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Sector-specific factors and the trade and wages debate

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**Sector-Specific Factors and the Trade and
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Sector-Specific Factors and the Trade and Wages Debate

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Abstract

I outline the potential implications of sectoral factor immobility for the debate on the effects of low-wage competition on wage inequality in advanced countries. In theory, the presence of sector-specific factors serves to damp the magnification effect of World traded prices upon relative wages, by reducing the shift of output from unskilled-intensive to skilled-intensive sectors, and Edwards and Whalley (2007) have shown that only modest amounts of fixed factors are required to alter results qualitatively. There is evidence among OECD countries of a negative relationship between the structural decline of manufacturing since 1970 and increasing wage inequality: it is argued that the less flexible labour market institutions in Continental Europe may have mitigated the downward pressure on unskilled wages by this route, particularly if factor depreciation is of

an ongoing maintenance cost variety.

Keywords: Trade, inequality, globalisation, factor immobility

JEL classifications: F16, F11, D51

The aim of this paper is to outline the potential implications for the trade and wages debate of factor immobility. In doing so, it is hoped to point the way to future research on the role of factor specificity, in particular making use of dynamic modelling techniques. Following Edwards and Whalley (2007), it is argued that, unless factor specificity - in a wide sense - is investigated, a proper understanding of the relationship between globalisation (in the form of a fall in the price of imports of low-skilled manufactures) and increasing inequality in the Western World cannot be reached. It is also suggested that recent advances in the theories of firm heterogeneity (Ghironi and Melitz (2005)), searching and matching (Rauch and Casella (2003), Edwards (2006)), as well as labour-market matching theory and the implications of hiring and firing costs (Bentolila and Bertola (1990)) can be interpreted in terms of firm-specific, industry-specific and trade direction-specific factors, which may help explain the apparently slow adjustment of many economies - particularly in Continental Europe - to trade shocks.

0.1 Wage inequality trends

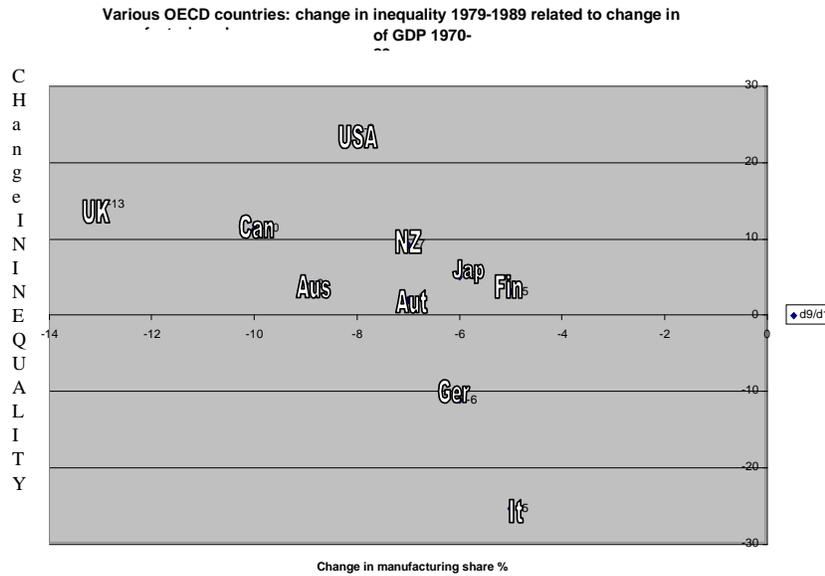
Wage differentials sharply widened during the 1980s in two main economies: Britain and the United States¹ (see Table 1), although a number of other countries saw a more limited increase in differentials.

¹Of the smaller economies, Portugal also experienced a large increase in inequality.

Country	1970s change	1980s change
Australia	-16.6	0.6
Austria	4.8	6.1
Denmark	-14.9	6.1
Finland	-16.5	-1.3
Ireland	NA	3.9
Japan	NA	2.2
Portugal	NA	14.5
Sweden	3.4	-3.1
United Kingdom	-2.7	12.0
United States	-2.5	7.6

Table 1: Changes in skill premia across ten countries (Source: Haskel and Slaughter (2002)) from United Nations General Industrial Data Base.

A frequently-expressed view is that the different experiences of Anglo-Saxon and Continental European economies in the 1980s reflects greater labour market rigidities. While there may be some validity in this (particularly bearing in mind the persistently high unemployment in Continental Europe in the 1990s), I suggest it is not valid to interpret the difference between the two economies (e.g. Davis (1996)) as being primarily one of a downwardly-rigid real wage for unskilled workers. Rather, a simple data plot suggests that the more important difference may be that Continental European economies have seen less of a restructuring of output away from manufacturing (which is unskilled-intensive) towards services - had wage rigidity been the case, the reverse would have been



the case. This is shown in Figure 1, below. This rather simple analysis suggests that the differences in manufacturing decline across different OECD countries since 1970 play an important role in understanding the widely different income distribution experiences in the 1980s - and that therefore a key issue is to find out why manufacturing's decline has varied so widely.

