by Steve Machin

Upgrading the workers

Higher education levels have produced increased numbers of better qualified workers in the labour market, yet the differential between skilled and unskilled wages has risen at the same time. Stephen Machin examines the key aspects of rising labour market inequality, with particular reference to the way in which technological change has shifted the labour market in favour of skilled workers.

There have been dramatic changes in the structure of employment in the labour markets of many countries in recent years. A key aspect has been the increased demand of employers for workers with higher educational qualifications and skill levels.

Another dramatic change, certainly in the US and the UK in the 1980s, has been rapidly rising wage inequality. This coincided with the period of the most significant direct impact of the computer revolution on the labour market, namely the introduction of personal computers (PCs) on desks where there had been no computer before.

In the academic literature there has been much emphasis on the impact of the new technologies on employers' demand for skills. Some of this work uses evocative phrases like "the collapse in demand for the unskilled", "the deteriorating position of low skill workers" and "rapidly rising wage gaps between the skilled and unskilled", all of which are in line with the notion that large shifts have occurred.

Certainly, many more skilled workers are now in employment than in the past, both in absolute numbers and relative to their less skilled counterparts. Table 1 shows for the US and the UK between 1980 and 2000 the shares of employment and hours worked and the relative wages of employees with a degree as compared with non-degree holders. It confirms the rapid increases in the shares of relatively higher educated workers (graduates) that have occurred in both countries.

It is also interesting that, despite their increased numbers, the relative wages of more skilled workers have not fallen. In fact, the wage gap between graduates and non-graduates rose in both countries (though at a faster rate in the US) and widened faster in the 1980s than in the 1990s. The table shows that higher relative wages and higher levels of employment for graduates moved in tandem. This was true for both decades and for both countries, though the relative wages clearly increased by more in the 1980s than in the 1990s.

An intuitive way of thinking about this relative demand shift

Table 1 Aggregate Trends in Graduate/Non-Graduate Employment, Hours and Relative Wages, UK and US 1980-2000

UK Labour Force Survey/General Household Survey

	% Graduate share of employment	% Graduate share of hours	Relative weekly wage (full-timers)
1980	5.0	5.1	1.48
1985	9.8	10.5	1.50
1990	10.2	11.0	1.60
1995	14.0	15.4	1.60
2000	17.2	18.8	1.64

US Current Population Survey

	% Graduate share of employment	% Graduate share of hours	Relative hourly wage (full-timers)
1980	19.3	20.4	1.36
1985	22.0	23.6	1.47
1990	23.8	25.6	1.55
1995	25.5	28.1	1.61
2000	27.5	29.5	1.66

Sample is all people age 18-64 in work and earning (except for relative wages, which are 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. The UK employment and hours shares are from the LFS. The relative wage gaps are from the GHS for 1980, 1985 and 1990 and the LFS in 1995 and 2000 (relative wages for 1995, the overlap year, were very similar). They are weekly wages because the hours question in the GHS was changed in the 1980s. The CPS data is the Economic Policy Institute CPS ORG labor extracts data. I thank John Schmitt for making them available to me.

in favour of the skilled is in terms of an economic model where the wages and employment of skilled and unskilled workers are the outcomes of a race between supply and demand. The general implication is that both demand and supply curves are shifting and the question is which curve has moved the most. It would seem that, to have generated simultaneously higher wages and higher employment for the skilled, relative demand for the skilled must have increased by more than relative supply. Put alternatively, over the period of rising wage inequality, demand won the race and employers were prepared to raise the pay of workers with appropriate skills more than that for less skilled workers, despite the fact that many more skilled workers were in the labour market.

What might have caused this relative demand to increase more rapidly than relative supply? A large body of work has argued that the critical factor has been the introduction of new technologies that are biased in favour of skilled workers. This "skill-biased technology change" hypothesis is founded on the notion that employers' demand for more skilled workers has been shaped by the kinds of new technologies that are permeating modern workplaces. Such new technologies lead to higher productivity, but only some workers possess the necessary skills to use them. So employers are prepared to increase the wages of their skilled workforce. At the same time, less skilled workers, who cannot operate the new technologies, find their wages are lowered, or lose their jobs.

