule is arbitrary. It produces a surface with highest values in central London, extending into the Thames Valley. The rate of decline in SSWD with distance south-west is increased relative to Figure 8.2.

Figure 8.4: *Ex post* smoothing, Method 3: SSWDs weighted by the reciprocal of distance (old areas).



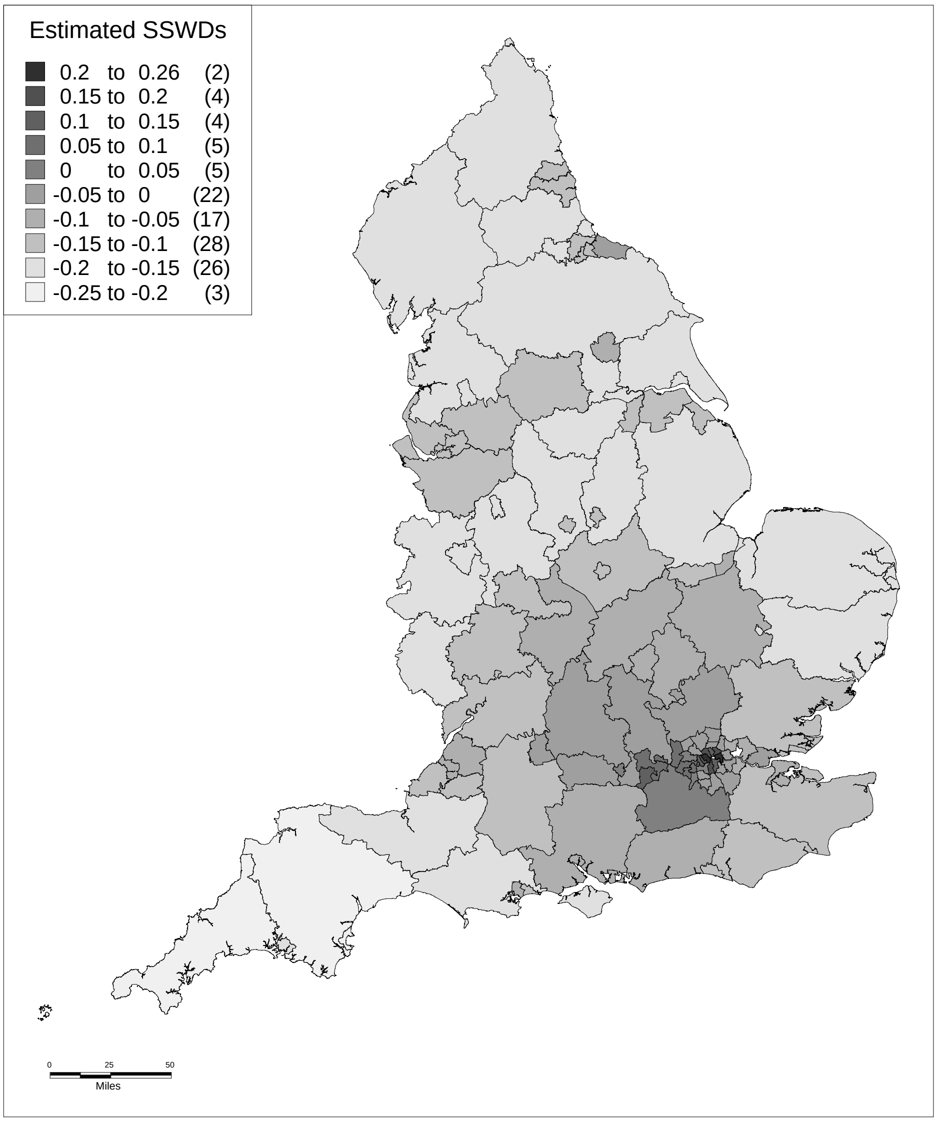
This method averages the SSWDs for each NES area and its neighbours, with the contribution of each to the calculation weighted by the reciprocal of distance between the centroids of each NES area. The area of interest receives a weight based on the average distance to its own borders from its centre (as measured by the centroid). The shape of the surface changes slightly, with the area of high wages being more symmetrical around London and extending less far west than is obtained when using boundary lengths as weights. SSWDs are higher in the M4/M3 corridor than to the north-west of London. The method highlights a contrast between lower SSWDs in Cumbria and higher values in the urban North East and Northumberland.

Figure 8.5: *Ex post* smoothing, Method 4: SSWDs weighted by the reciprocal of distance squared (old areas).



This method averages the SSWDs for each NES area and its immediate neighbours, with the contribution of each to the calculation weighted by the reciprocal of the square of the distance between the centroids of each NES area. The area of interest receives a weight based on the average distance to its own borders from its own centre (centroid). The surface has a more oval shape, and shows areas of higher wages along the "M4 corridor", extending into Wiltshire and Avon. There is greater variation in SSWDs in Figure 8.5 than Figure 8.4. This method highlights higher SSWDs in a band of areas stretching from Merseyside to Teesside and in Tyne & Wear.

Figure 8.6: Standardised wage differentials from the econometric model (OLS, cross-sectional), new areas

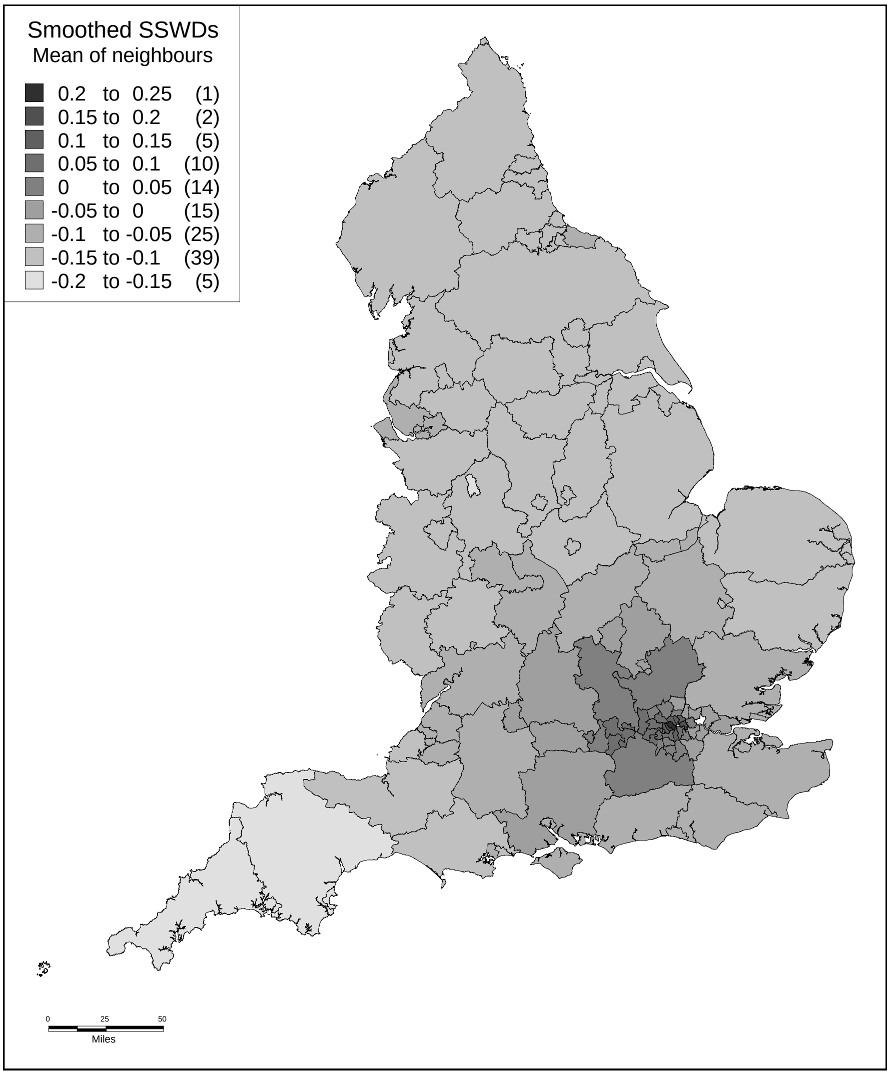


8.5 Smoothed Results using 119 NES zones

Figure 8.6 presents the geographical pattern estimated of SSWDs for the 119 NES zones. This reveals very high SSWDs in central London, extending westward into Berkshire, with lower (but still high) SSWDs in the western part of the South East region. SSWDS decline with distance away from this area of high wages, with higher wage rates in Bristol, Derby, Leicester, the Mersey-Humber belt, York, Teesside and Tyne & Wear. The lowest SSWDs occur in the more remote rural areas, especially in the south-west peninsula.

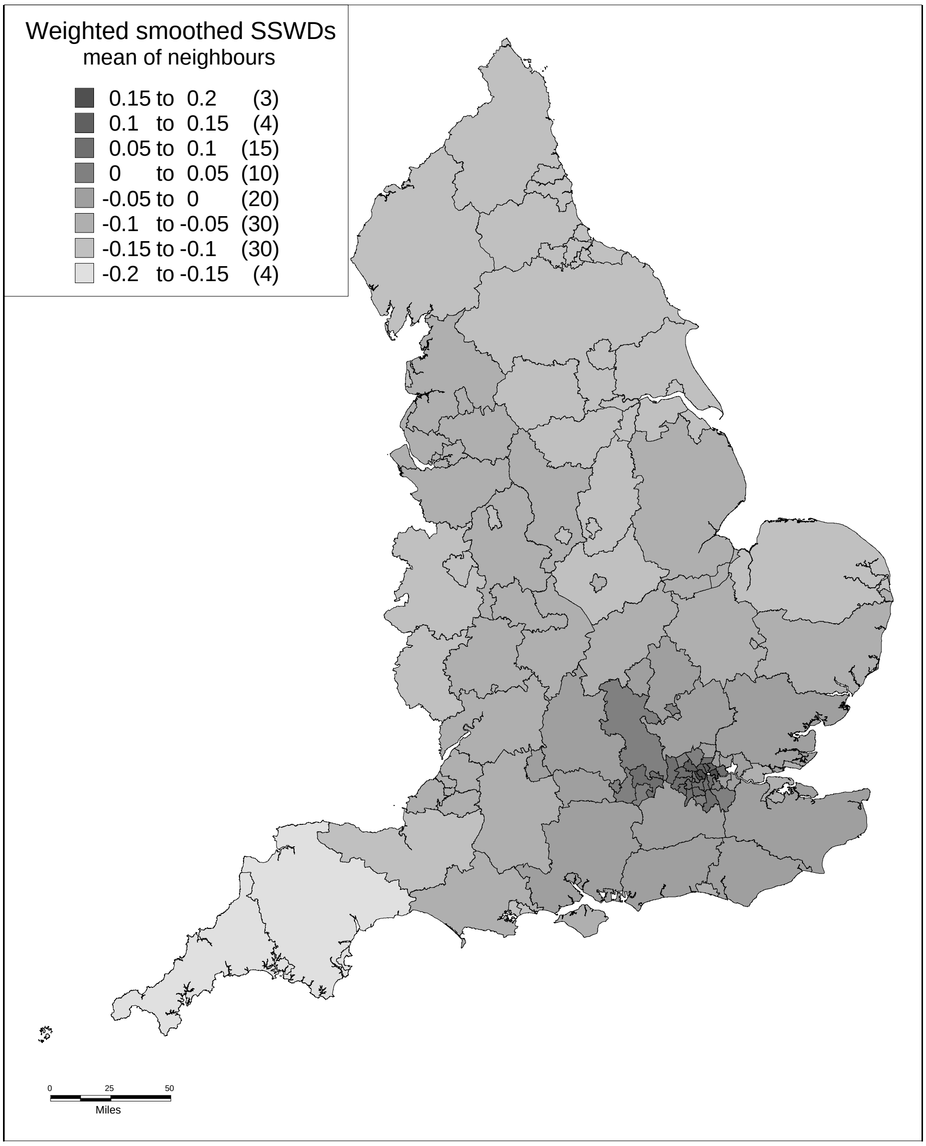
Figures 8.7, 8.9, 8.11 and 8.13 present the spatial distribution of SSWDs smoothed using four different methods. The smoothed mean SSWDs presented are simple averages. Figures 8.8, 8.10, 8.12 and 8.14 present averages weighted by the estimated population of each area in mid 2000. The more populous areas should have greater influence on these calculations, while less populous areas would have less influence.

Figure 8.7: Mean of SSWDs in neighbouring zones – self 50%, new areas



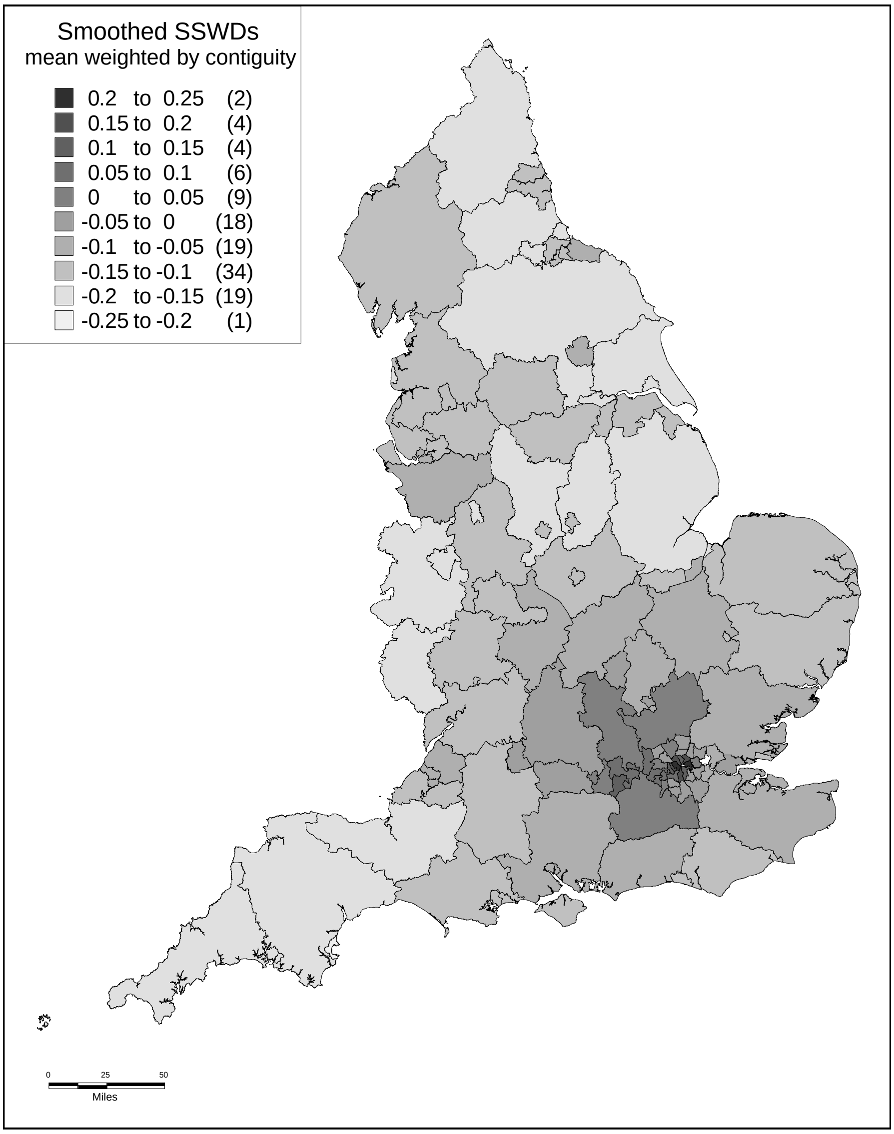
In *Figure 8.7*, the SSWDs have been 'smoothed' by taking the simple average of SSWDs for each NES area and its neighbours. The result is much less variation in SSWDs, with higher SSWDs across northern England (in which the urban/rural contrast in SSWDs largely disappears) and also higher SSWDs in East Anglia and the South West. The western Home Counties display high SSWDs and the east/west contrast in London is highlighted.