1 Trade shocks in a factors-mobile world

The centrepiece of neoclassical trade theory, the Heckscher-Ohlin (henceforth H-O) model and related Stolper-Samuelson theorem, rely upon the assumptions that technology and tastes are invariant across countries, along with a raft of

other assumptions², which ensure that the only cause for trade is the differences in relative factor endowments. Crucially, factors are also assumed to be fully mobile between sectors within a country, but immobile across national boundaries. Trade - if there are no barriers - therefore takes the place of international factor migration in serving to equalise factor returns across countries: countries will export the goods which are intensive in those factors in which they are relatively abundant.

1.1 General equilibrium of a non-specialised small, open H-O economy: magnification

Traditional H-O theory only operates over a range of prices where no country is completely specialised in one good (or, in a multi-factor case, in fewer goods than it possesses factors). Consider the case of a single small, open economy producing two goods, X and M , using two factors, U (unskilled labour) and S (skilled labour). We assume constant returns to scale, diminishing technical returns to substitution and perfect competition. A central result is the ‘magnification effect’, initially outlined by Jones, 1965. This states that a change in relative traded goods prices will lead to a larger change in the ratio of factor prices.

The setup of the economy is that factor input-output ratios $\alpha u_i, \alpha s_i$, in industry i ($i \in \{X, M\}$) are functions of factor wages W_u and W_s . I assume

²See a standard text, such as Krugman and Obstfeld (2003) for the full list of assumptions of the H-O model.

that there is no factor intensity reversal, and that industry X is always the more intensive in S ($\alpha s_X/\alpha u_X > \alpha s/\alpha u_M$). The zero profit conditions are

$$P_i = \alpha u_i W_u + \alpha s_i W_s, \quad (1)$$

where P_i , the price of good i , is set exogenously on World markets. Factors are fully mobile between sectors, but available in fixed national endowments, so factor wages serve to clear factor markets:

$$\begin{aligned} \sum_i \alpha u_i \{W_u, W_s\} Y_i &= \bar{U}; \\ \sum_i \alpha s_i \{W_u, W_s\} Y_i &= \bar{S}. \end{aligned} \quad (2)$$

Let us assume initially that all wages and prices are normalised at unity. Now a trade shock causes the price of unskilled-intensive good M , P_M , to fall, while P_X remains at 1. The magnification result is that, in the new equilibrium, $W_u < P_M < P_X < W_s$, so that the relative change in factor prices is greater than that in goods prices.

An intuitive explanation for this follows from the zero profit conditions in (1). Since W_u weighs more heavily in the costs of good M than of good X , now that P_M has fallen, we would expect W_u to fall. A related explanation is that the price shift causes producers to want to cut back on production of good M and increase production of good X . However, this is not possible with clearing markets, given the relative factor intensities of the two goods, unless the skilled/unskilled ratio in each industry rises: this will only happen if W_s

increases relative to W_u . But since the price of good X has not changed, it follows from the zero profit condition that, if the price of one input has fallen, then that of the other input, W_s , must have risen. Now looking at the zero profit condition, it is clear that, for P_M to have fallen while W_s has risen, W_u must have fallen even more sharply.

To look at magnification in more depth: if we restrict ourselves to the case of CES technology, then output of each industry, Y_i , is given by

$$Y_i = A_i(\beta_i U_i^\rho + (1 - \beta_i) S_i^\rho)^{1/\rho}, \quad (3)$$

where A_i is a set of scale parameters for each industry, β_i is a set of unskilled share parameters and ρ is a substitution parameter, where the elasticity of substitution $\sigma = 1/(1 - \rho)$. I am assuming the same substitution elasticity in each industry, to rule out issues of factor-intensity reversal. I also assume $\beta_M > \beta_X$, so that the exporting industry is more skill-intensive than the importing industry.

Assuming cost-minimisation, each firm will choose employment of each factor to equate the value of marginal product to the factor wage. This can be shown to imply

$$\alpha u_i = U_i/Y_i = (A_i \beta_i)^{1/1-\rho} (P_i/W_u)^{1/1-\rho}; \quad (4)$$

$$\alpha s_i = S_i/Y_i = (A_i (1 - \beta_i))^{1/1-\rho} (P_i/W_s)^{1/1-\rho};$$

$$S_i/U_i = (\beta_i/(1 - \beta_i))^{1/1-\rho}(W_u/W_s)^{1/1-\rho}. \quad (5)$$

which confirms that $\sigma = 1/(1 - \rho)$ is the elasticity of substitution. Henceforth, I rewrite the equations in terms of σ .

We can simplify the analysis further by choosing units such that $A_E = A_M = 1$. Also, we can set P_X at unity, allowing only P_M to vary, and we can denote $W_s/W_u = \phi$.

