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European trade with lower-income countries and the relative wages of the unskilled: an exploratory analysis for West Germany and the UK

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**European Trade with Lower-Income Countries
and the Relative Wages of the Unskilled –
An Exploratory Analysis for West Germany and the UK**

by

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JEL Classification: F14; J31

Abstract:

This paper develops a Heckscher-Ohlin-type framework in which relative factor prices are affected by output prices as well as by total factor productivity growth. The empirical analysis finds no evidence that the relative prices of unskilled-labour-intensive manufactures, adjusted for total factor productivity growth, declined after 1970 to depress the wages or employment opportunities (in the presence of an inflexible wage structure) of unskilled labour. Similarly, neither in West Germany nor in the UK did changes in the commodity composition of foreign trade reflect a sustained rise in the stock of unskilled labour in the rest of the world (which they should if labour markets were strongly affected by growing developing country exports).

1 Introduction*

Since the early 1970s, European imports of manufactures from developing countries, especially from East and Southeast Asia, have grown rapidly. Many of these imports require relatively large amounts of unskilled labour to produce. At the same time, the wage rate for unskilled labour has declined relative to skilled labour in some European countries while elsewhere in Europe unemployment among the unskilled has increased overproportionately.¹ Several recent studies, including in particular Wood (1994), have argued that these trends are linked and that it was growing imports from Asia and other lower-income countries that made the unskilled in many industrialized countries worse off. There has ensued a lively debate on this "trade impact" hypothesis, involving a wide variety of conceptual, methodological and data-related questions.² To date, most of the debate has been based on empirical

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¹ For example, the ratio of the highest decile of earnings of men in the UK over the lowest decile fluctuated around 2.4 throughout the 1970s but increased markedly during the 1980s to reach 3.2 in 1992 (Central Statistical Office, Annual Abstract of Statistics, various issues). In West Germany, the unemployment rate for workers without formal vocational training rose from close to 0 in 1970 to 7.4 per cent in 1975 and further to around 15 per cent in the early 1990s. During the same period, the unemployment rate for workers with vocational training or tertiary education only rose to 5 per cent (Paqué, 1994).

² A full summary of this literature until the mid-1990s is provided by Burtless (1995) and by a symposium in the *Journal of Economic Perspectives* (Freeman, 1995; Richardson, 1995; Wood, 1995). Important recent contributions include Baldwin, Cain (1997), Feenstra, Hanson (1997), Leamer (1996), Oscarsson (1996), and Sachs and Schatz (1996).

evidence for the United States. However, relative wages and employment opportunities are probably affected not only by international developments but also by a host of national institutions and policies. This paper, which is intended to open the way for a comparative study of several OECD countries, presents preliminary evidence on the link between international trade and the labour market in West Germany and the UK since 1970.

The trade impact hypothesis, as formulated by Wood (1994), is based on a three-factor Heckscher-Ohlin trade model with internationally mobile physical capital and immobile skilled and unskilled labour. As imports from developing countries have replaced domestic production of unskilled-labour-intensive manufactures in many industrialized countries, demand for unskilled labour must have fallen. When labour markets were flexible, such as in the United States and increasingly in the UK, reduced demand for unskilled labour led to a widening wage differential of skilled over unskilled labour while full employment might be maintained (Stolper-Samuelson effect). When the relative wages of skilled and unskilled labour were prevented from adjusting to the change in relative demand, such as in West Germany and other continental EU countries, the result was growing unemployment of unskilled labour.

Although the trade impact hypothesis is plausible *a priori*, the magnitude of the Stolper-Samuelson effect, possible alternative causes of the deteriorating position of unskilled labour, and various methodological issues are controversial. In this paper, I

account for this conceptual and methodological uncertainty by using two alternative modelling approaches adapted from Baldwin and Cain (1997) to assess the strength of the trade impact on the labour market. The two approaches make assumptions of varying stringency, and consequently shed light on the sensitivity of conclusions to the underlying assumptions. The first approach investigates the evolution of the relative prices of skilled versus unskilled-labour-intensive goods and represents a direct test of the trade impact hypothesis. However, the results can only be interpreted in a straightforward manner if certain strong assumptions are satisfied, such as infinitely price-elastic world demand for the domestic output (small country case) and the instantaneous adjustment of the output mix and factor input ratios to changing relative product and factor prices. The second approach investigates changes in the pattern of trade specialization to draw conclusions on *relative* factor endowments at home compared with the rest of the world. Additional information is then required to determine what changes in *absolute* endowments at home or abroad (for example, immigration or a growing global supply of unskilled labour) brought about the inferred changes in relative endowments.

In Section 2 below, I prepare the ground for the empirical analysis by discussing several conceptual issues that have been raised by recent papers on the link between international trade and the labour market. I start by demonstrating how an increasing global supply of unskilled-labour-intensive goods interacts with technical progress on factor prices and output in a simple Heckscher-Ohlin model of a small open

economy. Specifically, I argue that technical progress should be, and can be, included *explicitly* in the estimated model (Section 2.1). I then introduce the econometric approaches used in the analysis (Section 2.2). Section 3 presents the regression results. Section 4 concludes and discusses possible directions for future research.

2 Conceptual Issues

2.1 *Trade, Technical Progress, and Factor Prices in a Simple Heckscher-Ohlin Model*

This section discusses the link between trade, technical progress, and factor prices in the framework of a simple ‘two-by-two’ Heckscher-Ohlin model for a small open economy. Possible extensions of the model to more realistic dimensions (more than two factors, more goods than factors) will be discussed in the following section (2.2). The small-country assumption means that product prices are determined solely by world demand and supply; this implies infinitely price-elastic demand for the home country's output. The production side of the economy may be described on the basis of the assumption that both factors of production (henceforth to be called unskilled labour and human capital for convenience) are fully employed. Furthermore, the production functions of both industries (to be called clothing and machinery) are of the Cobb-Douglas type so that factor prices multiplied by factor inputs sum to output in each industry (zero-profit condition).

