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Abstract

We examine trends in wage inequality in the US and other countries over the past four decades. We show that there has been a secular increase in the 90-50 wage differential in the US and the UK since the late 1970s. By contrast the 50-10 differential rose mainly in the 1980s and flattened or fell in the 1990s and 2000s. We analyze the reasons for these trends and conclude that a version of the skill biased technical change hypothesis combined with institutional changes (the decline in the minimum wage and trade unions) continues to offer the best explanation for the observed patterns of change.

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1. Introduction

Study of the structure of wages has been a preoccupation of economists for a long time and dates back at least as far as Adam Smith. Until about 15 years ago economists commented on the remarkable stability of the wage structure in the post-war period. In the early 1990s, however, many empirical studies (e.g. Bound and Johnson, 1992) noticed that wage inequality in America had risen dramatically since the late 1970s. Other countries, notably the UK, also saw a significant increase in wage inequality at about the same time (Machin, 1996). These observations kick started what has become a huge empirical and theoretical literature seeking to measure and explain changes in wage inequality (see the survey of Katz and Autor, 1999). Since wages are a major part of people's income and economic well being, the increase in wage inequality feeds through to income, consumption and poverty rates. So understanding the patterns of wage inequality is important from a normative as well as positive perspective.

In this paper we examine what has happened to the wage distribution in the past 40 years, looking principally at the US where the bulk of the economic research has focused, but where possible also examining other countries. Section 2 describes the observed changes in the structure of wages (although we fully acknowledge there are some contentious, and as of yet unresolved, issues about the observed patterns of change). Section 3 looks at the main explanations of the observed changes that have emerged from the large body of work in this area. Section 4 offers some conclusions.

2. What Has Happened to the Wage Distribution?

2.1 Overall Trends in US Wage Inequality

To set the scene, Figure 1 (taken from Autor, Katz and Kearney, 2005a) plots out the salient features of the US full-time weekly wage distribution from 1963 through to 2003. At least three things stand out from Figure 1:

First, educational wage differentials - measured as the gap in pay between college and high school educated workers - have risen consistently since 1979 (after falling somewhat in the 1970s and rising somewhat in the 1960s). The rate of increase was more rapid in the 1980s than after 1992.[1]

Second, the 90-10 wage differential - defined as the difference in weekly pay for those at the 90^{th} and 10^{th} percentiles of the overall wage distribution - has been rising since 1976 (and maybe even earlier).

Third, the "residual" 90-10 wage differential - the difference between those at the 90^{th} and 10^{th} percentiles of the overall wage distribution after controlling for education, experience and gender - has risen consistently since 1967, especially after the mid 1970s (see Juhn et al, 1993). This increase in "within group" wage inequality has also generated much excitement and interest from theorists, but is particularly hard to interpret in the light of compositional changes (Lemieux, 2006).

The overall picture is one of a dramatic increase in American wage inequality since 1979. Different measures of inequality do give some different patterns – for example, educational wage premia fell in the 1970s when residual (and total) wage inequality was

[1] This ongoing secular rise in educational wage premia is also seen in the hourly wage series from March outgoing rotation group of the Current Population Survey (CPS) – see Lemieux (2006).

rising. It is also the case that hourly wages (as measured by the May outgoing rotation groups in the Current Population Survey) show less of an increase in overall and residual wage inequality after the late 1980s (for reasons that are still not completely understood). What the various data sources agree on, however, is that educational wage premia have risen consistently throughout the period.

2.2 Comparing the UK with the US

Table 1 contrasts the US experience with that of the UK, another country where wage inequality has risen dramatically. We focus on the period from 1979 onwards where most changes have taken place. Panel A shows annual real wage growth at several different percentile points of the UK and US wage distributions for all full-time workers.[2] The 1980s shows a clear picture in both countries: wage growth was more pronounced at higher points of the distribution and this is almost monotonic in both counties, leading to large increases in wage inequality. The lower panel shows that in the 1980s the 90-10 expanded by 1.9 percentage points a year in both countries. An important difference, however, is that in the UK there was positive wage growth throughout the distribution whereas in the US workers in the bottom quartile actually had zero or negative wage growth.

The picture is more complex post 1990. In both countries the 90-50 continues to diverge ("upper tail inequality") whereas the 50-10 ("lower tail inequality") in the US actually shrinks, indicating some wage compression. In the UK the 50-10 is stable (increasing a bit in the 1990s and shrinking a bit in the 2000s). Overall then, the increase in wage inequality has been stronger in the upper tail than the lower tail taking the period as a whole and has been more pronounced in the 1980s than post 1990.

Another way of looking at the trends is to examine the growth of employment in "good jobs" and "bad jobs" (defined here as high wage and low wage jobs). Figure 2 shows the change in the employment for jobs ranked by their position in the 1979 wage distribution for the UK. As expected we see a significant growth in well paid "good jobs" at the upper tail of the distribution – lawyers, senior managers and consultants. But we also see an increase in low-paid "bad jobs" in the lower tail of the distribution – cleaners, hair dressers, shop assistants and burger flippers. This is consistent with a "polarization" of the labor market. In the 1990s especially it seems that the middle of the distribution seemed to do somewhat worse than those at the top or bottom. Similar findings have been reported on US and German data (Autor, Katz and Kearney, 2006; Spitz-Oener, 2006).

A final similarity between the two countries that stands out in Table 1 is the continuous and rapid growth of wages at the very top of the distribution. British wage growth at the 95th percentile is greater than the other percentiles in the Table in the 1980s, 1990s and 2000s. This is also true for the US (except for the 10th percentile in the 1990s). So within the picture of overall rising inequality the very rich have done particularly well.

2.3 The Experience of Other Countries

There is less systematic evidence for the evolution of the wage distribution outside of the US and UK, especially for more recent years. Table 2 uses OECD data to show 90-10 male wage ratio for a range of countries between 1980 and 2000. Broadly speaking the 1980s rise in inequality was seen only in the UK and US and in specific countries where particular episodes to move to a much more market oriented economy occurred (notably New Zealand).

[2] The US numbers square up well with those from the CPS May/ORG samples in Autor, Katz and Kearney (2005a). The numbers in Table 1 are for men and women together, whereas Autor, Katz and Kearney report inequality numbers for men and women separately.

Elsewhere wage inequality did not alter much. The 1990s is a little different, for example with there being evidence of widening wage structures starting to occur in places previously characterised by stable wage structures – Germany is a very good example of this. Moreover, as we discuss below, the Continental European countries did have a larger increase in unemployment which may be due to the same underlying forces that have pushed up wage inequality in Britain and America.