Figure 8.8: Population-weighted mean of standardised wages in neighbouring zones – self 50%, new areas



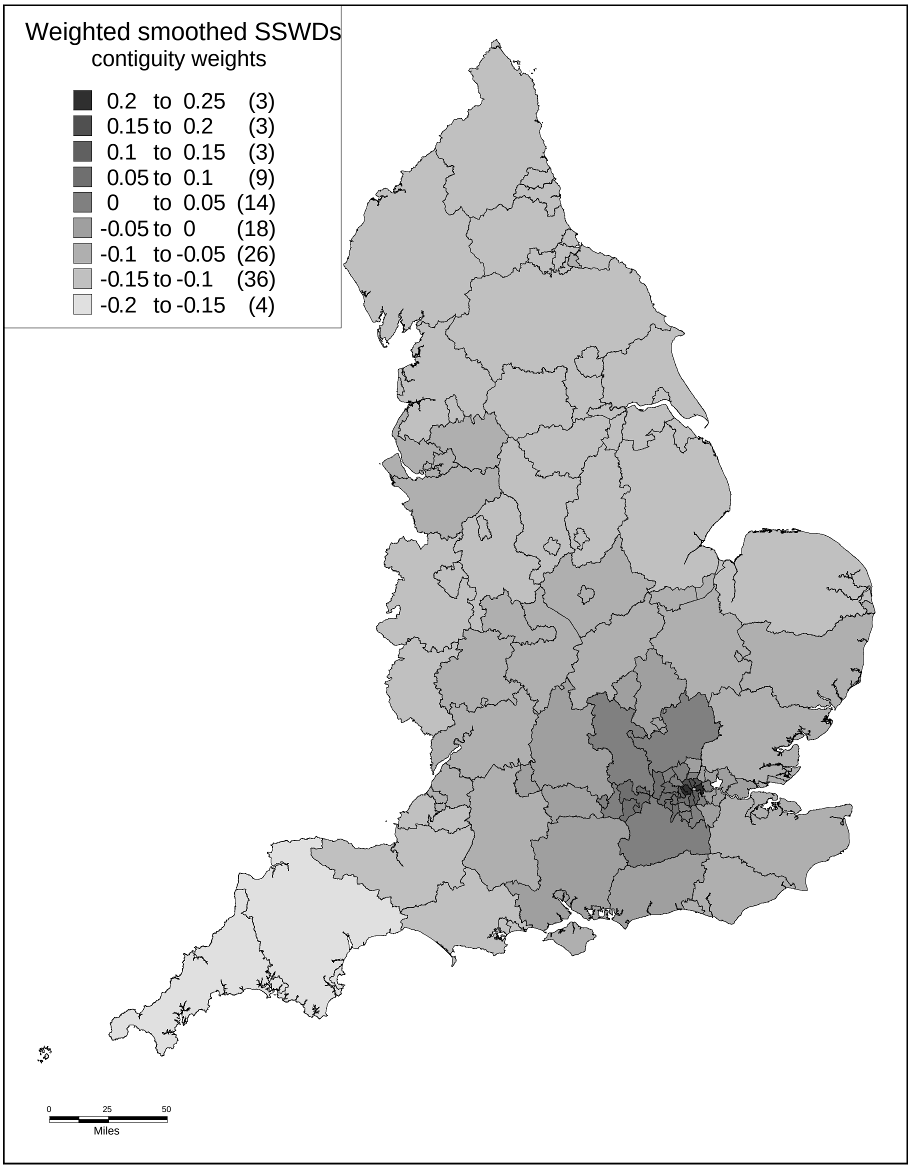
The population weighted smoothed SSWDs in *Figure 8.8* display less variation. SSWDs in Suurey and Hertfordshire are lower, those in the South west higher, and SSWDs are higher in the West Midlands and North West than in the East Midlands and Yorkshire.

Figure 8.9: Mean of standardised wages weighted by common boundary – self 50%, new areas



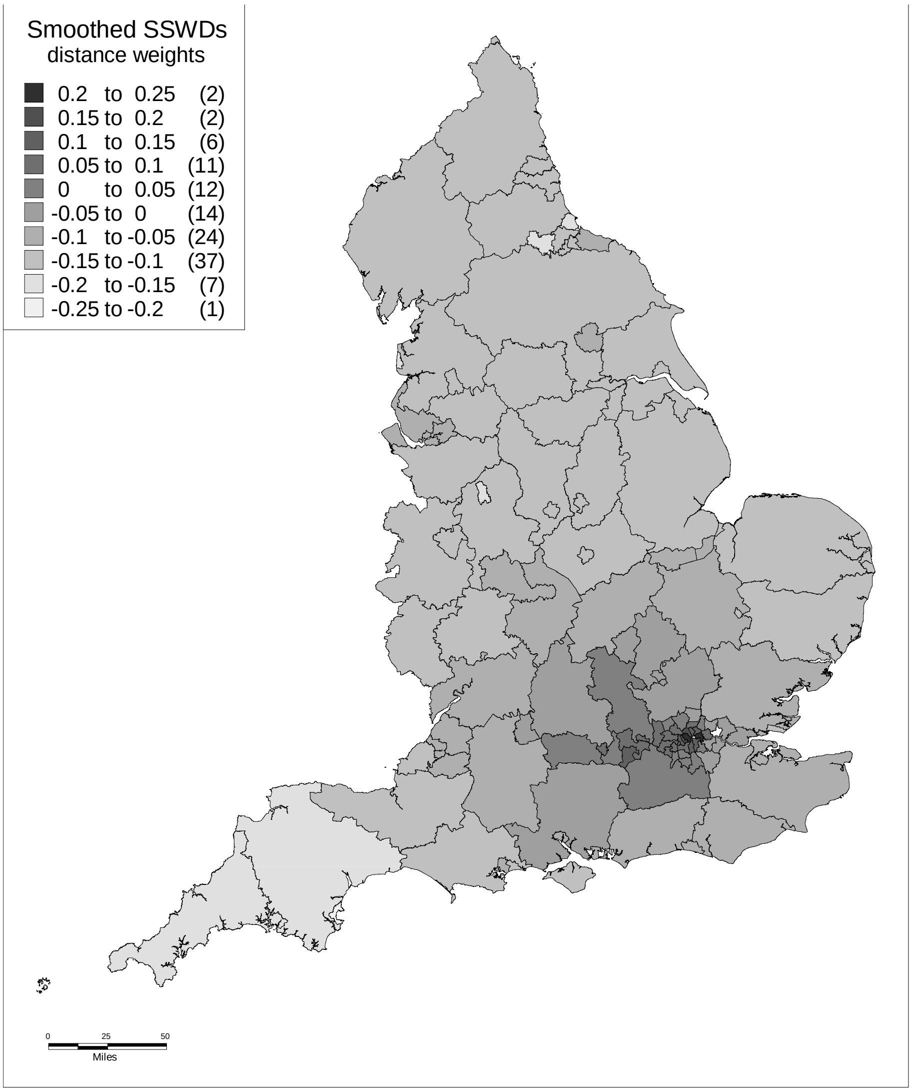
In *Figure 8.9*, the SSWDs have been 'smoothed' by weighting the average of SSWDs for each NES area and its neighbours by the *proportion of the boundary of each NES area accounted for by each neighbour*. The resulting spatial pattern is more complex, and the range of smoothed SSWDs is greater. The pattern of very high SSWDs extending westward from central London into Berkshire is replicated, with high SSWDs in Surrey, Hertfordshire and Buckinghamshire. SSWDs decline with distance from London, with higher values around Bristol, and extending through the West Midlands into the North West. The whole of the North West (including rural Lancashire and Cumbria) display high values. High SSWDs also occur in the urban areas of Yorkshire (except for Hull), Teesside, north Lincolnshire and Tyne & Wear.

Figure 8.10: Population-weighted mean of standardised wages weighted by common boundary – self 50%, new areas



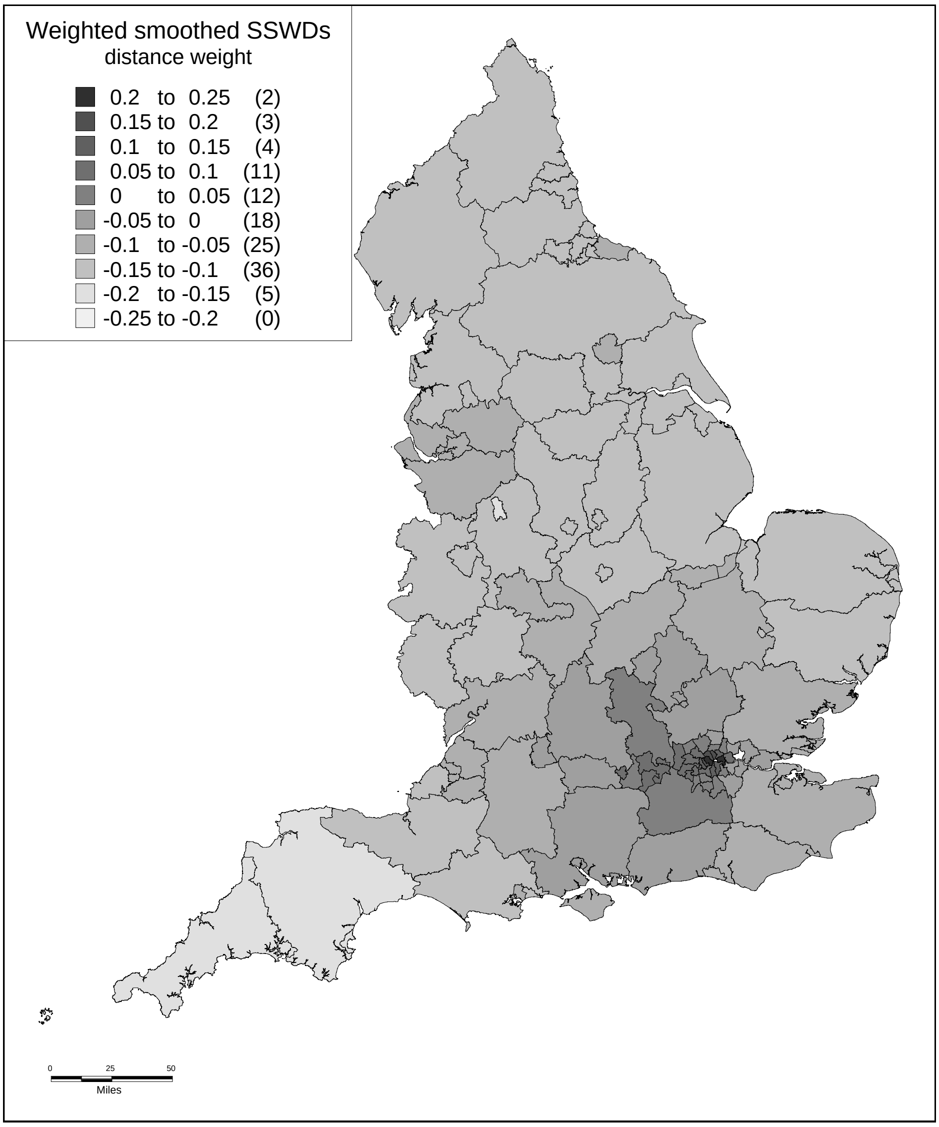
When weighted by population (*Figure 8.10*), there is less variation in SSWDs. SSWDS are higher in eastern England than for the unweighted calculations. SSWDs are also higher across the rural areas of northern England.

Figure 8.11: Mean of standardised wages weighted by inverse distance to neighbours, new areas



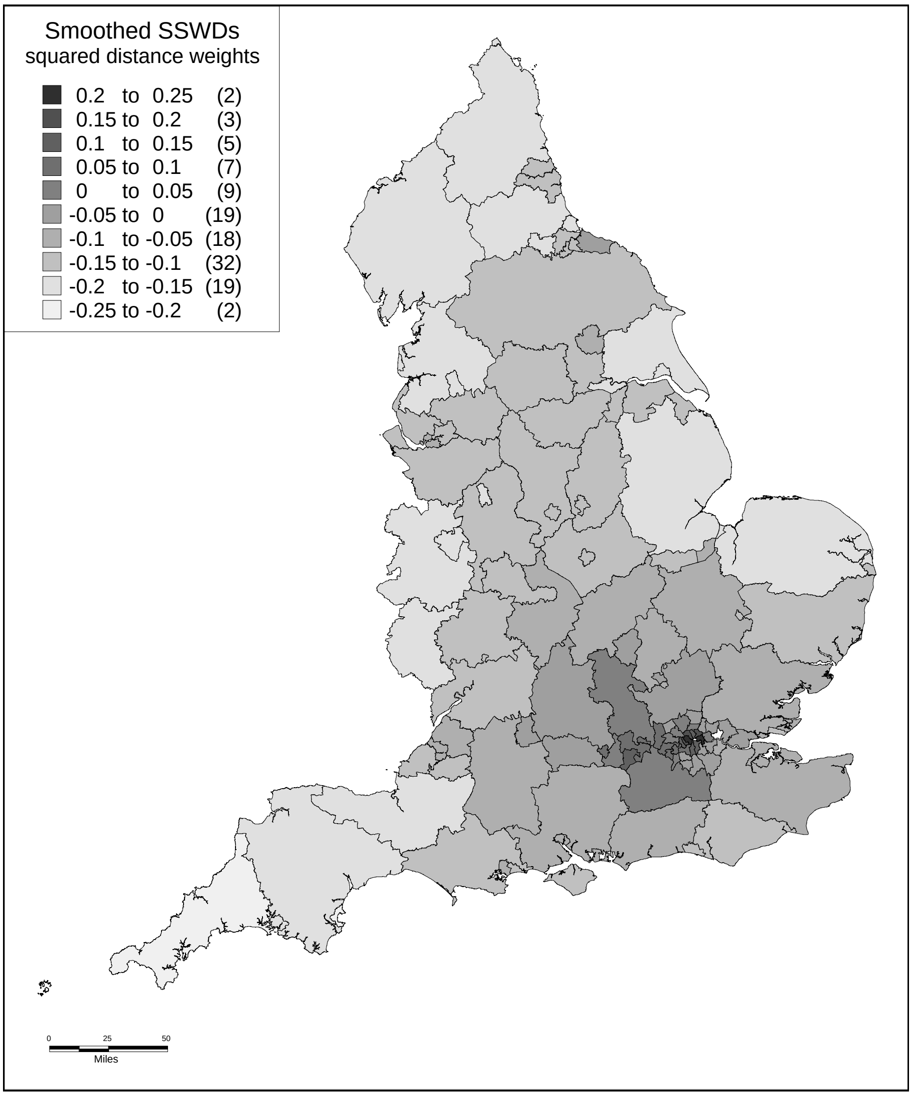
In *Figure 8.11*, the SSWDs have been 'smoothed' by weighting the average of SSWDs for each NES area and its neighbours by the *inverse of the distance* from the centre of each NES to the centre of each of its neighbours. The resulting spatial pattern is flatter than Figure 8.8, with fewer high positive or negative SSWDs. The pattern of very high SSWDs extending westward from central London into Berkshire is replicated, with high SSWDs also occurring in Surrey and Buckinghamshire. SSWDs decline with distance from London, but at a slower rate than in Figure 8.8. SSWDs are higher in the south and South East, but decline faster in a south-westwards direction than with distance north-west. There is much less variation in SSWDs in northern England than in Figure 8.8, though SSWDs are higher in Merseyside and York and lower in Stoke-on-Trent and around Teesside.

