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**Conference Paper**

## UK Earnings Dispersion: An Industry And Regional Perspective.

40th Congress of the European Regional Science Association: "European Monetary Union and Regional Policy", August 29 - September 1, 2000, Barcelona, Spain

**Provided in Cooperation with:**

European Regional Science Association (ERSA)

*Suggested Citation:* Taylor, Karl Bernard (2000) : UK Earnings Dispersion: An Industry And Regional Perspective., 40th Congress of the European Regional Science Association: "European Monetary Union and Regional Policy", August 29 - September 1, 2000, Barcelona, Spain, European Regional Science Association (ERSA), Louvain-la-Neuve

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# UK earnings dispersion: An industry and regional perspective

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To be presented at the  
40<sup>th</sup> European Regional Science Association

***ABSTRACT** This paper looks at male earnings dispersion in the United Kingdom across industries and regions over a fifteen year period. After controlling for differing worker characteristics across the population; that part of earnings dispersion which cannot be explained by observable worker characteristics based upon micro data, is examined at the 90<sup>th</sup>-10<sup>th</sup>, 90<sup>th</sup>-50<sup>th</sup> and 50<sup>th</sup>-10<sup>th</sup> deciles both at the industry and regional level to assess the key themes dominate in the literature capable of explaining within-group earnings dispersion, namely: technological change; globalisation; female participation; immigration; and institutional changes.*

**J.E.L Classification J31**

## ***1. Introduction.***

Over the past two decades a number of studies have documented the relative decline in unskilled wages (Bound and Johnson, 1992; Katz and Murphy, 1992; Machin, 1996; and Berman, Bound and Machin, 1998). Since the relative supply of unskilled workers has also declined in recent years, the trends in relative wages are seen as evidence of a shift away from unskilled workers caused by an increase in relative demand for higher skilled labour.

A number of explanations exist to explain this relative demand change, the two most common being skill-biased technological change (Krueger, 1993; Haskel, 1999; Autor, Katz and Krueger, 1998; and Machin and Van Reenen, 1998) and the growth in international trade (Wood, 1994, 1998). Less common explanations apparent in the literature which focus on market forces, are the role of female participation and immigration. Both of these factors may increase the supply of relatively low skilled labour, and thus drive down the wages of low skilled workers. Alternatively, the impact of both changing female participation rates, and immigration is largely dependent upon the degree of substitutability for low skilled males. For example, if females or immigrants are substitutes to low skilled workers, then a rise in the supply of either leads to a fall in the demand for the lower skilled (Topel, 1997).

Aside from market force explanations, other authors have stressed the importance of labour market institutions, in particular trade unions, in shaping the way labour markets have responded to these changes in demand and supply (Freeman, 1993; Gregg and Machin, 1994; and Machin, 1997). Market force explanations can explain many of the similarities in the development of the wage structure, but are less illuminating when attempting to explain differences (Gottschalk and Smeeding, 1997). Most economies have been subjected to increased technological change and globalisation, yet only the United Kingdom and United States experienced substantial increases in earnings dispersion (Katz, Loveman and Blanchflower, 1995). Furthermore, recent evidence has indicated that those countries with lower levels of centralised bargaining, in particular the United States and the United Kingdom, have experienced widening earnings dispersion (Teulings and Hartog, 1998). Following the same logic different institutional changes across industries and regions over time may account for some of the trend in earnings dispersion.

Another influence upon wages apart from the market mechanism is the role of minimum wages upon earnings dispersion. Although Britain did not have a national

minimum wage (prior to 1999), up until 1992 Wage Councils set minimum wages in certain low paying industries – such as textiles and service sector industries. Over time the ratio of minimum pay rates to economy wide average wages fell from 0.48 in 1979 to 0.40 in 1992 (Aghion and Williamson, 1998) before Wage Councils were abolished in 1993. In the 1960s around 60 industries were covered but by 1993 the 26 remaining Wages Councils set minimum wages for approximately 3 million workers in low paid sectors. To the extent that pay set by the Wage Councils aided the low paid the decline in the value of the minimum wage relative to average wages could be seen as a reason for increasing earnings dispersion. Indeed, Machin and Manning (1994) estimated that over the 1970s and 1980s declining toughness of minimum wages – measured as the log of the ratio of the minimum wage to average wages known as a Kaitz index – could explain between 9 and 20 per cent of the rise in dispersion across sectors.

The contributions this paper makes are to examine a number of industries including the service sector – this adds to the existing literature which is predominantly for the manufacturing sector only – and also regions. Whilst the rise in earnings inequality at the UK level and manufacturing sector is now well documented (Gosling et al, 1994; Machin, 1996) and evidence is emerging on industrial earnings dispersion (Riley and Young, 1999; Taylor, 1999) there is no empirical evidence on regional earnings dispersion. This is somewhat of a surprise given the well documented North-South divide in wages (Blackaby and Manning, 1990). Part of this paper is devoted to answering the question of whether earnings dispersion has risen at similar rates across UK regions. Prior research on inequality has almost always assumed that workers can be pooled across regions in an attempt to identify sources of the increase in relative demand for skilled labour. A key part of the analysis which follows is the extent of integration of UK labour markets, that is are shocks to regions transmitted quickly throughout the economy or do different regions experience demand and supply for labour adjusting at different paces? Secondly, wage inequality is considered after controls have been made for observable skills in the form of education and occupation for each industry and region. This is deemed important in so far as previous studies typically take a measure of wage inequality to be a ratio of one decile to another or the standard deviation of earnings. However, such an approach assumes that skills are evenly distributed across different groups in the population. The third contribution is to assess any remaining dispersion at the industry and regional level in terms of technological change, trade intensity, female participation, immigration, institutional

and minimum wage changes. Previous work has typically considered only one or two of the explanations at once – not all simultaneously. The final contribution is that wage inequality is considered at different parts of the earnings distribution – the 90<sup>th</sup>-10<sup>th</sup>, 90<sup>th</sup>-50<sup>th</sup> and 50<sup>th</sup>-10<sup>th</sup> deciles to see whether the effect of technology etc. is the same across not only industries and regions but also across the distribution of earnings. The approach to assess the influence of such factors upon earnings dispersion takes place in two stages.

An innovative approach used in the following analysis is the two stage empirical approach adopted to analyse earnings dispersion. Initially, repeated cross sections of the annual General Household Survey are used to control for differences in earnings. Earnings differentials which may arise between individuals stemming from differences in experience, education, personal characteristics, region (industry). This enables earnings dispersion to be split into between-group and within-group components, following Schmitt (1995), Machin (1996<sup>a</sup>) and Taylor (1999). The between-group component is that explained by data available from the General Household Survey based upon individuals in the population, and arises due to changing returns to individual characteristics. Of potentially greater importance is the trend in within-group earnings dispersion over time, that is what can not be explained by the micro data. In the second stage, the analysis considers the role of globalisation, technological change, female participation, immigration and labour market institutions. Of particular interest is how each may have influenced the trend in within-group earnings dispersion over time in each industry and region. The analysis firstly pools the data across industries, secondly looks at the impact of the above in manufacturing, the service sector and other industries, thirdly the evolution of regional earnings dispersion is considered by pooling across regions, and finally the impact of the potential players is considered for the North and South of the UK separately. A two stage empirical methodology is deemed preferable due to the problems of pooling the data over time, because data upon individuals is used along with more aggregate industry/regional level data. Consequently, pooling could result in aggregation bias where estimates are downwardly biased (Moulton, 1986)

Section 2 introduces the empirical methodology used to decompose earnings dispersion into between-group and within-group components, and the method used to assess the importance of the dominant themes in the literature upon within-group earnings

dispersion. Section 3 considers the data required to undertake the analysis, followed by a presentation of the industry results in Section 4. Regional earnings dispersion is examined in Section 5, whilst conclusions are given in Section 6.

## ***2. Empirical Methodology.***

The empirical framework takes place in two steps. Firstly, micro data based upon the individual are used to control for differences across the population in experience, education, occupation, personal characteristics and regional location (or industry) – all of which may influence earnings. This enables earnings dispersion to be split into within-group and between-group components, following Juhn, Murphy and Pierce (1993). In the second step aggregate industry (regional) data is used to proxy market forces and institution change, in an attempt to explain the trend in within-group earnings dispersion over time.

