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Rising Wage Inequality and Capital-Skill Complementarity

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Abstract

Increased wage inequality has been a sensitive policy issue in OECD economies in recent decades. A shortcoming in the literature investigating its causes, especially with regard to the role of new technology, is that technical change is commonly determined residually. We address this limitation by specifying a computable general equilibrium (CGE) model that identifies four labour types and three capital assets. When capital assets are measured in efficiency units and there is capital-skill complementarity, we can explain a large component of the increase in UK wage inequality over the 1980-97 period in terms of changes in factor endowments. This result has implications for how policy makers might react to rising skill premiums.

JEL classifications: O3, J31, D58

Keywords: Capital-skill complementarity, wage inequality, CGE modelling

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1. INTRODUCTION

Rising wage inequality in developed nations since 1980 has been well documented and its causes extensively examined. Most studies focus on increased trade between the skilled labour-abundant North and unskilled labour-abundant South, and/or skill-biased technical change.[1] Whether or not increased wage inequality is due to the expansion of trade or skill-biased technical change is important from a policy perspective. If trade is the key driver, governments may be persuaded to adopt protectionist trade policies targeted at low wage economies. By contrast, society may be more likely to tolerate an increase in wage inequality if this change is largely driven by advances in technology.

The consensus is that the impact of trade has been minimal and rising skill premiums in OECD countries, and in particular the US and UK, can be more reliably attributed to skill-biased technical change.[2] However, one can challenge the route to this conclusion. Several authors go to great lengths to quantify changes relating to trade and the mechanisms by which it influences relative wages, but pay little attention to changes in technology. The impact of skill-biased technical change is usually determined residually, as the proportion of the increase in relative wages unexplained by trade. In computable general equilibrium (CGE) settings, residually determined skill-biased technical change is modelled by adjusting production function parameters to simulate observed changes in relative wages (McDougall and Tyers, 1994; Cline, 1997; Tyers and Yang, 2000; Abrego and Whalley, 2000; De Santis, 2003). An alternative view of skill-biased technical change is as an increase in the stock of capital equipment when there is capital-skill complementarity. The notion of complementarity is due to Griliches (1969) and applies when capital equipment is less substitutable for skilled than unskilled labour. Hence, technical improvements that reduce the price of equipment lead to equipment deepening, an increase in the relative demand for skilled labour, and a rise in the skill premium. Such a treatment of skill-biased technical change allows changes in relative wages to be tracked in terms of (observable) factor supply changes.

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[1] See Slaughter (1999) and Greenaway and Nelson (2000 and 2003) for literature reviews.

[2] Bound and Johnson (1992), Lawrence and Slaughter (1993), Berman *et al.* (1994), Tyers and Yang (1997, 2000), and Berman *et al.* (1998) all reach this conclusion; whilst a notable exception is Wood (1994), who champions the role of increased trade.

In this paper, we undertake the first CGE analysis of relative wages that links changes in technology with movements in observable variables. It is also the first investigation of the connection between capital-skill complementarity and rising wage inequality in the UK, where relative wages have risen faster than any other OECD country apart from the US. An essential component is estimation of the stocks of four capital assets. We deflate investment data by quality-adjusted prices to measure technical change as variations in efficiency units. Our CGE model is based on the GTAP5inGAMS core static model and the Global Trade Analysis Project (GTAP) database. Significant alterations to the base model include: the augmentation of the UK component of GTAP to incorporate our capital estimates, data for four labour types, and modifications to the production specification to induce complementarities between certain factors of production. Our results indicate that an increase in the effective supply of capital equipment is the principal cause of rising wage inequality in the UK.

The paper has three further sections. The construction of our CGE model and salient features of its database are described in Section 2. Section 3 reports our simulation results and outcomes of sensitivity analyses. Section 4 discusses policy implications and concludes.