Consequently, (4) can be rewritten as

$$\begin{aligned} \alpha u_i &= U_i/Y_i = \beta_i^\sigma (P_i/W_u)^\sigma; \\ \alpha s_i &= S_i/Y_i = (1 - \beta_i)^\sigma (P_i/W_u)^\sigma \phi^{-\sigma}. \end{aligned} \quad (4a)$$

The zero profit conditions imply

$$\begin{aligned} W_u(\alpha u_X + \phi \alpha s_X) &= 1; \\ W_u(\alpha u_M + \phi \alpha s_M) &= P_M. \end{aligned}$$

$$\begin{aligned} W_u^{1-\sigma}[\beta_X^\sigma + \phi^{1-\sigma}(1 - \beta_X)^\sigma] &= 1; \\ W_u^{1-\sigma}[\beta_M^\sigma + \phi^{1-\sigma}(1 - \beta_M)^\sigma] &= P_M^{1-\sigma}; \end{aligned} \quad (6)$$

and dividing the equations in (6) and rearranging gives us

$$\begin{aligned}
[\beta_X^\sigma + \phi^{1-\sigma}(1 - \beta_X)^\sigma]P_M^{1-\sigma} &= [\beta_M^\sigma + \phi^{1-\sigma}(1 - \beta_M)^\sigma]; \\
\phi^{1-\sigma}[(1 - \beta_X)^\sigma P_M^{1-\sigma} - (1 - \beta_M)^\sigma] &= \beta_M^\sigma - \beta_X^\sigma P_M^{1-\sigma};
\end{aligned}$$

$$Z = \phi^{1-\sigma} = (\beta_M^\sigma - \beta_X^\sigma P_M^{1-\sigma}) / [(1 - \beta_X)^\sigma P_M^{1-\sigma} - (1 - \beta_M)^\sigma]. \quad (7)$$

Equation (7) is generally known as a mandated wages equation.

Differentiating (7) with respect to P_M , we find

$$\begin{aligned}
dZ/dP_M &= -(1 - \sigma)\beta_E^\sigma P_M^{-\sigma} / [(1 - \beta_X)^\sigma P_M^{1-\sigma} - (1 - \beta_M)^\sigma] \\
&\quad - (1 - \sigma)(1 - \beta_X)^\sigma P_M^{-\sigma} (\beta_M^\sigma - \beta_X^\sigma P_M^{1-\sigma}) \\
&\quad / [(1 - \beta_X)^\sigma P_M^{1-\sigma} - (1 - \beta_M)^\sigma]^2, \\
&= (1 - \sigma)Z P_M^{-\sigma} [-(\beta_X^\sigma / (\beta_M^\sigma - \beta_X^\sigma P_M^{1-\sigma})) \\
&\quad - (1 - \beta_X)^\sigma / ((1 - \beta_X)^\sigma P_M^{1-\sigma} - (1 - \beta_M)^\sigma)].
\end{aligned}$$

So

$$\begin{aligned}
d\phi/dP_M &= (d\phi/dZ)(dZ/dP_M), \\
&= Z^{1/(1-\sigma)} P_M^{-\sigma} [(\beta_X^\sigma / (\beta_X^\sigma P_M^{1-\sigma} - \beta_M^\sigma)) \\
&\quad - (1 - \beta_X)^\sigma / ((1 - \beta_X)^\sigma P_M^{1-\sigma} - (1 - \beta_M)^\sigma)]. \quad (8)
\end{aligned}$$

This is most easily evaluated at the point where $P_M = 1$, in which case

$$\begin{aligned}
(d\phi/dP_M)(P_M/\phi) &= d\ln\phi/d\ln P_M & (9) \\
&= [(\beta_X^\sigma/(\beta_X^\sigma - \beta_M^\sigma)) - (1 - \beta_X)^\sigma/((1 - \beta_X)^\sigma - (1 - \beta_M)^\sigma)].
\end{aligned}$$

Since $\beta_M > \beta_X$, $d\ln\phi/d\ln P_M$ is negative. If initial factor intensities are very close together ($\beta_M - \beta_X \rightarrow 0$), the elasticity will tend towards infinity. As σ tends to zero, $d\ln\phi/d\ln P_M$ tends to infinity.

Implications of the mandated wages equation (7) are that:

- relative factor wages move disproportionately when goods prices change (the magnification effect).
- relative factor wages are insensitive to factor endowments.
- (it is not difficult to show that) a change in the relative scale parameters, A_i , acts in the same way as a change in prices, causing a switch in demand towards the sector with growing A_i , and a rise in the relative price of the factor in which it is intensive. This is sector-biased technical progress.
- a change in the share parameters, β_i - factor-biased technical progress - will have ambiguous effects on relative wages. If β_i changes by a similar amount in both sectors, one might expect the effect on relative wages to be small. This effect was pointed out by Haskel and Slaughter (2002) and is contrary to the standard view that unskilled labour-saving technical progress in Western economies has been primarily responsible for the change in relative wages.³

³Though Krugman (2000) points out that technical progress, if it takes place across the advanced World, may well affect global prices and hence wages.

