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Relative Demand for Skills within Swedish Manufacturing

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Abstract

This paper seeks to identify the contribution of trade and technological change to the increase in inequality between skilled and unskilled workers in Sweden since the 1970s. An empirical approach is adopted which allows for the outsourcing of the low-skill parts of the production chain within industries to low-wage locations and is applied to detailed industry and trade data, the latter distinguishing between low-wage sources of imports and OECD countries. Another feature of the study is the use of data on patents to capture technological change. The paper finds that, in contrast to previous studies, trade with low-wage countries may have contributed to the rise in inequality in Swedish manufacturing. Here we identify this effect through changes in relative import prices and through changes in import penetration measured in volume terms. Changes in import penetration measured in value terms, which have been used in previous studies, are not found to be significant. In addition imports seem to have had a larger effect on inequality in high-skill intensive sectors rather than the low-skill sectors. The empirical results also suggest that the increased use of technology also played a role in creating greater inequality between skilled and unskilled workers in Sweden with the magnitude of this impact increasing in the 1990s.

Keywords: Outsourcing, technological change, skilled and unskilled workers, inequality

JEL Classification Number: F, J31, O33

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1. Introduction

The issue of skill upgrading within the manufacturing sector has been given much attention during the 1990's. One possible reason for the deteriorating position of unskilled workers is a shift in demand towards skilled workers. The two major competing explanations for this shift are technological change that is biased against unskilled workers and increasing international trade with low-wage countries that are abundant in unskilled workers. The relative impact of these two forces pushing industrial countries towards greater inequality is an empirical issue, which has been primarily addressed with regard to the experience of the US, although increasingly work on European countries is being produced (Brenton and Pelkmans (1999)). In general there is no conclusive evidence of significant changes in the relative price of unskilled compared to skilled intensive products that are required under the standard Heckscher-Ohlin-Samuelson (HOS) model for trade with low-wage countries to have affected labour market outcomes in industrial countries. Similarly, factor content studies, which translate changes in the quantity of trade into changes in demand for the different types of labour generally conclude that the impact of trade, whilst not insignificant, is small relative to that of technology. Borjas, Freeman and Katz (1992) for example, suggest that trade accounted for around 15 % of the increase in inequality in the US in the 1980s.

However, empirical studies that adopt a non-standard framework for analysis tend to apportion a bigger role to trade in contributing to inequality. Wood (1994) argues that many of the products imported from low-wage countries have no close domestically produced substitute in the industrial countries so that the typical approach of applying the same factor input coefficients for both imports and exports is incorrect. When factor input coefficients for production in the low-wage countries are used the computed quantity of labour displaced by imports into the industrial countries is of a magnitude 10 times greater than previous studies.

The standard HOS approach cannot explain why much of the observed increase in the ratio of skilled and unskilled workers has occurred *within* industries. One explanation for this is that technological progress has led to a splitting up of the production chain into various stages and that the unskilled intensive activities have been outsourced to low-wage countries. Feenstra and Hanson (1996) suggest that outsourcing may account for up to 50 % of the increase in the demand for skilled relative to unskilled workers that occurred in US manufacturing industry in the 1980s. Anderton and Brenton (1999) conclude that outsourcing to low-wage countries may have contributed to 40 % of the rise in the share of wages paid to skilled workers in the UK textiles sector during the 1980s and 1990s. This study also showed the importance of distinguishing imports from low-wage countries from imports from other OECD countries.

This suggests that to accurately identify the impact of globalisation we need to look deeply *within* broad industrial sectors. In this paper we examine the effect of technological change and international trade on skill upgrading within the Swedish manufacturing sector. We adopt an approach that allows us to identify the impact of outsourcing. A key feature of the work being the level of detail in the data that we use to test for the impact of trade and technology. Compared to other studies we are much better able to capture the within broad sector adjustments in skilled and unskilled labour inputs that have occurred.