2. MODEL STRUCTURE AND AGGREGATION

Our reference dataset is Version 5 of the GTAP database, as described by Dimaranan and McDougall (2002). This provides a detailed representation of trade, protection and production for the global economy in 1997, with five primary factors, 57 sectors and 66 regions. We augment the UK component to include four labour types – highly-skilled, skilled, semi-skilled and unskilled. Rather than relying on standard classifications such as production/non-production workers, the four types were identified by applying cluster analysis to data on academic and non-academic qualifications, as explained in Winchester, Greenaway and Reed (2006). We also construct a bespoke capital asset series, from data on new investment, depreciation and adjustments for quality improvement. An overview of the procedures we use to generate our capital stock data is provided in Appendix 1.[3] Capturing quality changes is central to our analysis. We do this by estimating the stock of computers (high-tech equipment) separately and, informed by econometric estimates, stipulating an average annual decrease in the quality-adjusted price of this asset of 25%. This parameter is discounted by five percentage points to account for quality changes relating to other assets, which, due to data limitations, we are unable to measure. High-tech and low-tech equipment are amalgamated post estimation to form an equipment aggregate, yielding three capital assets – buildings, vehicles, and equipment. We display capital cost shares by industry and asset type in Table A1.[4]

[Box 1 here]

Our base CGE model, GTAP5inGAMS, is summarised in Box 1.[5] We conduct simulations using two different aggregations, which differ with respect to factors of production as outlined in Box 2. Fourteen sectors are recognised, the most detailed sectoral classification permitted by our data. Skilled labour-abundant (UK, Western Europe, and Other Developed) and unskilled labour-abundant (Rapidly Developing and Rest of World) country groups are present. Aggregation (A) allows us to model capital-skill complementarity using conventional techniques, such as those employed by Tyers and Yang (2000), by merging highly-skilled and skilled labour, and semi-skilled and unskilled labour. Four labour types are distinguished in aggregation (B). Both identify three capital assets: buildings, vehicles, and equipment. Due to data limitations, only two types of labour (professional and production) and one capital asset are identified in regions outside the UK. Natural resources and land are identified in all regions in both aggregations.

[Box 2 here]

[3] A more detailed description is available from the authors upon request.

[4] Our conversion of capital stock units into capital cost shares assumes that risk premiums are equal across assets and that there is equal tax treatment of assets. Equating asset price to the present value of future earnings, the cost share of capital asset *j* relative to that of asset *q* in industry *i*, $kshare_{ji}$ / $kshare_{qi}$, is given by

$$\frac{kshare_{ji}}{kshare_{qi}} = \frac{(r+\delta_j)K_{ji}}{(r+\delta_q)K_{qi}}$$

where K and δ denote capital units and the rate of geometric depreciation respectively, and r is the real interest rate, which we set equal to 0.04.

[5] Rutherford and Paltsev (2000) describe the model in detail.

We specify two alternative production structures, which differ from that set out in GTAP5inGAMS and are necessary to model factor complementarities.[6] The form of value added production for simulations built on aggregation A is outlined in Figure 1. A CES aggregator brings together more-skilled labour (M) and equipment (E) in the bottom level of the nest. The M-E composite enters with less-skilled labour (L) in a further CES function; a third CES aggregator combines the M-E-L composite with other primary factors. Substitution possibilities at the third, second and first level of the nest are governed by parameters σ_{ME}^{A}, σ_{MEL}^{A}, and σ_{VA}^{A} respectively. Tyers and Yang (2000), influence our selections of these values. Their parameters range from 0.3 to 0.7 for branch elasticities of substitution between capital and professional labour and 0.7 – 2.8 for capital-professional labour and production labour. Accordingly, we choose σ_{ME}^{A} = 0.5 and σ_{MEL}^{A} = 1.5. We employ a Cobb-Douglas aggregator in the top level of the nest, σ_{VA} = 1.

[Figure 1 here]

The structure of value added used to operationalise Aggregation (B) is depicted in Figure 2. Value added comprises four CES aggregators, which allow substitution possibilities between equipment and assorted labour types to differ. The ease of substitution between: equipment (E) and highly-skilled labour (H); E-H and skilled labour (Sk); E-H-Sk and semi-skilled (Se) and unskilled labour (U); and E-H-Sk-Se-U and other primary factors are determined by σ_{HE}^{B}, σ_{HESk}^{B}, $\sigma_{HESkSeU}^{B}$, and σ_{VA}^{B} respectively. There is little to guide the assignment of these values and we tie our elasticity parameters to empirical estimates by noting that, as reported by Hamermesh (1993, Table 3.8, p. 115), the elasticity of substitution between capital and different types of labour is a decreasing function of skill. Consequently, we assume the labour cost-weighted average of σ_{HE}^{B} and σ_{HESk}^{B} is equal to σ_{ME}^{A} and stipulate that the ratio of σ_{HE}^{B} to σ_{HESk}^{B}, λ, is equal to 0.3. That is,

$$\sigma_{ME}^{A} = \pi_H \sigma_{HE}^{B} + (1-\pi_H)\sigma_{HESk}^{B} \text{ and } \sigma_{HE}^{B} = \lambda \sigma_{HESk}^{B}$$