### *Decomposing earnings dispersion into within- and between-group components*

One problem with existing studies is that the measure of dispersion used is typically a ratio of one relatively skilled group to a less skilled group, this raises the issue that any inference about determinants of dispersion assumes an equal distribution of human capital characteristics amongst groups of individuals. However, this is unlikely, and the approach taken compensates for this by deriving a measure of within-group earnings dispersion by industry and region free from the influence of measurable worker characteristics. A regression framework is used to control for specific individual characteristics (given as the vector  $X$  in equation 1, below) such as experience, colour, marital status, employment status, education, occupation and regional location (or industry). Under such a scenario within-group earnings dispersion can be seen as the dispersion of the residual from the regression (Juhn, Murphy and Pierce 1993), where a wider dispersion of the residuals shows greater earnings dispersion occurring within-groups. Such dispersion is important to understand, as the majority of earnings dispersion occurred within narrowly defined groups in the UK – Schmitt (1995), Machin (1996<sup>a</sup>) and Taylor (1999). The regressions are estimated cross sectionally over time, industry and region gaining a measure of within-group dispersion.

$$\text{Log}(Wages)_i = \mathbf{a}_i + \mathbf{m}_1 \text{Exp}_i + \mathbf{m}_2 \text{Exp}_i^2 + \mathbf{l} \text{Colour}_i + \mathbf{k} \text{Marital status}_i + \mathbf{y} \text{Job status}_i,$$

$$+ \mathbf{fEducation}_i + \mathbf{qOccupation}_i + \mathbf{gZ}_i + \mathbf{e}_i \equiv \mathbf{X}_i \mathbf{d} + \mathbf{e}_i \quad \forall j,r,t \quad (1)$$

$$\mathbf{e}_i \sim IID(0, \mathbf{s}^2)$$

Where *Exp* is experience entering as a quadratic, *Colour* is a non-white indicator, *Marital status* is given by a married dummy, *Job status* is defined by a part time dummy, *Education* is a vector of educational dummies, *Occupation* is a vector of occupational dummies and *Z* is a vector of regional or industry dummies. The interpretation given to the residual  $\mathbf{e}_i$  from an equation based upon the above, is that after controlling for personal characteristics, human capital endowments, occupation and regional location (or industry), remaining inequality can be referred to as within-group earnings dispersion. Within-group inequality in the  $j^{th}$  industry,  $r^{th}$  region at time  $t$  is given by the dispersion of the residual and is that part of wages which can not be explained by worker characteristics:

$$[D(\hat{\mathbf{e}}_p) / D(\hat{\mathbf{e}}_q)] \quad \forall j,r,t \quad (2)$$

where  $p$  is a higher decile than  $q$ , and a caveat indicates the coefficient is an estimate, thus  $\hat{\mathbf{w}}_i = \mathbf{X}_i \hat{\mathbf{d}}$  and  $\hat{\mathbf{e}}_i = \mathbf{w}_i - \hat{\mathbf{w}}_i \equiv \mathbf{X}_i (\mathbf{d} - \hat{\mathbf{d}})$ . We now have a scalar measure of within-group earnings dispersion for each industry, region and time period.

### Explaining trends in within-group earnings dispersion

The second stage of the analysis considers the possible sources of wage inequality over time across industries, regions and deciles. The general format for estimating the effects is as follows:

$$[D(\hat{\mathbf{e}}_p) / D(\hat{\mathbf{e}}_q)]_{gt} = \mathbf{a}_g + \mathbf{l}Technology_{gt} + \mathbf{g}Trade_{gt} + \mathbf{p}Institutional\ change_{gt} \\ + \mathbf{q}Kaitz\ index_{gt} + \mathbf{f}Female\ participation_{gt} + \mathbf{j}Immigration_{gt} + \mathbf{tQ}_{gt} + \mathbf{n}_{gt} \quad (3)$$

$$\mathbf{n}_{gt} \sim IID(0, \mathbf{s}^2)$$

Where  $g=j,r$  that is equation 3 is either pooled across  $j$  industries or across  $r$  regions, *Technology* represents technological change, *Trade* is trade intensity, *Institutional change* is a proxy for the change in unionisation, *Kaitz Index* is a measure of toughness of the minimum wage as defined by Machin and Manning (1994) and *Q* is a vector of other controls. By considering the absolute size of the coefficients in equation 3 this will enable us to test the explanations of earnings dispersion simultaneously, for example if  $\mathbf{l} > \mathbf{g}, \mathbf{p}, \mathbf{q}, \mathbf{f}, \mathbf{j}$  then technological change is the major culprit.

### **3. Data.**

The first step of the analysis based upon equation 1 above, requires information on the individual, whilst for the second step more aggregated data at the industrial and regional level is required to gain measures of market forces and institutional changes. Specific factors controlled for in equation 1 are experience, colour, marital status, full/part time employment, highest educational qualification<sup>1</sup>, occupation<sup>2</sup>, and regional location/industry. The GHS is a continuous survey of cross sections based upon individuals within the sample household. Six industries are derived over the period – Energy, gas and water; Manufacturing; Other Manufacturing; Construction; Transport and communication; and Services (given as sic 6 and sic's 8-9). Although the GHS has ten industrial sectors it was only possible to gain a measure of technological change for the six defined sectors. Ten regions are considered over time: North; York & Humberside; North West; East Midlands; West Midlands; East Anglia;; South East; South West; Wales and Scotland.

The more aggregated data used in the second stage of the analysis is required at the industry and regional level in order to attempt to find the possible causal factors of within-group earnings dispersion. Such explanations come in the form of market forces (demand & supply factors), institutional and minimum wage changes, where it is required to find some proxy for each. The following describes the data used first at the industry level and secondly for the regional analysis.

#### Industry level data

Due to the reclassification of industries in 1980 when the Standard Industrial Classification (sic) change from sic68 to sic80 it is only possible to consider the six industries from 1981 to 1995 (in previous work I found only four out of the six to be stable after the break – Taylor, 1999). On the demand side technological shocks are proxied by research & development intensity for each industry. This is defined as research and development expenditure as a proportion of value added, using data from the OECD ANBERD data base and OECD STAN data base respectively – with all expenditure data deflated to 1981 prices. Globalisation in the tradable sector was proxied by trade intensity, defined as import expenditure as a proportion of value added. The source of the trade expenditure data was also the OECD STAN data base – again all expenditure data was deflated to 1981 prices. For the supply side, immigration and



female participation by industry was derived from the General Household Survey, and was calculated as those individuals born outside the United Kingdom (female) who were in employment (defined as working more than one hour per week) as a ratio to total industry employment size.

To try to gain a measure of institutional change proved to be a relatively more difficult task than at first sight. The preferred measure to be used would have been trade union density or membership. Unfortunately the figures are only available consistently at an aggregate level from the department of employment. Previous researchers namely Bain & Price (1983) have constructed one digit industry level trade union membership and density, but only up until 1979, thereafter the source they use the Labour Force Survey does not collect union data at the industry level for each proceeding year. Thus in an attempt to proxy institutional change the number of workers involved in strikes for each industry based upon International Standard Industrial Classification codings was used, available from the International Labour Organisation. Strike action represents one form of bargaining power, where a threat to strike is credible if the firm cannot replace its workforce easily. Consequently, the extent of unionisation and the ease of substitutability between union and non-union members is of importance. The analysis of the second stage uses strikes to proxy for institutional change as it follows the trend in union membership – at the aggregate level a correlation of 0.9. This is consistent with previous findings (Machin, 1997). The simple measure of toughness of minimum wages over time is given by the Kaitz index defined by the log ratio of the minimum wage to average wage using data from the New Earnings Survey (Machin and Manning, 1994). Because the analysis below is for highly aggregated industries the Kaitz index should not differ too greatly between the sectors.

### Regional level data

The estimation period of equation 3 across the ten regions was the same as at the industry level 1981 to 1995 giving 150 observations when pooled. Unfortunately, to gain a measure of technological change using R&D data was not possible, since the Office for National Statistics only started to collect this information post 1992. In order to try to gain a proxy for technological change the ratio of non-manual to manual labour was used obtained from the New Earnings Survey – this is consistent with previous research (Leslie and Pu, 1996; and Lucifora, 1999) although is not ideal. Globalisation was considered to have the same impact across regions (basically this is because it is not

possible to obtain a measure of globalisation at the regional level), also it is unlikely different regions experience varying degrees of openness to trade – and was defined as above, deflated to 1981 prices. For the supply side immigration and female participation by region was derived from the General Household Survey, and was calculated as those individuals born outside the United Kingdom (female) who were in employment (defined as working more than one hour per week) as a ratio to total regional employment size.

Again as with the industry level data requirements trade union density or membership was not available consistently over the time period. In an attempt to proxy institutional change the number of days lost through strikes for each region was used, based upon data from Regional Trends. Again this measure has a high correlation over time with trade union membership – around 0.9, consistent with previous arguments (Machin, 1997). As with the industry analysis the toughness of minimum wages was defined by the Kaitz index and assumed to be the same across regions, although it should be realised that wage councils before 1986 actually set minimum wages differentiated by region.

Having described the data and time period to be used at the industry and regional level, the following two sections show the results of estimating equation 3 for across industries (Section 4) and regions (Section 5).