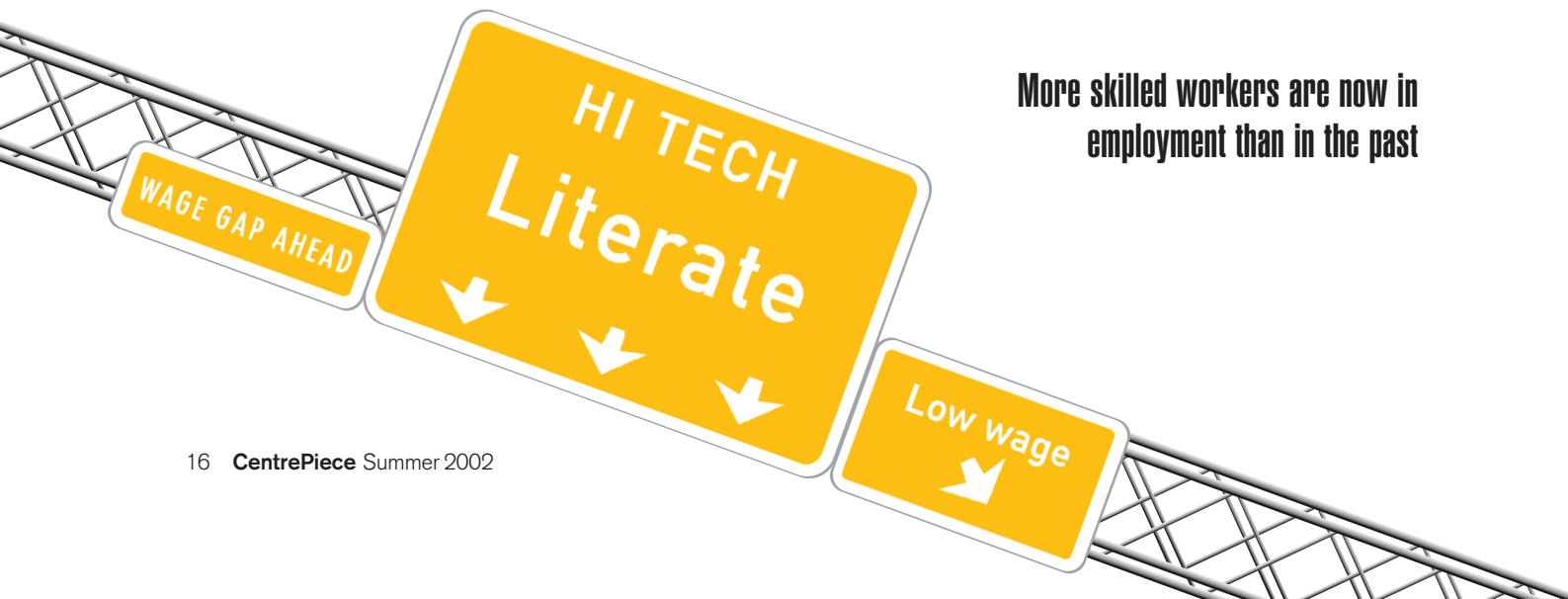
What evidence is there for this hypothesis? First, for the story to hold, shifts in skill demand must clearly be variable and that variability must be systematically related to the introduction of new technologies. Particular workplaces, firms or industries are likely to differ in the extent of their use of new technologies. So some indirect evidence on the hypothesis might come from looking at the shifts in relative demand within workplaces or firms or industries, rather than between them.