3. Explanations of Changes in Wage Inequality

A natural place to begin to analyze the observed changes in the wage structure is to consider a model of changes in supply and demand. We then need to incorporate institutional features (such as minimum wages and trade unions) into the model.

3.1 Sources of Skill Premia: Supply and Demand

Consider Figure 3 as a basic model of wage determination. We assume full employment and competitive labor markets. The initial equilibrium wage differential between skilled workers (W_s) and unskilled workers (W_u) is denoted $(W_s/W_u)_o$. This is determined by the intersection of the relative demand curve for skills (D_o) and the relative supply curve for skills (S_o). This equilibrium is associated with an initial relative employment ratio of skilled to unskilled workers $(N_s/N_u)_o$. Now assume that a shock to the relative demand curve shifts D_o to the right to D_1. The new relative wage equilibrium is $(W_s/W_u)_1$ and the new relative employment level is $(N_s/N_u)_1$. At the new equilibrium we observe greater wage inequality and a relatively higher employment of skilled to unskilled workers.

At a first pass this is broadly consistent with the stylized facts of the previous section. Where an increase in relative wages between more and less educated workers has occurred this has gone on hand in hand with an increase in the relative employment of educated workers. In Table 3, for example, the proportion of graduates grew from 20.8% in 1980 to 34.2% in 2004 in the US.[3] The equivalent figures from the UK were even more dramatic – the growth in graduates was from 5% to 21% over the same time period. The only way to reconcile these facts in the standard model is through a shift in the relative demand curve for skills.

A simple way to formalise this is in the context of a Constant Elasticity of Substitution (CES) production function with two labor inputs:

$$Q_t = [\alpha_t (a_t N_s)_t^{\rho} + (1-\alpha_t)(bN_u)_t^{\rho}]^{1/\rho} \qquad (1)$$

In (1) aggregate output is Q and is produced with college educated equivalent skilled labor (N_s) and high school educated equivalent unskilled labor (N_u) in period *t*. The parameters *a* and *b* represent skilled and unskilled augmenting technical change, α indexes the share of work activities of skilled labor and ρ is a parameter that determines the elasticity of substitution between skilled and unskilled labor ($\sigma = \frac{1}{1-\rho}$). Skill biased technological changes involve increases in *a/b* or α .

[3] In the US the graduate measure is having a bachelor's degree or higher (i.e. excluding people with some college who do not get a degree).

Assuming college and high school equivalents are paid their marginal product we can use equation (1) to solve for the ratio of marginal products of the two types of labor, W_s/W_u, and relative supplies of labor, N_s / N_u, in year *t* as:

$$\ln(W_s / W_u)_t = (1/\sigma)[D_t - \ln(N_s / N_u)_t] \quad (2)$$

where

$$D_t = \sigma[\ln(\alpha_t /(1-\alpha_t)) + \rho \ln(a/b)_t] \quad (3)$$

is a relative demand index of shifts favoring college equivalents and is measured in log quantity units. The impact of changes in relative skill supplies (N_s / N_u) depends on the elasticity of substitution, σ. The larger is this parameter the bigger will be the effects of supply changes on relative wages. Equation (3) shows that changes in *D* can arise from (disembodied) skill biased technical change, non-neutral changes in relative prices or quantities of non-labor inputs and shifts in product demand.

Katz and Murphy (1992) implemented an empirical version of equation (2) replacing D with a linear time trend for US data between 1963 and 1987. They estimate:

$$\ln(W_s / W_u)_t = \gamma_0 + \gamma_1 trend + \gamma_2 \ln(N_s / N_u)_t + v_t \quad (4)$$

finding $\hat{\gamma}_2$ to be significantly negative (equal to -.709), implying an elasticity of substitution of about 1.4 ($\sigma = -1/\hat{\gamma}_2 = 1.41$), with a significant trend increase in the college premium of 3.3% per annum ($\hat{\gamma}_1 = .033$). Autor, Katz and Kearney (2005a) use (differently filtered) data from 1963 to 2003 to estimate the same model and find a similar substitution elasticity of σ = 1.6, but with a lower trend growth of the college premium of 2% per annum. Although, as discussed above, there appeared to be a slowdown in demand growth for skilled workers in the 1990s relative to the 1980s, the main point is that there appears to be a systematic demand shift towards more skilled workers throughout the four last decades of the 20th century.

This is not to suggest that supply side changes are unimportant. Deviations of relative skill supplies from the trend are negatively associated with deviations of the relative wage from trend as suggested by $\gamma_2 < 0$. The *slowdown* of the growth of education in more recent cohorts is certainly one factor in accounting for the increase in inequality as shown by Card and Lemieux (2001). But the most important factor over the longer run in accounting for the growth in educational wage differentials appears to be the trend demand shift towards the more skilled. The critical question then becomes: what could account for this change?

3.2 The Cause of Relative Demand Shifts: Technology or Trade?

To date, the two main explanations for the demand shift towards the more skilled are skill biased technological change (SBTC) and increased international trade. We examine each of these in turn.

3.2.1. Skill Biased Technological Change

Equation (3) above directly relates the change in the skill premia to SBTC. The idea is that new technologies such as information and communication technologies (ICTs) are complementary with the skills of more educated workers. More educated workers may find it easier to cope with the uncertainty surrounding new technologies in general or it may be that they have a particular advantage in using IT effectively. Rapid falls in the quality adjusted prices of IT or a more rapid investment in new technologies (e.g. from higher R&D intensities) could therefore have shifted demand towards more skilled workers.

There is now abundant empirical evidence that suggests that SBTC *is* an important and international phenomenon (e.g. see the survey in Bond and Van Reenen, 2006). A typical analysis estimates the following cost share equation:

$$\Delta SHARE = \beta_1 TECH + \beta_2 \Delta \ln(K/Y) + \beta_3 \ln(W_s/W_u) + e \qquad (5)$$

where *SHARE* is the wage bill share of skilled workers, *TECH* is a measure of technical change, *K* is the capital stock, *Y* is value added, W_s/W_u is relative wages, Δ the difference operator and *e* an error term. This relationship can be derived from the stochastic form of a translog short-run variable cost function with labor as the two variables and fixed and technological capital as the two fixed factors (e.g. Berman, Bound and Griliches, 1994). The test of skill biased technical change is whether $\beta_1 > 0$, and the overwhelming preponderance of evidence supports this finding.