[6] We also make two other modifications to the core model. Specifically, we double all Armington elasticities in GTAP database and assume that the representative consumer in each region allocates expenditure across private, public and investment spending according to Cobb-Douglas function.

where π_H is the cost share of highly-skilled labour in the combined cost of highly-skilled and skilled labour. Furthermore, we suppose that the branch elasticity of substitution between H-E-Sk and semi-skilled and unskilled labour is equal to that between equipment-more-skilled labour and less-skilled labour in aggregation (A), $\sigma^{B}_{HESkSeU}$ = 1.5, and that the top level of the value added nest is Cobb-Douglas,

σ^{B}_{VA} = 1.

[Figure 2 here]

3. SIMULATION RESULTS FOR EXOGENOUS AND POLICY SHOCKS

Each model is subjected to three shocks representing significant changes occurring between 1980 and 1997. The first captures changes in globalisation. We remove changes in UK imports relative to GDP by specifying an endogenous tariff in each sector for imports from each region. Shock (2) simulates the combined effect of shock (1) and changes in labour employment shares as set out by Winchester, Greenaway and Reed (2006). Shock (3), in addition to changes in Shock (2), simulates the impact of changes in capital stock shares measured in efficiency units. We do this by holding aggregate capital in raw units constant so that improvements in the efficiency of equipment do not influence capital - labour ratios for other assets. Backcast shocks to import volumes and capital and labour shares are outlined in Tables A2 and A3.

Simulated results together with actual changes in relative wages are reported in Table 1. For the globalisation shock reduced trade barriers increased the ratio of more- to less-skilled wages by about half of one percentage point in aggregation (A). Movements in relative wages, with the exception of the skilled to semi-skilled wage ratio, are also consistent with Stolper-Samuelson predictions in Aggregation (B). Although these results replicate the pattern of growing wage inequality, simulated changes in relative wages are only a small fraction of actual movements.

[Table 1 here]

Most measures signify a sharp decline in wage inequality when shock (2) is simulated. The ratio of more- to less-skilled wages decreases by about 37% and the relative wage of highly-skilled labour falls by around 60%. In other measures of wage inequality, the ratios of skilled to semi-skilled and skilled to unskilled wages experience moderate decreases and wage inequality between the semi-skilled and unskilled increases. The comparatively small decline in skilled wages is a by-product of the large increase in the supply of highly-skilled labour and production complementarities between the two labour types at the high end of the skill distribution. The increase in the semi- to unskilled wage ratio can be attributed to the fall in the semi-skilled labour endowment relative to unskilled labour (see Table A3). Overall, shock (2) indicates that a substantial decrease in wage inequality would have been observed had increased globalisation and movements in labour employment shares been the only changes occurring between 1980 and 1997.

Turning to shock (3), even though our results underestimate changes in the more- to less-skilled wage ratio and the increase in the relative wage of the highly-skilled, simulated changes are much closer to observed movements. Although the simulated change in the more- to less-skilled wage ratio is barely positive, changes in capital endowments account for 67% of the difference between the estimated change in the ratio in shock (2) and its actual change. Corresponding figures for the ratios of highly-skilled to skilled, highly-skilled to semi-skilled, and highly-skilled to unskilled wages are 75%, 77% and 84% respectively. Also in aggregation (B), the more- to less-skilled wage ratio, calculated as an employment weighted average, changes by –33% and +7% following shocks (2) and (3) respectively. Thus, although simulated changes in relative wages do not exactly match actual movements, the output from shock (3) indicates that growth in equipment's share of the capital stock when there is capital-skill complementarity is the dominant explanation for increased wage inequality.

Our findings are consistent with Krusell *et al.* (2000) and Tyers and Yang (2000). The former conduct simulations using a neoclassical aggregate production function with capital-skill complementarity. They conclude that, during 1963-92 in the US, changes in the relative quantities of different types of labour decreased the skill premium by about 40% while the increase in the effective supply of equipment facilitated a 60% rise in it. While technical change is determined residually in Tyers and Yang's (2000) analysis, their preferred results are derived from a model with a large increase in the effective supply of capital when there is capital-skill complementarity.