Figure 8.12: Population-weighted mean of standardised wages weighted by inverse distance to neighbours, new areas



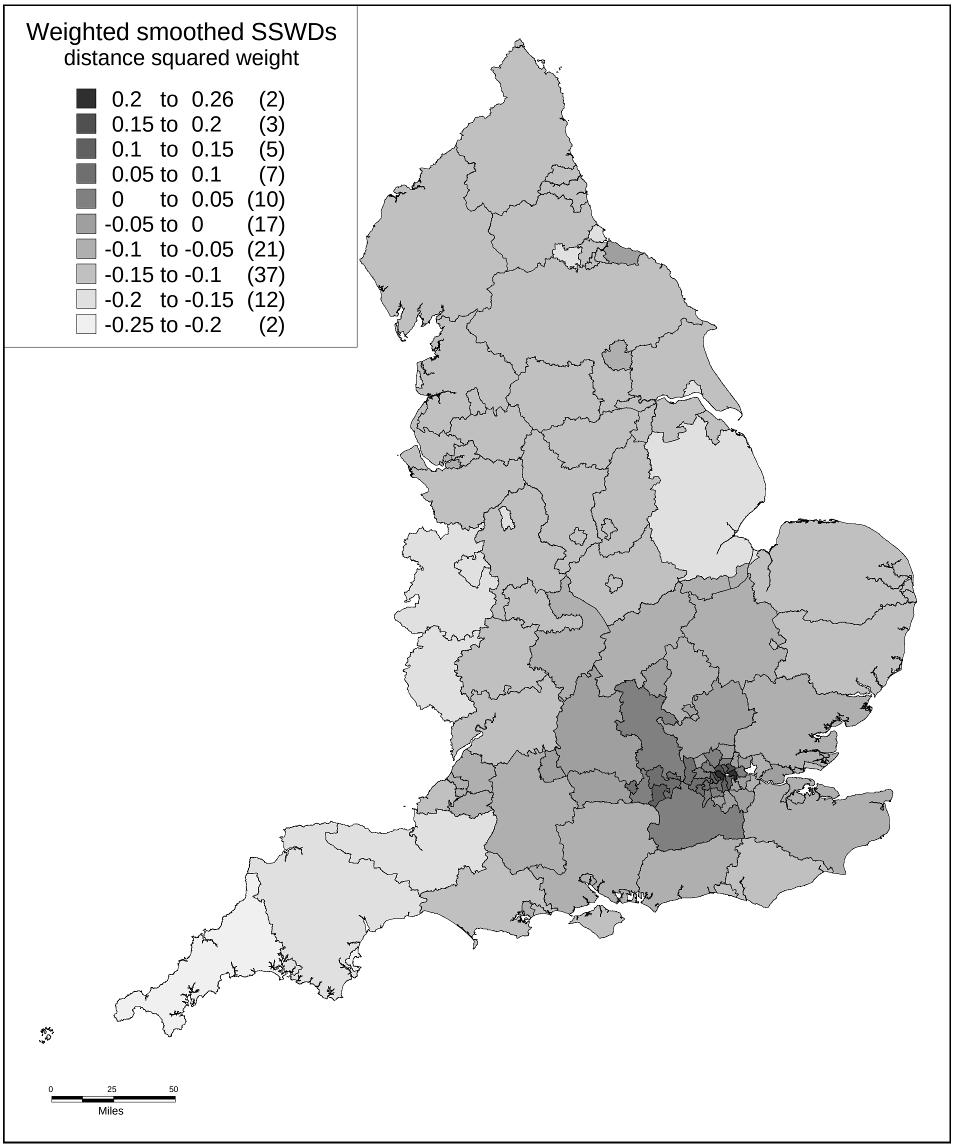
In the pattern of SSWDs weighted by population (*Figure 8.12*), SSWDs are higher in East Sussex and lower in western Berkshire. Higher SSWDs occur in the urban conurbations of south Lancashire and north Cheshire.

Figure 8.13: Mean of standardised wages weighted by inverse distance squared to neighbours, new areas



In *Figure 8.13,* the SSWDs have been 'smoothed' by weighting the average of SSWDs for each NES area and its neighbours by the *squared inverse distance* from the centre of each NES to the centre of each of its neighbours. The resulting spatial pattern displays greater variation than Figure 8.9, with a greater range of SSWDs and more high positive or negative SSWDs. The pattern of very high SSWDs extending westward from central London into the urban areas of Berkshire, Surrey and Buckinghamshire occurs again. SSWDs decline with distance from London, but an axis of higher SSWDs extending through the midlands into North West England and western Yorkshire is evident. SSWDs decline with distance away from this area, with the lowest values recorded in peripheral rural areas. In the Midlands, the SSWDs is higher in Warwickshire than the (former) West Midlands metropolitan county, and Stoke-on-Trent again has a low SSWD. In northern England, SSWDs are high in the Mersey-Humber axis and in Tyne & Wear, and particularly high SSWDs occur in York and Redcar.

Figure 8.14: Population-weighted mean of standardised wages weighted by inverse distance squared to neighbours, new areas



When the smoothed SSWDs are weighted by population (*Figure 8.14*), the rate of decline in SSWD with distance north is reduced. The whole of rural northern England emerges as having higher SSWDs, as does Norfolk.

Table 8.1: Smoothing MFFs: alternative methods of smoothing SSWDs (78 areas)

Area	Wage estimate	Averages of wage rates				Weighted averages of wage rates Population				*Ex post* Trend surfaces		
		Neigh-bours	Contig-uity	Distance	Squared distance	Neigh-bours	Contig-uity	Distance	Squared distance	Linear	Quadratic	Cubic
City of London	-1	20.07	20.31	20.1	20.14	20.51	20.6	20.52	20.53	17.06	17.04	17.34
Barking and Dagenham	17.35	16.65	16.79	17.01	17.26	16.52	16.65	16.92	17.23	17.18	17.08	17.25
Barnet	17.16	17.12	17.06	17.15	17.16	17.47	17.17	17.53	17.34	16.89	16.90	17.33
Bexley	15.99	16.31	16.21	16.23	16.07	15.91	15.91	16.15	16.06	17.28	17.18	17.26
Brent	17.13	18.25	17.56	17.8	17.33	19.4	18.44	18.84	17.85	16.90	16.94	17.35
Bromley	16.5	16.93	16.62	16.79	16.61	16.8	16.62	16.83	16.61	17.29	17.23	17.30
Camden	19.52	18.39	19.07	19.2	19.5	19.7	19.71	19.82	19.68	16.99	16.99	17.35
Croydon	16.91	17.3	17.14	17.06	16.95	17.56	17.38	17.19	16.97	17.23	17.21	17.33
Ealing	17.96	17.67	17.82	17.8	17.91	17.91	17.96	17.93	17.95	16.89	16.95	17.34
Enfield	17.09	16.54	16.82	16.79	16.97	16.38	16.74	16.76	17	16.93	16.91	17.30
Greenwich	17.07	16.53	16.69	16.79	16.98	16.5	16.65	16.74	16.96	17.21	17.14	17.30
Hackney	18.64	18.22	18.47	18.59	18.68	19.18	19.39	19.48	19.68	17.04	17.01	17.33
Hammersmith	18.26	18.12	18.32	18.33	18.33	18.15	18.33	18.34	18.33	17.00	17.02	17.35
Haringey	15.92	17.79	16.89	17.14	16.35	18.47	17.44	17.87	16.76	16.97	16.96	17.33
Harrow	16.14	17.26	16.8	16.73	16.29	17.3	17.09	17.08	16.46	16.81	16.87	17.33
Havering	15.52	16.32	15.88	16.07	15.75	15.9	15.75	15.88	15.68	17.20	17.07	17.20
Hillingdon	18.27	17.4	17.65	17.84	18.14	17.34	17.61	17.91	18.21	16.80	16.88	17.32
Hounslow	18.28	18.01	18.08	18.06	18.16	18	18.07	18.11	18.21	16.93	16.99	17.34
Islington	19.74	18.45	19.1	19.16	19.58	19.16	19.48	19.52	19.69	17.01	17.00	17.34
Kensington & Chelsea	18.96	18.81	19.19	19.07	19.03	20	20.11	19.91	19.51	17.01	17.02	17.35
Kingston-on-Thames	17.03	17.09	17.19	17.03	17.02	17.46	17.57	17.2	17.05	17.06	17.10	17.34
Lambeth	19.33	17.72	18.48	18.59	19.13	17.95	18.6	18.74	19.18	17.11	17.10	17.35
Lewisham	16.54	17.27	16.99	16.95	16.67	17.5	17.25	17.28	16.84	17.19	17.14	17.33
Merton	16.41	17.25	16.8	16.87	16.55	17.44	16.95	17.08	16.65	17.11	17.12	17.35
Newham	17.03	17.96	17.58	17.6	17.21	18.8	18.23	18.15	17.42	17.13	17.07	17.30
Redbridge	16.69	16.46	16.57	16.68	16.71	16.01	16.12	16.51	16.69	17.10	17.03	17.27
Richmond-on-Thames	17.49	17.51	17.54	17.57	17.56	17.7	17.68	17.71	17.65	16.97	17.03	17.34
Southwark	18.98	17.84	18.5	18.58	18.89	18.06	18.77	18.77	18.95	17.12	17.09	17.34

Table 8.1: Smoothing MFFs: alternative methods of smoothing SSWDs (78 areas)

Area	Wage estimate	Averages of wage rates				Weighted averages of wage rates				*Ex post* Trend surfaces		
						Population						
		Neigh-bours	Contig-uity	Distance	Squared distance	Neigh-bours	Contig-uity	Distance	Squared distance	Linear	Quadratic	Cubic
Sutton	16.85	17	16.99	16.85	16.84	17.43	17.42	17.05	16.87	17.16	17.17	17.33
Tower Hamlets	21.58	19.08	19.92	20.63	21.36	20.25	20.96	21.31	21.53	17.10	17.06	17.33
Waltham Forest	16.45	16.79	16.65	16.75	16.55	16.07	16.18	16.45	16.48	17.04	16.99	17.30
Wandsworth	16.98	17.45	17.37	17.28	17.09	17.7	17.56	17.43	17.14	17.07	17.08	17.35
City of Westminster	20.9	19.13	19.91	20.03	20.55	20.06	20.56	20.61	20.81	17.01	17.02	17.35
Bedfordshire	15.65	16.07	15.95	15.93	15.75	16.15	16.06	16.04	15.81	16.35	16.42	17.05
Berkshire	17.69	16.68	17.09	17.25	17.6	16.65	17.05	17.25	17.6	16.57	16.74	17.07
Buckinghamshire	16.44	16.88	16.54	16.72	16.55	16.95	16.6	16.76	16.56	16.37	16.50	17.11
East Sussex	14.84	16.07	15.36	15.32	14.94	16.2	15.5	15.53	15	18.02	17.91	16.74
Essex	15.73	16.11	15.73	16.04	15.88	15.95	15.77	15.86	15.78	17.26	17.00	16.76
Hampshire	15.78	16.31	16.09	16.11	15.89	16.4	16.07	16.07	15.86	16.65	16.92	16.23
Hertfordshire	16.89	16.57	16.56	16.75	16.84	16.38	16.56	16.69	16.84	16.67	16.70	17.25
Isle of Wight	14.4	15.09	14.86	14.54	14.42	15.71	15.64	15.3	14.64	16.81	17.12	15.41
Kent	15.69	16.16	15.67	15.92	15.76	16.27	15.74	15.86	15.72	17.92	17.56	16.64
Oxfordshire	16.64	16.17	16.48	16.43	16.6	16.31	16.57	16.51	16.62	16.07	16.26	16.73
Surrey	17.79	16.82	17.17	17.23	17.5	16.57	17.12	17.2	17.63	17.03	17.12	17.25
West Sussex	15.96	16.09	16.16	16.03	15.98	16.2	16.3	16.11	16.01	17.44	17.54	16.82
Cambridgeshire	15.74	15.43	15.49	15.59	15.71	15.55	15.57	15.66	15.73	16.14	16.12	16.43
Norfolk	14.75	14.88	14.86	14.82	14.77	14.96	14.89	14.85	14.77	16.13	15.71	13.98
Suffolk	14.78	15.25	15.05	14.97	14.82	15.34	15.15	15.05	14.85	16.83	16.35	14.95
Avon	15.8	15.42	15.49	15.64	15.76	15.55	15.64	15.72	15.78	15.31	15.42	15.32
Cornwall	13.4	13.62	13.62	13.45	13.4	13.71	13.71	13.51	13.42	12.75	12.09	13.88
Devon	13.83	14.16	14.02	13.96	13.86	14.18	13.99	13.94	13.85	14.19	14.12	12.91
Dorset	14.87	14.96	15.04	14.95	14.89	15.11	15.21	15.06	14.92	15.93	16.27	14.45
Gloucestershire	15.55	15.66	15.42	15.58	15.55	15.69	15.44	15.61	15.56	15.48	15.60	15.84
Somerset	14.56	14.96	14.67	14.82	14.65	15.05	14.73	14.97	14.74	15.13	15.25	14.54
Wiltshire	15.76	15.83	15.76	15.8	15.77	15.96	15.82	15.88	15.8	15.82	16.05	15.93
West Midlands	15.18	14.94	15.07	15.1	15.17	15	15.11	15.14	15.17	15.37	15.45	15.62
Hereford & Worcester	14.71	14.95	14.97	14.91	14.81	15.01	15.01	14.98	14.87	15.32	15.38	15.62

Table 8.1: Smoothing MFFs: alternative methods of smoothing SSWDs (78 areas)

Area	Wage estimate	Averages of wage rates				Weighted averages of wage rates				*Ex post* Trend surfaces		
						Population						
		Neigh-bours	Contig-uity	Distance	Squared distance	Neigh-bours	Contig-uity	Distance	Squared distance	Linear	Quadratic	Cubic
Shropshire	14.36	14.66	14.5	14.49	14.4	14.73	14.55	14.58	14.43	15.08	14.97	15.01
Staffordshire	14.4	14.81	14.62	14.66	14.49	14.9	14.74	14.75	14.54	15.18	15.21	15.09
Warwickshire	15.49	15.28	15.33	15.32	15.42	15.18	15.23	15.22	15.35	15.57	15.71	16.05
Derbyshire	14.58	14.75	14.61	14.64	14.59	14.85	14.66	14.71	14.61	15.18	15.29	15.10
Leicestershire	14.62	14.78	14.82	14.77	14.69	14.72	14.75	14.71	14.66	15.52	15.66	15.91
Lincolnshire	14.24	14.87	14.54	14.6	14.35	14.86	14.6	14.64	14.39	15.33	15.41	15.24
Northamptonshire	15.62	15.56	15.64	15.59	15.61	15.53	15.6	15.56	15.6	15.90	16.03	16.57
Nottinghamshire	14.51	14.51	14.5	14.52	14.52	14.53	14.52	14.53	14.52	15.25	15.38	15.28
South Yorkshire	14.53	14.69	14.61	14.61	14.55	14.75	14.65	14.66	14.56	14.96	15.08	14.61
West Yorkshire	15.04	14.76	14.88	14.9	15	14.85	14.95	14.97	15.02	14.81	14.87	14.21
Humberside	14.56	14.55	14.54	14.56	14.56	14.55	14.55	14.56	14.56	14.72	14.85	14.25
North Yorkshire	14.91	14.63	14.76	14.76	14.86	14.69	14.79	14.8	14.88	14.54	14.68	14.08
Greater Manchester	15.17	14.88	14.95	15.03	15.14	14.94	15.03	15.09	15.16	14.94	14.86	14.25
Merseyside	15	14.92	14.92	14.98	15	14.96	14.92	14.99	15	14.95	14.64	14.28
Cheshire	15.15	14.78	14.98	14.98	15.11	14.92	15.05	15.05	15.12	14.99	14.84	14.42
Lancashire	14.33	14.82	14.65	14.63	14.44	14.92	14.74	14.72	14.48	14.89	14.67	14.03
Tyne & Wear	15.04	14.47	14.59	14.83	15	14.68	14.8	14.95	15.02	14.14	14.27	14.89
Cleveland	15.35	14.7	14.91	15.13	15.31	14.71	14.9	15.11	15.3	14.23	14.39	14.23
Cumbria	14.45	14.41	14.45	14.42	14.44	14.41	14.45	14.41	14.44	14.92	14.45	14.55
Durham	13.86	14.69	14.37	14.44	14.13	14.78	14.49	14.56	14.23	14.29	14.39	14.43
Northumberland	14.53	14.47	14.51	14.56	14.59	14.64	14.64	14.74	14.75	14.13	14.22	15.54