An example of the genre is Machin and Van Reenen (1998) who examine this relationship using manufacturing data across many industries in seven OECD countries (the US, UK, France, Japan, Germany, Denmark and Sweden) in the 1970s and 1980s. In all of the countries examined they found that demand was shifting more quickly towards skilled workers in the more technologically advanced industries (i.e. $\beta_1 > 0$ in equation (5)). This was robust to using either occupation or education as a measure of skills; using either R&D intensity or computer use as a measure of technology and instrumenting own R&D with frontier (US) R&D. In most countries they also found evidence of capital-skill complementarity ($\beta_2 > 0$). Estimating versions of equation (5) in other countries, in non-manufacturing sectors (e.g. Autor, Katz and Krueger, 1998) and on more disaggregated plant level data (e.g. Doms, Dunne and Troske, 1997) also appears to uncover evidence of SBTC.

Further evidence on SBTC comes from considering whether one can identify common patterns of cross-country change. In particular, if one sees faster skill demand shifts occurring in the same sorts of industries in different countries one may view this as informing the SBTC hypothesis (to the extent that similar industries in different countries utilize similar technologies). Berman, Bound and Machin (1998) looked at country by country pairwise correlations of industry skill demand shifts for the same industries in different countries (using data from the United Nations Industrial Statistics database for twelve countries. They found that most industrial demand shifts covary positively across countries, in line with the notion that SBTC matters.

A less used alternative to test for SBTC is to regress the adoption of technologies on skill prices (i.e. when skilled workers wage rise relative to unskilled workers this should depress the incentive to adopt new technologies) or skilled labor supply. Some evidence for this method is in Caroli and Van Reenen (2001) and Doms and Lewis (2006) and also supports SBTC. A third method is to directly estimate the production function or the cost function underlying the factor demand equation (5). This has also tended to uncover evidence of skill-technology complementarity (e.g. Bresnahan et al, 2002).

Finally some authors have directly regressed individual wages on computer use or controlling for other factors (e.g. Krueger, 1993). This is a rather unsatisfactory test of SBTC, however, as computers are likely to be allocated to more productive workers as has been found by several studies (Chennells and Van Reenen, 1997; DiNardo and Pischke, 1997). This method therefore conflates selection and SBTC.

Although we have stated the SBTC hypothesis in quite a blunt fashion the influence of technical change is almost certainly more nuanced as detailed case studies suggest (Blanchard, 2004). For one, new technologies typically present opportunities to increase productivity if firms are able to successfully invest in re-organizing their firm (e.g. through decentralizing or delayering hierarchies). Some econometric studies suggest that it is these

organizational changes that are typically associated with increased demand for skilled workers (Caroli and Van Reenen, 2001; Bresnahan et al, 2002).

In a related vein, computerization does not simply involve increasing all skill demand but it substitutes for different types of tasks. For example, "routine" manual tasks such as working on a production line have been increasingly replaced by automated IT. By contrast, non-routine analytical tasks performed by consultants and academic economists have been helped by this routinization. This is the classical SBTC mechanism increasing the relative demand for the more skilled non-manuals relative to blue collar workers. But routine non-manual tasks such as clerical work have also been replaced by computers and these clerical workers are more in the middle of the income distribution. By contrast, some non-routine manual tasks such as cleaning at the bottom of the wage distribution are largely unaffected by IT. Using detailed information on occupational tasks Autor, Levy and Murnane (2003) show the quantitative importance of this phenomenon. As expected, computerization is connected with a decrease in demand for manual and non-manual routine skills, but an increase in demand for analytic skills. Building on this, Autor, Katz and Kearney (2006) show how a model where IT replaces routine tasks can rationalize the experience of the 1990s where there appeared to be a polarization of jobs with the "middle" of the wage distribution suffering at the expense of the bottom as well as the top.

Overall then there is strong support for the importance of SBTC. Some critics (most strongly expressed in Card and DiNardo, 2002) argue that SBTC cannot be the reason for increased inequality because technical change is continuous whereas the change in wage inequality is episodic. Regardless of whether one agrees with the characterisation of technical change, this misses the point that SBTC is meant to account for the longer-run pressure to increase skill demand (the D in equation (2)) and not necessarily the "twist" in the 1980s. Similarly the fact that inequality growth slowed down post 1995 whereas productivity growth accelerated does not "disprove" the SBTC argument as the speed of technical change is simply not the same as the bias of technical change.

3.2.2 Increased International Trade

At first glance, the simple Heckscher-Ohlin model of trade offers a seemingly cogent explanation of why unskilled workers have fared badly in recent decades. Less developed countries such as China and India have become integrated into the global economy as trade barriers, transportation and communication costs have fallen. Unskilled workers in the OECD counties now have to compete not only with workers at home but also with a large number of workers overseas. The influx of cheap goods produced with low skill labor puts downward pressure on the wages and employment opportunities of unskilled workers in the West and is responsible for the shift in labor demand in Figure 3.

To model this we explicitly consider two regions: "North", which is skill abundant and "South" which is unskilled abundant. There are four industries: tradable high skill intensive, tradable low skill intensive, non-tradable high skill intensive and non-tradable low skill intensive. The Stolper-Samuelson theory establishes that relative wages in each country will depend on relative output prices of the tradable industries: the higher the relative price of the skill intensive good the higher the relative wage of the skilled workers. What happens when a small open economy in the North moves from autarky to free trade? The removal of trade barriers increases the relative price of the skill intensive good and this means the skill premium rises in the North.

Although this model is coherent, it also offers several other predictions which turn out to be at odds with the data (see Desjonqueres, Machin and Van Reenen, 1999, for extensive discussion of these predictions). First, the increasing specialisation of the North in skill

intensive goods under free trade means that employment should shift *between* industries to skill intensive industries. But because relative skill prices have risen we should expect to see that employment *within* industries shifts towards (the cheaper) unskilled workers. Decompositions of the increase in the aggregate employment share of skilled workers, however, almost all show that within industries there has been a strong shift towards skilled workers. This might be because the level of aggregation of industries is too high, but more disaggregated industries and even firm level studies suggest that a sizeable proportion is "within". Even more convincingly, Desjonqueres et al (1999) show that non-traded sectors - such as hotels and wholesale outlets - also show a shift towards skilled workers (and an increase in the educational wage premium). This pattern of within industry shifts is consistent with general SBTC, but inconsistent with the basic trade theory.