We ask two questions before proceeding. First, is it possible that improvements in the efficiency of computers, which account for less than seven percent of aggregate investment, are responsible for dramatic changes in the wage distribution? We think the answer is yes. Krueger (1993), Berman, Bound and Griliches (1994), and Autor, Katz and Krueger (1998), all link computerisation and recent growth in wage inequality. Bresnahan (1999) concludes that computers have not influenced the output of skilled labour through direct use, but because they have altered the organisation of the workplace. The timing of the increase in the skill premium is a second consideration. Why when spectacular advances in technology have occurred since the computer's inception, did the skill premium only begin to rise in recent decades?[7] A possible answer, given by Autor *et al.* (1998), is the change in the nature of computer technology. Prior to the diffusion of personal computers, they were cumbersome machines managed by highly specialised operators. During the 1970s producers undertook projects to put computers in the hands of single users. The Apple II, released in 1977, and IBM's first personal computer, created in August 1981, were products of such endeavours and signalled the dawn of a new computing era. These machines were simple to operate and could perform a wide range of tasks.[8] Therefore, it is plausible to conjecture that output was produced under different sets of elasticity parameters pre and post 1980.

***Sensitivity Analysis*:** Due to the uniqueness of our production specifications, we examine the sensitivity of our simulations to key parameter values influencing the degree of capital-skill complementarity and change in the stock of equipment. We report changes in the relative wage of more- to less-skilled labour under alternative parameter values following shock (3) in Table 2. The relationships between simulated changes in relative wages and key parameter values have intuitive appeal: wage inequality increases as substitution possibilities between equipment and more skilled labour decrease and/or the increase in the stock of equipment is made larger. This

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[7] The skill premium was reasonably constant during the 1970s even though the relative supply of skilled labour was increasing. This indicates that improvements in the efficiency of computers could have placed upward pressure on the skill premium during this decade. Nevertheless, this pressure has grown in intensity since 1980.

[8] The change in the character of computers is evident in documentation concerning the IBM 5110 Computing System, configured in 1978, "*Unlike the 5100 — which met the needs of professional and scientific problem-solvers — the 5110 was offered as a full-function computer to virtually all business and industry.*" (Before the Beginning: Ancestors of the IBM Personal Computer).

reveals that the change in relative wages is mildly sensitive to changes in the elasticity of substitution between more skilled labour and equipment and the average annual decrease in the quality-adjusted price of high-tech equipment. However, in light of the sharp decrease in wage inequality simulated in shock (2), our conclusions are robust to alternative (plausible) values of these parameters.
[Table 2 here]

Our sensitivity analysis for Aggregation (B) is reported in Table 3. Highly-skilled labour, which has an employment share of less than 15%, is closely tied to equipment in our production specification, so movements in relative wages involving the highly-skilled wage are especially sensitive to the average annual decrease in the quality-adjusted price of high-tech equipment. Simulated changes in relative wages for other labour types, which are more substitutable with equipment, are less sensitive. The sensitivity of changes in relative wages relating to highly-skilled and/or skilled labour to changes in λ increases as the average annual decrease in the quality-adjusted price of high-tech equipment gets larger. The change in the highly-skilled wage is particularly sensitive to movements in this; so much so that the model produces implausibly large estimates of the increase in the highly-skilled wage when we increase both λ and the average annual decrease in the quality-adjusted price of high-tech equipment. Simulated changes in semi-skilled and unskilled wages are insensitive to different values of λ. In summary, changes in wage inequality not related to highly-skilled labour are robust to alternative parameter values, but those for highly-skilled labour are not. This highlights the need for accurate estimation of efficiency improvements relating to high-tech equipment and additional work to determine the form of production when diverse arrays of labour types and capital assets are specified.

[Table 3 here]

4. POLICY IMPLICATIONS AND CONCLUSIONS

This paper has examined drivers of increased wage inequality in the UK using a CGE analysis that specifies a larger number of factors than the norm. Stocks of four capital assets in different industries were estimated. These, together with data describing four types of labour, were mapped on to the UK component of the GTAP database. This enabled us to specify production complementarities between capital equipment and labour groups at the high end of the skill distribution. When these are accounted for and capital assets measured in efficiency units, we find that a significant component of increased wage inequality over the last two decades of the twentieth century can be explained by changes in factor endowments. This represents an advance on studies that determine skill-biased technical change residually and has important implications for policy makers. Specifically, in the eyes of the voting public some causes of rising wage inequality seem to be more acceptable than others. If increased trade between developed and developing countries has hurt unskilled workers this could lead to a protectionist backlash. On the other hand, the general public appears to be more willing to accept increased wage inequality if it results from technical progress.