Table 2 Within/Between Decompositions of Skill Demand Changes

Study	Unit of Analysis	Time period	Skill Demand Measure	Annualised Change (Percentage Points)	Percent Within
Autor, Katz and Krueger (1998)	140 US industries	1990-96	College employment share	.300	87
			College wage bill share	.587	82
		1980-90	College employment share	.469	79
			College wage bill share	.878	70
		1970-80	College employment share	.586	79
			College wage bill share	.662	84
		1960-70	College employment share	.324	27
			College wage bill share	.511	45
Berman, Bound and Machin (1998)	450 US manufacturing industries	1979-87	Non production employment share	.552	70
			Non production wage bill share	.774	60
	360000 US manufacturing plants	1977-87	Non production employment share	.367	82
	100 UK manufacturing industries	1979-90	Non production employment share	.387	82
			Non production wage bill share	.669	83
	402 British workplaces	1984-90	Non production employment share	.41	83
Machin (1996)	402 British workplaces	1984-90	Managers employment share	.14	86
			Senior technical and professionals employment share	.19	95

Table 2 summarises the evidence from three studies for the UK and US at workplace and industry level. At both these levels of aggregation it is clear that the bulk of the observed wage and employment shifts in favour of the relatively skilled group occur within, rather than between, industries. (The only exception is the Autor, Katz and Krueger result for the 1960s.) If skill-biased technological change is even to be a starter as a possible explanation of the observed shifts in skill demand, it is essential that some industries should have faster rates of skill upgrading than others.

The second question is whether the identification of industries that have had faster rates of upgrading (and an analysis of their characteristics) can shed light on what may underpin the improving relative labour market position of the more skilled. Indeed, it is clear that those industries showing the biggest increases in relative wages and/or employment of more skilled workers are those where technological change has been more important. For example, industries that have seen the fastest skill upgrading have been those spending more on Research and



More skilled workers are now in employment than in the past

Development (R&D), producing more commercially significant innovations and employing more workers who use computers.

One way to test this formally is to estimate cost share equations that relate changes in the skilled wage bill (or employment) share in a given industry to observable measures of technology use. Table 3 summarises some results for the US and the UK. It is clear that, for a range of time periods, for different levels of aggregation and for different technology measures there is a positive association for a given industry between shifts in the skilled wage bill (or employment) shares and enhanced use of new technology. Put differently, it appears that the technologically more advanced industries have shown the faster increases in the relative demand for skilled workers. This finding certainly supports the skill-biased technology change hypothesis.

A third, more controversial, line of research has asserted that individuals receive a wage premium for working with computers. If true, this would be very much in line with the hypothesis, since it would imply that computer users are rewarded for the higher productivity linked to their use of computers. The most well known paper here is Krueger's 1993 study of US Current Population Survey data, where he adds a "computer usage" dummy to standard earnings functions. Even after controlling for a wide range of human capital and job related characteristics, his analysis found a sizable wage premium for computer users. According to his figures, the wage premium attributable simply to using a computer at work was 15% in 1984 and went up to 18% by 1989, despite the rise in the total number of computer users over the same period.

There are some clear concerns about this methodology. For example, DiNardo and Pischke in the *Quarterly Journal of*

Table 3: Regression Correlations of Skill Demand Changes and Technology Measures

Study	Unit of Analysis	Time period	Skill Demand Measure	Technology Measure	Coefficient (Standard Error)	Controls
Autor, Katz and Krueger (1998)	140 US industries	1990-96	College wage bill share	Industry computer use (1984-93)	.289 (.081)	None
		1980-90			.147 (.046)	
		1970-80			.127 (.031)	
		1960-70			.071 (.025)	
	123 US industries	1960-90		Computer investment per FTE	.130 (.027)	Change in log(capital/labour), decade dummies
	450 US manufacturing industries	1959-89	Non production wage bill share	Computer investment / investment	.027 (.007)	Change in log(capital/output), Change in log(output)
Berman, Bound and Griliches (1994)	143 US manufacturing industries	1979-87	Non production wage bill share	Computer investment / investment	.028 (.006)	Change in log(plant/output), Change in log(equipment/
				R&D / Sales	.097 (.021)	output), Change in log(output)
Machin (1996)	16 UK manufacturing industries	1982-89	Non production wage bill share	R&D/Sales	.065 (.026)	Change in log(capital), Change in log(real sales),
	16 UK manufacturing industries	1980-85		Innovation Count From 1970s	.092 (.053)	1 digit industry dummies
	398 British workplaces	1984-90	Managers , senior technical and professional employment share	Micro computers introduced	.044 (.022)	Dummy for employment decline, 1 digit industry dummies
Machin and Van Reenen (1998)	15 UK manufacturing industries	1973-89	Non production wage bill share	R&D/Value Added	.026 (.009)	Change in log(capital), Change in log(output), year dummies