A second prediction of the basic trade model is that wage differentials should fall in developing countries as there is effectively an increase in skilled labor supply from the North. There is no evidence that such a compression has occurred: if anything most developing countries studied appear to also have experienced a growth in skill premia.

Thirdly, we should observe that relative prices of the unskilled-intensive sectors should fall rapidly in the North. There is some evidence for this in the US but there is no significant relationship for any other country (at least until the mid 1990s). Even in the US the evidence from Krueger (1996) is that this relationship was only apparent after 1989 when wage inequality grew slowly.

Finally, naïve regressions that include import penetration and other trade variables in equation (5) generally find no role for these trade variables (e.g. Machin and Van Reenen, 1998). This does not take into account the general equilibrium effects underlying the Heckscher-Ohlin model of course.

Overall there is little support for the trade-based explanation of demand shifts. There are two caveats to this conclusion. First, most of these studies were based on data prior to 1995 when China started to become more of a major exporter. Second, trade might induce some of the skill biased technological change discussed in the previous section as suggested by Acemoglu (2002). As far as we know there is no empirical evidence on this speculation either way.

3.3 Labor Market Institutions

In research trying to reconcile cross-country differences in change in wage inequality, an emphasis has been placed upon the role of labor market institutions that affect wages differently in different places. There are several features of this work, ranging from studies that look in detail across countries to those which focus on the role played by particular labour market institutions like minimum wages or trade unions.

3.3.1 Cross Country Evidence

As discussed in section 2 the wages structure in OECD countries has evolved in many different ways in the last 30 years. The rise in inequality was much stronger in the Anglo-Saxon countries (e.g. the US and UK) than elsewhere (e.g. France, Germany and Japan). Although the technology and/or trade shocks discussed in the previous sub-sections should affect all countries, the Continental European and Japanese economies have experienced a much greater increase in unemployment than the US since the late 1970s. One view is that European unemployment and American inequality are "two sides of the same coin" – institutional rigidities (and perhaps generous welfare benefits) placed a floor under the wages of unskilled workers in Continental Europe, so as technology and globalisation forced low

skilled American workers to accept lower wages, in Europe the equivalent less skilled individuals lost their jobs.[4]

This is probably too crude. Nickell and Bell (1995) have shown that relative unemployment rates between skilled and unskilled workers did not rise by as much as would be expected in this simple model. Similarly, the cross country correlation between the growth in unemployment and earnings inequality is not very strong (e.g. Burniaux et al, 2006). Finally, European countries may have been better at keeping up the growth of supply of the quantity and quality of skills than in the US and UK (although Table 3 shows that skill expansion in the UK was very rapid).

At the very least, the fact that wage inequality has not risen in the countries where minimum wages and/or union power remained strong suggests that institutions do have an important role to play.

3.3.2 Minimum Wages

There is much evidence that minimum wages compress wage differentials (DiNardo et al, 1996). In the US the real value of the Federal minimum wage fell significantly during the 1980s and some authors argue that this can account for all of the change in wage inequality (e.g. Lee, 1999). By the same token the uprating of the Minimum wage in the 1990s helps explain the slowdown in wage inequality. As Card and DiNardo (2002) emphasis the time series pattern is very strong – see Figure 4 (taken from Autor, Katz and Kearney, 2005a).

A problem with the "purely institutional" argument, however, is that it seems highly unlikely that the minimum wage can explain what is happening in the top half of the wage distribution. Analysis of the minimum wage suggests that the impact on workers above median wages is close to zero. Nevertheless, the most striking finding of the analysis in Section 2 was that there appeared to be a secular increase in the 90-50 wage ratio since the late 1970s in the US (and the UK). It is hard to reconcile these facts with the view that the minimum wage can explain all the change in the wage distribution. Similarly, when Autor, Katz and Kearney (2005a) add the minimum wage to equation (4) although it has the expected negative sign, it does little to reduce the long-run unexplained relative demand shift towards higher education wage differentials.

Where the institutional story does better is in accounting for the dramatic increase in residual wage inequality in the bottom half of the wage distribution in the 1980s. This residual wage change was more episodic and the majority of the change is plausibly accounted for by the minimum wage (and compositional effects – see below).

Another problem with the pure minimum wage explanation is that wage floors changed much less in other countries where wage inequality also rose. For example in the UK, the minimum wage system that operated at the time when wage inequality rose (the "Wage Councils") only covered a relatively small proportion of the workforce (around 12% at the time of abolition in 1993). Furthermore, during the 1993-1999 time period when all non-agricultural minimum wages were abolished in the UK, wage inequality at the lower end actually started to stabilise (Dickens, Machin and Manning, 1999; Machin and Manning, 1994).

[4] There is a also a new, growing body of work arguing that tastes and social norms are important for explaining cross-country patterns of change (see, amongst others, Benabou and Tirole, 2006).

3.3.3 Trade Unions

As with minimum wages there is robust evidence that unions act to compress wage differentials (e.g. Freeman, 1980; Card, 1996). Since unions have declined in the US and the UK, this may be another institutional mechanism putting upwards pressure on wage inequality. Unionization rates fell from 25% to 15% between 1979 and 1998 in the US and from 53% to 31% in the UK over the same period. Gosling and Lemieux, (2004) argue that union decline can account for over a third of the increase in male wage inequality in both countries over the 1983-1998 period.

As with the minimum wage explanation, it is rather difficult to evaluate these statistical decompositions as they are not based on an underlying economic model. But it does seem rather implausible that unions could be the major explanation in the US for the ongoing increase in the 90-50 ratio since (a) they comprise such a small part of the workforce and (b) their membership is mainly drawn from the bottom half of the wage distribution.

3.4 Within Group Wage Inequality

It was noted above (in Section 2) that within-group inequality has been rising consistently in the US. This observation has spawned a literature trying to pin down and better understand the reasons why.

3.4.1 Skill Prices

In an early contribution, Juhn et al (1993) argue that the increase in residual inequality reflects differences in skill prices. But this assumes a competitive model of the labor market that is somewhat at odds with the evidence from matched worker firm information that "firm effects" appear important even after controlling for observed and unobserved worker quality.

3.4.2 Imperfect Competition

An alternative set of theories has emerged that builds upon frictions in the labor market generating heterogeneous wages even for identical workers. Some more productive/technologically advanced firms may share quasi-rents with workers who are matched with them (e.g. Van Reenen, 1996). If the dispersion of these wage premia have increased over time this could lie behind the increase in residual wage inequality. For example, in Caselli (1999) firms experiment with the uncertain new technology and some of those who are successful obtain higher productivity, resulting in higher wages for the workers with whom they are matched. There is little hard empirical evidence on these theories although Faggio et al (2006) offer some evidence that firm productivity heterogeneity has increased and this is linked to firm wage inequality as Caselli's model would suggest.