#### ***4. Empirical results across UK industries.***

This section firstly gives the results of decomposing earnings dispersion into between and within-group components, discussing the trend across time of industry within-group earnings dispersion. The second part of this section considers what may have caused within-group earnings dispersion across different sectors.

##### *An analysis of within-group earnings dispersion across industries*

Figures 1 to 3, below, show the results of estimating equation 1 giving within-group industry earnings dispersion defined by equation 2 – that is inequality is measured free from human capital and personal controls after the estimation of equation 1 based upon heteroscedastic consistent T-ratios<sup>3</sup> – for the 90<sup>th</sup> to 10<sup>th</sup> decile, 90<sup>th</sup> to 50<sup>th</sup> decile, and 50<sup>th</sup> to 10<sup>th</sup> decile. Each figure shows within-group earnings dispersion for 1981, 1985, 1990 and 1995. It is noticeable that each industry has experienced different

trends in earnings dispersion once controls have been implemented for observable characteristics. For example, considering the top to bottom decile ratios in Figure 1, whilst the manufacturing, textile and construction industries witnessed an increase in dispersion over time, the same is not true of other industries. The remaining industries experienced a fall in earnings dispersion as measured by the 90<sup>th</sup> to 10<sup>th</sup> decile in 1990. Considering the top half of the earnings distribution in Figure 2 none of the industries saw a monotonic rise in within-group earnings inequality, rather the general trend was for earnings dispersion to decline in 1990 relative to 1985. For the bottom half of the distribution of earnings displayed in Figure 3 for manufacturing, textiles and service industries the 50<sup>th</sup> to 10<sup>th</sup> ratio has increased year on year.

The feature of key interest from the results of the first stage decomposition is that the industry which has received almost all of the attention in the UK that is manufacturing – exceptions are Riley and Young (1999) and Taylor (1999) – experienced one of the lowest levels of within-group earnings dispersion over time. This makes it imperative that industries other than just manufacturing or economy earnings are considered in particular construction and the service sectors since Figures 1 to 3 show it is here that earnings dispersion has been the most rampant.

#### Explanations of within-group earnings inequality across industries

Having discussed the results from the first step of the empirical process, and found that each industry experienced different trends in earnings dispersion, the following looks at the results from the second stage of the empirical approach. The results are shown in Table 1 to 4 below, where equation 3 is estimated for each of the three inequality groups, with the vector  $Q$  including time dummies and in Table 1 a service sector dummy. In each Table a significant coefficient is shown in bold with T-ratios in parenthesis. In each of the tables <sup>[1]</sup> refers to the factor which has the largest absolute impact and <sup>[2]</sup> the factor which has the second largest absolute impact. The final column of each table shows an  $F[n_1, n_2]$  test of whether the two largest coefficients in absolute magnitude are equal.

Table 1: Determinants of earnings dispersion – All industries

	Decile ratios of the residual from equation 1					
	90 <sup>th</sup> -10 <sup>th</sup>		90 <sup>th</sup> -50 <sup>th</sup>		50 <sup>th</sup> -10 <sup>th</sup>	
Technology intensity	<b>0.0357</b>	<sup>[2]</sup> (3.93)	<b>0.0198</b>	<sup>[1]</sup> (5.29)	<b>0.0158</b>	<sup>[2]</sup> (2.25)

Trade intensity	<b>0.7062e<sup>-4</sup></b> (2.02)	<b>0.5038e<sup>-4</sup></b> (3.08)	0.2025e <sup>-4</sup> (0.75)
Institutional change	<b>0.0131</b> (1.71)	<b>0.0043</b> <sup>[2]</sup> (1.73)	0.0087 (1.36)
Kaitz index	<b>-0.0002</b> (4.08)	<b>-0.729e<sup>-4</sup></b> (4.15)	<b>-0.0001</b> (3.17)
Female participation	0.0259 (1.01)	0.0070 (0.58)	0.0189 (0.88)
Immigration	<b>0.0540</b> <sup>[1]</sup> (2.28)	0.0092 (0.71)	<b>0.0448</b> <sup>[1]</sup> (2.31)
Service sector	0.2056 (3.92)	0.0933 (4.03)	0.1123 (2.70)
Observations	90	90	90
$\bar{R}^2$	0.730	0.665	0.628
Heteroscedasticity	40.84	7.99	50.37
F[1,81]	8.24 <sup>**</sup>	18.76 <sup>**</sup>	5.96 <sup>*</sup>

<sup>\*\*</sup>Significant at the 1 per cent level, <sup>\*</sup>Significant at the 5 per cent level.

Table 1, above, shows estimates of equation 3 across all six industries. Considering the top and bottom decile ratios in the first column, the main impact upon earnings dispersion is from immigration and technology intensity. Although immigration does not have an influence on the top part of the earnings distribution i.e. 90<sup>th</sup>-50<sup>th</sup> decile ratio it is important at the lower end of the earnings distribution – having the largest impact. This means that those workers affected adversely by immigration (either because immigrants are substitutes for low skilled males or because they are higher skill endowed than natives) reside at the lower end of the distribution. The influence of factors other than the market mechanism are also important, with both institutional change and the minimum wages (shown by the Kaitz index) also being significant. The top part of the earnings distribution the 90<sup>th</sup>-50<sup>th</sup> decile ratio is influenced by technology, institutional change, minimum wages and trade intensity (listed by order of magnitude). The final row of Table 1 shows the results of an F test to determine whether the two largest effects across decile ratios are equal in size, in each case the hypothesis that they are equal can be rejected at the 5 per cent level.

Table 2: Determinants of earnings dispersion – Manufacturing sector

	Decile ratios of the residual from equation 1					
	90 <sup>th</sup> -10 <sup>th</sup>		90 <sup>th</sup> -50 <sup>th</sup>		50 <sup>th</sup> -10 <sup>th</sup>	
Technology intensity	<b>0.0655</b> <sup>[2]</sup>	(2.19)	<b>0.0366</b> <sup>[1]</sup>	(2.08)	<b>0.0289</b>	(1.78)
Trade intensity	<b>0.2860</b> <sup>[1]</sup>	(2.76)	0.0448	(0.79)	<b>0.2413</b> <sup>[1]</sup>	(1.72)

Institutional change	-0.0241	(1.22)	0.0106	(1.39)	<b>-0.0347</b>	(2.10)
Kaitz index	-0.509e <sup>-4</sup>	(1.25)	<b>-0.5e<sup>-4</sup></b> [2]	(2.26)	-0.376e <sup>-5</sup>	(0.11)
Female participation	-0.0493	(0.37)	-0.0071	(0.15)	-0.0422	(0.38)
Immigration	0.1116	(1.60)	-0.0602	(1.22)	<b>0.1718</b> [2]	(2.49)
Observations	30		30		30	
$\bar{R}^2$	0.752		0.576		0.670	
Heteroscedasticity	9.47		2.39		18.53	
F[1,22]	5.62*		3.38		0.39	

\*\* Significant at the 1 per cent level, \* Significant at the 5 per cent level.

Minimum wages have their largest impact at the bottom half of the earnings distribution and is in line with previous work (Fortin and Lemieux, 1997; Lucifora, 1999). However, it is surprising to find that institutional changes have only had a significant impact at the top half of the earnings distribution and are insignificant at the bottom half at the 5 per cent level. The specification shown in Table 1 includes a service sector dummy which enters as a positive and significant coefficient indicating that earnings dispersion is higher in the service sector. The results in Table 1 have shown that the factors able to explain earnings dispersion have a different impact across the earnings distribution. The results in Tables 2 to 4 further the analysis by not only considering the influence of potential explanations across the earnings distribution but also for different industrial sectors.

The Manufacturing sector is analysed in Table 2, above – defined as sic 3 and 4 (i.e. manufacturing and other manufacturing). Looking at the overall distribution the main impact is from trade intensity, which is due to its large impact at the bottom end of the earnings distribution. Technology intensity is the second largest influential factor upon the 90<sup>th</sup>-10<sup>th</sup> decile and unlike trade intensity this is due to its effect at the top half of the distribution. Supply side and institutional effects are all insignificant in influencing the overall decile ratio. Considering the top half of the earnings distribution the largest impact as we have already seen was from technology intensity, followed by the impact of minimum wages. Surprisingly, minimum wages did not have an impact at the lower end of the distribution, although institutional changes were significant here, rather this was affected by trade and immigration followed by technology. Technology enters as a positive coefficient in each column implying skill-technology bias, since

technology intensity has fallen over time. Although in Table 2 the largest two impacts across each decile ratio have been identified, only at the 90<sup>th</sup>-10<sup>th</sup> part of the distribution is the hypothesis that the two are not be rejected.