Our finding that changes in technology are responsible for rising wage inequality is more convincing than those presented by other empirical analyses as we are able to specify that the increase in the skill premium is a result of skill-biased technical change as the null hypothesis rather than determining the impact of technology residually. Additionally, our results indicate that policy changes aimed at removing changes in trade volumes will be mis-directed in addressing wage inequality concerns.

Sensitivity analysis revealed that our results are moderately sensitive to the elasticity of substitution between more-skilled labour and equipment and the average annual decrease in the quality-adjusted price of high-tech equipment when only two types of labour are identified. With four types our model has difficulty replicating the exact pattern of changes in relative wages and movements in the highly-skilled wage are sensitive to changes in key parameters. Although we tied our parameters to econometric estimates, this indicates that determining the form of production and values of relevant elasticity parameters when multiple capital assets and labour types are present is a worthwhile avenue for future research. Nevertheless, our simulations are able to explain much of the observed increase in wage inequality.

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BOX 1. – THE GTAP5INGAMS CORE STATIC MODEL

Imports: Using the Armington assumption (Armington, 1969), imports are differentiated by source and composite imports are differentiated from domestic production. The regional composition of imports is the same in public, private and intermediate demand, but the aggregate share of imports may differ across demands.
Production: Goods and services are produced by constant returns to scale technologies. Leontief nests of value added and a composite of intermediate inputs produce outputs. At a lower level of the production nest, a Cobb-Douglas aggregation of primary factors produces value added in each sector, and a further Leontief nest of intermediate inputs by product type produces an intermediate composite for each sector.
Expenditure on final goods: A utility maximising representative agent determines private, public and investment demand in each region. Public and investment expenditures are fixed in absolute value, so only the value of private expenditure changes with income. Private and public expenditures are Cobb-Douglas functions of domestic-import composites by product category.
Primary Factors: Factors are perfectly mobile intersectorally but immobile internationally. Land and natural resources are specific to agriculture and mining respectively.

Source: Winchester and Richardson (2003).

BOX 2. – MODEL AGGREGATIONS

REGIONS	FACTORS[d]
United Kingdom (UK)	*United Kingdom*
Western Europe (WE)[a]	(A)
Other Developed (OD)[b]	More-skilled labour (M)
Rapidly Developing (RD)[c]	Less-skilled labour (L)
Rest of World (RoW)	Buildings (B)
	Equipment (E)
	Vehicles
SECTORS	Natural Resources
Agriculture & mining	Land
Food and beverages	
Textiles, wearing apparel & leather	(B)
Paper products & publishing	Highly-skilled labour (H)
Fuels and chemicals	Skilled labour (Sk)
Other minerals	Semi-skilled labour (Se)
Metal products	Unskilled labour (U)
Transport equipment	Buildings (B)
Electronic equipment	Equipment (E)
Other manufacturing	Vehicles
Water	Natural Resources
Construction	Land
Trade	
Transport	*Other regions*
Communication	Professional Labour
Financial & public services	Production labour
Dwellings	Capital
	Natural Resources
	Land

FIGURE 1. – UK VALUE ADDED NEST IN AGGREGATION (A)