In a comparative-static interpretation, the model may be written in relative rates of change and (exogenous) technical progress may be allowed to affect factor input coefficients. The following two equations then describe the difference between two equilibria, assuming that the differences in variables are small:³

$$(1) \quad \lambda(\hat{Q}_C - \hat{Q}_M) = (\hat{L} - \hat{H}) + (\pi_L - \pi_H) + \delta(\hat{w}_L - \hat{w}_H)$$

$$(2) \quad \theta(\hat{w}_L - \hat{w}_H) = (\hat{p}_C - \hat{p}_M) + (\pi_C - \pi_M)$$

where

λ, δ, θ positive constants (cf. Jones, 1970 for details)

\hat{x} percentage change in x

Q_C clothing output

Q_M machinery output

L stock of unskilled labour

H stock of human capital

w_L unskilled wage

w_H return to human capital

π_L, π_H increase in effective (productivity-adjusted) factor stocks through technical progress

³ For the derivation, see Jones (1965; 1970); a fuller description of the model is contained in Lücke (1992). The equations reflect the Rybczinski and Stolper-Samuelson theorems, respectively.

π_C, π_M percentage change in total factor productivity through technical progress

p_C, p_M price of clothing/machinery

Equations (1) and (2) show that a decrease in the relative price of clothing in the world market ($\hat{p}_C - \hat{p}_M < 0$), for example due to increased supply from developing countries, leads to a new equilibrium that differs from the former in three important ways. First, according to equation (2), the unskilled wage declines relative to the return to human capital: $\hat{w}_L - \hat{w}_H < 0$. Second, according to equation (1), clothing output decreases and machinery output increases. Third, because of the reduction of the unskilled wage, production in both sectors becomes more unskilled-labour-intensive. This is achieved by transferring human capital and unskilled labour from clothing to machinery production in such proportion that in clothing production the amount of human capital is reduced by a greater proportion than unskilled labour and in machinery production the amount of human capital is increased by a smaller proportion than unskilled labour.

Technical progress affects both effective (i.e. productivity-adjusted) factor endowments at the national level (π_L and π_H in equation (1)) and total factor productivity at the sectoral level (π_C and π_M in equation (2)). The impact of technology-induced changes in effective factor endowments ($\pi_L - \pi_H$) is equivalent to changes in actual endowments, e.g. through migration ($\hat{L} - \hat{H}$). The impact of sectoral total factor productivity growth ($\pi_C - \pi_M$) is equivalent to changes in the

relative product price ($\hat{p}_C - \hat{p}_M$). Note that if the small-country assumption holds and the economy produces both goods, the relative wage is determined solely by world market product prices and sectoral total factor productivity; changes in effective factor endowments, either through technical progress or through actual changes in stocks, are accommodated through inter-sectoral factor mobility and changes in the output mix. This is the factor price equalization theorem emphasized, inter alia, by Leamer (1995). For example, immigration of predominantly unskilled labour ($\hat{L} > \hat{H}$) leads to an increase in clothing production ($\hat{Q}_C > \hat{Q}_M$) in accordance with equation (1), but leaves relative factor prices unaffected (equation (2)).⁴

These observations explain why the factor content of trade, for example increasing OECD net imports of unskilled labour in the form of imported manufactures (Wood, 1994), may not reveal much about the causes of shifts in relative factor prices. If the factor price equalization theorem holds - as it should as long as the economy is not completely specialized in the production of one good - then the output mix and the amount of trade may change without any change in relative factor prices. It follows that if the entry of developing countries into the international division of labour had a measurable impact on the relative wage, then this must have been transmitted through goods prices, not through trade alone.

⁴ Factor endowments only affect factor prices in the case of *complete* specialisation where all factors have moved into the production of one good and production of the other good has ceased. In that case, the full employment assumption requires factor prices to adjust such that all factors are employed in the one remaining industry in the proportion in which they are nationally available.

Several studies based implicitly on equation (2) seek to identify the effects of trade or of technical progress on relative factor prices, mainly in the US. Baldwin and Cain (1997) abstract from technical progress and assume that all changes in product prices reflect changes in the international division of labour. Hence they calculate the (hypothetical) changes in relative factor prices that follow from the (given) changes in product prices and compare these to the actual changes in factor prices. Conversely, Leamer (1994) seeks to isolate the impact of technical progress by calculating the (hypothetical) changes in relative factor prices that follow from the (given) rates of total factor productivity growth.

In this paper, I take the view that technical progress is essentially a world-wide phenomenon. As a first approximation, it can be assumed to occur at similar rates at home and abroad. Hence a firm in an industry with especially rapid technical progress will normally face a declining relative price for its output in the world market; at the same time, however, its production costs per unit of output decline due to the growth in total factor productivity. If we assume further that demand is homothetic, then expenditure shares are constant and a decline in the output price leads to a compensating increase in the quantity demanded. As a result, there may be no need for any reallocation of factors of production and total factor productivity growth may have no impact on labour demand after compensating product price changes are accounted for. Quite plausibly, the sum of the relative changes in output

prices and total factor productivity may then be looked upon as reflecting the impact of factors other than technical progress on the domestic labour market.⁵

2.2 *Dimensionality Issues and Econometric Models*

For the purpose of the empirical analysis, the two-by-two model in the preceding section needs to be replaced by a framework that allows for more than two factors of production and for more goods than factors. To avoid data problems related to the measurement of the stocks of natural resources and agricultural land, the present empirical analysis is limited to broadly defined manufactures, including food processing and metallurgy.⁶ Assuming further that all material inputs are freely traded internationally, it is plausible to consider unskilled labour, human and physical capital as the relevant factors of production and to measure output by gross value added.

⁵ In a more recent paper, Leamer (1996) makes several alternative assumptions about the extent to which changes in total factor productivity are passed through to product prices. Oscarsson (1996) uses a procedure similar to mine in her analysis of trade and relative wages in Sweden.