In the Service sector (Table 3, below) all factors except institutional changes and immigration influence the 90<sup>th</sup>-10<sup>th</sup> inequality index. Interestingly the technology coefficient is positive indicating a possible low-skill technology bias – since the measure of technology intensity fell over the period in all sectors. Although significant in each regression the Kaitz index has a small impact having its largest effect at the lower end of the earnings distribution – as found when all sectors were pooled. Technological change has its largest impact upon the top half of the earnings distribution whilst female participation is important at both the top and bottom end of the distribution, although its impact is larger at the 50<sup>th</sup>-10<sup>th</sup> decile ratio. As in Table 1 when considering all industries the largest two effects in the service sector across each ratio are found to be significantly different to each other at the 5 per cent level.

Table 3: Determinants of earnings dispersion – Service sector

	<b>Decile ratios of the residual from equation 1</b>					
	90 <sup>th</sup> -10 <sup>th</sup>		90 <sup>th</sup> -50 <sup>th</sup>		50 <sup>th</sup> -10 <sup>th</sup>	
Technology intensity	<b>0.2860</b> <sup>[2]</sup>	(2.07)	<b>0.0206</b> <sup>[2]</sup>	(1.92)	0.0099	(0.87)
Institutional change	-0.0153	(0.53)	-0.0089	(0.88)	-0.0064	(0.27)
Kaitz index	<b>-0.0003</b>	(3.37)	<b>-0.0001</b>	(4.71)	<b>-0.002</b> <sup>[2]</sup>	(2.44)
Female participation	<b>0.2860</b> <sup>[1]</sup>	(5.05)	<b>0.1131</b> <sup>[1]</sup>	(6.33)	<b>0.1579</b> <sup>[1]</sup>	(3.30)
Immigration	0.0908	(0.89)	-0.0060	(0.14)	0.0969	(1.00)
Observations	30		30		30	
$\bar{R}^2$	0.722		0.723		0.586	
Heteroscedasticity	25.45		6.54		22.28	
F[1,23]	7.98 <sup>**</sup>		9.17 <sup>**</sup>		7.07 <sup>*</sup>	

<sup>\*\*</sup> Significant at the 1 per cent level, <sup>\*</sup> Significant at the 5 per cent level.

Table 4: Determinants of earnings dispersion – Energy, gas & water and Construction

	<b>Decile ratios of the residual from equation 1</b>					
	90 <sup>th</sup> -10 <sup>th</sup>		90 <sup>th</sup> -50 <sup>th</sup>		50 <sup>th</sup> -10 <sup>th</sup>	
Technology intensity	<b>0.0538</b> <sup>[1]</sup>	(3.12)	<b>0.0332</b> <sup>[1]</sup>	(4.32)	<b>0.0206</b> <sup>[1]</sup>	(1.71)
Institutional change	0.0110	(0.77)	-0.0015	(0.33)	0.0125	(1.14)

Kaitz index	<b>-0.002</b> <sup>[2]</sup>	(2.88)	<b>-0.5e<sup>-4</sup></b> <sup>[2]</sup>	(1.76)	<b>-0.002</b> <sup>[2]</sup>	(2.99)
Female participation	0.0841	(0.97)	0.0444	(1.32)	0.0399	(0.55)
Immigration	0.0241	(0.56)	-0.0087	(0.43)	0.0328	(0.95)
Observations	30		30		30	
$\bar{R}^2$	0.668		0.590		0.557	
Heteroscedasticity	8.59		1.66		6.93	
F[1,24]	16.16 <sup>**</sup>		22.28 <sup>**</sup>		5.76 <sup>*</sup>	

<sup>\*\*</sup> Significant at the 1 per cent level, <sup>\*</sup> Significant at the 5 per cent level.

Considering Energy, gas & water and Construction in Table 4, above, technology intensity is significant and has the largest impact for each inequality measure, although playing a larger role at the top half, and its sign implies skill-technology bias. The only other significant factor in explaining inequality across the earnings distribution are minimum wages having their greatest impact for the lowest paid workers – as seen before in other sectors. For each inequality measure the top two impacts in absolute size are found to be significantly different at the 5 per cent level.

Having considered the impact of market forces and institutional changes upon within-group industry earnings dispersion the following considers the impact upon the evolution of within-group regional earnings dispersion.

### ***5. Empirical results across UK regions.***

An assumption made in the literature when testing for the causes of the rise in wage inequality is that labour markets in the UK are integrated and can be treated uniformly. The argument here is that regional labour markets are only integrated in the long run. To provide evidence on the integration of regional labour markets the returns to different levels of education were calculated for each of the ten regions (following Bernard and Jensen, 1998). The education premia from the wages of male workers are relative to an individual with no qualifications. In Table 5 the education premia associated with Degrees and A' levels are shown for 1975, 1980, 1985, 1990 and 1995, based upon the specification in equation 1 above. Clearly the education premia show substantial heterogeneity across regions. For example in 1975 an individual with a degree relative to someone with no qualifications earned a return between 0.76 log

points in Scotland to just 0.43 log points in the East Midlands. The same pattern of differing returns across regions is apparent in 1995, ranging between 0.91 log points in the North West to 0.42 log points in the South West. The existence of different education premia in any year may be as a results of temporary shocks to the regional labour markets. However, Table 5 shows evidence that the premia are persistent across time. The persistence of regional shocks on relative wages and the magnitude and persistence of the regional education premia lead to the conclusion that regional labour markets will have important effects upon the level and distribution of wages.

Table 5: Education premia across regions

	1975		1980		1985		1990		1995	
	<i>Deg</i>	<i>A'lev</i>	<i>Deg</i>	<i>A'lev</i>	<i>Deg</i>	<i>A'lev</i>	<i>Deg</i>	<i>A'lev</i>	<i>Deg</i>	<i>A'lev</i>
<i>North</i>	0.48*	0.23*	0.59*	0.29*	0.72*	0.39*	0.66*	0.35*	0.55*	0.33*
<i>York &amp;</i>	0.55*	0.30*	0.58*	0.31*	0.45*	0.00	0.59*	0.26*	0.61*	0.32*
<i>Humberside</i>										
<i>North West</i>	0.56*	0.19*	0.39*	0.17*	0.67*	0.36*	0.67*	0.14	0.91*	0.62*
<i>East</i>	0.43*	0.27*	0.56*	0.20*	0.48*	0.16*	0.71*	0.26*	0.65*	0.38*
<i>Midlands</i>										
<i>West</i>	0.55*	0.22*	0.47*	0.17*	0.58*	0.30*	0.59*	0.21*	0.67*	0.27*
<i>Midlands</i>										
<i>East Anglia</i>	0.64*	0.18	0.28*	–	0.46*	–	0.58*	–	0.85*	0.35*
<i>South East</i>	0.57*	0.23*	0.46*	0.26*	0.49*	0.26*	0.67*	0.40*	0.52*	0.33*
<i>South West</i>	0.67*	0.37*	0.57*	0.32*	0.43*	0.33*	0.59*	0.29*	0.42*	0.19*
<i>Wales</i>	0.71*	0.26*	0.64*	0.15*	0.70*	0.09	0.62*	0.29*	0.82*	0.68*
<i>Scotland</i>	0.76*	0.48*	0.55*	0.33*	0.54*	0.20*	0.67*	0.31*	0.57*	–

\*Coefficients significant at the 5% or 1% level. *Deg*=Degree, *A'lev*=A' Levels.

Consequently, the following sub-section firstly gives the results of decomposing earnings dispersion into between and within-group components, discussing the trend across time of within-group regional earnings dispersion. This is followed by a consideration of what may have caused within-group earnings dispersion across different regions.

*An analysis of within-group earnings dispersion across regions*



Whilst the different returns to education shown in Table 5 are part of the story of the increase in inequality, the bulk of the variation remains unexplained by observable worker characteristics. From the regression of equation 1 three measures of the residual distribution of log weekly wages are considered defined by equation 2, these are the same as those used at the industry level – the 90<sup>th</sup> to 10<sup>th</sup> wage differential, the 90<sup>th</sup> to 50<sup>th</sup> and 50<sup>th</sup> to 10<sup>th</sup> differentials shown in Figure 4 to 6 below. Each figure shows within-group regional earnings dispersion in 1981, 1985, 1990 and 1995. As with the industry level findings each region experienced different trends in earnings dispersion after controls have been implemented for observable worker characteristics. For example, considering the 90<sup>th</sup> to 10<sup>th</sup> measure of inequality, whilst the North, North West, East Midlands, South West and Wales experienced an increase in earnings dispersion year on year the remaining regions did not. The region with highest earnings dispersion has changed over time – for instance in 1981 the South East had the largest dispersion and the North the lowest, by 1990 the North West had the largest dispersion with the West Midlands and East Anglia having the lowest. Considering the top half of the earnings distribution in Figure 5, only four regions experienced a monotonic trend in inequality – the North, North West, South West and Wales. In 1981 the South East had the worst level of dispersion and the North the lowest. By 1990 it was the North of the UK with the worst level of inequality with Scotland having the lowest. Figure 6 considers the evolution of inequality at the lowest level of the earnings distribution where in 1981 the South East had the highest inequality and West Midlands the lowest, by 1990 the North West was the worst off with the West Midlands still having the lowest dispersion. Clearly, over time each region has seen a change in fortunes in terms of the different measures of inequality and by 1995 York and Humberside had the highest overall inequality (Figure 4) this was driven by having the highest inequality at the 50<sup>th</sup> to 10<sup>th</sup> decile ratio. The following considers the role technology, trade etc. has had upon the trend in within-group regional earnings dispersion across different deciles – this is something which for the UK has been unexplored.