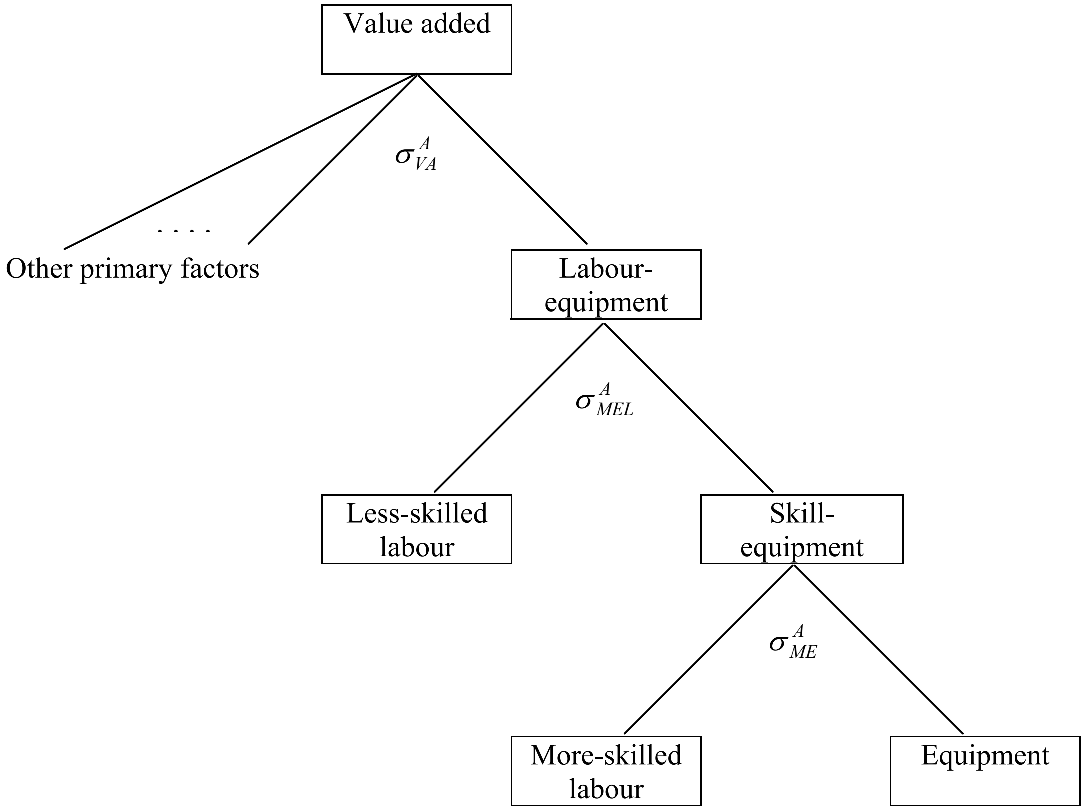

FIGURE 2. – UK VALUE ADDED NEST IN AGGREGATION (B)