⁶ Lücke (1992) discusses the implications of this limitation in greater detail. In the case of Germany, the wide definition of manufactures that is used in the empirical analysis covers 98 per cent of German exports and 89 per cent of German imports in 1995. The labour market impact of imports from developing countries should therefore have been transmitted through the portion of trade covered in the analysis. In the case of the UK with its growing oil exports since the late 1970s, one may expect that the resulting real appreciation has affected domestic factor demand because of the induced shift of resources from the production of tradables to non-tradables. However, a strong impact of developing country imports on labour demand should still be felt in the prices of tradable goods or in the sectoral pattern of trade specialisation, independent of the level of output of tradable goods. Quite remarkably, while resources moved into (potentially unskilled-labour-intensive) services, the ratio of the highest over the lowest decile of weekly earnings among men in the UK increased from approximately 2.5 in the early 1980s to approximately 3.2 in the early 1990s.

In a three-factor, multi-product framework, a country produces a range of goods whose factor intensities are similar to its relative factor endowments ("Leamer triangles").⁷ Changes in a country's factor endowments lead to a different output mix, but do not affect factor prices as long as the country produces the same set of goods. This is equivalent to incomplete specialisation in the two-by-two model and applies even when factors of production are not substitutable but used in fixed proportions (Leamer, 1994, p. 11). However, if relative factor endowments change substantially, for example through sustained human or physical capital accumulation, then the country may produce a different set of goods and relative factor prices may change as a result. This is equivalent to the shift from incomplete to complete specialisation in the two-by-two model.

Even such an extended model predicts that most countries produce a far smaller set of manufactures than they actually do. On the one hand, this may result from non-tradable activities subsumed in some manufacturing sectors. On the other hand, this observation may reflect the heterogeneity of most manufactures which implies that firms operate under monopolistic competition.⁸ Hence, if faced with increasing import pressure, firms may maintain their output prices by specializing in high-value-added product varieties. Even within a given industry, the quality attributes of domestic production may then be very different from those of imports from low-

⁷ Leamer (1995) presents a recent summary of such a three-factor, multi-product framework.

⁸ Trefler (1995) finds that global trade patterns reflect consumer preferences in favour of domestic products (in the sense of the Armington assumption) as well as higher total factor productivity in the advanced industrialized countries.

wage countries. Another implication of monopolistic competition is that although the domestic output price may not change in response to increased import competition, firms may still have to reduce their output. Therefore, factors of production need to be reallocated to other sectors and factor prices need to adjust just like in the case of actual output price changes.

Given these conceptual and data-related uncertainties, the present empirical analysis follows the example of Baldwin and Cain (1997) in taking a two-pronged approach. First, the zero-profit condition in a multi-industry framework is used to establish which (hypothetical) changes in factor prices would have been consistent with the changes in product (i.e. value added) prices and total factor productivity over consecutive five-year periods since 1970. This is essentially an extension of equation (2) to a three-factor, multi-product framework. The zero-profit condition for industry i may be written as

$$(3) \quad p_i = a_{Li}w_L + a_{Hi}w_H + a_{Ki}w_K$$

where

a_{Li}, a_{Hi}, a_{Ki} factor input coefficients

w_K return to physical capital

i industry index

Equation (3) may be written in relative rates of change to give the link between product price changes, the growth of total factor productivity, and the implied changes of relative factor prices. Outsourcing may be accounted for by introducing a

new input which represents those material inputs or externally purchased services (a_x) which are purchased at the end of the period of observation (i.e. at time 1) to replace activities which were still part of the industry's value added chain at the beginning of the period of observation (i.e. at time 0).⁹ By taking differences and dividing through by p_i we obtain:

$$(4) \quad \hat{p}_i = \sum_k \theta_{ki}^{(0)} \cdot \hat{w}_k + \sum_k \theta_{ki}^{(0)} \hat{a}_{ki} + \sum_k \theta_{ki}^{(0)} \hat{a}_{ki} \hat{w}_k + a_{xi}^{(1)} \cdot p_x^{(1)} / p_i^{(0)}$$

where

$$k = L, H, K$$

$\theta_{Li}, \theta_{Hi}, \theta_{Ki}$ shares of factors of production in gross value added

$$\hat{y} = (y^{(1)} - y^{(0)}) / y^{(0)}$$

The change in factor input coefficients may be rewritten as

$$(5) \quad \hat{a}_{ki} = (\hat{R}_{ki} - \hat{Q}_i) / (1 + \hat{Q}_i)$$

where

R_{ki} input of factor k in production of good i

Q_i output of good i

It follows that

⁹ In the empirical analysis, $dv = a_{xi}^{(1)} \cdot p_x^{(1)} / p_i^{(0)}$ was initially estimated from the change in the share of gross value added (VA) in the value of production (VP):

$$dv = (VA^{(0)} / VP^{(0)} \cdot VP^{(1)} - VA^{(1)}) / VA^{(0)}$$

However, it turned out that the share of physical capital (estimated as the difference between gross value added and employee compensation) was subject to substantial cyclical fluctuations. Therefore, employee compensation was ultimately used instead of gross value added.

$$(6) \quad \sum_k \theta_{ki}^{(0)} \hat{a}_{ki} = -\pi'_i$$

with

$$(7) \quad \pi'_i = \left(\hat{Q}_i - \sum_k \theta_{ki}^{(0)} \hat{R}_{ki} \right) / (1 + \hat{Q}_i)$$

Thus defined, π'_i may be interpreted as the growth rate of total factor productivity in the production of product i in discrete time. By substituting equations (7) and (5) into (4) we obtain:

$$(8) \quad \hat{p}_i + \pi'_i - dv = \sum \hat{w}_k \cdot \theta_{ki}^{(0)} (1 + \hat{a}_{ki}) = \sum \hat{w}_k \cdot \theta'_{ki}$$

with

$$\theta'_{ki} = \theta_{ki}^{(0)} (1 + \hat{a}_{ki})$$

$$dv_i = a_{xi}^{(1)} \cdot p_x^{(1)} / p_i^{(0)} \quad (\text{outsourcing})$$

Equation (8) is written in discrete time because the econometric analysis is based on relative changes in variables over 5-year periods that are not necessarily small in the sense that the equivalent of equation (8) in continuous time represents an acceptable approximation.¹⁰ Although equation (8) is an identity, it may not hold exactly in reality for a variety of reasons such as measurement errors, etc. Hence I regress the sums of price changes and total factor productivity growth rates in each sector on factor shares. The resulting coefficients are the hypothetical changes in factor prices that would be consistent with the given product price changes. Furthermore, equation (8) may be rewritten slightly to obtain a direct estimate of the