1.2 Complete specialisation

Relative factor wages will only conform to (7) as long as the economy continues to produce as many goods as it has factors. However, as fall in P_M will lead to a shift in production towards good X , eventually a price level, P_M^* , will be reached at which the economy is entirely specialised in producing good X . P_M^* is the goods price ratio at which the ratio of employment of the two factors in industry X , $\alpha u_X/\alpha s_X$, will equal the economy-wide ratio of factor endowments, \bar{U}/\bar{S} . Adapting equation (5), we find

$$\begin{aligned}\bar{S}/\bar{U} &= (\beta_X/(1-\beta_X))^\sigma \phi^{*1-\sigma}; \\ \phi^* &= ((1-\beta_X)/\beta_X)(\bar{U}/\bar{S})^{1/\sigma}.\end{aligned}\tag{5a}$$

But from (7),

$$\begin{aligned}\phi^{*1-\sigma} &= (\beta_M^\sigma - \beta_X^\sigma P_M^{*1-\sigma})/[(1-\beta_X)^\sigma P_M^{*1-\sigma} - (1-\beta_M)^\sigma], \\ &= ((1-\beta_X)/\beta_X)^{1-\sigma} (\bar{U}/\bar{S})^{(1-\sigma)/\sigma};\end{aligned}$$

$$((1-\beta_X)/\beta_X)^{1-\sigma} (\bar{U}/\bar{S})^{(1-\sigma)/\sigma} [(1-\beta_X)^\sigma P_M^{*1-\sigma} - (1-\beta_M)^\sigma] = (\beta_M^\sigma - \beta_X^\sigma P_M^{*1-\sigma});$$

$$\begin{aligned}
P_M^{*1-\sigma}[(1-\beta_E)^\sigma((1-\beta_E)/\beta_E)^{1-\sigma}(\bar{U}/\bar{S})^{(1-\sigma)/\sigma} + \beta_E^\sigma] &= \beta_M^\sigma \\
&+ (1-\beta_M)^\sigma((1-\beta_X)/\beta_X)^{1-\sigma}(\bar{U}/\bar{S})^{(1-\sigma)/\sigma}; \\
P_M^{*1-\sigma}[(1-\beta_X)(\bar{U}/\bar{S})^{(1-\sigma)/\sigma} + \beta_X] &= \beta_M^\sigma \beta_X^{1-\sigma} \\
&+ (1-\beta_M)^\sigma(1-\beta_X)(\bar{U}/\bar{S})^{(1-\sigma)/\sigma};
\end{aligned}$$

$$\begin{aligned}
P_M^* &= \{[\beta_M^\sigma \beta_X^{1-\sigma} + (1-\beta_M)^\sigma(1-\beta_X)(\bar{U}/\bar{S})^{(1-\sigma)/\sigma}] \quad (10) \\
&/[(1-\beta_X)(\bar{U}/\bar{S})^{(1-\sigma)/\sigma} + \beta_X]\}^{1/(1-\sigma)}.
\end{aligned}$$

Once the price has fallen below P_M^* , further World price changes will have no effect on relative wages. On the other hand, wages will now be very sensitive to changes in relative factor supplies, and to factor-biased technical progress (changes in β_X).

2 The effect of factor fixity

As Mayer (1974), Mussa (1974) and Neary (1978) established, the introduction of factor fixity reduces both the degree of sectoral shift and the change in relative wages in response to a trade price shock. A recent paper by Edwards and Whalley (2007) showed that, on plausible substitution elasticity assumptions, this effect significantly changes the World price-wages relationship even when the degree of factor fixity is small.

Edwards and Whalley (2007) outline a number of number of forms of factor fixity:

2.1 The Ricardo-Viner three factor model

In a Ricardo-Viner model (Jones (1971), Samuelson (1971)) one factor, usually capital, is sector-specific. Consequently, its price will vary across sectors and it can, in effect, be considered as a different factor in every sector in which it is employed. Prices are still set on World markets, subject to perfect competition, but in this case changes in the relative rental wages of the fixed factor in each sector mean that the zero profit conditions for the declining and expanding industries and market clearing for the mobile factor can be satisfied with much smaller changes in either sectoral output or the wage of the mobile factor.

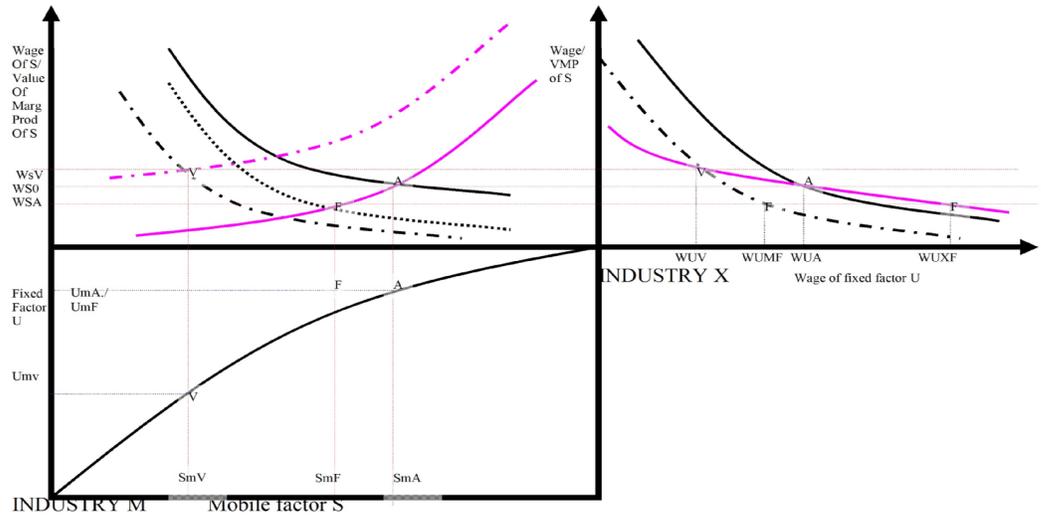
Indeed, the Mussa (1974), Mayer (1974) and Neary (1978) papers established a possibly counterintuitive result: the effect in a two-good, two-factor model of making one factor sectorally immobile (so it effectively becomes two factors) is to reduce the responsiveness of all factor prices (including the immobile factors) to a change in World traded prices. This is because, if a factor cannot move, then sectoral output will shift less than in a H-O model, and consequently there will be less change in the relative demand for different factors. Extending Neary's (1978) analysis, I show this first diagrammatically, assuming that factor U is sectorally immobile, while factor S is fully mobile within a country.