#### *Explanations of within-group earnings inequality across regions*

Having briefly discussed the results from the first stage of the empirical approach, finding that regions experienced different levels and trends in within-group inequality and for different inequality measures, the following looks at the results of the second stage where the potential determinants of regional earnings dispersion are tested.

The results are shown in Table 6 to 8 below, where equation 3 is estimated for each of the three inequality groups, with the vector  $Q$  including time dummies and in Table 6 a North dummy. In each Table a significant coefficient is shown in bold with Heteroscedastic consistent T-ratios in parenthesis, where <sup>[1]</sup> refers to the factor which has the largest absolute impact and <sup>[2]</sup> the factor which has the second largest absolute impact. Table 6, below, shows estimates of equation 3 across all ten regions.

Table 6: Determinants of earnings dispersion – All regions

	Decile ratios of the residual from equation 1					
	90 <sup>th</sup> -10 <sup>th</sup>		90 <sup>th</sup> -50 <sup>th</sup>		50 <sup>th</sup> -10 <sup>th</sup>	
Technology intensity	<b>0.1806</b> <sup>[1]</sup>	(3.05)	<b>0.1101</b> <sup>[2]</sup>	(3.61)	0.0706	(1.52)
Trade intensity	0.1118	(0.97)	<b>0.1328</b> <sup>[1]</sup>	(1.89)	-0.0209	(0.26)
Institutional change	<b>-0.022</b> <sup>[2]</sup>	(1.69)	0.0015	(0.23)	<b>-0.024</b> <sup>[1]</sup>	(2.26)
Kaitz index	<b>-0.0002</b>	(3.81)	<b>-0.665e<sup>-4</sup></b>	(3.13)	<b>-0.001</b> <sup>[2]</sup>	(3.44)
Female participation	-0.0008	(0.00)	-0.1321	(0.62)	0.1314	(0.48)
Immigration	-0.0087	(0.57)	-0.0003	(0.04)	-0.0084	(0.75)
North dummy	0.0365	(1.26)	0.0192	(1.73)	0.0174	(0.72)
Observations	150		150		150	
$\bar{R}^2$	0.586		0.401		0.546	
Heteroscedasticity	71.72		25.29		67.98	
F[1,141]	7.13 <sup>**</sup>		0.06		2.77	

<sup>\*\*</sup> Significant at the 1 per cent level, <sup>\*</sup> Significant at the 5 per cent level.

Looking at the first column the main impact upon the 90<sup>th</sup>-10<sup>th</sup> decile is from technology followed by institutional changes. The impact of technology stems from its significance at the top half of the earnings distribution where it has the second largest impact, only outweighed by trade intensity. The two key influences upon the lowest half of the distribution come from institutional changes and minimum wages with no demand or supply factors showing significance. Only for the 90<sup>th</sup>-10<sup>th</sup> decile ratio can the hypothesis that the two largest impacts are equal be rejected.

Table 7, below, considers the impact of each potential factor in the North of the UK – where the North is defined as: North; York & Humberside; North West; and Scotland. At both the top and bottom half of the distribution the largest significant

impact comes from trade intensity – having a larger impact at the lower part. For the overall earnings distribution trade intensity is the only factor to have a significant effect upon within-group earnings dispersion. Technology only has an effect on the top half of the distribution having the second largest impact and institutional changes had their largest and only significant affect at the 50<sup>th</sup>-10<sup>th</sup> ratio. For each inequality measure the top two factors in terms of absolute size of coefficients are found to be insignificantly different from one another.

Table 7: Determinants of earnings dispersion – The North

	Decile ratios of the residual from equation 1					
	90 <sup>th</sup> -10 <sup>th</sup>		90 <sup>th</sup> -50 <sup>th</sup>		50 <sup>th</sup> -10 <sup>th</sup>	
Technology intensity	0.2420	(1.25)	<b>0.1839</b> <sup>[2]</sup>	(1.98)	0.0978	(0.71)
Trade intensity	<b>0.3836</b> <sup>[1]</sup>	(1.75)	<b>0.1973</b> <sup>[1]</sup>	(1.77)	<b>0.2451</b> <sup>[1]</sup>	(1.73)
Institutional change	-0.0146	(0.48)	-0.0129	(1.41)	<b>-0.037</b> <sup>[2]</sup>	(1.83)
Kaitz index	-0.0002	(1.45)	-0.447e <sup>-4</sup>	(1.44)	-0.0001	(1.29)
Female participation	-0.5792	(0.89)	-0.3004	(0.91)	-0.3795	(0.95)
Immigration	-0.0008	(0.03)	-0.0091	(0.92)	0.0018	(0.09)
Observations	60		60		60	
$\bar{R}^2$	0.526		0.459		0.475	
Heteroscedasticity	33.48		14.46		36.30	
F[1,52]	na		0.01		0.96	

\*\* Significant at the 1 per cent level, \* Significant at the 5 per cent level.

Finally, Table 8 below, considers the South of the UK. Across the widest part of the earnings distribution the main impact is from technology followed by institutional change. Technology is also the main influence at the top half of the distribution followed by minimum wages. As for the case when all regions were pooled together, at the bottom part of the distribution only institutional changes and minimum wages had an impact with no role for the market mechanism. Only at the bottom half of the distribution can the hypothesis that the largest two impacts are equal in size not be rejected at the 5 per cent level.

Table 8: Determinants of earnings dispersion – The South

<b>Decile ratios of the residual from equation 1</b>						
	90 <sup>th</sup> -10 <sup>th</sup>		90 <sup>th</sup> -50 <sup>th</sup>		50 <sup>th</sup> -10 <sup>th</sup>	
Technology intensity	<b>0.1692</b> <sup>[1]</sup>	(2.60)	<b>0.0891</b> <sup>[1]</sup>	(2.58)	0.0800	(1.60)
Trade intensity	-0.0871	(0.67)	0.0274	(0.31)	-0.1145	(1.17)
Institutional change	<b>-0.029</b> <sup>[2]</sup>	(1.80)	-0.0054	(0.62)	<b>-0.024</b> <sup>[1]</sup>	(2.46)
Kaitz index	<b>-0.0002</b>	(3.79)	<b>-0.8e<sup>-4</sup></b> <sup>[2]</sup>	(2.86)	<b>-0.002</b> <sup>[2]</sup>	(3.51)
Female participation	0.4931	(1.01)	0.1282	(0.42)	0.3649	(0.92)
Immigration	-0.0107	(0.56)	0.0079	(0.82)	-0.0186	(1.36)
Observations	90		90		90	
$\bar{R}^2$	0.608		0.378		0.579	
Heteroscedasticity	33.71		14.47		30.07	
F[1,82]	5.96*		4.71*		3.12	

\*\* Significant at the 1 per cent level, \* Significant at the 5 per cent level.

## 6. Conclusions.

The above analysis firstly purged earnings dispersion of human capital and worker characteristics gaining a measure known as within-group earnings dispersion. Data from the General Household Survey were used to accomplish this task over the period 1981 to 1995 for the industry and regional analysis. Consequently, in the second step the trend in within-group earnings dispersion across different parts of the earnings distribution was examined to discover which of the themes in the literature were capable of explaining within-group earnings dispersion.

The crucial findings of this study are:

- Pooling across all industries the main impact is from immigration followed by technology intensity. In the manufacturing sector the main impact is from trade intensity followed by technology. For the service sector industries female participation is the most important factor followed by technology, and in the remaining industries the main influence is technology followed by minimum wages.
- It is important to investigate industries other than Manufacturing since within-group earnings dispersion was higher in Construction and the Service sectors.
- The impact of each potential explanation tends to vary across the top and bottom half of the earnings distribution in each industry, excluding Energy, gas & water and Construction.