¹⁰ Actually, it turned out that estimating the econometric model in continuous time did not substantially change the results.

difference between the rates of change of unskilled wages and of the return to human capital. Thus the econometric model becomes

$$(9) \quad \hat{p}_i + \pi'_i - dv_i = \beta_1(\theta'_{Li} + \theta'_{Hi} + \theta'_{Ki}) + \beta_2\theta'_{Hi} + \beta_3\theta'_{Ki} + u_i$$

where

$$\beta_1 = \hat{w}_L$$

$$\beta_2 = \hat{w}_H - \hat{w}_L$$

$$\beta_3 = \hat{w}_K - \hat{w}_L$$

$$u_i \quad \text{error term}$$

A positive and significant estimate of β_2 implies that relative product prices have shifted so as to depress the unskilled wage relative to the return to human capital. To the extent to which domestic value added price changes result from changes in world (rather than domestic) demand and supply, such a finding would support the trade impact hypothesis. If the estimate of β_2 is not positive and significant, several possible explanations need to be considered. For example, with an inflexible wage structure (like in Germany) and product differentiation, the model may be inappropriate because production and employment rather than product prices adjust to growing competitive pressure from developing country producers. At the same time, the zero profit condition could still be assumed to hold because domestic prices do not imply a shift in relative factor prices wages nor is such a shift actually observed. With a flexible wage structure (like, increasingly, in the UK) and a growing observed skill differential in wages, the absence of a significant positive β_2

coefficient raises potentially more difficult questions. First, the zero-profit condition may not hold in reality even over the chosen, relative long period of observation so that output prices can move relatively independently of factor prices. This possible explanation would not be very plausible, but would invalidate the analytical approach. Second, there may be serious data or conceptual problems that prevent us from observing the (existing) link between output and factor prices. For example, the calculation of the underlying value added price indices or the adjustment of price changes for outsourcing may be incorrect. The appropriate response in this case would be a more detailed analysis of relative price changes.

The econometric model in equation (9) may appear counter-intuitive because the exogenous variables (world market prices and total factor productivity growth) are on the left-hand side of equation (5) whereas the dependent variables (implied factor price changes) are on the right-hand side. Note, however, that we are interested in finding those values of $(\beta_1, \beta_2 \text{ and } \beta_3)$ that "minimize the difference between" (intuitively speaking) the sum of the products on the right-hand side of equation (4) and the sum of changes in product prices and total factor productivity on the left-hand side. This is exactly what the least-squares method does. Furthermore, observations are weighted by each sector's value added to account for the fact that output prices in large sectors have a greater impact on national factor prices than output prices in small sectors.

An alternative approach at assessing the impact of increasing trade with developing countries on developed country labour markets has also been proposed by Baldwin and Cain (1997). Rather than describing small changes in variables over time, equation (4) may also be thought of as describing small differences in product and factor prices between two countries under autarky (say, between the home country and the rest of the world). Further, it is likely that even under actual trading conditions, product prices are not completely equalized across countries because of transportation costs, product differentiation, etc. In this case, positive net exports of a given sector imply a lower product price at home than abroad under autarky. Relative product prices are related to relative factor prices under autarky and, by implication, to relative factor endowments according to equation (4). Abstracting from possible differences in value-added-chains within industries ($dv = 0$) and from technological differences across countries ($\pi'_i = 0$), a cross-section regression of net exports on factor shares should therefore reveal the ranking of relative factor prices under autarky and, by implication, the ranking of relative factor endowments at home and abroad. These considerations lead to the following econometric model:

$$(10) \quad NX_{i,t} = \beta_{L,t} \theta_{Li,t} + \beta_{H,t} \theta_{Hi,t} + \beta_{K,t} \theta_{Ki,t} + u_{i,t}$$

Equation (10) may be rewritten so that estimated coefficients relate directly to the endowments with human and physical capital relative to unskilled labour (using

$$\theta_{Li,t} + \theta_{Hi,t} + \theta_{Ki,t} = 1):$$

$$(11) \quad NX_{i,t} = \beta_{L,t} + (\beta_{H,t} - \beta_{L,t}) \theta_{Hi,t} + (\beta_{K,t} - \beta_{L,t}) \theta_{Ki,t} + u_{i,t}$$

For example, a positive and significant estimate of $(\beta_{H,t} - \beta_{L,t})$ implies that the home country is well-endowed with human capital relative to unskilled labour, compared with the rest of the world.

The trade impact hypothesis suggests that, in the industrialized countries, $(\beta_{H,t} - \beta_{L,t})$ increases over time: As the supply of unskilled labour increases in the rest of the world, industrialized countries become *relatively* better endowed with human capital relative to unskilled labour. A similar hypothesis may be formulated for physical capital. Both hypotheses may be tested in a second-stage regression of the form

$$(12) \quad (\beta_{H,t} - \beta_{L,t}) = \alpha_H + \gamma_H T + v_{Ht}$$

$$(13) \quad (\beta_{K,t} - \beta_{L,t}) = \alpha_K + \gamma_K T + v_{Kt}$$

where

T time trend (1970 \doteq 0)

v_{Ht}, v_{Kt} error terms

Combining the first and second stages into a variable coefficient model, the econometric model may be written as

$$(14) \quad NX_{i,t} = \text{CONST} + D_{71} + \dots + D_{92} + \alpha_H \theta_{Hi,t} + \gamma_H (T \cdot \theta_{Hi,t}) \\ + \alpha_K \theta_{Ki,t} + \gamma_K (T \cdot \theta_{Ki,t}) + z_{it}$$

where the variables have the following interpretation:

$z_{i,t}$ error term

CONST β_L in 1970

$CONST + D_t \quad \beta_L$ for t later than 1970

$\alpha_H \quad (\beta_H - \beta_L)$ in 1970

$\gamma_H \quad$ annual change in $(\beta_H - \beta_L)$

$\alpha_K \quad (\beta_K - \beta_L)$ in 1970

$\gamma_K \quad$ annual change in $(\beta_K - \beta_L)$.