Table 8.2 Unsmoothed and smoothed standardised spatial wage rates (new areas)

Area	Standardised Wage rate	Unweighted means				Population-weighted means			
		Simple	Contiguity	Distance	Distance^2	Simple	Contiguity	Distance	Distance^2
Barking and Dagenham	17.35	16.91	17.07	16.94	17.18	16.77	16.87	16.97	17.18
Tyne and Wear MC	15.06	14.71	14.83	14.82	14.98	14.57	14.69	14.8	14.96
Darlington	14.13	14.42	14.24	14.38	14.21	14.49	14.31	14.3	14.18
Durham	14.44	14.5	14.45	14.56	14.55	14.48	14.46	14.48	14.48
Hartlepool	14.13	14.51	14.36	14.34	14.18	14.53	14.39	14.27	14.16
Middlesbrough	14.94	15.2	15.14	15.22	15.03	15.08	15.09	15.06	14.98
Northumberland	14.28	14.49	14.38	14.58	14.55	14.57	14.47	14.56	14.53
Redcar and Cleveland	16.65	15.66	15.95	16.04	16.38	15.01	15.18	15.55	15.99
Stockton-on-Tees	15.34	14.87	15.17	14.87	15.11	14.52	14.73	14.78	15.02
Greater Manchester MC	15.29	15.11	15.24	15.07	15.17	14.92	15.06	15.04	15.17
Halton	15.51	15.4	15.46	15.43	15.49	15.34	15.36	15.4	15.47
Warrington	15.14	15.27	15.19	15.27	15.19	15.32	15.28	15.29	15.21
Cheshire	15.51	15.21	15.42	15.21	15.35	14.89	15.09	15.12	15.32
Cumbria	14.56	14.5	14.53	14.52	14.55	14.5	14.49	14.53	14.55
Blackburn with Darwen	14.45	14.72	14.59	14.56	14.48	14.83	14.7	14.6	14.49
Blackpool	14.31	14.49	14.49	14.33	14.31	14.58	14.58	14.36	14.31
Lancashire	14.68	14.72	14.69	14.67	14.58	14.89	14.79	14.77	14.65
Merseyside	15.25	15.24	15.22	15.27	15.28	15.16	15.13	15.23	15.25
South Yorkshire MC	14.64	14.68	14.65	14.7	14.67	14.88	14.76	14.83	14.73
West Yorkshire MC	15.14	14.91	15.05	14.9	15.04	14.75	14.95	14.93	15.07
East Riding of Yorkshire	14.47	14.73	14.5	14.76	14.6	15.2	14.68	14.96	14.72
Kingston upon Hull	14.45	14.46	14.46	14.45	14.45	14.46	14.46	14.45	14.45
North East Lincolnshire	15.01	14.87	14.71	15	15.01	15.16	14.78	15.08	15.02
North Lincolnshire	15.54	15.02	15.33	15.06	15.38	14.91	15.25	15.28	15.47
York	15.98	15.2	15.45	15.6	15.89	15.28	15.62	15.82	15.95
North Yorkshire	14.39	14.69	14.44	15.07	15.18	15.01	14.84	15.26	15.49
Derby	15.25	14.82	14.82	15.16	15.24	14.71	14.71	15.12	15.23
Derbyshire	14.39	14.71	14.44	14.8	14.67	14.92	14.56	14.75	14.61
Leicester	14.88	15.03	15.03	15	14.97	15	15	14.97	14.95
Leicestershire (including Rutland	15.17	15	15.14	14.94	14.9	14.78	15.01	14.9	14.89
Lincolnshire	13.93	14.59	14.07	14.85	14.5	15.18	14.79	15	14.69

Table 8.2 Unsmoothed and smoothed standardised spatial wage rates (new areas) (continued)

Area	Standardised Wage rate	Unweighted means				Population-weighted means			
		Simple	Contiguity	Distance	Distance^2	Simple	Contiguity	Distance	Distance^2
Northamptonshire	15.76	15.8	15.78	15.87	15.85	15.67	15.74	15.74	15.78
Nottingham	15.02	14.74	14.74	14.93	15	14.87	14.87	14.99	15.02
Nottinghamshire	14.46	14.62	14.49	14.71	14.71	14.93	14.66	14.83	14.82
West Midlands MC	15.37	15.23	15.32	15.26	15.33	15.07	15.2	15.22	15.32
Herefordshire	14.21	14.49	14.33	14.48	14.32	14.53	14.35	14.36	14.26
Worcestershire	14.89	14.89	14.9	14.95	14.95	14.79	14.8	14.86	14.91
Telford and Wrekin	14.53	14.46	14.42	14.46	14.5	14.52	14.46	14.51	14.52
Shropshire	14.1	14.43	14.19	14.5	14.38	14.6	14.43	14.52	14.46
Stoke-on-Trent	13.9	14.3	14.3	13.97	13.91	14.22	14.22	13.95	13.9
Staffordshire	14.7	14.77	14.7	14.72	14.65	14.68	14.62	14.6	14.56
Warwickshire	15.69	15.54	15.66	15.47	15.56	15.34	15.47	15.36	15.44
Bath and North East Somerset	15.29	15.25	15.24	15.36	15.36	15.26	15.08	15.43	15.45
Bristol, City of	15.96	15.61	15.81	15.73	15.9	15.55	15.75	15.81	15.92
North Somerset	14.77	14.99	14.85	14.99	14.86	15.14	14.93	15.05	14.89
South Gloucestershire	15.71	15.57	15.66	15.66	15.74	15.53	15.6	15.72	15.78
Cornwall	13.56	13.72	13.72	13.61	13.57	13.74	13.74	13.62	13.58
Plymouth	14.32	14.1	14.1	14.3	14.32	14.04	14.04	14.29	14.32
Torbay	13.38	13.63	13.63	13.41	13.38	13.64	13.64	13.41	13.38
Devon	13.88	13.96	13.9	13.91	13.84	14.02	13.95	13.9	13.82
Bournemouth	15	15.06	15	15.11	15.04	15.01	14.95	15.11	15.05
Poole	15.7	15.23	15.36	15.44	15.61	15.01	15.12	15.41	15.61
Dorset	14.54	14.78	14.6	15	14.97	14.91	14.72	14.94	14.9
Gloucestershire	15.31	15.44	15.32	15.48	15.41	15.32	15.26	15.3	15.3
Somerset	14.38	14.56	14.4	14.63	14.55	14.57	14.39	14.55	14.49
Swindon	16.77	16.23	16.49	16.48	16.72	15.92	16.13	16.43	16.71
Wiltshire	15.19	15.46	15.24	15.63	15.52	15.57	15.38	15.55	15.46
Luton	16.65	16.59	16.46	16.62	16.65	16.67	16.44	16.65	16.65
Bedfordshire	15.82	16.2	15.94	16.35	16.19	16.53	16.31	16.4	16.23
Peterborough	15.42	15.34	15.34	15.41	15.42	15.21	15.17	15.38	15.42
Cambridgeshire	16.12	15.74	16.03	15.69	15.91	15.52	15.69	15.74	15.94

Table 8.2 Unsmoothed and smoothed standardised spatial wage rates (new areas) (continued)

Area	Standardised Wage rate	Unweighted means				Population-weighted means			
		Simple	Contiguity	Distance	Distance^2	Simple	Contiguity	Distance	Distance^2
Southend-on-Sea	14.93	15.26	15.26	14.98	14.94	15.3	15.3	14.99	14.94
Thurrock	17.24	16.52	16.76	16.85	17.13	16.32	16.6	16.94	17.17
Essex	15.58	15.89	15.63	16.03	15.89	16.2	15.9	16.1	15.94
Hertfordshire	17.22	16.95	17.13	16.87	16.95	16.7	16.89	16.87	16.98
Norfolk	14.49	14.7	14.63	14.7	14.58	14.74	14.75	14.67	14.57
Suffolk	14.7	15.05	14.86	14.98	14.8	15.17	14.96	14.93	14.78
Barnet	17.11	17.24	17.12	17.29	17.22	17.29	17.13	17.25	17.19
Bexley	16	16.13	16.06	16.2	16.09	15.89	15.92	16.05	16.02
Brent	16.82	17.9	16.96	18.15	17.46	18.73	17.25	18.02	17.31
Bromley	16.6	16.74	16.57	16.78	16.68	16.65	16.29	16.74	16.69
Camden	20.24	19.31	20.1	19.59	20.09	18.77	19.7	19.57	20.06
Croydon	16.54	17.08	16.69	17.09	16.79	17.69	17.07	17.3	16.9
Ealing	17.72	17.83	17.77	17.84	17.78	17.5	17.64	17.55	17.63
Enfield	16.56	16.59	16.59	16.65	16.6	16.73	16.76	16.72	16.62
Greenwich	16.57	16.48	16.51	16.47	16.52	16.44	16.43	16.44	16.46
Hackney	20.1	19.21	19.91	19.3	19.8	18.93	19.75	19.46	19.83
Hammersmith and Fulham	19.43	18.84	19.3	19.21	19.48	18.57	19.28	19.35	19.69
Haringey	16.66	17.51	16.83	17.82	17.31	18.35	17.63	18.38	18.1
Harrow	16.69	17.06	16.8	17.08	16.84	17.19	17	17.03	16.84
Havering	16.01	16.33	16.14	16.5	16.33	16.55	16.42	16.61	16.47
Hillingdon	18.28	17.9	18.16	17.87	18.08	17.51	17.7	17.75	18
Hounslow	18.53	18.4	18.44	18.36	18.41	18.18	18.21	18.26	18.32
Islington	19.66	19.33	19.62	19.46	19.62	19.66	19.72	19.69	19.68
Kensington and Chelsea	19.97	19.64	20.1	20.01	20.08	19.32	20.17	19.99	20.06
Kingston upon Thames	17.58	17.55	17.6	17.54	17.56	17.61	17.65	17.59	17.59
Lambeth	20.07	18.84	19.7	18.98	19.62	18.22	19.23	19.07	19.67
Lewisham	16.6	17.02	16.81	17.07	16.84	17.22	16.88	16.9	16.72
Merton	16.77	17.29	16.9	17.37	17.07	17.79	17.23	17.46	17.11
Newham	16.96	17.7	17.12	17.84	17.39	18.07	17.36	17.67	17.27
Redbridge	16.41	16.45	16.43	16.61	16.55	16.54	16.47	16.64	16.56
Richmond upon Thames	18.24	18.1	18.19	18.17	18.24	17.96	18.09	18.1	18.2

Table 8.2 Unsmoothed and smoothed standardised spatial wage rates (new areas) (continued)

Area	Standardised Wage rate	Unweighted means				Population-weighted means			
		Simple	Contiguity	Distance	Distance^2	Simple	Contiguity	Distance	Distance^2
Southwark	19.16	18.46	18.97	18.75	19.05	17.95	18.34	18.46	18.86
Sutton	16.89	17.03	16.94	16.94	16.89	17.15	16.98	17	16.92
Tower Hamlets	21.81	20.17	20.9	20.76	21.46	19.26	20.31	20.63	21.45
Waltham Forest	16.5	16.78	16.56	17.02	16.79	16.82	16.63	16.91	16.74
Wandsworth	17.96	18.06	18.03	18.13	18.07	18.13	18.15	18.15	18.08
City of Westminister	21.67	20.34	21.16	20.56	21.05	19.44	20.4	20.3	20.79
Bracknell Forest	19.52	18.42	19.17	18.69	19.23	17.67	18.61	18.66	19.22
Newbury	16.93	16.77	16.81	16.98	17.05	16.47	16.43	16.83	17
Reading	18.15	17.52	17.83	17.84	18.08	17.08	17.34	17.73	18.05
Slough	18.39	18.1	18.12	18.33	18.38	18.04	18.05	18.34	18.39
Windsor and Maidenhead	18.35	18.18	18.31	18.29	18.37	18.08	18.22	18.29	18.37
Wokingham	17.13	17.34	17.19	17.76	17.59	17.41	17.31	17.71	17.53
Brighton and Hove	15.31	15.35	15.34	15.35	15.32	15.31	15.32	15.33	15.32
East Sussex	14.75	15.46	14.95	15.35	14.96	15.72	15.31	15.31	14.97
Milton Keynes	16.48	16.38	16.4	16.36	16.44	16.26	16.24	16.3	16.41
Buckinghamshire	17.27	17.22	17.24	17.38	17.46	17.12	17.07	17.33	17.44
Portsmouth	16.08	16.05	16.05	16.08	16.08	16.04	16.04	16.08	16.08
Southampton	16.02	16.01	16.01	16.02	16.02	16.01	16.01	16.02	16.02
Hampshire	16.01	16.29	16.01	16.42	16.25	16.35	15.88	16.34	16.23
Isle of Wight	14.52	15.28	15.03	15.03	14.7	15.52	15.26	15.02	14.7
Medway Towns	15.66	15.64	15.64	15.65	15.66	15.62	15.62	15.63	15.65
Kent	15.61	15.88	15.6	15.83	15.7	15.87	15.54	15.71	15.65
Oxfordshire	16.58	16.52	16.57	16.65	16.71	16.36	16.53	16.56	16.64
Surrey	17.74	17.45	17.67	17.57	17.73	17.02	17.1	17.51	17.71
West Sussex	16.02	15.99	16.05	15.92	15.9	15.83	16	15.82	15.83

8.6 The Recommended Smoothing Solution and the Rationale for Choosing It

The advantage of calculating some form of spatial average for each area is that it "smooths out" differences between areas which may be the result of random variations in the NES sample, revealing the "genuine" pattern of wage rate variation over space. (Generally, differences between the various smoothing methods are much less than those between smoothed and unsmoothed SSWDs).

The preferred spatial smoothing solution is to calculate spatial averages for each zone and its neighbours, with the contribution of each weighted by the inverse of the squared distance from the population-weighted geographical centroid of this zone to the equivalent point in each of its neighbours.

The method of distance-weighting is preferred over simple averaging of neighbours or contiguity weighting. It builds in information about the spatial relationship of NES areas, while avoiding the problem of contiguity weighting. The latter calculation is influenced by the shape of the area and the number of contiguous neighbours. For example, the long narrow area covered by Buckinghamshire has more neighbours than a square area such as Cambridgeshire. Geographically central areas may have more neighbours than coastal areas.

There is not a great deal of difference between the use of distance or distance squared. The latter gives somewhat greater weight to nearby areas and allows for a greater deterrence effect of distance on commuting to job opportunities (and conversely the former gives somewhat less weight to the nearest neighbours).