- Previous research on wage inequality has tended to overlook an important source of information, the heterogeneity of inequality across regions. If there is a nation-wide setting of wages, then there would be no reason to consider regional sources of the rise in inequality. However, this paper shows that education premia show large persistent differences across regions suggesting that labour markets should be considered from a regional perspective.
- The potential explanations have a different impact across the different parts of the regional earnings distribution. Across the widest part of the distribution the main impacts are from technology and institutional changes with minimum wages also having a small but significant influence. In particular for the North of the economy trade has a role to play with technology having an influence at the upper end of the earnings distribution and institutional changes at the lower half. For the South of the economy whilst technology and institutional changes have the largest significant impacts at the widest part of the distribution, only institutional and minimum wage changes are significant in influencing the lowest portion of the distribution – there is no role for demand or supply effects.

This paper has considered the industry and regional evolution of earnings dispersion after controls for worker characteristics, testing the potential explanations across different parts of the earnings distribution. At both the industry and regional level although technology plays an important part in the evolution of earnings dispersion the analysis has found a role for supply side influences such as immigration and female participation. Generally factors other than market forces have had significant but small effects upon earnings dispersion, usually having the largest impact at the bottom half of the distribution.

Figure 1: Within group industry earnings dispersion - the 90th to 10th decile

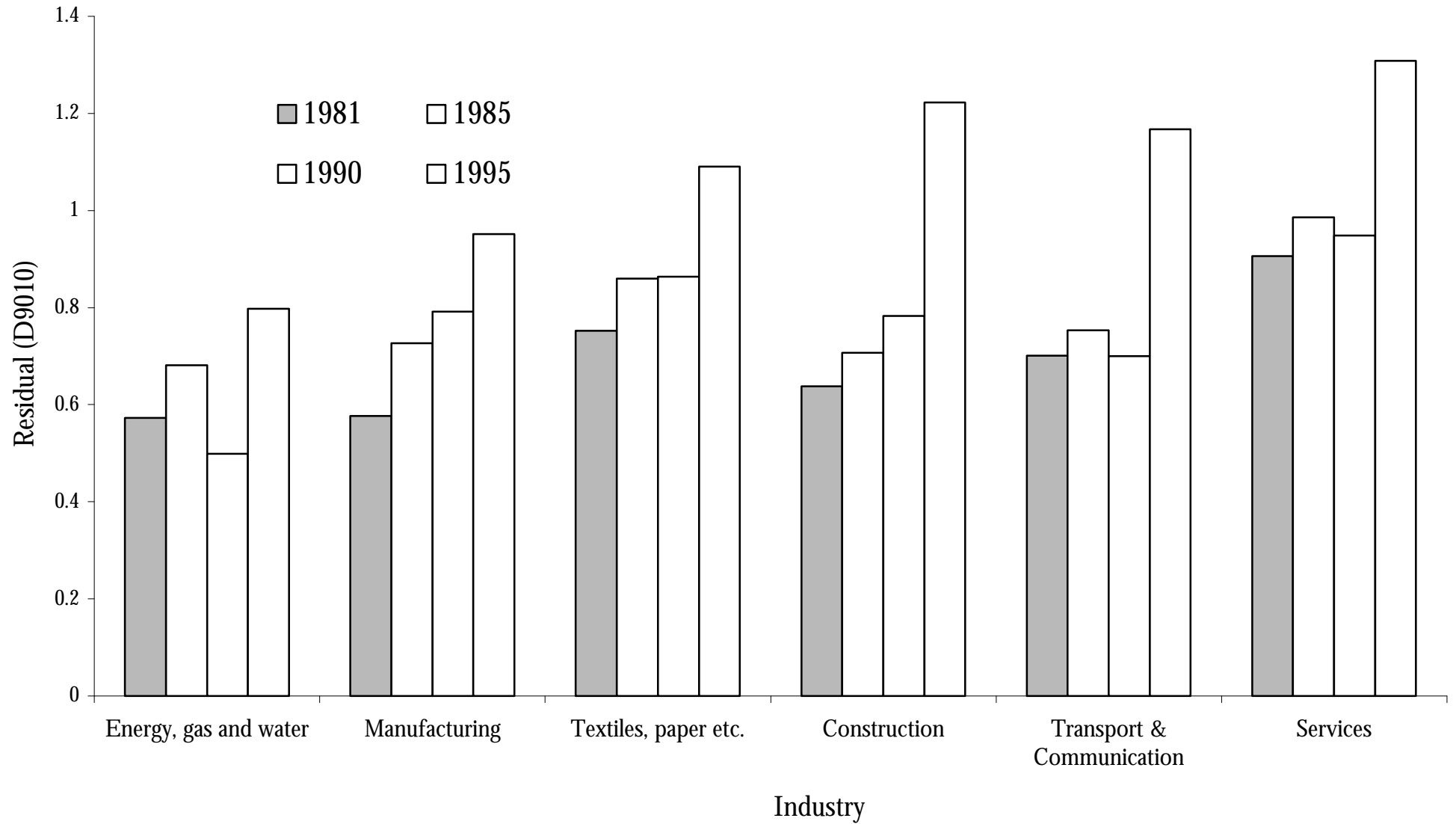


Figure 2: Within group industry earnings dispersion - the 90th to 50th decile

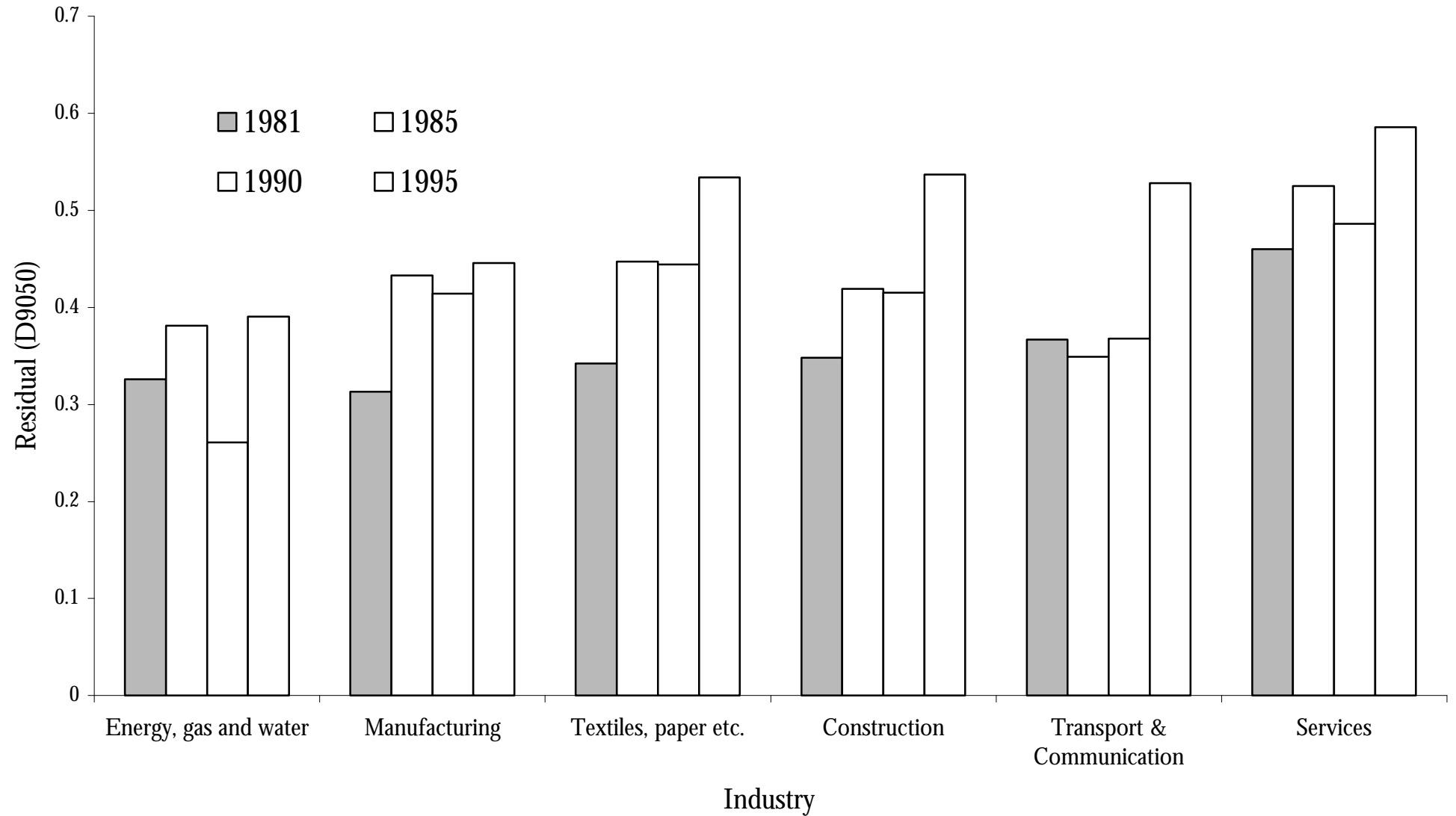


Figure 3: Within group industry earnings dispersion - the 50th to 10th decile

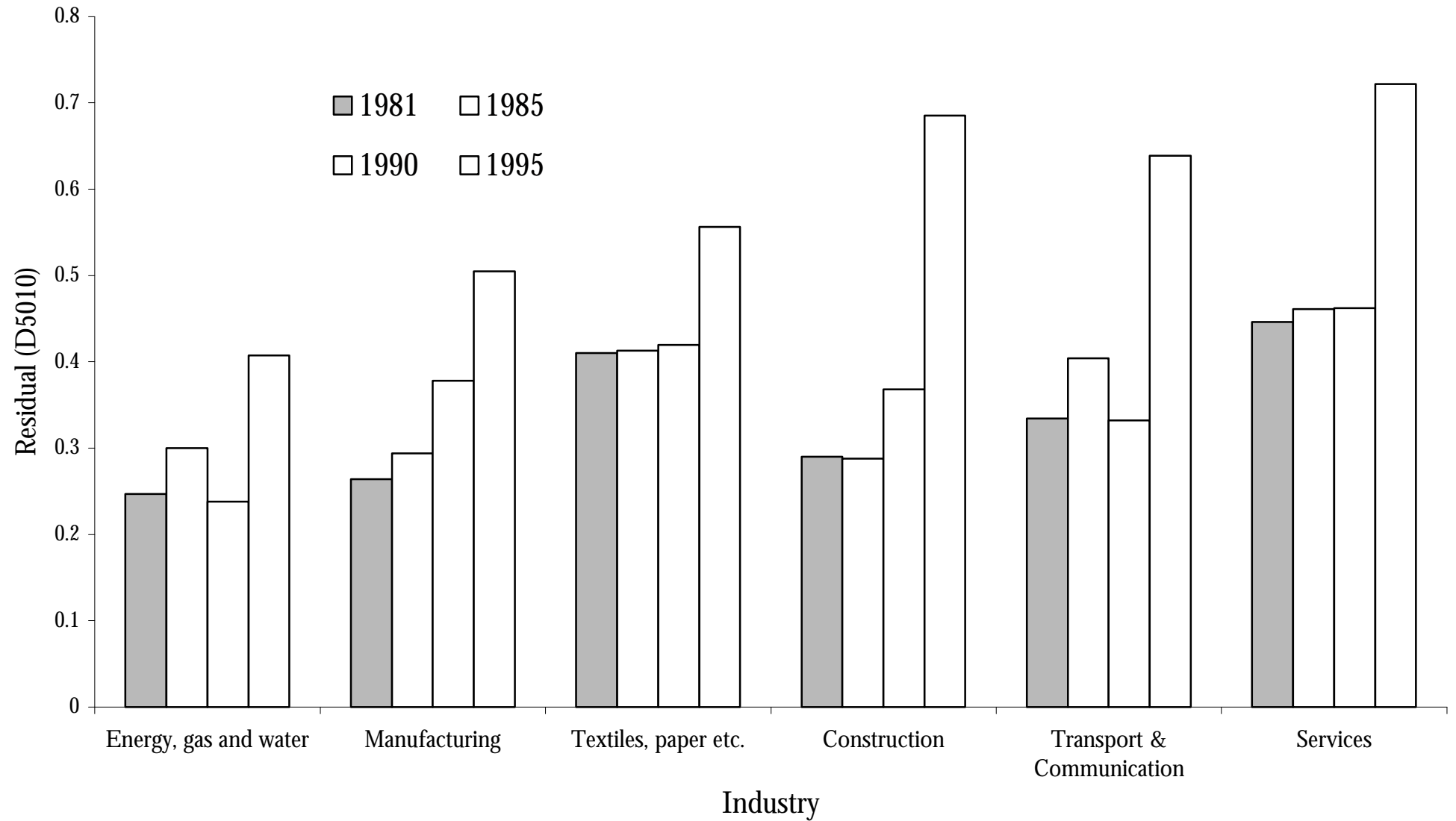




Figure 4: Within group regional earnings dispersion - the 90th to 10th decile

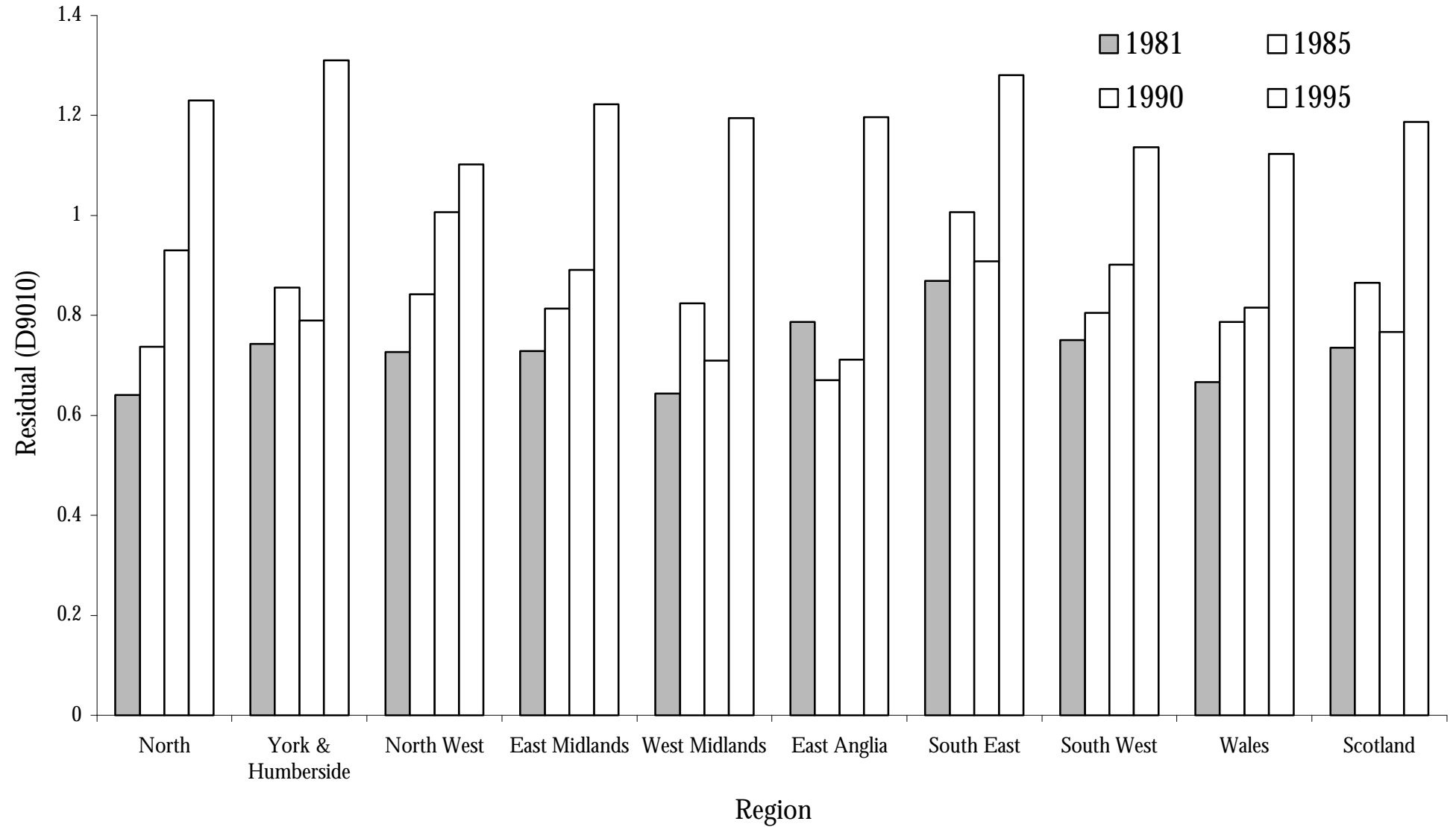


Figure 5: Within group regional earnings dispersion - the 90th to 50th decile

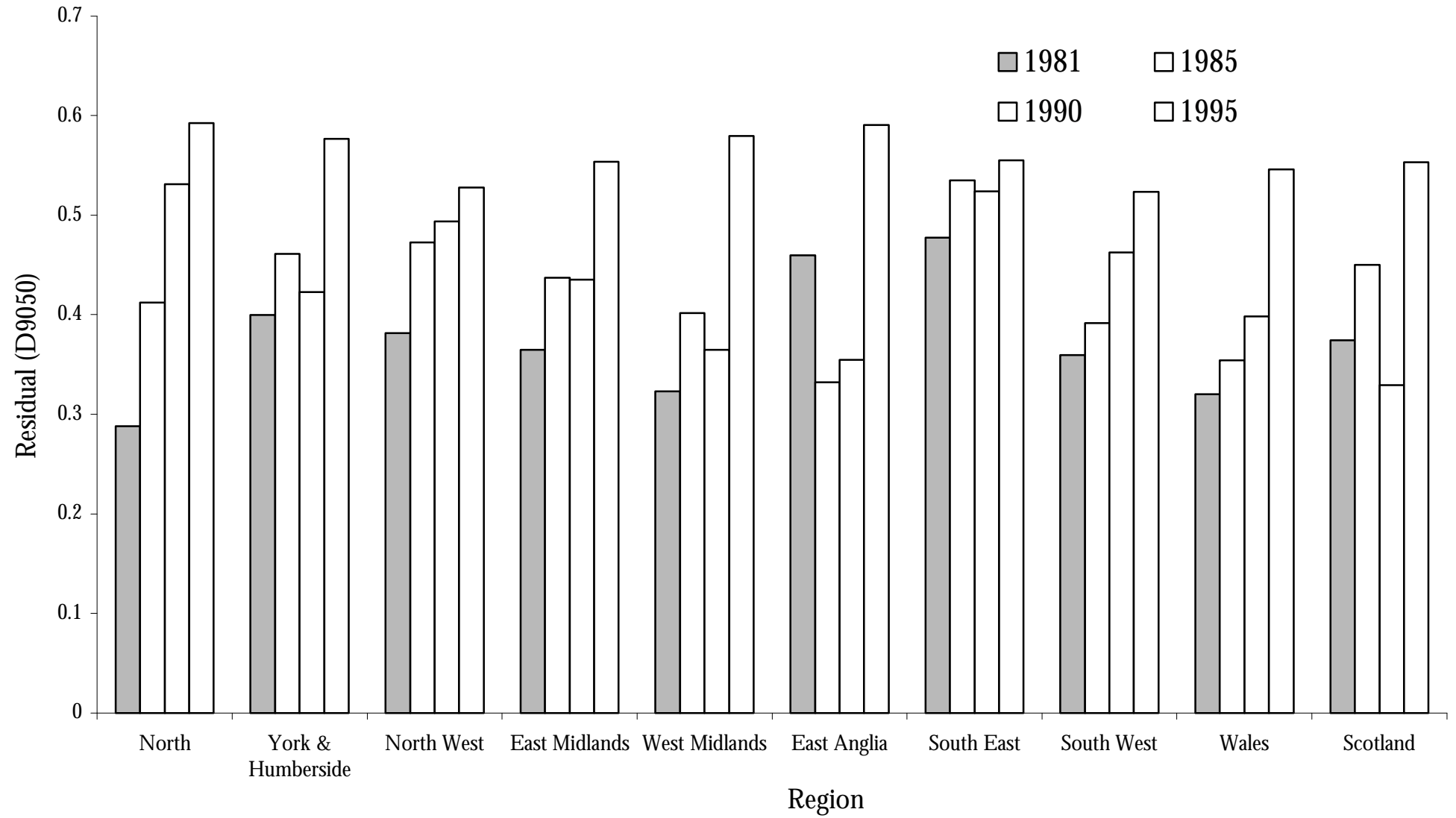
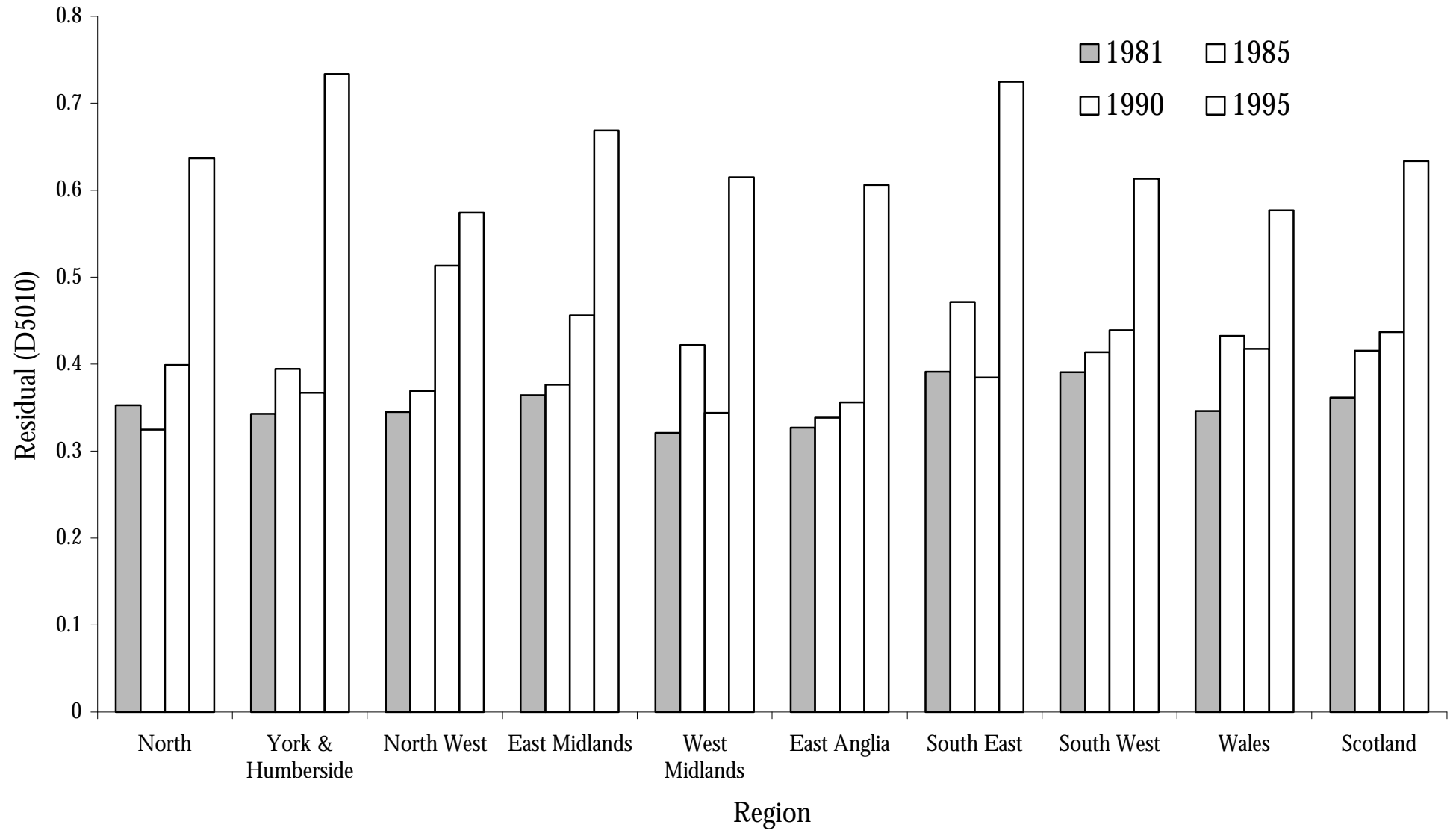


Figure 6: Within group regional earnings dispersion - the 50th to 10th decile



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**Endnotes.**

<sup>1</sup> The categorisations available from the General Household Survey consist of fifteen possible consistent groups over the period from higher degree to no qualifications. However, because earnings dispersion is considered within specific industries/regions some of the education categories had no variation, as sample sizes fell over time. Thus it made sense to group certain categories together to a more aggregate level. Following