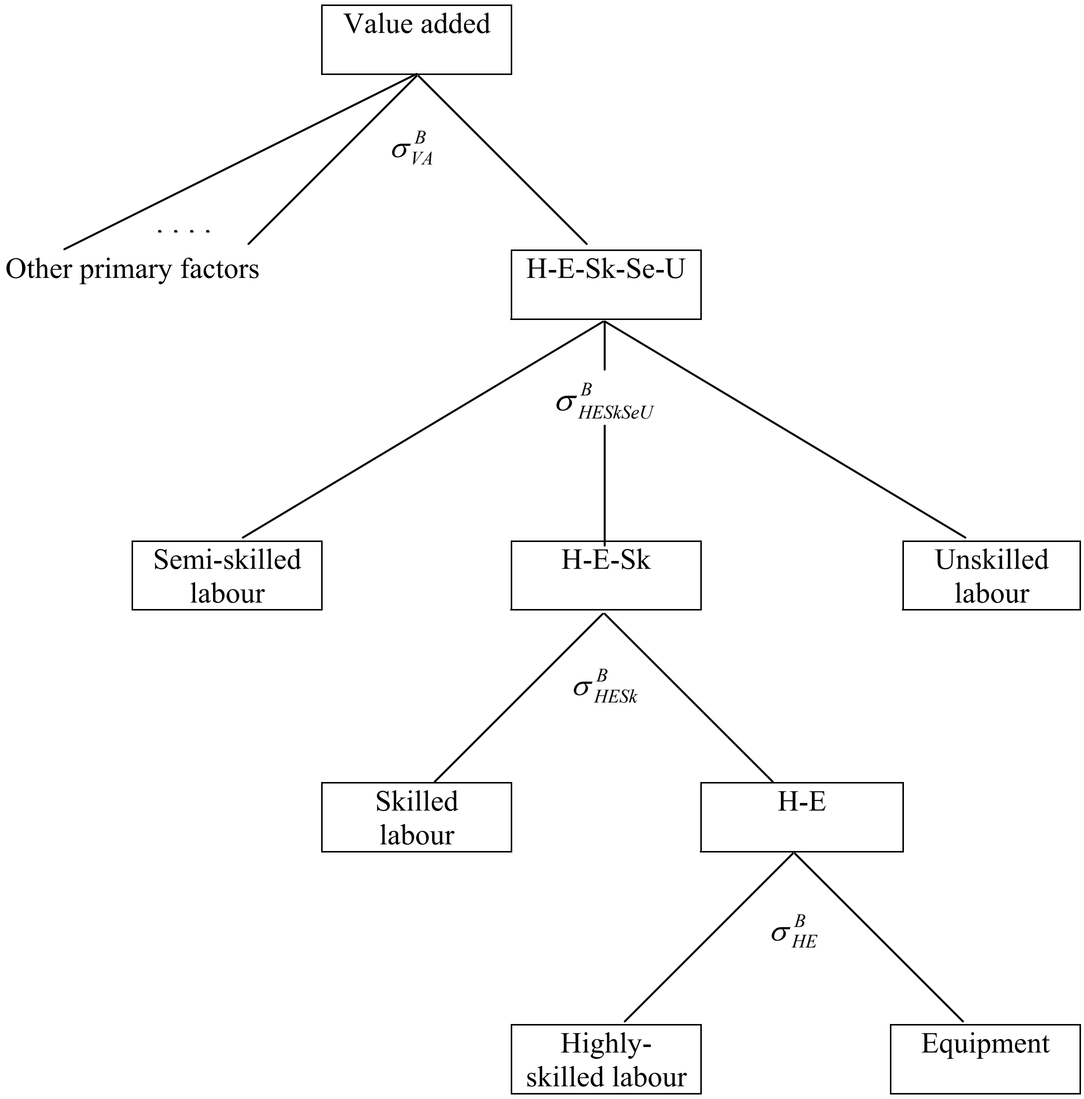

TABLE 1. – SIMULATED AND ACTUAL CHANGES IN RELATIVE WAGES, 1980-97 (%)

Relative wage	(1) Trade	(2) (1) + Labour	(3) (2) + Capital	Actual
		Aggregation A		
$\frac{w_{More-skilled}}{w_{Less-skilled}}$	0.60	-36.59	0.81	18.82
		Aggregation B		
$\frac{w_{Highly-skilled}}{w_{Skilled}}$	1.25	-56.71	-3.79	14.11
$\frac{w_{Highly-skilled}}{w_{Semi-skilled}}$	1.03	-65.30	-1.81	16.84
$\frac{w_{Highly-skilled}}{w_{Unskilled}}$	1.94	-61.59	12.61	26.56
$\frac{w_{Skilled}}{w_{Semi-skilled}}$	-0.21	-19.84	2.05	2.39
$\frac{w_{Skilled}}{w_{Unskilled}}$	0.69	-11.27	17.04	10.91
$\frac{w_{Semi-skilled}}{w_{Unskilled}}$	0.90	10.69	14.68	8.31

Note: Trade refers to a globalisation shock (see Table A2), and labour and capital refer to changes in labour and capital employment shares respectively (see Table A3).
Source: Backcast simulations described in text and actual changes in relative wages are from Winchester, Greenaway and Reed (2002).

TABLE 2. – SIMULATED CHANGES IN THE MORE-SKILLED-TO LESS-SKILLED RELATIVE WAGE IN AGGREGATION (A) UNDER ALTERNATIVE PARAMETER VALUES FOLLOWING SHOCK (3), 1980-97 (%)

σ_{VME}^{A}	Quality-adjusted price of high-tech equipment, average annual decrease				
	0.18	0.19	0.20	0.21	0.22
0.30	-2.53	4.98	14.09	25.36	39.61
0.40	-6.64	-0.60	6.57	15.22	25.83
0.50	-9.93	-4.98	0.81	7.63	15.81
0.60	-12.61	-8.49	-3.76	1.75	8.22
0.70	-14.83	-11.38	-7.45	-2.94	2.28

Source: Backcast simulation described in text.

TABLE 3. - SIMULATED CHANGES IN RELATIVE WAGES IN AGGREGATION (B) UNDER ALTERNATIVE PARAMETER VALUES FOLLOWING SHOCK (3), 1980-97 (%)

λ	Quality-adjusted price of high-tech equipment, average annual decrease				
	0.18	0.19	0.20	0.21	0.22
			$\frac{w_{Highly-skilled}}{w_{Unskilled}}$		
0.20	-8.72	11.64	44.36	102.31	217.48
0.25	-14.07	1.73	25.22	62.65	127.35
0.30	-18.22	-5.42	12.61	39.36	81.63
0.35	-21.42	-10.67	3.90	24.51	55.13
0.40	-24.12	-14.93	-2.84	13.62	36.97
			$\frac{w_{Skilled}}{w_{Unskilled}}$		
0.20	4.78	8.25	12.32	17.16	22.95
0.25	6.58	10.25	14.57	19.68	25.80
0.30	8.53	12.44	17.04	22.47	28.97
0.35	10.47	14.64	19.52	25.28	32.17
0.40	12.44	16.88	22.05	28.16	35.46
			$\frac{w_{Semi-skilled}}{w_{Unskilled}}$		
0.20	14.15	14.51	14.83	15.11	15.32
0.25	14.09	14.43	14.75	15.03	15.26
0.30	14.04	14.37	14.68	14.96	15.21
0.35	14.00	14.32	14.63	14.91	15.16
0.40	13.97	14.28	14.58	14.86	15.12

Source: Backcast simulation described in text.