3.4.3 Compositional Effects

The increase in the proportion of the workers with more education can mechanically raise "within group" wage inequality because earnings variation is higher for those with college education relative to high school education (the same is true for experience). Lemieux (2006) argues that all of the post 1988 increase in residual wage inequality is due to these compositional effects. Autor, Katz and Kearney (2005b) analyze 90-50 and 50-10 differentials separately and find a larger role for prices. Nevertheless, closer inspection of Figure 1 suggests that residual inequality increased far less after 1992 than before in the

March CPS data (and it hardly moves at all in the CPS May/ORG data studied in Autor at al, 2005a). This implies that residual inequality may actually be less of an important phenomenon than is sometimes asserted.

4. Conclusions

There has been a dramatic increase in wage inequality since the late 1970s in the US, UK and other Anglophone countries. A significant reason for this is the growth of wage differentials between educational groups. We have argued that the fundamental reason for this is a long-run growth in the relative demand for skills driven by technology change (rather than trade). Changes in skill supply and institutional changes have affected the timing of how skill biased technical change the wage structure. The increase in US and UK inequality slowed down after 1990 but has continued to grow in the upper tail of the wage distribution, and wage inequality has started to rise in places previously characterised by stable wage structures (like Germany), indicating that changing patterns of wage inequality remain high on the research agenda of empirical economists.

References

Acemoglu, D. (2002) Technical Change, Inequality and the Labour Market, Journal of Economic Literature, 40, 7-72.

Autor, D., L. Katz, and M. Kearney (2005a) Trends in US Wage Inequality: Re-Assessing the Revisionists, NBER Working Paper 11627.

Autor, D., L. Katz, and M. Kearney (2005b) Rising Wage Inequality: The Role of Composition and Prices, mimeo.

Autor, D., L. Katz, and M. Kearney (2006) The Polarization of the U.S. labor market, American Economic Review, Papers and Proceedings, 96, 189-94.

Autor, D., L. Katz, and A. Krueger (1998) Computing Inequality: Have computers changed the labor market?, Quarterly Journal of Economics, 113, 1169-1214.

Autor, D., F. Levy and R. Murnane (2003) The Skill Content of Recent Technological Change: An Empirical Investigation, Quarterly Journal of Economics, 118, 1279-1333.

Benabou, R. and J. Tirole (2006) Belief in a Just World and Redistributive Politics, Quarterly Journal of Economics, 121, 699-746.

Berman, E. J. Bound and Z. Griliches (1994) Changes in the Demand for Skilled Labor Within US Manufacturing Industries: Evidence from the Annual Survey of Manufacturing, Quarterly Journal of Economics, 109, 367-98.

Berman, E., J. Bound and S. Machin (1998) Implications of Skill-Biased Technological Change: International Evidence, Quarterly Journal of Economics, 113, 1245-1280.

Blanchard, O. (2004) The Economic Future of Europe, Journal of Economic Perspectives, 18, 3-26.

Bond, S. and J. Van Reenen (2006) Micro-Econometric Models of Investment and Employment, in J. Heckman and E. Leamer (eds.) *Handbook of Econometrics,* Volume VI, North Holland.

Bound, J. and G. Johnson (1992) Changes in the Structure of Wages in the 1980s: An Evaluation of Alternative Explanations, American Economic Review, 83, 371-92.

Bresnahan, T., E. Brynjolfsson and L. Hitt (2002) Information Technology, Workplace Organization and the Demand for Skilled Labour: Firm-level Evidence, Quarterly Journal of Economics, 117, 339-76.

Burniaux, J., F. Padrini and N. Brandt (2006) Labour Market Performance, Income Inequality and Poverty in OECD Countries, OECD Economics Department Working Paper 500.

Card, D. and J. DiNardo (2002) Skill-Biased Technological Change and Rising Wage Inequality: Some Problems and Puzzles, Journal of Labor Economics, 20, 733-83.

Card, D. and T. Lemieux (2001) Can Falling Supply Explain the Rising Return to College for Younger Men?, Quarterly Journal of Economics, 116, 705-46.

Card, D. (1996) The Effects of Unions on the Structure of Wages, Econometrica, 64, 957-79.

Caroli, E. and J. Van Reenen (2001) Skill-Biased Organizational Change? Evidence from a Panel of British and French Establishments, Quarterly Journal of Economics, 116, 1449-92.

Caselli, F. (1999) Technological Revolutions, American Economic Review, 89, 78-102.

Chennells, L. and J. Van Reenen (1997) Technical Change and Earnings in British Establishments, Economica, 64, 587-604.

Desjonqueres, T., S. Machin and J. Van Reenen (1999) Another Nail in the Coffin? Or can the Trade Based Explanation of Changing Skill Structures be Resurrected?, Scandinavian Journal of Economics, 101, 533-554.

Dickens, R., S. Machin and A. Manning (1999) The Effects of Minimum Wages on Employment: Theory and Evidence From Britain, Journal of Labor Economics, 17, 1-22.

DiNardo, J., N. Fortin and T. Lemieux (1996) Labor Market Institutions, and the Distribution of Wages, 1973-1992: A Semi-parametric Approach, Econometrica, 64, 1001-1044.

DiNardo, J. and S. Pischke (1997) The Returns to Computer Use Revisited: Did Pencils Change the Wage Structure Too?, Quarterly Journal of Economics, 112, 291-303.

Doms, M. and E. Lewis (2006) Labor Supply and Personal Computer Adoption, Federal Reserve Bank of Philadelphia Research Paper 06-10, June.

Doms, M., T. Dunne and K. Troske (1997) Workers, Wages and Technology, Quarterly Journal of Economics, 112, 253-289.

Faggio, G, J. Van Reenen and K. Salvanes (2006) Increasing Inequality of Firm Productivity, mimeo.

Freeman, R. (1980) Unionism and the Dispersion of Wages, Industrial and Labor Relations Review, 34, 3-23.

Goos, M. and A. Manning (2006) Lousy and Lovely Jobs: The Rising Polarization of Work in Britain", Review of Economics and Statistics, forthcoming.