Blackaby et al (1997) the educational dummies were constructed as (1) Degree, including first and higher degrees; (2) Higher Vocational education; (3) A levels; (4) O levels; (5) Apprenticeships; (6) Other groups (i.e. a catch all category). The reference category is individuals with no qualifications.

<sup>2</sup> Occupational categories are given as: Professional, Management, Non-manual, Skilled manual, and unskilled manual. The later group is the reference category.

<sup>3</sup> The occurrence of heteroscedasticity in the model would be potentially harmful, because in the probability limit the estimator  $\hat{\mathbf{d}}$  from the following equation  $\mathbf{w} = \mathbf{X}\mathbf{d} + \mathbf{e}$  would not be equal to the true value  $\mathbf{d}$  i.e.  $\text{Plim } \hat{\mathbf{d}} \neq \mathbf{d}$  and consequently the residual  $\text{Plim } \hat{\mathbf{e}} = \mathbf{w} - \mathbf{X}\hat{\mathbf{d}} \neq \mathbf{e}$ . Since the standard deviation of the residual is used as the measure of inequality, the absence of homoscedasticity would lead to an incorrect estimate of the dispersion. Hence estimation is based upon Generalised Least Squares using Whites technique (White, 1980).

**Acknowledgements.**

Material from the General Household Survey has been made available by the Office for National Statistics through the Data Archive and has been used by permission. Neither the ONS nor the Data Archive bear any responsibility for the analysis or interpretation of the data herein.

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