APPENDIX 1: Capital Stock Estimation

We estimate capital stocks for four assets – buildings, vehicles, high-tech and low-tech equipment – across 17 industries using the Perpetual Inventory Method (PIM) and, guided by Hulten and Wykoff (1981a,b), assuming depreciation follows a geometric series. The stock of capital asset *j* in industry *i* at time *t*, $K_{ji}(t)$, is given by

$$K_{ji}(t) = \sum_{v=0}^{v=t-t_j^0} (1 - \delta_j)^v I_{ji}(t - v) \qquad \text{(A1)}$$

where both *v* ant *t* index time, t_j^0 is the starting period for the PIM calculation for asset *j*, and δ is the geometric rate of depreciation.

We operationalise equation (A1) by choosing depreciation parameters in line with Hulten and Wykoff's (1981a) estimates and generating new investment data by industry and asset type. We construct investment series using the *Input-Output Tables for the United Kingdom* (1979 and 1984) and the *United Kingdom Input-Output Supply and Use Balances* (1995 and 1997) to estimate investment shares by industry and asset types for two time periods (1980 and 1997), interpolating investment shares in intermediate years, and attributing aggregate investment, which we source from the 2001 *Economics Trends Annual Supplement* , to each asset in each industry using our estimates of investment shares. Our capital stock estimates also capture technical innovations concerning computer technology by deflating expenditure on high-tech equipment by a quality-adjusted price index. Our price index – which is influenced by Triplett (1989), Nelson *et al.* (1994), Berndt *et al.* (1995), Baker (1997) and Berndt and Rappaport (2001) – stipulates that the quality adjusted price of high-tech equipment declined at an average annual rate of 25 percent.

APPENDIX 2: Data for the CGE Analysis

TABLE A1. – UK CAPITAL COST SHARES, 1997

	Buildings	Vehicles	Equipment
Agriculture & mining	0.504	0.035	0.461
Food and beverages	0.215	0.069	0.716
Textiles & leather	0.144	0.088	0.767
Paper products & publishing	0.124	0.069	0.807
Fuels and chemicals	0.301	0.031	0.669
Other minerals	0.176	0.085	0.738
Metal products	0.137	0.080	0.783
Transport equipment	0.154	0.034	0.812
Electronic equipment	0.183	0.058	0.758
Other manufacturing	0.153	0.097	0.749
Water	0.736	0.016	0.247
Construction	0.108	0.336	0.555
Trade	0.374	0.152	0.474
Transport	0.273	0.566	0.161
Communication	0.079	0.054	0.867
Financial & public services	0.480	0.148	0.373
Dwellings	0.950	0.000	0.050

Source: Capital stock estimates described in text.

TABLE A2. – BACKCAST SHOCKS TO IMPORT VOLUMES RELATIVE TO GDP 1997-80 (%)

	Western Europe	Other Developed	Rapidly Developing	Rest of World
Agriculture & mining	61	156	184	317
Food and beverages	-29	39	-6	9
Textiles & wearing apparel	-47	-3	-60	-80
Paper & publishing	-46	-21	-78	-76
Fuels and chemicals	-43	-53	-88	-38
Other minerals	-65	-71	-82	-86
Metal products	-5	-1	-59	-36
Transport equipment	-63	-74	-79	-82
Electronic equipment	-62	-59	-92	-73
Other manufacturing	-63	0	-70	-92

Note: Our globalisation shock only considers trade in manufacturing goods due to data limitations.
Source: Trade changes are from the GTAP Version V database (Dimaranan and McDougall, 2002) and the change in UK GDP is taken from the World Bank World Tables database.

TABLE A3. – BACKCAST SHOCKS TO LABOUR EMPLOYMENT SHARES AND EFFECTIVE CAPITAL STOCK SHARES 1997-80 (%)

Labour employment shares		Effective capital stock shares	
Highly-skilled	-46	Buildings	0
Skilled	-19	Vehicles	26
Semi-skilled	26	Equipment	-72
Unskilled	7		

Source: Changes in labour employments shares are from Winchester, Greenaway and Reed (2002) and changes in capital stock shares are described in the text.