Weighting the calculation by population builds in the size of area. More populous areas, receive greater weight and influence than areas of small populations.

The use of an estimate of average distance within each zone also allows the density of population within that zone to influence the calculation. The larger its geographical area, the larger will be this distance, and the smaller an influence the zone has on its own calculation relative to other areas[30].

[30] *In extremis*, a very tiny area's SSWD is based solely on its own value. For a very large area, the area receives equal weight to all it's neighbours.

9 Future Developments

9.1 Background

In the first meeting of the ATSG it was agreed that several of the options raised in the original IER proposal were probably too ambitious to be achieved within the present timescale. However, it was suggested that it would be useful if the final report had a section entitled 'The Future' to provide a commentary on these points, and to suggest how they could be taken forward over the longer term. The review element of the research has been taken forward with this in mind. This section brings together these ideas for further refinement and improvements.

9.2 Geography: Enhancing the Information Available from the NES

It was recognised that a limiting factor was the relatively small number of areas identified in the NES data set. The current panel data set only includes information on which of the 119 zones an individual works in.

Various smoothing options have been considered. *Ex ante* trend surfacing has also shown promise. The latter is the only option that 'builds-in' such spatial considerations to the estimation. However, without small area level spatial information from the NES panel data set, the sophistication of the approach that can be adopted is limited. The present version of the data set only allows spatial co-ordinates to be allocated to to 119 NES zones rather than to the individual's particular workplace.

It was agreed that IER would explore the possibility of getting an enhanced version of the data set, where postcodes for individual cases might be available. However it was recognised that any analysis based on such data was probably not feasible for the current review.

Subsequent approaches to ONS on this issue have initiated an internal debate within ONS about the feasibility and practicalities of doing this. The initial results of this suggest that it is feasible. However, the terms of the Statistics of Trade Act, regarding confidentiality of individual data, raise concerns which need to be explored by the ONS legal department.

It is worth noting in this context that NES data have now been made available on NOMIS (as part of the progress towards the development of ONS's "Neighbourhood Statistics"). The NES data have been made available at ward level (and for other standard geographies) enabling users to have the flexibility to aggregate areas dynamically. Thus, in theory, it should be possible to look at differentials between central cores of cities and outlying areas. (Note however that this is for whole areas, rather than individual data).

9.3 Estimation Methods

Fixed effects methods

Generally the fixed effects results show very marked differences from the cross-sectional results. This confirms the results previously reported by Bell (1998). The estimated SSWDs are very much smaller than those based on the cross-sectional methods. Indeed, the current results show an even sharper reduction for the aggregated four zone geography than found by Bell.

The pattern is also very different across the detailed (119) spatial areas than those from the cross-sectional analysis, with sharp reductions in the estimated SSWDs. However, there are also some dramatic changes in the rankings of the individual areas. The estimated SSWDs appear to be very sensitive to the estimation method used. The results obtained here differ in a number of respects from those reported by Bell (1998). The reasons for this remain unclear and require further research.

For the aggregated zones, the fixed effects differentials for 2000 are only around a third of the size estimated using the cross-sectional technique. However, it is not just these coefficients which change. Many of the coefficients on the other explanatory variables also exhibit marked differences.

Given the importance of the SSWD estimates, these fixed effect results seem to raise almost as many questions as they have answered. At this stage it is still not clear whether or not the fixed effects approach is the best way to proceed. It is possible that the fixed effects method may be "over-adjusting" and that some of the real long-run spatial differences, which the regression analysis is designed to capture may be lost by use of this method.

The fixed effect nets out unmeasured individual attributes, which are in principle “fixed”. In the case of the NESPD these may include formal qualifications (which are not measured in the NES) as well as motivation and other individual characteristics such as ability. The latter may be taking things too far. Although it would probably be generally accepted that is important to remove qualification effects (in order to compare “like with like”), to attempt to net out factors such as motivation may be a step too far. For example the motivations and ambitions of those working in the City of London may be exceptional and very different from those employed in the public sector.

On the other hand, Bells’s (1998) results suggest that there may be significant differences between the public and private sectors in this respect. He finds that SSWDs based on fixed effects are similar for private and public sectors whereas unstandardised differentials and SSWDs based on cross-sectional analysis are not.

Bell has, however, recognised that there are potential problems with the fixed effects method. One set of reservations relates to the questions of measurement error (see the discussion in Annex C). This suggests that if there is measurement error in the NES (which is almost inevitable) then this may bias the fixed effect estimates downwards

The fixed effect method (effectively 1st differences) may also be removing some long run "level" effects about the disamenities of space. A key question is how much the results are focussing on ***changes*** in earnings between the two periods rather than ***differences*** in wage levels across space, which is the real focus of attention?

The fixed effect method offers, in principle, a way of dealing with unmeasured attributes. However, it may be introducing other problems, which are clouding the issue as far as getting at the underlying spatial wage differentials. Essentially, the fixed effects approach is equivalent to taking "first differences" of the observations on each individual case for the two periods chosen (see the discussion in Annex B). The problem with this is that there is a danger that such a transformation loses the "long-run" information on the levels of the variable. In a different context, David Hendry has criticised those who have run time series models using first difference data, arguing the need to build in the long-run information by developing "error-correction" type models. However, it is not clear what the equivalent would be in the present context. In principle, it is straightforward to extend the fixed effect approach to cover a sequence of time series observations (although this may risk some problems of sample attrition). However, without some change in the approach, this would still not build in the long-run information on levels analogous to Hendry's, two stage, error correction approach. The latter involves establishing the time series properties of the data, and developing a "co-integrated" data set. However, the tests required to do this require far more time series observations than are available in the NESPD. Moreover, there are probably a host of other technical problems of applying such methods to a panel data set, which have so far not been addressed in the literature.

The question of why fixed effects modelling makes such a significant difference to the SSWD estimates is a key one and this needs to be the focus of further research.

Random effects

The possibility of using a ***Random effects*** model has also been considered. In theory this could produce more efficient estimates than a fixed effects model. However, the estimates are biased if the residuals (i.e. the area effects or SSWDs) are not independent of the other variables. Since it is regarded as quite likely that occupation and industry are not independent of the area effects, it was concluded that such an approach is probably not worth pursuing.

Further comments from David Bell, which are summarised in Annex C, add weight to the idea that the random effects option is not optimal in this particular case. As a consequence, this method has not been pursed further.

Multi-level modelling

Multi-level modelling techniques have also been considered but in the light of pressing timescales and the large number of other issues to be pursued, these were felt to be something for the 'The Future' category. This approach is discussed in more detail in Section 9.7 below.

9.4 Choice of Data Set

The present analysis suggests that the NES remains the preferred data set. However, a major problem with the use of NES remains ONS's reluctance to devote sufficient resources to its upkeep. Much of the current work on keeping this up to date relies on work being done by Oxford University for their own research purposes. This does not therefore guarantee that all variables available now would continue to be so the future. Following initial approaches by IER to ONS, the Department of Health needs to follow up with ONS on this issue, with a view to putting this on to a much firmer footing.

In contrast, the LFS is much better resourced and is due to have its sample size increased. This could reduce the advantages of using the NES. Moreover, the repetition of questions on income in the 1st and 5th sweeps, now allows, in principle, a panel style analysis, albeit based on only a very small sample by comparison with the NES[31]. Some further work using this data set may, therefore, be worthwhile.

On balance, the NES still seems to be the front runner, because it offers better coverage, a larger sample size, and has a larger panel element (which is essential for estimating the fixed effects model). However, its continued use is dependent upon ONS devoting sufficient resources to maintaining it in good operational condition.

9.5 Contouring Methods

The shape of the three-dimensional surface of SSWDs is crucially influenced by the geography of the areas used for the publication of data from the NES. This report has presented results using 79 and 119 NES areas, and the influence of the size, number and geographical arrangement of zones is apparent from comparing these maps. At present, there are a large number of data observations for Greater London, and few in the Midlands and the north of England. The surface could be considerably enhanced by the inclusion of more data points.

Estimation of a more detailed surface would be facilitated by the availability of NES data for the (c.7,500) postcode sectors in England, the boundaries of which are available in digital form. The methods presented here could be applied to areas based on aggregation of such data and variations, such as including neighbours within a given distance threshold, could be experimented with. The use of contouring would probably be more successful, as the estimated surface would be less susceptible to the influence of unusually high or low values in areas of sparsely distributed data points. Alternatively, individually post-coded data could be used to develop more precise *ex ante* surfaces

In order to illustrate these methods two and three dimensional views of a "contour" surface are presented below, in which unsmoothed SSWDs for the 119 NES areas are contoured[32]. Contour methods interpolate the values of the variable being contoured (in this instance it is a wage rate rather than a SSWD) from the data points to each intersection on a regular grid. This grid is then used to draw the contour map using an algorithm which traces an isoline (line of equal value) through this grid. The shape of the surface is influenced by the size of the grid, the rate of decay in the influence of each point upon the calculation of the value at each intersection point and the geographical pattern of data points.

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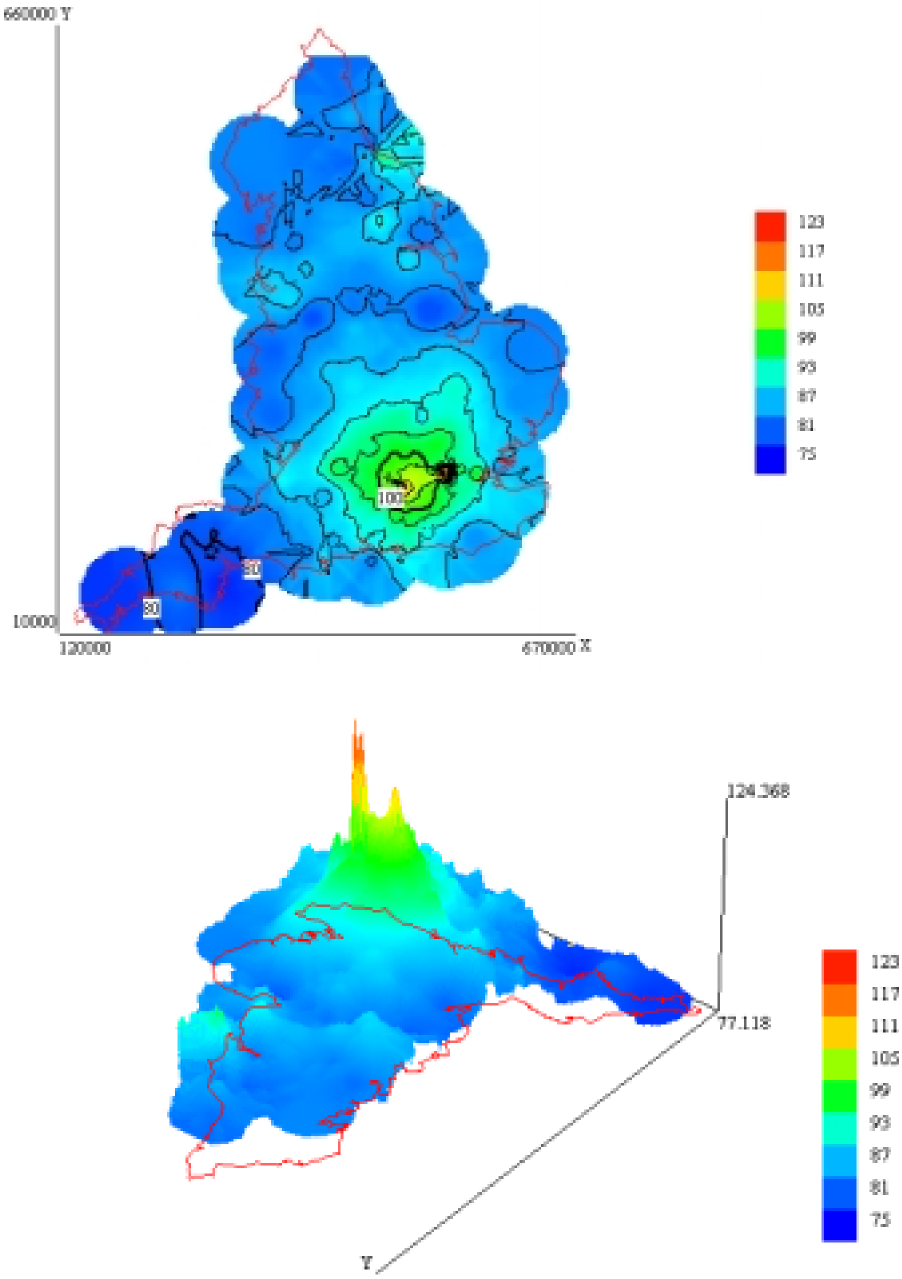
[31] It is possible, therefore, to set up the LFS in two ways:
a) a full data set – to assess the marginal effect of qualifications
b) as a "panel" based on 1999 questions for waves 1 & 2
The LFS estimation conducted as part of the present exercise is based on the full data set, using cross-sectional regression analysis.

[32] In this case, SSWDs are presented as indices or percentages, rescaled to 100 so that negative values are now under 100, while positive values are over 100.

Figure 9.1 Contour Map of Standardised Wage Indices (SWIs)



Contour maps are a powerful presentational tool, which demonstrate clearly the features of the wage surface. The three-dimensional view demonstrates even more dramatically the extreme ‘peak’ in wage rates extending from London into Berkshire. However, the regular grid of estimated SWIs created by the contouring package can also be used for further analysis. For example, a Primary Care Trust (PCT) could be allocated the SWI for the grid intersection nearest to it, or the grid intersections falling within the territory of a PCT averaged to give an estimated SWI value.

9.6 *Ex Ante* Surfacing

With a greater number of data points, *ex ante* trend surface analysis (i.e. fitting a 3-dimensional surface using regression methods) may yield better results. This would also enable trend surface models to be estimated for separate geographical regions. An even more efficient approach might be to explore the use of *Geographically Weighted Regression* (GWR), which permits regression parameters to vary over space[33].

One of the difficulties in analysing spatial data is the problem of spatial non-stationarity: the variation in relationships and processes over space. If spatially varying relationships are modelled within a single regression model, then the error terms in the regression model may exhibit spatial autocorrelation. This autocorrelation will effect the standard errors associated with parameter estimates. Brunsdon, Fotheringham and Charlton (1999) note that there are many areas where spatial variations in relationships may occur, including house prices, voting behaviour and out-migration rates. Geographically Weighted Regression deals with any spatial non-stationarity by allowing the calibrated model to vary spatially. GWR weights each observation according to its location in geographical space. The technique provides a means of computing localised regression estimates. This may be advantageous in a geographical context. For example, Brunsdon *et al* (1999) note that if at some point housing markets in two locations are behaving very differently, it is not helpful to calibrate models in either of these places using data from the other.

9.7 Multi-level Modelling

Another avenue of future development is the use of *Multi-Level Modelling (MLM)*. This technique appears well suited to the estimation of area cost differentials. This technique was developed at the Institute of Education of the University of London in order to represent the hierarchy within which individuals were organised within a single regression framework and to identify the separate effects operating at different levels of this hierarchy *simultaneously*. The most common application of this technique has been in the field of education. School children can be seen to be part of a hierarchical framework including school and geographical area. Children are grouped into schools which are nested within local education authorities. The method enables the individual characteristics of children and their families, the performance of the school and the characteristics of the LEA to be built into one model which enables separate parameters to be estimated for individual, school and LEA effects. The model can yield a separate intercept term for each school or permit all parameters to vary within each school. The parallels with estimating SSWDs are clear. These are the intercepts for each NES area from a model in which individual and area characteristics are included. If area characteristics were only represented by a dummy variable, the results would be little different from conventional regression estimates. The estimation process is generally much more efficient for MLM than OLS regression.