Economics in 1997, replaced "computer use" variable with a "pencil use" variable and uncovered an apparent wage premium linked to pencil use. The likely explanation here is that the "computer use" variable is a proxy for other characteristics of employees not captured in the survey data and, therefore, not controlled in the regression equation. Nonetheless, the computer premia in Krueger's analysis are sizable.

Fourth, adopting a wider international perspective, looking to see whether faster changes in skill demand are concentrated in similar industries in different countries could shed further light on the validity of the hypothesis. Table 4 gives a calculation of cross-country correlations of changes in non-production wage bill shares of particular industries for the period 1980 to 1990. It shows a wide cross-country correspondence for different industries: 31 out of 36 paired comparisons are positive and many (13) of the correlations are statistically significant. This does suggest that skill upgrading has a tendency to be clustered in the same sorts of industries in different countries.

Fifth, it seems that skill upgrading has also been happening in the more technologically advanced industries in some developing countries. This suggests that skill-biased

Table 4 Cross-Country Correlations Changes in Nonproduction Wage Bill Shares in Developed Countries: 1980-90

	USA	Sweden	Australia	Japan	Denmark	Finland	Austria	UK
Sweden	.15							
Australia	.35	.16						
Japan	.09	.14	.08					
Denmark	.66*	.06	.11	.14				
Finland	.70*	.12	.37*	.33	.52*			
Austria	.27	-.44*	.14	-.11	.31	.29		
UK	.64*	.06	.38*	.01	.53*	.39*	.47*	
Belgium	.45*	-.19	-.28	-.12	.41	.45*	.51*	.47*

Notes
Calculations based on the 28 industry data used in Berman, Bound and Machin (1998). * denotes statistical significance at the 5% level or better.

Table 5 Correlations of Country-Specific Industry Skill Upgrading With Technology Variables

	Correlations of 1980s' upgrading with US computer usage	Correlations of 1980s' upgrading with OECD R&D intensity (1980-90)	Correlations of 1970s' upgrading with US computer usage	Correlations of 1970s' upgrading with OECD R&D intensity (1973-80)
High Income Group				
Countries	10	10	12	12
Positive	10	8	10	10
Significant positive	5	4	6	4
Significant negative	0	0	1	1
Middle Income Group				
Countries	12	12	8	8
Positives	8	9	5	4
Significant positives	3	2	3	1
Significant negatives	0	0	1	2
Low Income Group				
Countries	6	6	5	5
Positives	3	3	4	2
Significant positives	1	1	0	0
Significant negatives	1	0	0	1

Notes
Taken from Berman and Machin (2000). Groups of countries are as follows.
High income: Australia, Austria, Belgium, Denmark, Finland, Germany, Japan, Sweden, UK, US ('80s), plus Norway, Germany ('70s).
Middle income: Colombia, Cyprus, Czechoslovakia, Greece, Guatemala, Hungary, Ireland, Malta, Portugal, South Korea, Spain, Turkey ('80s).
Low income: Bangladesh, Egypt, Ethiopia, India, Nigeria, Tanzania ('80s).

technology change is altering relative wage and employment outcomes globally, with the patterns seen in industrialised countries repeating themselves in the developing world. Table 5 shows correlations for 28 countries (grouped by income level) between industry changes in non-production wage bill shares and both US computer usage and the OECD's estimates of R&D intensity for those industries. The pattern in the table for the high income countries again shows a strong correspondence between skill upgrading and technology deployment. But the same pattern is also strong for the middle income countries. Indeed, patterns of skill upgrading in middle income countries in the 1980s are well predicted by the two OECD indicators of recent skill-biased technological change. The evidence of skill-biased technology transfer altering the mix of employment in the smaller sample of lower income countries is weaker, where only half the correlations with the technology indicators are positive.