Gosling, A. and T. Lemieux (2004) Labor Market Reforms and Changes in Wage Inequality", in D. Card, R. Blundell and R. Freeman (eds.) *Seeking a Premier League Economy*, NBER/Chicago University Press.

Juhn, C., K. Murphy and B. Pierce (1993) Wage Inequality and the Rise in Returns to Skill, Journal of Political Economy, 101, 410 – 442.

Katz, L. and D. Autor (1999) Changes in the Wage Structure and Earnings Inequality, in O. Ashenfelter and D. Card (eds.) *Handbook of Labor Economics*, Volume 3, North Holland.

Katz, L. and K. Murphy (1992) Changes in Relative Wages, 1963-87: Supply and Demand Factors, Quarterly Journal of Economics, 107, 35-78.

Krueger, A. (1993) How Computers Have Changed the Wage Structure: Evidence From Microdata, 1984-1989, Quarterly Journal of Economics, 108, 33-60.

Krueger, A. (1996) Skill Intensity and Industrial Price Growth, Industrial Relations Research Association, Proceedings, 48, 11-18.

Lee, D. (1999) Wage Inequality in the United States During the 1980s: Rising Inequality or Falling Minimum Wages, Quarterly Journal of Economics, 114, 997-1023.

Lemieux, T. (2006) Increasing Residual Wage Inequality: Composition Effects, Noisy Data, or Rising Demand for Skill?, American Economic Review, 96, 461-498.

Machin, S. (1996) Wage inequality in the UK, Oxford Review of Economic Policy, 7, 49-62.

Machin, S. and A. Manning (1994) Minimum Wages, Wage Dispersion and Employment: Evidence from the U.K. Wages Councils, Industrial and Labor Relations Review, 47, 319-29.

Machin, S. and J. Van Reenen (1998) Technology and Changes in Skill Structure: Evidence From Seven OECD countries, Quarterly Journal of Economics, 113, 1215-44.

Machin, S. and A. Vignoles (2005) *What's the Good of Education? The Economics of Education in the UK*, Princeton University Press.

Nickell, S. and B. Bell (1995) The Collapse in Demand for the Unskilled and Unemployment Across the OECD, Oxford Review of Economic Policy, 11, 40-62

Spitz-Oener, A. (2006) Technical Change, Job Tasks and Rising Educational Demands: Looking Outside the Wage Structure, Journal of Labor Economics, 24, (forthcoming).

Van Reenen, J. (1996) The Creation and Capture of Economic Rents: Wages and Innovation in a Panel of UK Companies, Quarterly Journal of Economics, 111, 195-226

Table 1: Hourly Wage Inequality in the UK and US

Changes in Hourly Wage Inequality (Full-Time Workers)

A. Real Wage Trends By Percentile (Annualised Percentage Points)

	UK			US		
	1980s	1990s	2000s	1980s	1990s	2000s
5th percentile	1.8	1.0	3.0	-1.6	1.3	1.8
10th percentile	1.6	1.1	2.6	-0.6	1.5	1.4
25th percentile	1.8	1.2	2.3	0.0	0.9	0.4
50th percentile	2.3	1.5	2.4	0.3	0.8	1.1
75th percentile	3.0	1.9	2.8	0.6	1.0	1.6
90th percentile	3.5	2.1	3.0	1.3	1.3	1.9
95th percentile	3.8	2.2	3.5	2.0	1.3	1.9

B. Trends in Inequality Indices (Annualised Percentage Points)

	UK			US		
	1980s	1990s	2000s	1980s	1990s	2000s
90-10 differential	1.9	1.0	0.4	1.9	-0.2	0.5
90-50 differential	1.2	0.6	0.6	1.0	0.4	0.8
10-50 differential	-0.7	-0.4	0.2	-0.9	0.7	0.3
95-90 differential	0.3	0.1	0.5	0.7	0.0	0.0
5-10 differential	-0.2	-0.1	0.4	-1.0	-0.2	0.4

Notes: UK - derived from New Earnings Survey (NES); US - derived from Current Population Survey data (the Outgoing Rotation Group, ORG, data from NBER). The time periods used are: 1980s – 1979 to 1989; 1990s – 1989 to 1999; 2000s – 2000 to 2004.

Table 2: Male 90-10 Wage Ratios Across Countries, 1980-2000

	Male 90-10 Wage Ratios		
	1980	1990	2000
Australia	2.73	2.71	3.16
Finland	2.44	2.57	2.47[f]
France	3.38	3.46	3.28[e]
Germany	2.53[b]	2.44	2.86[e]
Italy	2.09[b]	2.38	2.44[c]
Japan	2.60	2.84	2.74[f]
Netherlands	2.32[a]	2.48	2.83[f]
New Zealand	2.72	3.08	3.55[d]
Sweden	2.11	2.07	2.35[e]
UK	2.63[b]	3.24	3.40
US	3.58	4.41	4.76

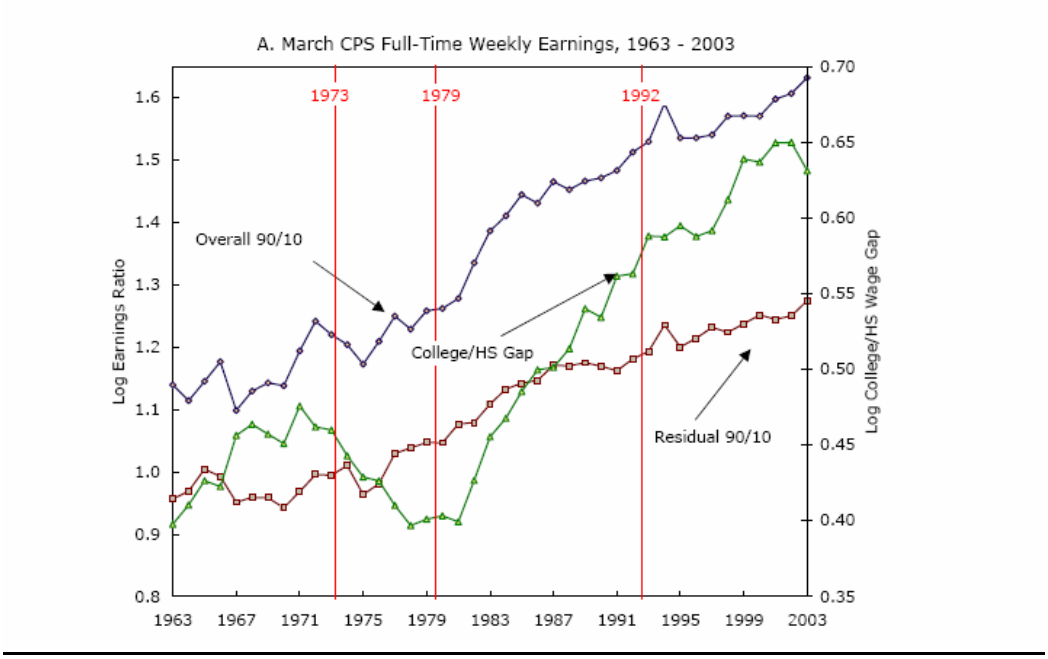
Notes: Taken from OECD data web site (http://www1.oecd.org/scripts/cde/members/lfsdataauthenticate.asp). Data is from different years as denoted by the following superscripts: a – 1985; b – 1986; c – 1996; d - 1997; e – 1998; f – 1999.