9.8 Treatment of National Boundaries

Another possible issue to be considered for future development is the treatment of national boundaries. At present, England is treated as if it is an island, with no neighbours on the Welsh and Scottish borders. However, Wales and Scotland may have an influence upon the border areas, especially if wage rates are higher; as is the case for teachers in Scotland. It

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33 see http://www.ncl.ac.uk/geography/GWR

may thus be more realistic to build in some estimate of SSWDs for Welsh and Scottish areas bordering England into the smoothing calculations (though this would require repeating the exercise of estimating SSWDs for these two countries).

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Annex A: The Calculation of SSWDs 1996-2000: OLS Cross-sectional estimates

1. The dependent variable is the (log) of hourly earnings[34]. The regressions were of the following general form:

$$
\begin{aligned}
\text{Log (Earnings)} = a &+ \Sigma b_i && \text{(age dummies)} \\
&+ \Sigma c_j && \text{(industry dummies)} \\
&+ \Sigma d_k && \text{(occupational dummies)} \\
&+ e && \text{(gender dummy)} \\
&+ f && \text{(public sector dummy)} \\
&+ \boldsymbol{\Sigma g_e} && \textbf{(area dummies)}
\end{aligned}
$$

2. The regression analysis attempts to control or 'standardise' for those factors – such as an individual's educational qualifications, age, sex, occupation, industry of employment, and work area – which economists have previously found to be important determinants of an individual's earnings. Area wage differentials which remain after all *measurable* differences in worker quality and job attributes have been controlled for are then taken to reflect the size of compensation that workers require to work in any particular area. The primary influences determining these area effects are taken to be the relative key pressures in the local labour markets: for example, the level of unemployment and the local housing and commuting costs as well as other disamenities associated with working in a particular location.. In general, one would expect that these factors would tend to vary rather smoothly from one area to the next, so that their level in one local area will usually be more similar to other areas nearby than to more distant areas.

3. Technically, the coefficients on the area dummies represent the standardised spatial wage differentials (SSWDs), that is the additional pay that local employers in any area would need to offer, to be able to recruit and retain labour of a comparable quality.

4. Effectively the regression results allow the creation of a representative worker who has free choice over where to locate. The SSWD or area MFF represents the additional compensation necessary to attract and retain this worker in a given area.

5. For target-setting purposes the staff MFF for 1996-2000 was based on the SSWDs estimated from the three latest years of the New Earnings Survey Panel Data Set (NESPD). A three year rolling average was used to smooth out any erratic annual fluctuations. For 2001/02 HA allocations the data used were from 1997, 1998, and 1999. The analysis used individual earnings of full-time employees aged 16-70 in the private sector – the annual sample used was around 75,000. For consistency with earlier analysis these estimates related to 79 NES zones – based on London Boroughs and the former Metropolitan and Shire counties (although the underlying data for 119 separate area codes are now available).

6. The SSWD estimates are not used directly by the NHS to set the MFF. The key reason for this is that as a matter of judgement the NHS labour market is not believed to mimic the external labour market in a one-for-one fashion. Various adjustments are made which damp-down the size of the MFF, in particular by raising the 'floor' at which adjustments take place.

[34] Since the dependent variable in the regressions is the log of earnings the coefficients on the spatial dummy variables must be anti-logged (ie take the exponential), subtracted from 1 and multiplied by 100 in order to correct them into percentage differentials from the comparator zone.

Annex B: Fixed Effects and Random Effects Models

1. To help clarify some of the technical issues it is helpful to set out the model in algebraic form[35]:

$$y_{it} = \alpha_i + \gamma_t + \beta X_{it} + \eta_{it}$$

Where:

- y_{it} is the level of wages of individual I in year t
- α_i is a component which varies across individuals, but, by assumption is fixed over time. It is not assumed in general that it is measured. Typically some fixed characteristics like gender are observed whereas others like intelligence or motivation are not
- γ_t is a component which is common to each individual but varies over time (for example the aggregate level of prices in the economy)
- X_{it} includes observed variables which vary from individual to individual and over time (hence the subscript "it") and β is their effect on wage rates. That is, β is a set (or vector) of parameters, one for each variable in X (which is a matrix of observations). The variables in X are observed, by assumption.
- η_{it} is a random error tem. This reflects anything not captured by the other terms including errors in measurement of variables.

2. Generally X_{it} includes binary or dummy variables indicating the area where the individual works, one for each area. If an individual works in that particular area in a year it is coded 1 and is coded zero otherwise. The corresponding coefficients β give the regional pay premia of standardised spatial wage differentials. If β is estimated by standard OLS regression using a cross-section of data (the method used at the moment) then the estimates will be unbiased only if the composite error term $\alpha_i + \eta_{it}$ is uncorrelated with X_{it}, but this is not necessarily invariably the case. The method of fixed effects addresses this problem by, effectively, allowing the intercept in the equation to differ between individuals.

3. By comparing the same individuals over-time it is possible to effectively 'net-out' those factors which are unobserved but fixed over time (this is analogous to comparing twins where the fixed genetic factors are controlled for). Use of a fixed effects model can therefore be argued to offer superior standardisation of characteristics influencing earnings and hence provide better estimates of area wage differentials. They allow account to be taken of fixed unobserved heterogeneity (ie α_i) – fixed effects between individuals, which are not explicitly measured in the available data.

4. Green (1997) notes that the fixed effects model is a reasonable approach when we can be confident that the differences between individuals can be viewed as parametric shifts of the regression function. This model might be viewed as applying only to the cross sectional units within the study, not to additional ones outside the sample. In other settings, it might be more appropriate to view the individual specific constant

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[35] This section draws heavily on a '*Report of Advisory Committee on the use of Fixed Effects Methods in Area Cost Adjustment'* By K. Denny & I. Preston June 1998

terms as randomly distributed across cross sectional units. This would be more appropriate if we believed that the sampled cross sectional units were drawn from a large population, rather than being exhaustive of all the available cross sectional units. This random effects specification can be formulated as follows:

$$y_{it} = \alpha + \upsilon i + \beta X_{it} + \eta_{it}$$

The component μ_i is the random disturbance characterizing the ith individual. The choice between the alternative fixed effects and random effects specification is considered below in Annex C.

5. The estimation process can be implemented in several entirely equivalent ways. For example, a dummy variable can be included in the regression for each individual in the sample. In practice this is usually impractical since with large data sets such as the NESPD, this would imply too many regressors for the standard econometric package to cope with. Equivalently, rather than focussing on the original cross-sectional data, one can one can operate with first differences over time for those individuals who appear in the panel for more than a single time period. Alternatively, the fixed effects can be "swept out" by taking differences of all variables from individual means over time and applying regression methods to the resulting data. The latter is the procedure used in most econometric packages.

Annex C: The Relative Merits of Fixed Effects, Random Effects and Cross-sectional Approaches[36]

(1) Random versus Fixed Effects Approaches

Although the Random effects method (as set out in Annex B)) offers the possibility of some improvements compared to the fixed effects method, these are probably more theoretical than practical. In particular, there are two quite strong arguments against using a random effects model with the NESPD.

(a) Bias
The random effects model is more efficient than fixed effects only if the unobserved individual effects are uncorrelated with the observed regressors. There is no *a priori* reason to believe that this is the case with the NESPD. Although this has a quite limited set of potential explanatory variables, it seems more than likely that these will be correlated with unobserved individual effects (for example, formal qualifications held (not observed) and occupation (observed)). If the correlation is in fact non-zero, then the fixed effects estimator is inefficient but consistent, whereas the random effects estimator is inconsistent

(b) Heteroscedasticity
The NESPD is a not a balanced panel. The number of observations on each individual is highly variable. This poses no particular problems for the fixed effects estimator, but in the random effects case it means that the estimator of the regression variance is biased due to heteroscedasticity in the variance components. For this not to be a problem requires that the length of time an individual is present in the panel is randomly distributed (see Green's *Econometric Analysis* (1997, p 578). This seems to be unlikely in the case of the NESPD.

(2) Measurement Error and the advantages of the fixed effects approach compared to cross-sectional estimates

The possibility of measurement error in the NESPD also means that the supposed superiority of the fixed effects estimator compared to that from a simple cross-sectional analysis cannot be taken for granted.

It is generally assumed that fixed effects models are superior to cross-section models because, unlike cross-sectional estimators, they can take account of unobserved heterogeneity. However there is an important qualification to this conclusion which should be borne in mind if there are potential problems of measurement error in the data set.

Suppose there is measurement error of the form:

$$x^* = x + e$$

where x^* is the observed regressor, x is the true value and e is a white noise error with variance σ^2_e. Then the probability limit of the cross-sectional estimator is:

$$plim(\beta_c) = [\beta m_{xx} + cov(x\alpha)]/[m_{xx} + \sigma^2_e] \qquad (1)$$

whereas if we take the simplest panel estimator – a first difference model – the probability limit is given by

[36] This Annex is based on correspondence from David Bell.

$$plim(\beta_F) = \beta m_{Dx} /[m_{Dx} + \sigma^2_{De}] \qquad (2)$$

The cross-sectional estimator has two sources of bias: (a) that cause by the covariance of the fixed effects and the regressors - $cov(x\alpha)$; and (b) the variance of the measurement error - σ^2_e. The first difference estimator has only one source of bias, namely that caused by the measurement errors. The relevant variance here, however is the variance of the *first difference* of the measurement errors - σ^2_{De}, just as the relevant variance for the true regressors is the variance in their *first differences* - m_{Dx} – rather than the variance in their levels - m_{xx}.

The cross-sectional estimator therefore has two, rather than one, source of bias in the presence of measurement error. However, it is not obvious that the fixed effect estimator is invariably preferable to the cross-sectional one. A key factor determining the relative bias in the two estimators, is the size of the variation in the true x's and the measurement errors, compared with the relative sizes of the variation in the *differences* in these quantities[37]. If the regressors do not change very much across individuals through time, as is often the case with panels (including the NESPD), then the ratio of the variances m_{Dx} /σ^2_{De} will be small compared to m_{xx} /σ^2_e . As a consequence, the estimates based on first differences may be more heavily attenuated (biased towards zero) than the cross-sectional estimates. This argument carries over quite simply from the first-difference to the fixed-effects version of the panel estimator.

It seems quite reasonable to assume that there is a significant amount of measurement error in the NESPD. This raises some doubts, therefore, about the extent to which the reduction in the estimated SSWDs based on the fixed effect method (compared to the cross-sectional estimates) reflect the true SSWDs.

[37] Conditional on the problems caused by the covariances of the fixed effects and the regressors.

Annex D: Review of Methods and Approaches to Resource Allocation across Spatial Areas

D.1 Introduction

This Annex presents a brief review of recent research on the methods and approaches used to allocate public resources across spatial areas. It focuses on the issue of differences in labour market costs. This represents a key component in Task 1 of the project specification agreed with the Department of Health, which was set out in the original project proposal (Wilson, 2001).

Following this brief introduction, Section D2 provides some general background. Section D3 then reviews the methods used to allocate resources to local authorities. Sections D4-D6 provide some other examples.

D.2 Background

A number of exercises have been undertaken to assess the most appropriate methods for allocating government resources to compensate for geographical differences in wage rates. This section provides a brief review of some of the methods that have been adopted for calculating the "geographical" element of earnings differentials. These focus on the differences that remain, having taken account of differences in the composition of the workforce in different areas.

There are broadly two types of approach:

1) a "specific cost" approach based on the actual pay of workers in the sector being studied;
2) a "general labour market" approach based on external data.

Intuitively, the *specific cost approach* has considerable appeal. It requires information on the differences in earnings across spatial areas needed to pay for staff of similar quality. Data on individual wage rates for the sector under consideration would be ideal, but are rarely obtainable. Even where such data do exist, they are rarely sufficiently complete to ensure that the point about equal quality of staff is met.

The *general labour market approach* assumes that workers in the sector under consideration can be regarded as operating in the overall labour market, and that public sector employers face the same market pressures as other employers in trying to recruit and retain its workers. In this case, evidence of the pay (e.g. from the New Earnings Survey or Labour Force Survey) of a large sample of workers will be provide an accurate indication of the pay rates necessary to compensate staff for the disamenities of working in particular areas.

A number of studies have been undertaken of these issues in the UK and elsewhere in recent years. These include major reviews conducted for the Department of the Environment and Transport relating to the so called Area Cost Adjustment (NERA, 1996; Elliott *et al*., 1996; DETR, 1998), as well as more specific studies concerned with the Police and teaching staff in further education. However, it is considered by DETR that no new ground breaking work of a methodological nature has been undertaken in the last 2-3 years[38].

[38] Personal communication with Joe Beeley (DETR).

These results tend to confirm the basic ideas underlying the development of the Standardised Spatial Wage Differentials for the NHS (and the corresponding Regional Pay Premia advocated by Professor Elliott in the context of the allocation of Local Authority funding). These ideas suggest that general labour market forces will tend to force employers to compensate their employees for working in less attractive areas. Even where there are rigid national pay scales, such forces will lead to employers making use of overtime, accelerated promotion and other mechanisms to pay their staff more where conditions are less attractive. If these factors are insufficient, the employer will bear the burden in other ways such as greater staff wastage or lower average quality of staff (*ceteris paribus*).

D.3 An example of a general labour market approach: the Area Cost Adjustment for Local Authorities in England

Central government funding of local authorities in England is based on a set of Standard Spending Assessments (SSAs) for the various "service blocks". The bulk of SSA calculations are concerned with differences in costs incurred in producing a common level of service which arise because of differences in the volume of inputs required to produce a given output. This cost differential could be because of different structural factors (e.g. distance and traffic congestion affect travel times and therefore contact time per client) or client factors (e.g. a multi-ethnic community may require information to be circulated in several languages other than English). In the context of the SSA, the area cost adjustment (ACA) is intended to reflect differentials in the cost of inputs between local authorities. The ACA takes the form of a multiplier applied at the end of each SSA formula (but before scaling to fit the appropriate control total)[39], with different ACA factors for each SSA block, depending on the extent to which costs are deemed to relate to labour or rates. Since most local authority activities are heavily labour-intensive, the bulk of the ACA is labour-related. The ACA distributes £1.6 billion to the South East, £550 million of which was to local authorities outside London.

The most relevant part of the ACA for this paper is the Labour Cost Adjustment (LCA) factor, which compensates local authorities for the cost of employing staff. The LCA adopts a 'general labour market' approach, the underlying rationale of which is that local authorities have to compete for staff with other potential employers. Hence, in order to secure and retain various categories of staff of a given quality, they will need to pay the local 'going rate'. This is measured by comparing regional rates of pay in relevant occupations for a wide range of employees in both the public and private sectors.

[39] The multiplier does not apply to police and fire pensions or to rent allowance payments, flood defence or capital financing

Table D.1: Occupational groups and weights used in the calculation of the area cost adjustment, 1997/98

SOC occupation group	Males	Females
1a Corporate managers and administrators	19.8%	7.0%
2c Teaching professionals	3.6%	5.1%
2d Other professional occupations	3.2%	1.8%
4a Clerical occupations	11.1%	17.9%
4b Secretarial occupations	0	7.6%
6a Protective service occupations	3.6%	0
6b Personal service occupations	3.4%	5.6%
9b Other elementary occupations	8.0%	2.2%
TOTAL	**52.8%**	**47.2%**

The LCA calculations make use of wage rates for full-time employees from the New Earnings Survey, for selected occupational groups (broken down by gender) which are considered relevant to the local authority employment market (Table D.1). Where data for a given occupation is missing, the population-weighted average for the relevant LCA class of authority is inserted[40].