Is there evidence that technology driven shifts in employer demand have continued to affect contemporary labour markets as they seem to have done in Table 1 between 1980 and 2000? The only data on technology measures that exist for similar definitions at a reasonably disaggregated level across the whole economy for both the US and the UK are those measuring computer usage in the workplace. Data on computer usage at work are available for several years in the US in various supplements of the monthly Current Population Survey. The first is for October 1984, with further supplements of the same structure in October 1989 and 1993. The most recent is for October 1997. Data for the UK are more sparse. There is the British Social Attitudes Surveys for 1985 (for a very small sample) and for 1987 and 1990. There are also data in the more recent 1997 Skills Survey.

A full description of the correlations between skill upgrad-

Table 6 Changes in Computer Usage and the Wage Structure: US 1984-97

	Descriptive Statistics			
	1984	**1989**	**1993**	**1997**
% using computer at work	25.1	37.4	46.6	50.6
Sample size	61667	62748	59852	56247
% graduate share of employment	21.6	23.4	24.8	26.2
% graduate share of wage bill	32.2	35.8	38.5	41.5
Sample size	168208	167526	166665	147033

Notes
1. All people with a job aged 18-64.
2. Computer numbers based on October Current Population Survey supplement in relevant year. Responses to question 'Does….directly use a computer at work?'.
3. Wage data from all outgoing rotation groups in each year (from the EPI ORG files).
4. Weighted using CPS person weights.

Table 7 Industry Level Regressions of Changes in Graduate Wage Bill Shares on Changes in Computer Usage in the United States 1984-97

	Annualised Change in Graduate Wage Bill Share			
	(1)	(2)	(3)	(4)
	1984-97	**1984-89**	**1989-93**	**1993-97**
Changes in % using computer at work	.069	.102	.075	.021
	(.025)	(.031)	(.050)	(.050)
Sample size	660	220	220	220

Notes
1. Dependent variable is annualised change in graduate wage bill share.
2. All regressions weighted by average of industry wage bill across the relevant time periods.
3. Year dummies included in column (1).
4. Standard errors in parentheses.

Less skilled workers, who cannot operate the new technologies, find their wages lowered

ing and changes in computer usage at work that emerge from all this data is contained in the paper on which this article is based. The most striking conclusion, however, is the strong correspondence between industry computer usage across the two countries. In other words, it is very much the same industries that have more employees working with computers. It is also clear that by 1997 some industries in both countries were at near saturation point so far as the spread of computer use was concerned. This, of course, causes problems for any hypothesis that wants to relate skill upgrading in an industry to increased computer use.

For the US, where the data go back further to 1984, it is also possible to look at things at a more disaggregated level. Table 6 shows that the proportion of workers in the US using computers doubled from 25% in 1984 to 50% by 1997. The graduate shares of both employment and the total wage bill also rose sharply over the same period, mirroring the figures in Table 1.