We are comparing three scenarios: A is the starting scenario. F represents equilibrium after a fall in the price of good M , in the case where factor U (the

factor in which M is intensive) is sectorally immobile. V represents the long-run case where all factors can move. We note first that in the Edgeworth box diagram (bottom left) points A and V lie on the contract curve, while F does not. The curvature of the contract curve reflects the difference in relative factor intensities of the two industries and the substitution elasticity. The shift from A to V represents a redeployment of resources away from industry M .

The top left-hand diagram shows the equilibrium for the mobile factor S . In each industry, value of marginal product of S will decline as employment of S increases, though an increase in employment of U will shift the curve upwards. Equilibrium occurs where value of marginal product in both industries is equated: before the price change, this is at point A .

A fall in the price of good M will cause the VMP curve for S in industry M to shift downwards. Consequently, this causes a fall in W_s , and a redeployment of S away from industry M towards industry X , as shown at point F . The corresponding equilibrium in the market for factor U (an addition to Neary's (1978) exposition) is shown in the top right-hand quadrant. Point A represents the economy in long-run equilibrium prior to the shock, so W_u is equated across the two sectors. The curves through A are obtained by inverting the initial zero profit conditions for the two industries. I will call these relative wage schedules. The schedule for the more S -intensive industry X has the steeper gradient. A fall in the price of M causes the schedule for M to fall. Mapping across the equilibrium wages for S from the top left-hand diagram enables us to calculate the two equilibrium wages for U in the different sectors (marked by



F). By contrast, point *V* in the top right-hand diagram is where both relative wage schedules intersect, as in the long-run mobility of *U* allows its wage to be equated in both sectors. Note this involves moving up and leftwards from point *F*, so that *U*'s wage falls further in the long-run than in the short-run, even in the declining industry. By contrast, the wage of factor *S* must rise, even compared to the case *A*, because point *V* lies up and to the left of *A* along the relative wage schedule for industry *X*, where the product price is unchanged.

In the top left-hand quadrant, the movement of *U* in the long-run shifts the VMP curve for *S* in declining sector *M* downwards, while that in sector *X* moves upwards, leading to a new equilibrium at *V*.

It follows from this that skilled wages fall slightly in the short run, but rise in the long run. Unskilled wages rise in the expanding sector and fall in the declining sector in the short run, but fall in both sectors in the long run. Ironically, factor U is better off in both sectors if it is unable to move than if it is fully mobile.

2.2 The four factor model

As a variant on the Ricardo-Viner three factor model, Edwards and Whalley (2007) consider a four-factor model, with capital stocks in each sector fixed in the short run, while both types of labour are sectorally mobile in the short- and long-run. As a simple way of developing this model, Edwards and Whalley (2007) develop a nested production structure. First, the two forms of labour, S and U , are combined to form aggregate labour using a CES form:

$$L_i = A_i(\beta_i U_i^\rho + (1 - \beta_i) S_i^\rho)^{1/\rho}. \quad (11)$$

Note the strong similarity to equation (3). The higher level of the production function combines aggregate labour with sectorally immobile capital, by means of a Cobb-Douglas aggregation:

$$Y_i = B_i \bar{K}_i^{\gamma_i} L_i^{1-\gamma_i}, \quad (12)$$

where γ_i is capital's share in value added in each sector. Since K_i is fixed in the short-run, we can rewrite this as

$$Y_i = C_i L_i^{1-\gamma_i}, \quad (12a)$$

where C_i is a constant. It follows that

$$\begin{aligned} WL_i/P_i &= \partial Y_i / \partial L_i = (1 - \gamma_i) C_i L_i^{-\gamma_i}; \\ \partial(WL_i/P_i) / \partial L_i &= -\gamma_i (WL_i/P_i) / L_i, \end{aligned} \quad (13)$$

which is negative. Consequently, if labour (skilled and unskilled) flows into an expanding sector, X , then the aggregate labour wage in that sector, WL_E , will decline relative to the goods price P_X , while in the declining sector, M , the aggregate labour wage WL_M will not fall as fast as P_M . But by analogy with equation (7), the skilled-unskilled wage ratio will be a function of WL_M/WL_X :

$$\phi^{1-\sigma} = (\beta_M^\sigma - \beta_X^\sigma (WL_M/WL_X)^{1-\sigma}) / [(1-\beta_X)^\sigma (WL_M/WL_X)^{1-\sigma} - (1-\beta_M)^\sigma]. \quad (14)$$

Since the fall in WL_M/WL_X is less than the fall in P_M , it follows that ϕ will change less when there is a fixed factor. Moreover, from (13) we would expect that, the higher the capital share in value added, γ_i , the less sensitive relative skilled and unskilled wages will be to changes in product prices.