The basic approach to calculating the LCA is as follows:

- calculate a 'standard wage' for each zone, which is the average wage for the area if it had the national mix of the occupational groups used for ACA purposes. The standard wage is therefore the sum of the sample wage data for each occupational group multiplied by the national weight for that group.
- calculate a population-weighted average wage for each ACA zone by taking the sum of the standard wage multiplied by the relevant authority's population estimate, and then dividing this sum by the total population for that ACA zone.
- calculate wage relativities by dividing the weighted standard wages for each ACA zone by the weighted standard wage for the rest of England.

A series of scaling factors are applied in order to produce a reasonably smooth progression of standard wages over space[41] (particularly for the ‘inner fringe’ and ‘outer fringe’ areas and the ‘other South East districts’).

Only in London and the Rest of the South East do employers face employment costs which are consistently and significantly higher than the national average. The LCA measures the ratio between average wage rates in each of six zones in the South East (identified in Table D.2), as compared with those in the rest of the country.

Table D.2: Labour cost adjustment (LCA) zones

London	**Rest of the south-east**
- City of London;	- `inner fringe area';
- inner London boroughs;	- `outer fringe area'; and
- outer London boroughs;	- `other south-east districts'

40 The area cost adjustment classes’ are: the City of London, Inner London Boroughs, Outer London Boroughs, the rest of the south-east and the rest of England. Thus, if there was a missing value for Kensington and Chelsea in a particular occupational group, it would be replaced by the Inner London Boroughs’ population-weighted average for that occupational group. For the City of London, the average for Inner London, inflated by 25 per cent, is used.

41 Particularly for the Rest of the South East.

The ACA probably gives rise to more debate than any other SSA issue (ACT, 2001). This is because modelling price differentials depends to a great extent on which theories regarding the way local authorities interact with the wider economy are held to be appropriate. For example, there are differing views regarding:

- the extent to which local authority employees respond to changes in the labour market by moving into the private sector within the same region, rather than staying within the public sector but changing regions,
- how regions are defined, and
- the extent of sub-regional effects.

The ACA was criticised in a debate in the House of Commons (Hansard, 1997) on two grounds. First, that it assumed there were no differences in cost between local authorities outside the boundaries of London and the Rest of the South East. Secondly, the phenomenon of "cliff-edges" had been created whereby adjoining authorities, perceived to have similar labour markets with comparable cost levels, received markedly different labour cost adjustments.

In another debate in January 2001 (Hansard, 2001), Andrew Lansley (MP for South Cambridgeshire) raised the problem of authorities being over-compensated by the LCA, where they were compensated for higher labour costs in their area, but were paying their staff on national rates. Using data on the cost of living, Lansley remarked that "..it is nonsense to suggest that Bedfordshire has higher labour costs than south Cambridgeshire. In fact, the reverse is the case. So, year after year, Cambridgeshire has to spend more than its SSA, which suggests that it is a higher spending authority; but, in fact, its services are being chronically underfunded because of the SSA's departure from reality" (Hansard, 2001).

A review of the ACA was initiated by in response to the complaint by many northern councils that it over-compensated authorities in London and south-east England. A number of weaknesses in the existing methodology had been identified:

- it was questioned whether the eight occupations used in the calculation represented the general labour market in a complete way
- the definition of Inner and Outer London areas was rather arbitrary
- standard wages were not controlled for many of the factors (age, education, length of services, etc) which affect wages in different areas.

This review (Elliott *et al.* [1996]) argued that the market for local authority labour is not discrete from the general labour market and therefore advocated the use of the general labour market approach. It concluded that Regional Pay Premiums could be identified using Labour Force Survey data adjusted for factors such as education, qualifications and the industrial or occupational make-up of an area and that this could be disaggregated to county level outside London.

The Conservative government did not pursue the Elliott review because of the need for further technical work, and because there was no consensus among the local authority associations. The Labour government commissioned two associated pieces of research, into generating the necessary data and on determining the appropriate geographical framework, but did not undertake research into the question of the interaction of national pay scales and local labour market conditions. Substantial adjustments towards local labour market conditions are undertaken by local authorities within national pay agreements, demonstrated by the way in which (within national pay scales) staff move between authorities. The Elliot review's advocacy of the county scale for adjustments has also been criticised on the grounds that this does not reflect intra-county variations in employment costs (e.g. south Cambridgeshire is affected by the London labour market, while wage rates in less accessible parts of the county are much lower)[42].

Under the Labour administration, the DETR conducted a thorough review of the calculation of the ACA before the 1999/2000 settlement. This investigated the use of a specific cost approach, involving considering the way in which local authorities have adapted national pay scales to their labour costs. In summer 1998, a set of 21 options for reform of the area cost adjustment were published, but no consensus could be reached on the preferred way forward.

D.3 Another example of the general labour market approach: The National Health Service Executive approach

The Department of Health distributes funds to the 100 health authorities in England based on a capitation formula which includes a staff Market Forces Factor (MFF). This capitation formula takes into account demand side indicators such as population size, age structure, health status and indicators of socio-economic conditions in each area. The MFF is intended to account for variations in staff costs across England. The current method of calculating the MFF is based on the approach recommended by Wilson *et al* (1996), following a detailed review of these issues.

Estimates of these labour cost factors are derived from a regression analysis of data from the New Earnings Survey (NES), with a wide range of individual characteristics included as explanatory variables. The regression model yields area wage differentials for seventy-eight groups of Health Authorities. A cut–off point designed is imposed for the lowest 28 Health Authorities, equivalent to the area where the "going rate" for labour equated with the NHS pay rate.

D.4 A US example of specific costs: The Area Wage Index of the Medicare Inpatient Hospital Prospective Payment System'

In the United States, hospital payment rates under the Medicare Prospective Payment System (PPS) are determined by adjusting the standardised amount for variations in the types of cases treated and area wage levels. The payment a hospital receives is determined by the costs of treating the type of case involved, adjusted to reflect area wage levels. An area wage index (AWI) has been created for each urban and rural labour market, which expresses the ratio between the average hourly hospital wages in an area and the national average hourly hospital wage.

The relative value of the wage index and its impact on payment are influenced by the percentage of the standardised amount associated with labour; the assignment of hospitals to labour market areas; and the occupational mix of employment in a given hospital used to calculate total hospital wages. The index has been criticised on the grounds that the wage index should measure only geographic differences in the salary scales of hospitals rather than

42 This suggests a need to use finer grained areas than counties in modelling work.

the average salaries paid by hospitals. The geographical areas used for calculating the wage index have also often been found to be ‘too large’ (i.e. too heterogeneous[43]).

D.5 Other British examples: estimating pay differentials in Further Education colleges (Maxwell Stamp plc)

The specific institutional approach aims to take into account the market imperfections inherent in public sector pay, by examining the actual pay of employees in an institution and relating this to the employee’s characteristics. The pay differences across regions are then used to calculate the labour cost adjustment factors. The supposed advantage of this approach is that it uses actual data rather than estimates based on general labour market indicators. The drawbacks to this approach are:

- First, the difficulty of obtaining institutional data and the fact that institutions may face perverse incentives if they are aware that the data they supply is a key factor in determining their funding allocation.
- Second, the fact that the wage differentials actually observed may be inadequate to compensate staff appropriately, with the consequence that there are unmeasured differences in staff quality, staff turnover and other non-wage costs.

A recent study of wage differentials for the Further Education Funding Council found a high positive correlation (r=0.88) between public and private sector wage differentials (Maxwell Stamp, 1999). However, this study also found that public sector area wage differentials tend to be lower than those in the private sector, and this factor will be stronger the more an institution is exposed to national wage scales or bargaining arrangements with unions.

This exercise used FEFC data on the total pay and individual characteristics (including age, gender, qualifications, ethnic origin, experience, training details and type of college) of college employees for 1994 to 1997. The data were converted into a set of 800 college averages and fed into a regression model which estimated the relationship between the log of average pay and individual and locational characteristics. The results reveal a strong London effect, with highest wage differentials in central London (where wages for a standard FE worker are a third higher than in the area of lowest wages), and high wages in inner and outer areas of London and the surrounding counties. Elsewhere in England, positive estimated wage differentials were discerned in the West Midlands and Greater Manchester.

D.6 Other British examples: estimating pay differentials for the Police and Teachers

Maxwell Stamp plc have also estimated a set of salary differentials for each of the police force areas in England and Wales (Maxwell Stamp, 1999). Taking into account differences in age, gender and number of years in the service, the estimates indicate a spatial gradient in earnings. Officers serving in the City of London, Metropolitan, Thames Valley and Leicestershire Police Services, enjoy salary premia of 9.8 per cent, 7.8 per cent, 3.8 per cent and 3.7 per cent respectively relative to Cornwall. These differences are further magnified if housing allowances are taken into account. Therefore, even in an environment where regional pay variation is deliberately suppressed through a rigid national pay scale, there still remains evidence of police authorities in some areas paying more for a comparable worker than in others.

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43 This is the same point raised in relation to the variation in local labour market conditions across Cambridgeshire.

This is confirmed by another study, in which regression analysis was used to estimate standardised salary differentials for teachers in England. This revealed pay rates to be on average 16 per cent higher in Inner London and 10 per cent higher in Outer London than those of the lowest salary area (Cleveland). As in the case of police officers, teachers are paid according to national wage scales.

In both cases the spatial differentials estimated fail to deal with the issues of quality or staff, turnover and other costs, which may differ significantly between areas if the spatial differentials fail to fully compensate the employees for working in less attractive areas.

Annex E: The Effects of 'Premature Ageing' upon Standardised Spatial Wage Differentials.

This annex considers the influence of the age inconsistencies within the NESPD upon the estimation of Standardised Spatial Wage Differentials. As outlined in Section 1, approximately half of those people who appeared in the panel during 1999 and 2000 registered an increase in age of 2 years. It must be assumed therefore that some of the new entrants into the NESPD 2000 may well have the 'wrong' age. If the age variable is measured with error, then OLS estimates of all the coefficients contained within the model (not just those on the age variables) will be biased, as the explanatory variables are no longer independent of the error process. Whilst it is possible to correct the ages of those who appeared within the panel previously, it is not possible to identify and correct for possible premature ageing amongst the 2000 entrants.

The impact of measurement error in the age variable upon the estimates of the SSWDs is considered through the results of 2 sets of additional regressions. The standard cross sectional estimates are based upon a sample of approximately 66,000 individuals who appeared within the NES in 2000 and who met the standard inclusion criteria set out in Section 1. The additional regressions presented here focus upon approximately 52,000 of these people who also appeared within the NESPD during 1999. Two sets of additional regression can therefore be estimated, based upon (a) the original specification of the age variable and (b) an age variable corrected for premature ageing. The values of SSWDs based upon these 2 specifications of the age variable are presented in Table E.1. The specification of the model is otherwise identical to that used to produce the annual update of the SSWDs presented in Section 2.3.

In considering the sizes of the coefficients on the age dummy variables, the impact of premature ageing will have the largest impact upon the size of the estimated area coefficient in cases where an individual is recorded as being aged 25 when in fact they are actually aged 24. This measurement error would result in an individual moving from the 16 to 24 age category and into the 25 to 34 age category. Estimates indicate that this movement would be associated within an increase in hourly earnings of 28%. This is the largest estimated change in earnings that occurs as a result of progression to an adjacent age band. If a significant number of people within an area are incorrectly allocated to the 25 to 34 age range, this could lead to a reduction in the size of the estimated SSWD. Wage premiums paid to compensate employees for living within a certain area would instead be attributed to their age. A smaller increase in earnings is associated with a movement from the 25 to 34 age category into the 35 to 44 age category, whilst reductions in earnings are associated with movements to higher age categories amongst older workers.

Considering the results for the Scheme A areas in Table E.1, it can be seen that the measurement error within the age variable does not generally lead to large changes in the size of estimated coefficients and their associated SSWDs. This is confirmed for the area coefficients based upon the Scheme I area definitions where it can be seen that incorporation of the corrected age variable generally has a minimal effect upon the size of the estimated coefficients. However, some significant variations are observed for Hackney, Bexley and Merton. In particular, secondary analysis of the NESPD indicated that Hackney had an unusually high proportion of employees who were aged 25 at the time of the survey. This points towards premature ageing as an explanation of the large fall in the estimated SSWD for Hackney presented in table 4.3. However, apart from this obvious case, it is difficult to identify clearly problems of premature ageing by secondary analysis of the data. It is concluded that the error in the treatment of age in the NESPD for 2000 has not had a significant impact on the estimated SSWDs.

Table E.1 Age Specification and SSWDs

Original Age Variable			Corrected Age Variable			Effect of premature ageing upon SSWD
NES Area	Coefficient	SSWD	NES Area	Coefficient	SSWD	
Outer London	-0.14	-13.07	Outer London	-0.142	-13.197	0.127
Rest of South East	-0.191	-17.409	Rest of South East	-0.194	-17.617	0.208
Rest of England	-0.275	-24.035	Rest of England	-0.278	-24.247	0.212
Hackney	0.03	3.082	Hackney	0.039	3.999	-0.917
Bexley	-0.116	-10.911	Bexley	-0.108	-10.208	-0.703
Southwark	0.098	10.279	Southwark	0.101	10.639	-0.36
Tower Hamlets	0.206	22.859	Tower Hamlets	0.208	23.172	-0.313
City of Westminster	0.174	19.042	City of Westminster	0.177	19.328	-0.286
Hounslow	0.042	4.279	Hounslow	0.045	4.562	-0.283
Lambeth	0.091	9.516	Lambeth	0.093	9.79	-0.274
Hammersmith	0.045	4.615	Hammersmith	0.048	4.885	-0.27
Sutton	-0.074	-7.103	Sutton	-0.071	-6.859	-0.244
Brent	-0.035	-3.448	Brent	-0.033	-3.231	-0.217
Barnet	-0.032	-3.128	Barnet	-0.03	-2.934	-0.194
Greenwich	-0.032	-3.184	Greenwich	-0.031	-3.051	-0.133
Harrow	-0.06	-5.828	Harrow	-0.059	-5.704	-0.124
Lancashire	-0.196	-17.817	Lancashire	-0.195	-17.737	-0.08
Camden	0.118	12.511	Camden	0.118	12.577	-0.066
Berkshire	0.004	0.432	Berkshire	0.005	0.486	-0.054
Islington	0.113	11.941	Islington	0.113	11.995	-0.054
Ealing	0.021	2.16	Ealing	0.022	2.213	-0.053
Staffordshire	-0.21	-18.943	Staffordshire	-0.21	-18.913	-0.03
Cleveland	-0.131	-12.288	Cleveland	-0.131	-12.291	0.003
Bedfordshire	-0.117	-11.012	Bedfordshire	-0.117	-11.019	0.007
Bromley	-0.077	-7.395	Bromley	-0.077	-7.406	0.011
Devon	-0.249	-22.061	Devon	-0.249	-22.077	0.016
Hillingdon	0.03	3.078	Hillingdon	0.03	3.05	0.028
Buckinghamshire	-0.071	-6.834	Buckinghamshire	-0.071	-6.864	0.03
Kensington & Chelsea	0.095	9.915	Kensington & Chelsea	0.094	9.881	0.034
Greater Manchester	-0.148	-13.777	Greater Manchester	-0.149	-13.816	0.039
North Yorkshire	-0.17	-15.663	North Yorkshire	-0.171	-15.712	0.049
Hertfordshire	-0.052	-5.106	Hertfordshire	-0.053	-5.166	0.06
Nottinghamshire	-0.193	-17.517	Nottinghamshire	-0.193	-17.58	0.063
Durham	-0.232	-20.728	Durham	-0.233	-20.794	0.066
Cornwall	-0.276	-24.104	Cornwall	-0.277	-24.173	0.069
Oxfordshire	-0.061	-5.894	Oxfordshire	-0.061	-5.964	0.07
Merseyside	-0.145	-13.539	Merseyside	-0.146	-13.616	0.077