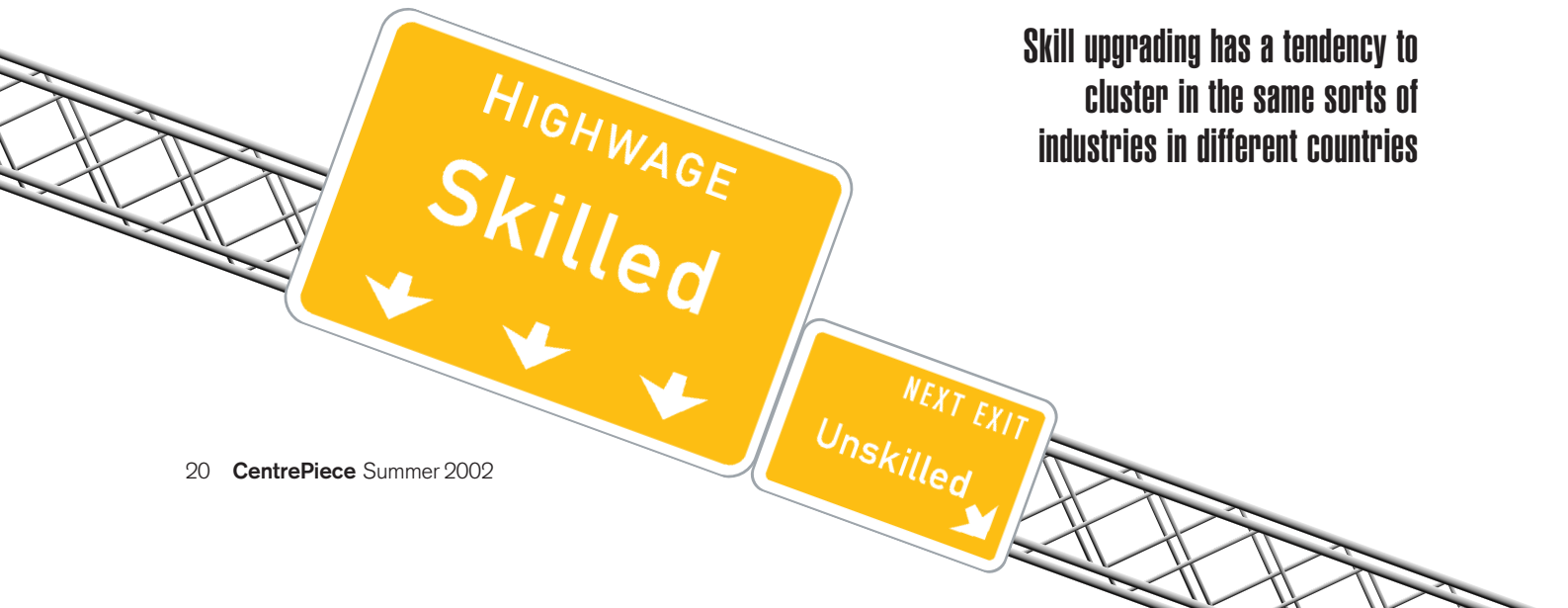
Table 7 gives estimated regression coefficients for US changes in the graduate wage bill share on increases in computer usage, first for the whole period from 1984 to 1997 and then for the three sub-periods for which I have data (1984-89, 1989-93 and 1993-97). The 1984-97 regression shows a strong association between changes in graduate wage bill shares and increased computer usage. However, when one looks at the sub-period regressions, the coefficient on computer usage falls over time and the relationship disappears by the final column specification for 1993-97. It appears that some technologically advanced industries reached saturation point in terms of computer diffusion and thus the links between skill upgrading and

Table 8 Changes in Computer Usage and Changes in Wage Structure in Britain in the 1990s

		Skills Survey Data		
	1997	**1997 if same job as 1992**	**1992**	**Change 1992-1997 (if same job)**
% Using Computer at Work	68.2	71.7	54.4	17.3
Of Which:				
Essential	30.3	28.6	15.7	12.9
Very Important	14.7	16.5	10.6	5.9
Fairly Important	12.7	14.1	12.9	1.2
Not Very Important	11.5	12.5	15.1	-2.6
Sample size	2467	1270	1270	1270

		Labour Force Survey		
	1997	**1994**	**1992**	**Annualised Change (Percent log points)** A: 1992-1997 B: 1994-1997
% Graduate Share of Employment	14.8	13.4	12.1	A: 4.0
				B: 3.3
% Graduate Share of Wage Bill	24.7	23.7	21.2	A: 3.0
				B: 1.4

Notes
1. Many thanks to Francis Green for providing me with the Skills Survey data used in the upper panel of the Table



Skill upgrading has a tendency to cluster in the same sorts of industries in different countries

Table 9 Industry Level Regressions of Changes in Graduate Wage Bill Shares on Changes in Computer Usage in Britain in the 1990s

	Annualised Change in Graduate Wage Bill Share, 1994-97			
	(1)	(2)	(3)	(4)
Changes in % Using Computer at Work	-.045			
	(.080)			
Changes in % Using Computer at Work For		.086		
Whom Fairly Important, Very Important or Essential		(.057)		
Changes in % Using Computer at Work For			.106	
Whom Very Important or Essential			(.068)	
Changes in % Using Computer at Work For				.138
Whom Essential				(.044)
Sample size	53	53	53	53

Notes
1. Dependent variable is annualized change in graduate wage bill share.
2. All regressions weighted by average of industry wage bill across the relevant time periods.
3. Standard errors in parentheses.

increased computerisation, at least measured in head count terms, no longer existed. This does not mean that skill-biased technology change no longer exerted an influence on the wage structure, but it casts doubt on simple measures of computer use as explanations for skill-biased technology change in the 1990s.