Table 3: Aggregate Trends in Graduate/Non-Graduate Employment and Wages

	UK		US	
	% Graduate Share of Employment	Relative Weekly Wage (Full-Time)	% Graduate Share of Employment	Relative Weekly Wage (Full-Time)
1980	5.0	1.48	20.8	1.41
1985	9.8	1.50	24.2	1.53
1990	10.2	1.60	25.7	1.60
1995	14.0	1.60	31.8	1.65
2000	17.2	1.64	31.8	1.69
2004	21.0	1.64	34.2	1.66
Changes:				
1980-2004	16.0	.16	13.4	.25
1980-1990	5.2	.12	4.9	.19
1990-2000	7.0	.04	6.1	.09
2000-2004	3.8	.00	2.4	-.02

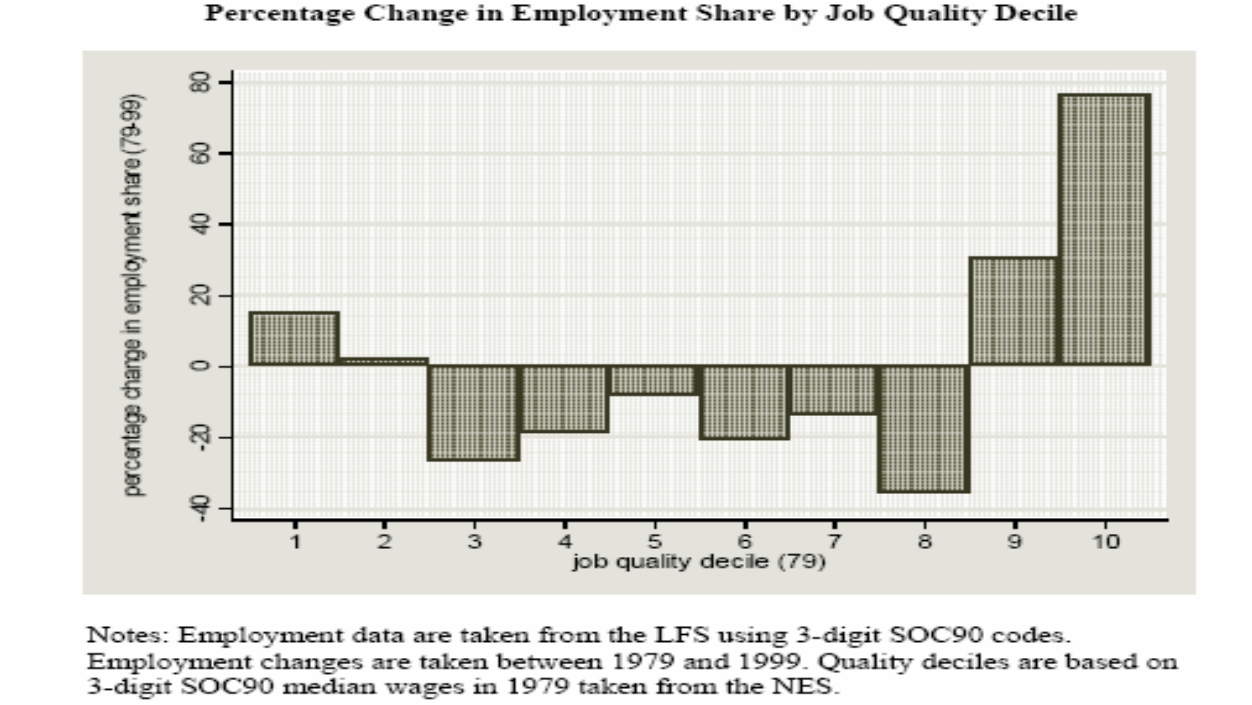
Notes: UK - derived from General Household Survey (GHS) and Labour Force Survey (LFS); US - derived from Current Population Survey data. UK Updated from Machin and Vignoles (2005). Sample includes all people aged 18-64 in work and earning, except for relative wages which are defined for full-time workers. The relative wage ratios are derived from coefficient estimates on a graduate dummy variable in semi-log earnings equations controlling for age, age squared and gender (they are the exponent of the coefficient on the graduate dummy).

Figure 1: Changes in US Wage Inequality, 1963-2003



Source: Autor, Katz and Kearney (2005a) – based on full-time weekly earnings for all workers in the March Current Population Survey.