Table E.1 Age Specification and SSWDs (continued)

Original Age Variable			Corrected Age Variable			Effect of premature ageing upon SSWD
NES Area	Coefficient	SSWD	NES Area	Coefficient	SSWD	
Leicestershire	-0.17	-15.656	Leicestershire	-0.171	-15.736	0.08
West Sussex	-0.108	-10.197	West Sussex	-0.108	-10.279	0.082
Surrey	0.002	0.2	Surrey	0.001	0.114	0.086
Croydon	-0.062	-6.026	Croydon	-0.063	-6.123	0.097
Hampshire	-0.106	-10.059	Hampshire	-0.107	-10.157	0.098
West Yorkshire	-0.162	-14.919	West Yorkshire	-0.163	-15.018	0.099
Northumberland	-0.2	-18.122	Northumberland	-0.201	-18.223	0.101
Cheshire	-0.145	-13.481	Cheshire	-0.146	-13.59	0.109
Humberside	-0.2	-18.164	Humberside	-0.202	-18.274	0.11
Hereford & Worcester	-0.19	-17.331	Hereford & Worcester	-0.192	-17.442	0.111
Kingston-on-Thames	-0.032	-3.122	Kingston-on-Thames	-0.033	-3.234	0.112
Shropshire	-0.2	-18.09	Shropshire	-0.201	-18.205	0.115
Haringey	-0.115	-10.868	Haringey	-0.116	-10.983	0.115
Lincolnshire	-0.209	-18.853	Lincolnshire	-0.21	-18.974	0.121
Cumbria	-0.2	-18.094	Cumbria	-0.201	-18.218	0.124
Lewisham	-0.038	-3.756	Lewisham	-0.04	-3.886	0.13
Northamptonshire	-0.126	-11.829	Northamptonshire	-0.127	-11.963	0.134
West Midlands	-0.15	-13.923	West Midlands	-0.152	-14.06	0.137
Cambridgeshire	-0.107	-10.109	Cambridgeshire	-0.108	-10.247	0.138
Newham	-0.041	-4.039	Newham	-0.043	-4.177	0.138
Somerset	-0.198	-17.948	Somerset	-0.2	-18.092	0.144
Derbyshire	-0.187	-17.016	Derbyshire	-0.188	-17.16	0.144
Richmond-on-Thames	0.031	3.13	Richmond-on-Thames	0.029	2.984	0.146
East Sussex	-0.16	-14.772	East Sussex	-0.162	-14.922	0.15
Kent	-0.124	-11.641	Kent	-0.126	-11.797	0.156
Avon	-0.116	-10.944	Avon	-0.118	-11.101	0.157
Dorset	-0.179	-16.413	Dorset	-0.181	-16.58	0.167
Wiltshire	-0.115	-10.905	Wiltshire	-0.117	-11.075	0.17
Tyne & Wear	-0.155	-14.387	Tyne & Wear	-0.158	-14.577	0.19
South Yorkshire	-0.189	-17.233	South Yorkshire	-0.191	-17.424	0.191
Essex	-0.12	-11.344	Essex	-0.123	-11.537	0.193
Redbridge	-0.062	-6.027	Redbridge	-0.064	-6.23	0.203
Warwickshire	-0.124	-11.647	Warwickshire	-0.126	-11.86	0.213
Gloucestershire	-0.125	-11.726	Gloucestershire	-0.127	-11.941	0.215
Norfolk	-0.174	-16	Norfolk	-0.177	-16.221	0.221
Suffolk	-0.179	-16.403	Suffolk	-0.182	-16.627	0.224
Enfield	-0.018	-1.825	Enfield	-0.021	-2.07	0.245
Havering	-0.141	-13.165	Havering	-0.144	-13.421	0.256
Isle of Wight	-0.185	-16.928	Isle of Wight	-0.189	-17.229	0.301
Waltham Forest	-0.058	-5.671	Waltham Forest	-0.062	-6.034	0.363
Wandsworth	-0.014	-1.362	Wandsworth	-0.018	-1.752	0.39
Merton	-0.083	-7.942	Merton	-0.089	-8.49	0.548

Annex F: NES Area Codes and Zones

Scheme A	Zones	
		NES areas (pre 1998)
Area 1	Inner London	01, 07, 12, 13, 14, 19, 20, 22, 23, 25, 28, 30, 32, 33
Area 2	Outer London	02 – 11, 15, 16, 17, 18, 21, 24, 26, 27, 29, 31
Area 3	Rest of South East	34 – 45
Area 4	Rest of England	46 – 60, 62 - 79

NESPD 2000 area codes (119 areas)

1	Tyne and Wear MC
2	Darlington
3	Durham
4	Hartlepool
5	Middlesbrough
6	Northumberland
7	Redcar and Cleveland
8	Stockton-on-Tees
9	Greater Manchester MC
10	Halton
11	Warrington
12	Cheshire
13	Cumbria
14	Blackburn with Darwen
15	Blackpool
16	Lancashire
17	Merseyside
18	South Yorkshire MC
19	West Yorkshire MC
20	East Riding of Yorkshire
21	Kingston upon Hull
22	North East Lincolnshire
23	North Lincolnshire
24	York
25	North Yorkshire
26	Derby
27	Derbyshire
28	Leicester
29	Rutland
30	Leicestershire
31	Lincolnshire
32	Northamptonshire
33	Nottingham
34	Nottinghamshire
35	West Midlands MC
36	Herefordshire
37	Worcestershire
38	Telford and Wrekin
39	Shropshire
40	Stoke-on-Trent
41	Staffordshire
42	Warwickshire
43	Bath and North East Somerset
44	Bristol, City of
45	North Somerset
46	South Gloucestershire
47	Cornwall
48	Plymouth
49	Torbay
50	Devon
51	Bournemouth
52	Poole
53	Dorset

54	Gloucestershire
55	Somerset
56	Swindon
57	Wiltshire
58	Luton
59	Bedfordshire
60	Peterborough
61	Cambridgeshire
62	Southend-on-Sea
63	Thurrock
64	Essex
65	Hertfordshire
66	Norfolk
67	Suffolk
68	City of London
69	Barking and Dagenham
70	Barnet
71	Bexley
72	Brent
73	Bromley
74	Camden
75	Croydon
76	Ealing
77	Enfield
78	Greenwich
79	Hackney
80	Hammersmith and Fulham
81	Haringey
82	Harrow
83	Havering
84	Hillingdon
85	Hounslow
86	Islington
87	Kensington and Chelsea
88	Kingston upon Thames
89	Lambeth
90	Lewisham
91	Merton
92	Newham
93	Redbridge
94	Richmond upon Thames
95	Southwark
96	Sutton
97	Tower Hamlets
98	Waltham Forest
99	Wandsworth
100	City of Westminster
101	Bracknell Forest
102	Newbury
103	Reading
104	Slough
105	Windsor and Maidenhead
106	Wokingham
107	Brighton and Hove
108	East Sussex

109	Milton Keynes
110	Buckinghamshire
111	Portsmouth
112	Southampton
113	Hampshire
114	Isle of Wight
115	Medway Towns
116	Kent
117	Oxfordshire
118	Surrey
119	West Sussex

Matching new and old spatial codes

1996 code	1997 code			1998/99/00 codes					
3 Barnet	58			70					
4 Bexley	59			71					
5 Brent	60			72					
6 Bromley	61			73					
7 Camden	62			74					
8 Croydon	63			75					
9 Ealing	64			76					
10 Enfield	65			77					
11 Greenwich	66			78					
12 Hackney	67			79					
13 Hammersmith	68			80					
14 Haringey	69			81					
15 Harrow	70			82					
16 Havering	71			83					
17 Hillingdon	72			84					
18 Hounslow	73			85					
19 Islington	74			86					
20 Kensington & Chelsea	75			87					
21 Kingston-on-Thames	76			88					
22 Lambeth	77			89					
23 Lewisham	78			90					
24 Merton	79			91					
25 Newham	80			92					
26 Redbridge	81			93					
27 Richmond-on-Thames	82			94					
28 Southwark	83			95					
29 Sutton	84			96					
30 Tower Hamlets	85			97					
31 Waltham Forest	86			98					
32 Wandsworth	87			99					
33 City of Westminster	88			100					
34 Bedfordshire	49	53		58	59				
35 Berkshire	89			101	102	103	104	105	106
36 Buckinghamshire	91	96		109	110				
37 East Sussex	90	92		107	108				
38 Essex	51			62	63	64			
39 Hampshire	93	98	99	111	112	113			
40 Hertfordshire	52			65					
41 Isle of Wight	94			114					
42 Kent	95			115	116				
43 Oxfordshire	97			117					
44 Surrey	100			118					
45 West Sussex	101			119					
46 Cambridgeshire	50			60	61				
47 Norfolk	54			66					
48 Suffolk	55			67					
49 Avon	36	37		43	44				
50 Cornwall	41			47					
51 Devon	42			48	49	50			
52 Dorset	40	43	45	51	52	53			
53 Gloucestershire	39	44		46	54				

Matching new and old spatial codes

1996 code	1997 code				1998/99/00 codes			
54 Somerset	38	46			45	55		
55 Wiltshire	47	48			56	57		
56 West Midlands	30				35			
57 Hereford & Worcester	31				36	37		
58 Shropshire	32				38	39		
59 Staffordshire	33	34			40	41		
60 Warwickshire	35				42			
62 Derbyshire	22	23			26	27		
63 Leicestershire	24	25	29		28	29	30	
64 Lincolnshire	18	19	26		22	23	31	
65 Northamptonshire	27				32			
66 Nottinghamshire	28				33	34		
67 South Yorkshire	14				18			
68 West Yorkshire	15				19			
69 Humberside	16	17			20	21		
70 North Yorkshire	20	21			24	25		
71 Greater Manchester	9				9			
72 Merseyside	13				17			
73 Cheshire	10				10	11	12	
74 Lancashire	12				14	15	16	
75 Tyne & Wear	1				1			
76 Cleveland	4	5	7	8	4	5	7	8
77 Cumbria	11				13			
78 Durham	2	3			2	3		
79 Northumberland	6				6			

Annex G: Dealing with the Problem of Boundary Changes

The spatial analysis undertaken during this project was complicated by the large number of local government boundary changes which have taken place since 1996. Post-1974 local authorities and counties have been re-organised into unitary authorities and two-tier authorities in three separate waves. There has been some difficulty in integrating data sets collected on a post-1974 local authority basis with those available for unitary authorities, because the number of unitary authorities changed from year to year in the late 1990s, and there was no definitive source of information on how local authority boundaries related to unitary authority boundaries for any given year. In the majority of cases, entire local authorities were re-designated as unitary authorities, or two or more local authorities merged to form a new unitary authority. However, there were more complex boundary changes in some areas, notably around York and in South Humberside. This was a particular problem in allocating 1991 Census Enumeration Districts to unitary authorities, for the purpose of calculating the population-weighted geographical centroid of each area. Census areas were "best-fitted" into unitary authority areas, and minor boundary changes were ignored.

The analysis based on 1996 New Earnings Survey (NES) areas was little affected by boundary changes, since these areas were composed of post-1974 counties and London Boroughs. Only very minor boundary changes occurred within London and all the changes outside London took place within post-1974 county boundaries, and hence data for unitary authorities could be easily re-aggregated to the 79 NES zones. The main problem with the analysis based on 1998 NES areas (the 119 zones) was that digital boundary data are not readily available for these areas. Digital boundary data are needed in order for the neighbours of each NES zone to be identified and the lengths of their common boundaries to be calculated. Boundary data was generated for the 119 NES zones by aggregating boundaries for the 354 unitary authorities (available from the UKBORDERS service) before the spatial analysis could be undertaken.

Annex H: The "Smoothing" Methodology

a) *Spatial means:* The simplest smoothing method was to calculate the average of the SSWD for each NES area (Z_i) and its neighbours. SSWD values were summed across these areas and divided by the number of areas involved (k); if a NES area had four neighbours, the sum would be divided by 5. Thus, the calculation is as follows:

$$Z_i = \left(\sum_{j=1}^{k} SSWD_j \right) \div k$$

The weighted version of this calculation uses mid-2000 population for each area (P_j) as follows:

$$Z_i = \left(\sum_{j=1}^{k} SSWD_j \times P_j \right) \div \sum_{j=1}^{k} P_j$$

b) *Means weighted by contiguity:* In this method, the SSWD for an area was averaged across itself and its k neighbours, with the contribution made by each to the calculation weighted by the proportion of the land boundary of the NES area (C_j). The calculation is as follows:

$$Z_i = \left[SSWD_i + \left(\sum_{j=1}^{k} SSWD_j \times C_j \right) \right] \div 2$$

The population weighted version of the calculation is:

$$Z_i = \left[(SSWD_i \times P_i) + \left(\sum_{j=1}^{k} (SSWD_j \times P_j) \times C_j \right) \right] \div \left(P_i + \sum_{j=1}^{k} P_j \right)$$

c) *Means weighted by distance:* This method produces an average SSWD for a NES zone and its k neighbours by weighting the contribution of each neighbour to the calculation by the inverse of the distance (d_{ij}) between its geographical centroid and that of the area for which the calculation is being made[44]*:*

$$Z_i = \left[\left(SSWD_i \times \left(\frac{1}{d_{ii}} \right) \right) + \left(\sum_{j=1}^{k} SSWD_j \div \left(\frac{1}{d_{ij}} \right) \right) \right] \div \left(\left(\frac{1}{d_{ii}} \right) + \sum_{j=1}^{k} \left(\frac{1}{d_{ij}} \right) \right)$$

The calculation for the population-weighted version of this measure is:

$$Z_i = \left[\left((SSWD_i \times P_i) \times \left(\frac{1}{d_{ii}} \right) \right) + \left(\sum_{j=1}^{k} (SSWD_j \times P_j) \div \left(\frac{1}{d_{ij}} \right) \right) \right] \div \left(\left(\frac{1}{P_i \times d_{ii}} \right) + \sum_{j=1}^{k} \left(\frac{1}{P_j \times d_{ij}} \right) \right)$$

44 Distances are calculated by application of Pythagoras' Theorem to the x and y co-ordinates of each pair of centroids.

d) *Means weighted by distance squared:* The same calculations were used, with the square of distance substituted for distance:

$$Z_i = \left[\left(SSWD_i \times \left(\frac{1}{d^2_{ii}} \right) \right) + \left(\sum_{j=1}^{k} SSWD_j \div \left(\frac{1}{d^2_{ij}} \right) \right) \div \left(\left(\frac{1}{d^2_{ii}} \right) + \sum_{j=1}^{k} \left(\frac{1}{d^2_{ij}} \right) \right) \right.$$

The calculation for the population-weighted version of this measure is:

$$Z_i = \left[\left(\left(SSWD_i \times P_i \right) \times \left(\frac{1}{d^2_{ii}} \right) \right) + \left(\sum_{j=1}^{k} \left(SSWD_j \times P_j \right) \div \left(\frac{1}{d^2_{ij}} \right) \right) \div \left(\left(\frac{1}{P_i \times d^2_{ii}} \right) + \sum_{j=1}^{k} \left(\frac{1}{P_j \times d^2_{ij}} \right) \right) \right.$$

e) Mean Distance Travelled within a Zone

These calculations use an estimate of the mean distance (d_{ii}) from the centroid of the zone for which the calculation is being made to all points within the zone. This is calculated from the geographical area A_i of the zone, as follows:

$$d_{ii} = \left(\frac{A_i}{\pi} \right) \times 0.5$$