To explain this more intuitively, the magnification effect on the skilled/unskilled

wage premium occurs because a switch in output from industry M to industry X requires a rise in the skilled/unskilled labour ratios in both sectors, in order to clear labour markets, given set labour endowments. However, the sectoral shift of output will be damped because capital is immobile, so that capital rents rise in the expanding sector, discouraging expansion.

Edwards and Whalley (2007) found in simulations for the United Kingdom, assuming $\sigma = 1.25$, that the effects of a fall in World prices of unskilled-intensive good M on the skilled/unskilled wage ratio were reduced by 1/3 if even 2% of value added comprised payments to a fixed factor, compared to a full mobility model. With 5% fixed factor, the relative wage change was less than half that with a Heckscher-Ohlin model. With all capital immobile between sectors, the effect of World prices on wages is just 1/8 of that when all factors are fully mobile.

It follows that short-run capital fixity could play a very important role in damping relative wage changes. Against this, however, it is worth noting that capital depreciates over time: for example, Nadiri and Prucha (1997) estimated that physical capital in US manufacturing depreciates at 5.9% per annum, while the rate for R&D capital is 12%. This estimate is higher than those typically used by National Accounts statisticians. A depreciation rate of 7% per annum on average would reduce the capital stock, over 25 years, to just 16% of its initial value (or perhaps just over 5% of value added). This might still be enough to halve the impact of a World price change on relative wages, according to the Edwards and Whalley (2007) simulations.

2.3 Costs on Labour Mobility

Even when labour can, in theory, move between sectors, there may be costs to doing so. These vary from the costs of moving house through to those of a possible period of transitional unemployment. There are also the costs to employers of hiring new workers.

In the short-run, if the expanding sector, X , can only attract new workers by taking them from the declining sector, M , and if, for simplicity, we assume the costs of this movement are borne by the workers moving, then a potential wage gap can open up between the two sectors, of up to the cost of moving, τ . If τ is constant for all workers, then there will be no movement between sectors until the wage gap exceeds this threshold.⁴ This effectively makes labour a semi-specific factor.

There is evidence that unskilled labour is sectorally less mobile than skilled labour. For example, Haynes et al (2000) found that those in the UK with lower skills experience longer periods of unemployment when laid off. Greenaway et al (2001) found a 7 3/4% average wage differential in the UK between sectors with expanding employment and those with declining employment. Assuming this differential were entirely explained by mobility costs on unskilled workers, Edwards and Whalley (2007) suggest this would imply a 13.7 % maximum wage differential for the unskilled, before they would be prepared to move, and simulations implied a differential would reduce the effects of a World price

⁴In practice, we would probably expect τ to be an increasing function of the number of workers moving.

change on the wage differential by nearly half.

This position may be even more significant when we look at Continental Europe, where firing costs of workers are generally regarded as higher. The OECD generally only produces a country ranking on this: a 1994 ranking (repeated in Nickell (1997)) suggests the USA has the lowest difficulty of firing, while Italy is the highest, with France, Belgium and Germany close behind. The UK was in seventh place, somewhere between the other Anglo-Saxon economies and Continental Europe.

Unemployment benefit replacement ratios are also higher in Continental Europe: however, the effect on job mobility costs is likely to be ambiguous. On the one hand, a firm may need to offer higher wages to attract new workers. Against this, high benefits cushion the effects of transitional unemployment for workers laid off.

Again, one would expect these labour mobility costs to be more of a short- than a long-run phenomenon, given that we would expect that approximately 1/40 of the workforce retires each year and is replaced. However, there may be lasting problems of regional mobility in some countries.

A difference between the USA (in particular) and the UK (to a lesser extent) compared to Continental Europe has been faster growth of the number of workers in employment in the past two decades. One might expect this to make it easier for the expanding industry to hire workers, so reducing the role of intersectoral immobility in the Anglo-Saxon countries.

3 Factor Specificity in a Dynamic Context: the nature of depreciation

While estimated depreciation and turnover rates may give some indication of the decline of sector-specific factor endowments over time, these have to be taken with a good deal of care. This is because there are a number of different models of depreciation. Following Edwards (2006a), I focus here on two particular models of depreciation, which could be considered polar opposites: the constant probability of death model and the constant annual maintenance cost model.

With the constant probability of death model, a depreciation rate of, say, 6 per cent per annum means that there is a 6 % chance in any one year that the capital stock of any firm will need total replacement. One might expect that, after a negative trade shock, a firm whose capital expires will shut, up to the point where the industry is in a new equilibrium. There will therefore be a slow adjustment over time in the capital stock of the declining industry, until the industry has shrunk to its new equilibrium level. This might well suggest that a fairly crude dynamic model of industry capital stock in year t would work acceptably:

$$K_{it} = \max((1 - \delta)K_{it} - 1, K_{it}^*), \quad (15)$$

where K_{it}^* represents the long-run equilibrium level. Investment would be zero until the capital stock has fallen to K_{it}^* .