The UK situation in the 1990s is considered in Tables 8 and 9. Using the 1997 Skills Survey data, the upper panel of Table 8 compares computer usage in 1992 and 1997. It gives two 1997 numbers, one for the whole sample and one for people who were still in the same job as they had been in 1992. The top line of the table confirms that increased computerisation of jobs carried on through the 1990s.

The breakdown made possible by the 1997 Skills Survey into sub-groups for whom whether computers were "essential", "very important", "fairly important" or "not very important" shows a rise in the first three categories and a fall in the "not very important" group.

The lower part of the table gives the graduate share of employment and of the wage bill, taken from the Labour Force Survey, for three years (1992, 1994 and 1997). These years are chosen because an industry definition change occurred between 1992 and 1997, which means that it is possible to make the industry-level empirical analysis between 1994 and 1997 for a consistent set of industries.

Accordingly, Table 9 gives a set of industry-level regressions of changes in graduate wage bill shares in the UK in the 1990s on changes in the percent of people using a computer at work. The column (1) computer use variable is for all people and columns (2), (3) and (4) gradually refine the variable for those who reported varying degrees of importance to working with computers. The first column shows no relation between 1990s skill upgrading and the increased use of computers in the 1990s. This mirrors the US finding over the same period and supports the notion that simple computer usage measures may not be particularly good for looking at technology change in the 1990s, because of high computer use levels in technologically advanced industries.

However, once broken down by importance of the computer to the job, industry skill upgrading is still associated with increased computer use. The strongest positive (and statistically significant) association is between changes in graduate wage bill shares and changes in the percent using a computer for whom it is "essential" to the job. It seems that, even in the 1990s, relative demand was still shifting in favour of skilled workers in industries where computers are becoming more important.

Thus the evidence for skill-biased technology change hypothesis is substantial. But there are questions about it. For example, other hypotheses are also consistent with the evidence. There is still a debate as to whether technology change or other factors, like increased trade, account for most of the rises in labour market inequality.

In its simplest form, the trade argument goes as follows. Suppose there are two countries that, to start with, do not trade with each other. Both have skilled and unskilled workforces, which respectively manufacture skill intensive and skill unintensive products. One country (high wage/developed) has a comparative advantage in making skill intensive products with skilled labour. The other country (low wage/developing) has a comparative advantage in making skill unintensive products with unskilled labour. When these two countries begin to trade with one another, according to the standard Heckscher-Ohlin model of international trade, the developed country will begin to import

skill unintensive products from the low wage country since they are cheaper. This will then lower the wages of unskilled workers in the developed country and reduce their employment levels. In this model, the rise in the relative wages and employment of skilled workers is caused by the opening up of trade with the developing country.

This hypothesis has intuitive appeal. However, for several reasons, it has proven hard to back it with sound empirical evidence. Though trade flows with low wage countries have been rising fast in recent years, they have been from very low initial levels and do not seem big enough to explain the large changes in labour market inequality seen in a number of developed countries. What is more, those industries that have seen the biggest increases in trade with the developing world do not appear to be the ones that have seen large labour market shifts in favour of more skilled workers. Then, as we have already noted, skill upgrading (higher relative wages and employment for more skilled groups of workers) has been going on in the developing as well as the developed world. This runs counter to the Heckscher-Ohlin model, which predicts that skill upgrading should increase in developed economies, but that the less skilled should do better in the developing world as demand for the products they manufacture rises.