Thus a positive and significant estimate of γ_H would be consistent with, but would not constitute positive proof of the trade impact hypothesis. Further information would be needed to assess where the divergence in relative factor endowments between the home country and the rest of the world originated. For example, an increase in the home country's endowment with human capital relative to unskilled labour compared with the rest of the world could result from better education and training at home as well as from a growing stock of unskilled labour in the rest of the world. The possible advantage of this approach is that it does not rely on observed value added prices which may be difficult to interpret, especially in the presence of product differentiation between domestic and foreign goods.

3 Sectoral Product Prices and Trade Patterns in West Germany and the UK since 1970

3.1 *Definitions of Variables and Data Sources*

The analysis is based on national accounts data for German manufacturing and on the OECD STAN database for UK industry and trade data.¹¹ Manufacturing is defined widely to include food processing and metallurgy. At this level of aggregation, data are available for roughly 30 industries whose size varies widely. Although it would be desirable to use more disaggregated data (if only for a sensitivity analysis), this is impossible because capital stock data by branch of industry which are required for the calculation of total factor productivity are not available at a lower level of aggregation.

The input of human capital is measured on the basis of the assumption that the compensation received by each person engaged reflects remuneration both for unskilled labour services and for human capital services. Thus my definition of human capital includes formal education as well as training on the job as both are reflected in wages. Alternative definitions of human capital, such as the number of persons engaged with a certain minimum duration of training, take care only of formal education and neglect learning by doing which is potentially equally

¹¹ Capital stock data for the UK have kindly been provided by Mary O'Mahoney of the National Institute of Economic and Social Research, London.

important. Therefore, the stock of unskilled labour is defined as the total number of persons engaged. The unskilled wage in West Germany is proxied by two thirds of the compensation received by a salaried employee without vocational training and with only minimal training on the job. In the UK, the unskilled wage is proxied by the average earnings of the bottom ten per cent of wage earners. The total remuneration of human capital employed in production is then defined as that portion of employee compensation (adjusted for the hypothetical compensation paid to owner-managers) that exceeds the hypothetical compensation of unskilled labour. The total remuneration of human capital is deflated by the difference between the compensation of highly qualified employees (top ten per cent of wage earners in the UK) and the hypothetical unskilled wage to obtain a proxy for the volume of human capital employed in production.

Output is defined as gross value added. Accordingly, the compensation of the three factors of production is calculated as follows: For unskilled labour, it is the number of persons engaged times hypothetical compensation; for human capital, total compensation of the persons engaged minus the compensation of unskilled labour; for physical capital, the difference between gross value added and the compensation of unskilled labour and human capital. Output prices are value added prices that relate to the goods actually produced domestically rather than non-competing imports that are no longer produced at home.

3.2 *Changes in Product Prices and Total Factor Productivity*

Tables 1 and 2 report estimates of equation (9) for West Germany and the UK for consecutive 5-year periods since 1970. The regression model according to equation (9) is equivalent to regressing \hat{p} on the adjusted factor income shares (θ'_L, θ'_H and θ'_K), total factor productivity (π') and the outsourcing effect (dv), under the restrictions that the coefficient of π' is equal to (-1) and the coefficient of dv equal to 1.¹² Since both π' and dv are subject to measurement problems, these restrictions are tested explicitly. Model I without either π' or dv provides a point of reference for all the other estimates. A comparison of these results with Model II demonstrates that accounting for the impact of technical progress (π') on output prices affects the estimates of the skill differential ($\hat{w}_H - \hat{w}_L$) considerably. The results of the Wald test for the estimated coefficient of π' demonstrate that the estimate is often not significantly different from (-1) so that the restriction imposed in Model III appears acceptable.

Similarly, the inclusion of dv influences some estimates considerably (Model IV). However, many of the estimated coefficients of dv deviate considerably from the expected value of 1 (Wald test). This is unsurprising because dv is only a rough estimate of the extent of outsourcing. Developing more detailed estimates, for

¹² Subindex i is suppressed from now on for simplicity.

example on the basis of input-output tables, therefore appears promising (cf. Feenstra and Hanson, 1996).

The estimates summarized in Tables 1 and 2 offer little support for the hypothesis that output price changes adjusted for total factor productivity growth tended to depress the price of unskilled labour relative to human capital. In the case of Germany, significant positive estimates of $(\hat{w}_H - \hat{w}_L)$ that are not sensitive to model specification are only found for the 1980 to 1985 period. The coefficient for the 1970 to 1975 period becomes significant only for Models IV and V. Quite unexpectedly, a significant, robust, negative estimate of $(\hat{w}_H - \hat{w}_L)$ is obtained for the 1985 to 1991 period. If the trade impact hypothesis were correct, however, the estimates of $(\hat{w}_H - \hat{w}_L)$ should be consistently positive throughout the 1970s and 1980s.

The econometric analysis of trade specialization in the following section can be expected to shed light on the question of whether the present, indifferent finding is due to widespread monopolistic competition with inflexible wage structures that causes quantities, rather than prices to adjust. Besides, it is conceivable that the very high absolute values of the estimates of $(\hat{w}_H - \hat{w}_L)$ for the 1980 to 1985 and 1985 to 1991 periods result from collinearity among the explanatory variables (about which nothing can be done, given the structure of the econometric model). For example, the estimates for 1980 to 1985 imply that the return to human capital should have increased by 50 to 70 percentage points *more* than the unskilled wage, whereas the sum of product prices and total factor productivity rose only by little more than 20

per cent during the same period. To the extent to which the estimates are affected by multicollinearity, few conclusions can be drawn either from the positive values for 1980 to 1985 or from the negative ones for 1985 to 1991.