However, if depreciation takes the alternative form, with a constant annual maintenance cost of $\delta\%$, then the analysis is quite different. In this case, the

only avoidable cost, if the firm decides to scrap its existing capital stock and shut capacity, is the maintenance cost. The interest cost on existing capital outlays is not recuperable. Consequently, if the industry had been earning normal profits (at rate $r\%$) prior to the trade shock, then returns on capital need to fall to proportion $r/(r + \delta)$ of normal returns before capacity will be scrapped. This is very akin to the semi-fixed model of labour discussed in section 2.3, in the case where there are costs on labour mobility: in this case the cost is on capital mobility, and consequently an industry has 3 potential states (see Edwards and Whalley (2007)): expanding, static (where its returns on capital are less than normal, but not sufficient to encourage scrapping) and declining. Where depreciation is purely of the ongoing maintenance cost variety, a declining industry is likely to undergo a rapid shake-out of capacity, until returns on the remaining capacity return to the threshold level above which capacity will not be scrapped.

There may, of course, be a hybrid model, in which total depreciation, δ , consists partly of the constant annual probability of death (δ_1) and partly of the ongoing maintenance cost variety (δ_2). The dynamics of the shake-out in this kind of industry require more analysis.

3.1 Labour turnover

In some respects, the turnover of labour is potentially even more complicated than that of capital. Labour may move out of a firm, and yet stay within the same industry, profession or region. Hence, crude labour turnover rates

may be quite misleading when estimating the dynamics of labour movement into and out of a sector. Moreover, as with the issue of depreciation rates, there may be difficulties in a firm simply not replacing staff when they are retired or leave due to natural wastage. This is because job definitions and complementarities may make it difficult to leave a particular post unfilled, while maintaining the productivity of those around. This could potentially turn labour turnover into something more akin to the ongoing maintenance cost form of capital depreciation: unless there is to be a major (and costly) restructuring of the firm's employment, posts may have to be filled even after a sector has been adversely affected by a trade shock.

3.2 Labour and Capital Complementarities

There may be important interactions between decisions on capital capacity reduction and labour force reduction, in particular if the conditions in the sections above hold. In other words, it may be difficult just to stop replacing capital, if that involves costly lay-off decisions for workers, and likewise it may be expensive to cease hiring replacement workers, if capital is in part a sunken cost, and failing to hire workers means scrapping capacity.

For these reasons, it is quite conceivable that sector-specificity of factors may be a long-standing issue, not simply a transitional one which gradually fades away in the face of depreciation following a trade shock. These issues need dynamic modelling - yet the modelling has to be done carefully, and may need to take account of a variety of different depreciation and labour turnover

assumptions. In particular, some depreciation and turnover specifications may imply threshold effects, so that a relatively small difference in policy on, say, firing costs or regional subsidies or taxation, may be enough to cause a quite significant difference between countries in terms of response to a trade shock. This may well be a key factor in understanding the very different dynamic responses in both sectoral output/employment patterns and in wage inequality between the UK and Continental Europe.

4 Unaccounted forms of Capital

In this section, I argue that standard trade models may be underestimating the capital stocks (broadly-defined) involved in production and trade. In particular, much of the current literature on heterogeneous firms or on searching and matching in trade can be interpreted in terms of either entrepreneurial or informational capital. I argue these phenomena effectively introduce new forms of specific factors into the trade-wages equation: with the effect of further damping sectoral shift and wage magnification following a trade shock.

4.1 Entrepreneurial capital

A number of recent papers have introduced the idea of firm heterogeneity into the analysis of trade.⁵ Firms vary in efficiency, at least in part, in a random way. However, when looking at the economy as a whole, over a period of time, firm

⁵See Ghironi and Melitz (2005), Bernard et al (2005), Edwards (2006a).

efficiency can be interpreted as a form of entrepreneurial capital: firms enter the market on a trial basis, with most never making a profit and eventually shutting. However, the probability that some of the firms entering will turn out to be highly efficient (and profitable) is what keeps new firms entering. In equilibrium, one would expect that the long-run expected returns on the survivor firms (after adjusting for risk) compared with the losses on failures would set the expected return on a new entrant equal to the normal return on capital. However, when looking at individual firms, the efficient (survivor) firms will be earning supranormal profits. Now, when faced with an adverse shift in traded prices for their output, many of the intramarginal, efficient firms may still be profitable and remain open, so reducing the degree to which output will fall in response to a price change.

4.2 Informational capital

Informational capital includes the returns spent on advertising, branding and signalling expenditure, all of which will allow some well-known brands to continue producing in a given location long after it ceases to have comparative advantage for a new entrant in that industry. However, it is worth noting that production of a well-known brand can often shift abroad over time. Against this, countries themselves can develop a reputation - to the extent that, say, BMW cars are reputable because they are associated with German engineering, production may not be very internationally mobile in response to shifts in comparative production costs.