A further conflict with the Heckscher-Ohlin model is that skill upgrading appears to be happening in industries that do not trade across international borders. If one includes a traded and a non-traded sector in that model, the prediction would be that unskilled workers displaced from the traded sector by the opening up to trade would find jobs in the non-traded sector, or would lower the wages of unskilled workers, or both. In reality, one does not see this. In non-traded sectors (e.g. in non-manufacturing industries like retailing) skill upgrading has also been happening (and often at similar rates to those in traded sectors).

The absence of evidence that increased trade has been the prime cause of increased inequalities between skilled and less skilled workers in the past does not, of course, mean that trade will have little impact here in future. It is implausible to suggest that globalisation is without serious ramifications for labour. However, the rises in labour market inequality of the last couple of decades do not seem attributable to rising competition with low wage countries.

A second worry with the skill-biased technology change argument is that the evidence supporting it mainly covers limited time periods. Perhaps more importantly, it is also mainly confined to manufacturing industries. This is because of a lack of good data on technology outside manufacturing and because researchers have wanted to look at the same industries across countries. Some work has managed to use data to look at longer time periods and at the whole economy. The most comprehensive for the US is the work already cited of Autor, Katz and Krueger, using census data back to 1960 and focusing as much as possible on non-manufacturing as well. They seem to find important shifts in the skill structure of employment that are related to technology and that have occurred economy-wide.

A more subtle (and probably more significant) argument is that shifts in the demand for more skilled workers have been happening for years and that it is significant supply changes that matter more. This argument rests on the notion that there has been a long trend increase in demand for skills and that movements in relative wages around this trend are principally influenced by relative supply changes. For example, it is well known that the supply of graduates rose fast in the 1970s, slowed in the 1980s and then rose again in the 1990s. The wage gap between educated and less educated workers fell in the 1970s, rose sharply in the 1980s and probably rose, but at a much slower rate, in the 1990s. This outcome is entirely consistent with a steady increase in demand for skilled workers, where their wage premiums over unskilled workers are affected by 10-year changes in relative supply.

This argument warrants attention. However, more solid empirical work is required before it can be accepted as substantially undermining the skill-based technology change hypothesis. In particular, steadily rising residual wage inequality between skilled and unskilled workers, which has been a feature of the last 20 years, is hard to square with the patterns of supply change.

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This article is an edited version of his paper "*The Changing Nature of Labour Demand in the New Economy and Skill-Biased Technological Change*". The full paper can be read at http://cep.lse.ac.uk/~machin and is forthcoming in the Oxford Bulletin of Economics and Statitsics.

Rises in labour market inequality do not seem attributable to rising competition with low wage countries

References & further reading

Autor, David, Lawrence F. Katz and Alan Krueger (1998) "*Computing Inequality: Have Computers Changed the Labor Market?*", Quarterly Journal of Economics, 113, 1169-1214.

Berman, Eli, John Bound and Zvi Griliches (1994) "*Changes in the demand for skilled labor within U.S. manufacturing industries: Evidence from the Annual Survey of Manufacturing*", Quarterly Journal of Economics, 109, 367-98.

Berman, Eli, John Bound and Stephen Machin (1998) "*Implications of Skill-Biased Technological Change: International Evidence*", Quarterly Journal of Economics, 113, 1245-1280.

DiNardo, John and Steve Pischke (1997) "*The Returns to Computer Use Revisited: Have Pencils Changed the Wage Structure Too?*", Quarterly Journal of Economics, 112, 291-303.

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

Machin, Stephen (1996) "*Changes in the relative demand for skills in the UK labor market,*" in Acquiring Skills: Market Failures, Their Symptoms and Policy Responses, Alison Booth and Dennis Snower (eds.), Cambridge: Cambridge University Press.

Machin, Stephen, and John Van Reenen (1998) "*Technology and changes in skill structure: Evidence from Seven OECD Countries*", Quarterly Journal of Economics, 113, 1215-1244.

Nickell, Stephen and Brian Bell (1995) "*The Collapse in Demand for the Unskilled and Unemployment across the OECD*", Oxford Review of Economic Policy, 11, 40-62.