In the case of the UK, significant positive estimates of $(\hat{w}_H - \hat{w}_L)$ are found for the 1980 to 1985 period (Models I, II, IV, V) and for the 1975 to 1980 period (Model V only). Even for the 1980 to 1985 period, however, the coefficient estimates of the factor income shares do not appear very robust because their size varies widely. Furthermore, this is the only period for which all coefficients of π' and dv are insignificant. Again, this may be due to collinearity among the explanatory variables or other special factors that permit few conclusions to be drawn from these findings.

It seems noteworthy, nevertheless, that for the 1980s, nearly all estimates of $(\hat{w}_H - \hat{w}_L)$ are positive (though insignificant for the 1985 to 1989 period), whereas for the 1970s the picture is very mixed in each subperiod. This is consistent with the evolution of the skill differential in UK earnings (top decile over bottom decile) which remained fairly constant during the 1970s but has risen markedly since the early 1980s. More detailed studies of sectoral price developments and of the precise form of outsourcing need to be undertaken to confirm the link between changes in value added prices (corrected for total factor productivity growth and outsourcing) and the rising skill differential since 1980. Furthermore, more analysis is needed to assess the extent to which changes in output prices, total factor productivity, and the

extent of outsourcing can be attributed to growing trade with low-income countries rather than to domestic developments. With these weighty qualifications, the findings are at least consistent with the hypothesis that UK value added prices have moved to depress unskilled wages at least partly in response to growing trade with lower-income countries.

3.3 *Changes in Net Exports and Factor Prices*

Estimates of equation (14) are presented in Table 3. In addition to normalizing net exports by the sum of exports and imports in each sector (NNX), I follow the example of Baldwin and Cain (1997) in normalizing net exports also by output in each sector (NXP). The use of alternative measures of specialization in international trade is justified because there is no one correct measure, and the available measures may point in different directions (Ballance et al., 1987). Furthermore, it turned out that the coefficients of the dummy variables ($D71$, ..., $D92$) in equation (14) change fairly monotonically. For simplicity, they are therefore replaced by a time trend without much change in the explanatory power of the model. As in the previous section, the factor income shares relate only to direct factor use in each industry. This is acceptable under the assumption that a cost advantage reflected in positive net exports arises not from access to cheap material inputs but within the value-added-chain of the particular industry (and vice versa). This will be the case, for example, when inputs are traded internationally.

Estimates of equation (14) differ substantially between Germany and the UK. The negative coefficient of $(\theta_H T)$ for both specifications of net exports indicates that West Germany has specialized *away* from industries with a high share of human capital in value added. Apart from being statistically significant, this coefficient is also of considerable magnitude. In the case of the *NNX* dependent variable, θ_H declines from approximately 6.6 in 1970 to 1.1 in 1992; in the case of *NXP*, θ_H declines from approximately 2.8 to 1.0 during the same period. Similarly, West Germany has specialized away from sectors with a high share of physical capital in value added. This finding implies that human capital per head in Germany (or, more precisely, the stock of human capital relative to the stock of unskilled labour) has *declined* relative to the rest of the world. This result contradicts the trade impact hypothesis which implies that trade patterns reflect an increase in the global availability of unskilled labour; if this were the case, human capital per head in Germany should have *increased* relative to the rest of the world.

In the UK, there is no change in the degree of specialisation on human-capital-intensive sectors as indicated by the insignificant coefficient of $(\theta_H T)$. When dummy variables (D71, ..., D92) are included in the model to replace the time trend, the positive coefficient of $(\theta_H T)$ even becomes statistically significant at the 5 per cent level for the *NXP* (but not for the *NNX*) dependent variable. Furthermore, the UK has clearly become more specialized in physical-capital-intensive sectors (significant positive coefficients of $(\theta_K T)$).

The validity of this analysis might be called into question on the grounds that the sectoral data are highly aggregated. It is conceivable that particularly German firms have specialized in relatively sophisticated (i.e. human-capital-intensive) products or product varieties in a broad range of industries. At the same time, the imports of these sectors, especially from lower-income countries, consist of much less sophisticated products. At a high level of sectoral aggregation, such trade would appear as intra-industry trade and would be "netted out" when net exports (NNX or NXP) are calculated. Substantially, however, such trade would be of the Heckscher-Ohlin type in the sense that the human capital intensities of exports and imports differ considerably and different factor endowments of producer countries are the cause of this trade. Streeck (1994) provides extensive circumstantial evidence that the "West German model of capitalism" was characterized exactly by relatively high wages and "niche production", i.e. production of sophisticated product varieties. Furthermore, in a slightly different context, Klodt and Maurer (1995) argue that Germany is more strongly specialized in human-capital-intensive, high-technology products than aggregate sectoral data suggest. Hence it is certainly possible that the decline in θ_H in the case of Germany would be less pronounced if the regressions were run on more deeply disaggregated data. However, the present findings for Germany would have to be exactly reversed for the results to be compatible with the trade impact hypothesis which I find it unlikely.

If the present findings are accepted as essentially correct (in direction if not in degree), the different performances of Germany and the UK need to be explained. As regards changes in factor endowments abroad, competition may have increased not only in relatively labour-intensive industries due to the integration of lower-income countries into the international division of labour, but also in relatively human-capital-intensive industries because of the growing weight of newly industrializing countries. This could explain why we do not find the expected shift into human-capital-intensive industries. Furthermore, depending on their specialization in particular human-capital-intensive industries, West German firms might have felt increasing competition from newly industrializing and also from less advanced industrialized countries more keenly than UK firms. This may have been the case especially in engineering industries where relatively small German firms have traditionally held a strong position in many world market segments.