We should also note that much trade is of the form of inter-firm trade and outsourcing, where inter-firm relationships are crucial. Firms in good matches with foreign partners may well survive an adverse shift in the terms of trade, damping the trade-wages relationship (Rauch and Casella, 2003). Besedes and Prusa (2006) and Edwards (2006b) suggest that these differences in match quality are actually indicative of a long-run search process for trading partners: Edwards (2006b) in particular suggests that match quality is a form of informational capital, and that, on a fairly rough formulation, the returns on informational capital could account in equilibrium for around 10% of the value of inter-firm trade.

4.3 Industry Specific Public Goods

Certain public goods or infrastructure investments may specifically support production of a particular good in a particular country or region: for example, the veterinary services which underpin livestock production, or the construction and provision of dedicated railway lines linking a coal mine or a port to a steelworks. Again, these should be counted as sector-specific capital.

5 Capital Formation Effects

A trade shock can also potentially cause substantial macroeconomic changes, with potential labour market implications, through its effects on capital formation. This is the case even where capital is immobile between countries, so long as a change in the return on investments leads to a change in aggregate capital

formation. However, these days, it may well be sensible to see new capital as being relatively mobile internationally, tending to equate capital returns across the advanced countries (at least).

In these circumstances, a shift in a country's terms of trade can potentially result in a large change in aggregate investment volumes, particularly in the case where there are either sector-specific factors present or where there are heterogeneous firms (which, as I have argued, can be interpreted as a form of sector-specific capital). This is because high levels of capital (or entrepreneurial capital) from past investments may remain for a long time in a sector in which a country formerly had a comparative advantage, but which is now declining, yet at the same time there will no longer be demand for any new capacity-increasing investments in that sector. At the same time, the slowness of output in the 'declining' sector actually to decline maintains demand for labour, so keeping wages above the level at which investment in the newer 'expanding' sector becomes economic. The country therefore goes through a prolonged phase in which, although its existing firms may remain competitive, new firms are not competitive in either sector.

While this analysis may be most appropriate to a heterogeneous firms model, I suggest it is most easily illustrated in the context of a traditional, two-factor model, with labour and capital employed by two industries using Cobb-Douglas technology:

$$Y_i = K_i^{\alpha_i} L_i^{1-\alpha_i}, i \in \{X, M\}. \quad (16)$$

Now, assume K_m is fixed at \bar{K}_m . Consequently, if the labour wage is W , and

the price of good i is P_i , then the demand for labour in the declining sector

$$L_m^{\alpha_m} = (1 - \alpha_m) \bar{K}_m^{\alpha_m} P_m / W. \quad (17)$$

I will assume in this simple example that, prior to the trade shock, sector X is not competitive and does not produce. Therefore, in the pre-shock situation, if we assume $P_{m0} = 1$, then

$$W_0 = (1 - \alpha_m) \bar{K}_m^{\alpha_m} / \bar{L}^{\alpha_m}, \quad (18)$$

where \bar{L} is the fixed national labour endowment. The return on capital in the pre-shock situation is given by

$$R_0 = \alpha_m \bar{K}_m^{\alpha_m - 1} \bar{L}^{1 - \alpha_m} = R^*, \quad (19)$$

which is the global rate of return on new investment. Now, as P_m falls following the trade shock, W and the return on capital in sector m , R_M will fall proportionately. However, assuming the price of good X is also unity, there will be no new investment in industry E until the wage falls to a critical level, W^* , which can be derived from the zero profit condition for industry X

$$\begin{aligned} 1 &= P_X = (R^* / \alpha_X)^{\alpha_X} (W^* / (1 - \alpha_X))^{(1 - \alpha_X)}; \\ W^* &= (1 - \alpha_X) (R^* / \alpha_X)^{\alpha_X / (\alpha_X - 1)}. \end{aligned} \quad (20)$$

However, wages may never fall to this level, if the capital stock in sector M depreciates on an ongoing maintenance cost basis, and if P_m stays high enough that R_m does not fall below $r/(r + \delta)$ times R_0 . The economy may continue to show high rates of capital formation, but this is mostly replacement investment.

A similar model can be derived where the sectorally-fixed capital stock is mostly informational or entrepreneurial capital. In this case, new investment (in the form of new firm start-ups and experimental matching) in sector M may stop or slow considerably following the trade shock. but physical capital formation and employment in this sector may remain high. Costs on labour mobility may, in theory, have similar effects as well.

6 Avenues for further enquiry

The ideas in this paper require exploration, particularly in the form of simulation modelling across various countries using a variety of parameters. The intention would be to find plausible ranges for the magnification effect of a trade shock in countries with different initial capitalisation of firms or different labour market institutions - looking both at comparative static and dynamic models. An interesting question is the degree to which 'sticky' labour markets in Continental Europe have actually served to damp the decline in unskilled labour demand there, compared to the Anglo-Saxon economies. The effects of differences in skills training policy and labour migration rates across countries

may also play a part in specific factors models (since factor price insensitivity⁶ assumes full intersectoral factor mobility), and need investigation.

Further, the analysis above has assumed wages clear labour markets. The interaction of specific factors models with bargaining theory of labour markets may be a fruitful analysis, since, in economies with large amounts of sector-specific factors, trades unions may potentially be able to bargain for higher wages, effectively sharing the fixed factor rents, though at a cost in terms of higher unemployment.

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⁶See, for example, Leamer and Levinsohn (1995).

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