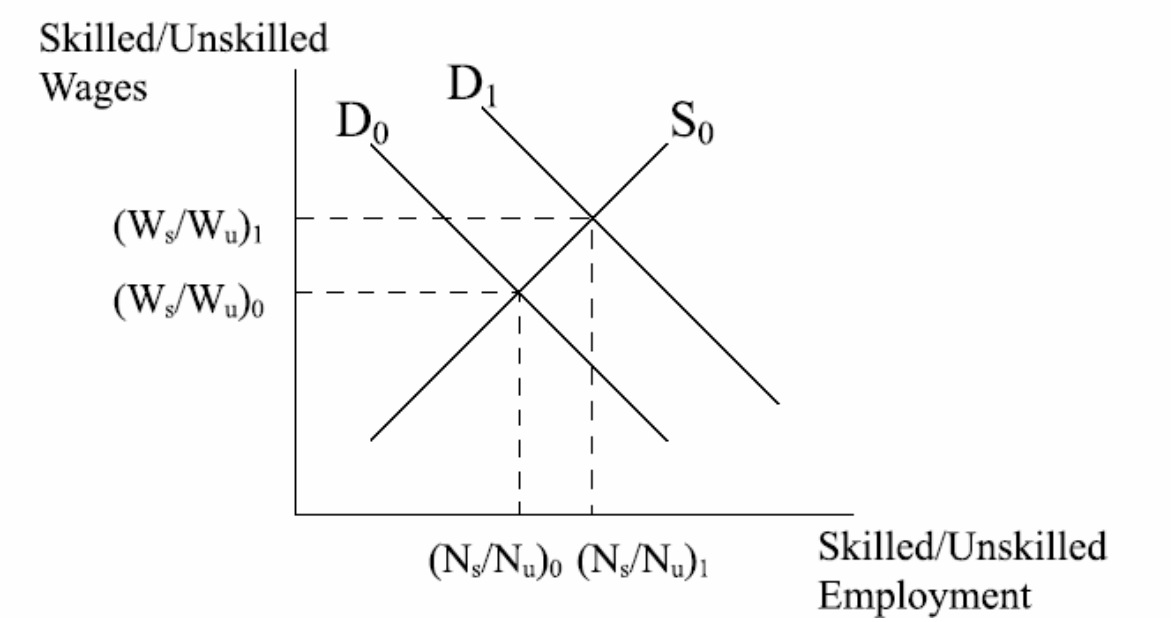
Figure 2: Good Jobs and Bad Jobs



Notes: Employment data are taken from the LFS using 3-digit SOC90 codes. Employment changes are taken between 1979 and 1999. Quality deciles are based on 3-digit SOC90 median wages in 1979 taken from the NES.

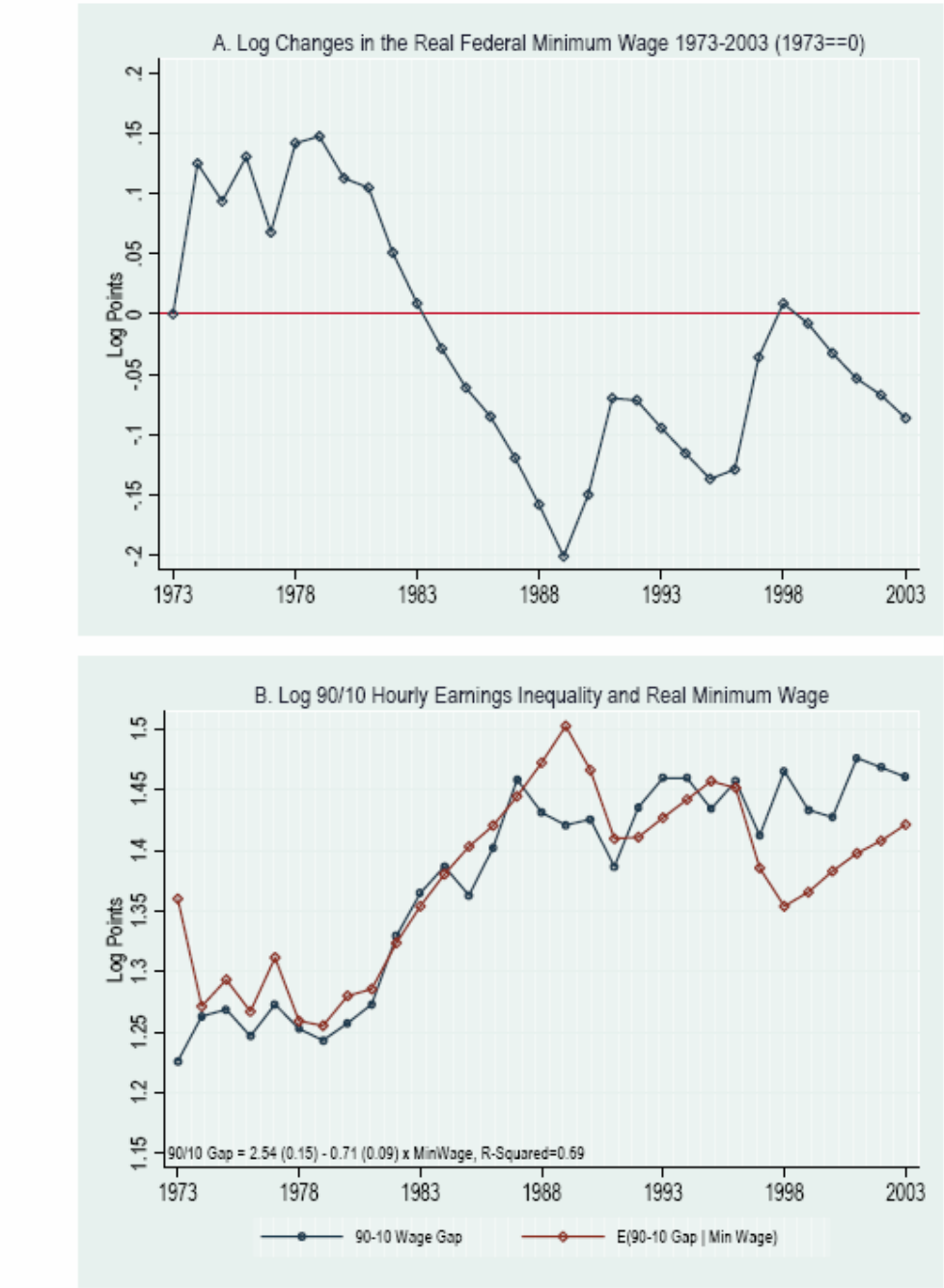
Source: Goos and Manning (2006)

Figure 3: Relative Wages and the Demand and Supply of Skills

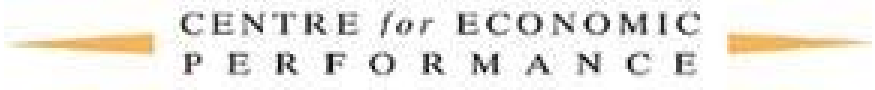


Notes: Equilibrium wage differentials $(W_s/W_u)_o$ begin at the intersection of the relative demand curve for skills (D_o) and the relative supply curve for skills (S_o). This is associated with relative employment of skilled to unskilled workers of $(N_s/N_u)_o$. A shock to the relative demand curve shifts D_o to the right (D_1). This increases the relative wage to $(W_s/W_u)_1$ and the relative employment to $(N_s/N_u)_1$. At the new equilibrium we observe greater wage inequality and a relatively higher employment of skilled to unskilled workers.

Figure 4: The Time Series Relationship between the US Federal Minimum Wage and Wage Inequality



Source: Autor, Katz and Kearney (2005a).



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