Apart from changes in factor endowments abroad, differences between Germany and the UK in the evolution of domestic factor endowments may also have affected the respective patterns of specialisation in trade. In particular, Germany experienced large-scale immigration during the 1980s that probably included a relatively large number of people with less-than-average skills. The resulting increase in the supply of "unskilled" labour may have affected the (market-clearing) relative wage of unskilled labour if, as is plausible, demand for German products was not infinitely price-elastic as implied by the small-country assumption. A similar effect may result

from labour-saving technical progress that affects industrialized countries more strongly than developing ones and increases the productivity-adjusted stock of unskilled labour faster than the productivity-adjusted stock of human capital ($\pi_L > \pi_H$ in equation (1)). Further investigation is necessary on how such labour-saving technical progress can be measured and whether it is plausible to assume that it affects predominantly industrialized countries.

4 Conclusions

The regression results reported in the two preceding sections fail to identify a single, main cause of the deteriorating position of unskilled labour in West Germany and in the UK. This raises the question of whether an explanation should not be sought outside the applied model. For example, growing unemployment of the (relatively) unskilled may arise when hysteresis plays a larger role in perpetuating unemployment among this group than in the case of skilled workers. Similarly, declining relative wages of the least-skilled compared with the highest-skilled group as in the UK might reflect an increasing divergence of skills in the two groups, rather than a diverging remuneration of certain given skills. However, there is little evidence that such supply-side factors in the labour market can explain the deteriorating position of relatively unskilled labour.

If an explanation is sought within the realm of the model, the preceding discussion suggests several directions for refining the analysis that may lead to less equivocal findings. First, the small-country assumption may be dropped and an attempt may be

made to quantify the impact of labour-saving technical progress. Berman et al. (1996) find pervasive skill upgrading in a wide variety of industries and countries and conclude that technical progress, rather than trade must have been responsible for the imply decrease in demand for unskilled labour. If the Stolper-Samuelson effect related to trade had dominated, production should have become less, not more skill-intensive. A preliminary screening of the data used in the present paper finds evidence of skill upgrading for the UK, but not for Germany. Extending this analysis to a larger number of countries would shed more light on this issue.

Second, applying the models used in Sections 3.2 and 3.3 to a larger number of countries would provide additional information on how national institutions, for example in the labour market, affect the results. Specification tests may also be undertaken to check for the sensitivity of findings to the level of sectoral aggregation, the period of observation, the use of value added rather than producer, wholesale or foreign trade prices, and the measurement of human capital.

Third, the price model used in this analysis (Section 3.2) may be modified to account more carefully for the outsourcing of labour-intensive processes to low wage countries. Pioneering work in this area is undertaken by Feenstra and Hanson (1996). This approach would require the use of the value of production, rather than value added, as a measure of output. At a practical level, this would entail a change in the main data source from national accounts or industry statistics to input output tables datasets.

Such extensions to the present model may complement studies on the basis of computable general equilibrium (CGE) models such as Cortes and Jean (1996) and Nahuis (1996). Compared with econometric studies such as the present one, CGE models offer the possibility of explicitly accounting for general equilibrium effects such as changes in productivity-adjusted factor endowments through technical progress, and of testing for the sensitivity of findings to important underlying assumptions, such as substitution elasticities in demand as well as production. Further information may be provided by studies based on household or employee data that make it possible to link the earnings and employment experience of a large number of individuals to characteristics of the industries in which they work (cf. Aiginger et al. 1996).

This discussion demonstrates that the causes of the deteriorating position of the unskilled in terms of relative wages and unemployment are not only relevant from the point of view of developing policies to counter the ensuing social exclusion of significant segments of the population. The debate also raises a variety of conceptual and methodological questions about the way economists think about structural change across as well as within industries. In this sense, the growing trade between Europe and East Asia is only a part, however important, of the larger picture of the globalisation of production and markets that presents firms, policy-maker and research economists with new challenges as well as opportunities.

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Table 1 — Regression Results for Relative Value Added Prices, Germany 1970-1991 (Weighted Least Squares)

Period	Model	Dep. Variable	Explanatory variables					Wald-Test ^a (F-statistic)	\bar{R}^2 (weighted) ^b	Mean of dep. variable (un-weighted)
			$\theta'_L + \theta'_H + \theta'_K(\hat{w}_L)$	$\theta'_H(\hat{w}_H - \hat{w}_L)$	$\theta'_K(\hat{w}_K - \hat{w}_L)$	π'	dv			
1970-75	I	\hat{p}	-0,13	0,71	0,58				0,89***	0,28
	II	\hat{p}	0,51*	-0,03	-0,29	-1,27***		1,5	0,95***	0,28
	III	$(\hat{p} + \pi)$	0,38	0,13	-0,10				0,94***	0,33
	IV	\hat{p}	0,10	0,84**	-0,05	-1,09***	1,30***	0,8	0,97***	0,28
	V	$(\hat{p} + \pi + dv)$	0,13	0,72**	0,07				0,97***	0,33
1975-80	I	\hat{p}	0,23	-0,04	0,02				0,76***	0,21
	II	\hat{p}	0,52**	-0,44	-0,18	-0,84***		0,7	0,85***	0,21
	III	$(\hat{p} + \pi)$	0,58***	-0,51	-0,22				0,90***	0,27
	IV	\hat{p}	0,53**	-0,44	-0,20	-0,86***	0,07	2,5	0,85***	0,21
	V	$(\hat{p} + \pi + dv)$	0,64***	-0,47	-0,36				0,91***	0,26

continued...

... Table 1 continued

Period	Model	Dep. Variable	Explanatory variables					Wald-Test ^a (F-statistic)	\bar{R}^2 (weighted) ^b	Mean of dep. variable (un-weighted)
			$\theta'_L + \theta'_H + \theta'_K (\hat{w}_L)$	$\theta'_H (\hat{w}_H - \hat{w}_L)$	$\theta'_K (\hat{w}_K - \hat{w}_L)$	π'	dv			
1980-85	I	\hat{p}	-0,09	0,50***	0,25**				0,93***	0,14
	II	\hat{p}	-0,11	0,61***	0,28***	-0,36***		60,1***	0,95***	0,14
	III	$(\hat{p} + \pi)$	-0,15	0,79***	0,33**				0,93***	0,23
	IV	\hat{p}	-0,06	0,49***	0,23***	-0,42***	0,29***	44,7***	0,96***	0,14
	V	$(\hat{p} + \pi + dv)$	0,03	0,31	0,16				0,88***	0,17
1985-91	I	\hat{p}	0,76***	-1,18**	-0,24				0,74***	0,17
	II	\hat{p}	0,68***	-0,75***	-0,39***	-1,18***		2,4	0,94***	0,17
	III	$(\hat{p} + \pi)$	0,69***	-0,82***	-0,37**				0,90***	0,28
	IV	\hat{p}	0,68***	-0,76***	-0,40***	-1,18***	0,09	21,6***	0,94***	0,17
	V	$(\hat{p} + \pi + dv)$	0,64**	-0,76*	-0,33				0,72***	0,28

***, **, * Significantly different from 0 at the $\alpha = 0,01$, $\alpha = 0,05$, $\alpha = 0,10$ level. ^aTests the hypothesis that the coefficient of π' is equal to (-1) and that the coefficient of dv (Model (V)) is equal to 1. — ^bThe significance level relates to the F-Test of the hypothesis that all coefficients are jointly 0.

Source: Data see text; own calculations.

Table 2 — Regression Results for Relative Value Added Prices, UK 1970-1989 (weighted least squares)

Period	Model	Dep. Variable	Explanatory variables					Wald- Test ^a (F- statistic)	\bar{R}^2 (weighted) ^b	Mean of dep. variable (un- weighted)
			$\theta'_L + \theta'_H$ $+ \theta'_K (\hat{w}_L)$	θ'_H $(\hat{w}_H - \hat{w}_L)$	θ'_K $(\hat{w}_K - \hat{w}_L)$	π'	dv			
1970-75	I	\hat{p}	1,11*	-0,25	-0,61				0,87***	1,02
	II	\hat{p}	0,88	0,05	-0,46	-0,80		0,2	0,88***	1,02
	III	$(\hat{p} + \pi)$	0,82	0,13	-0,42				0,86***	1,01
	IV	\hat{p}	1,04**	-0,12	-0,74	-1,69***	0,69***	4,8**	0,91***	1,02
	V	$(\hat{p} + \pi + dv)$	1,42**	-0,61	-1,08				0,90***	1,00
1975-80	I	\hat{p}	1,08***	0,10	-0,08				0,97***	1,06
	II	\hat{p}	1,20***	-0,18	-0,18	-0,83**		0,3	0,98***	1,06
	III	$(\hat{p} + \pi)$	1,23***	-0,24	-0,20				0,97***	1,08
	IV	\hat{p}	0,86***	0,41	0,17	-0,91***	0,92***	0,2	0,99***	1,06
	V	$(\hat{p} + \pi + dv)$	0,84***	0,43*	0,19				0,99***	1,06

continued ...

... Table 2 continued

Period	Model	Dep. Variable	Explanatory variables					Wald-Test ^a (F-statistic)	\bar{R}^2 (weighted) ^b	Mean of dep. variable (un-weighted)
			$\theta'_L + \theta'_H + \theta'_K (\hat{w}_L)$	$\theta'_H (\hat{w}_H - \hat{w}_L)$	$\theta'_K (\hat{w}_K - \hat{w}_L)$	π	dv			
1980-85	I	\hat{p}	-0,44*	1,39***	0,97***					
	II	\hat{p}	-0,24	1,16**	0,65	-0,22		9,1***	0,88***	0,30
	III	$(\hat{p} + \pi)$	0,50*	0,33	-0,14				0,91***	0,49
	IV	\hat{p}	-0,28	1,20**	0,65	-0,06	-0,30	3,8**	0,88***	0,30
	V	$(\hat{p} + \pi + dv)$	0,13	0,75*	0,39				0,89***	0,48
1985-89	I	\hat{p}	0,19	-0,06	0,17				0,82***	0,16
	II	\hat{p}	0,17	0,15	0,13	-0,40		6,2**	0,83***	0,16
	III	$(\hat{p} + \pi)$	0,15	0,48	0,07				0,90***	0,33
	IV	\hat{p}	0,12	0,39	0,24	-1,00***	0,56***	9,8***	0,91***	0,16
	V	$(\hat{p} + \pi + dv)$	0,10	0,32	0,38*				0,92***	0,31

***, **, * Significantly different from 0 at the $\alpha = 0,01$, $\alpha = 0,05$, $\alpha = 0,10$ level. ^aTests the hypothesis that the coefficient of π is equal to (-1) and that the coefficient of dv (Model (V)) is equal to 1. — ^bThe significance level relates to the F-Test of the hypothesis that all coefficients are jointly 0.

Source: Data see text; own calculations.

Table 3 — Regression Results for Changes in Net Exports, West Germany and UK 1970-1992
(Weighted Least Squares)

	Germany		UK	
	<i>NNX</i>	<i>NXP</i>	<i>NNX</i>	<i>NXP</i>
Explanatory variable				
constant	-3,01***	-1,31***	-0,72***	-0,17*
time trend (<i>T</i>)	0,03***	0,04***	-0,09***	-0,04***
θ_H	6,59***	2,83***	3,10***	1,07***
$\theta_H * T$	-0,25***	-0,08***	0,05	0,02
θ_K	2,24***	1,08***	0,18	-0,08
$\theta_K * T$	-0,12***	-0,04***	0,10***	0,05***
\bar{R}^2 ^a	0,79***	0,81***	0,35***	0,30***
<i>N</i>	736	736	736	736

***, **, * Significantly different from 0 at the $\alpha = 0,01, \alpha = 0,05, \alpha = 0,10$ level. — ^aThe significance level relates to an F test of the hypothesis that all coefficients are jointly 0.

Source: Data see text; own calculations.