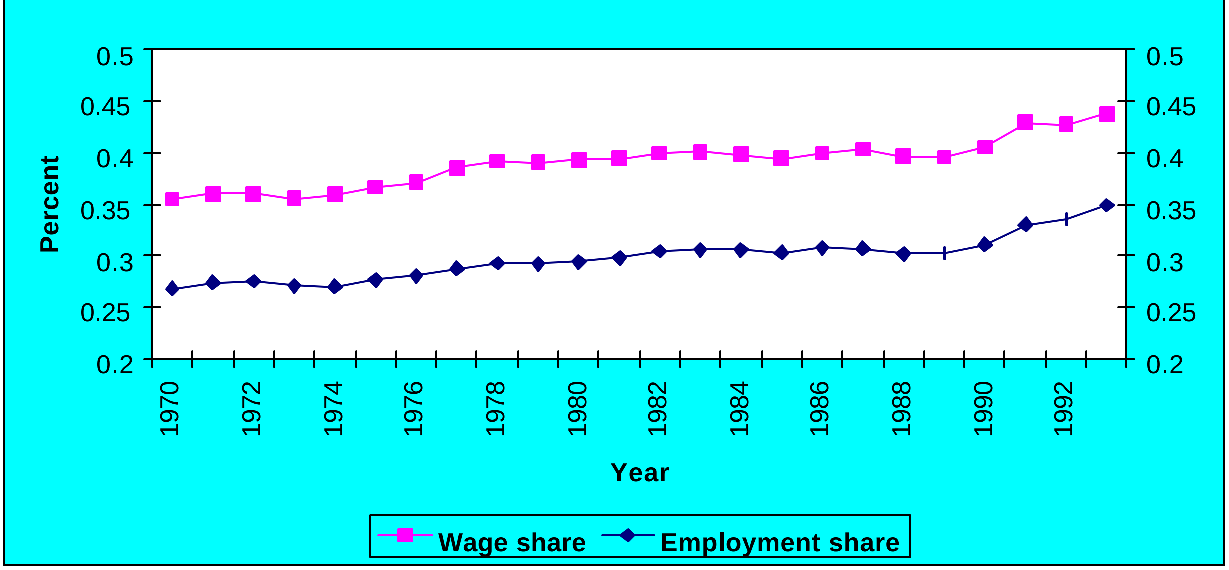
Sweden is an interesting case since it is much smaller and more open than the US and the UK and it has implemented fundamentally different labour market policies than these two countries, which are typically held up as paragons of flexible labour markets. Nevertheless, all three countries have all experienced a shift away from unskilled towards skilled workers within the manufacturing sector. The paper is organised as follows. In section 2, we describe changes in the wage and employment shares of skilled and unskilled workers in Swedish manufacturing since the 1970s and the available explanations for these trends. Section 3 presents our empirical model and the estimation results. Section 4 provides some concluding remarks.

2. Skill Upgrading in Swedish Manufacturing

Figure 1 shows the evolution of the share of the total wage bill for non-production workers - which in common with other studies we treat as being analogous to skilled workers - and the non-production worker share of total employment. The non-production worker share of employment increased from 27 to 35 % between 1970 and 1993, with a sharp increase from around 1990 onwards (when Sweden experienced a deep recession). The share of the total manufacturing wage-bill for non-production workers increased from 36 to 43 % during the same period.

The large proportionate change in the employment share compared to the wage-bill share of skilled workers suggests that the increase in inequality between skilled and unskilled workers in Sweden has arisen primarily in terms of employment opportunities rather than in the form of greater disparities in wages. This is confirmed by data which show that, in contrast to the US and the UK, the relative wage of non-production to production workers in Sweden remained constant (with a premium of about 50 %) throughout the 1970s and 1980s and actually fell during the recession of the early 1990s. On the other hand the ratio of non-production to production workers employed increased steadily from around 38 % in the mid 1970s to 45 % at the end of the 1980s with a big increase to 55 % in the early 1990s recession.

Figure 1: Wage and employment shares for non-production workers within Swedish manufacturing, 1970-93



Source: Manufacturing, various issues, Statistics Sweden.

Structural labour market rigidities may explain why most of the adjustment took place on the employment side, while relative wages remained stable. For example, the Swedish labour market is characterised by 'strong' trade unions (around 80 % of employees were union members in 1991; see Edin and Holmlund, 1995). As is well known, wage bargaining in Sweden was highly centralised during a considerable part of our sample period. The trade unions pursued a solidarity wage policy, until the breakdown of centralised wage bargaining in 1983, with the guiding principle of equal pay for equal work irrespective of the ability to pay among firms or industries. Such an institutional framework tends to compress wage-differentials between skill groups, with the result that a decrease in the relative demand for the less-skilled will be reflected in a fall in relative employment rather than relative wages –

which is consistent with labour market outcomes in Sweden. Accordingly, the Swedish experience appears to match the description of mainland Europe as being characterised by rigid labour markets, while the US and UK represent flexible labour markets. Decline in the demand for the less skilled will encourage a fall in relative wages in the US and UK, but cause rising unemployment for the less skilled in continental Europe.

Table 1 gives a more detailed sectoral overview of the Swedish manufacturing sector and changes in total employment and the ratio of skilled to unskilled workers. In 1975 the Swedish manufacturing sector employed nearly one million workers, around 23 % of total employment. The largest 2-digit sector, measured by employment, is manufacturing of fabricated metal products followed by paper, paper products, printing and publishing.

Table 1. The structure of the Swedish manufacturing sector, 1975 and 1993

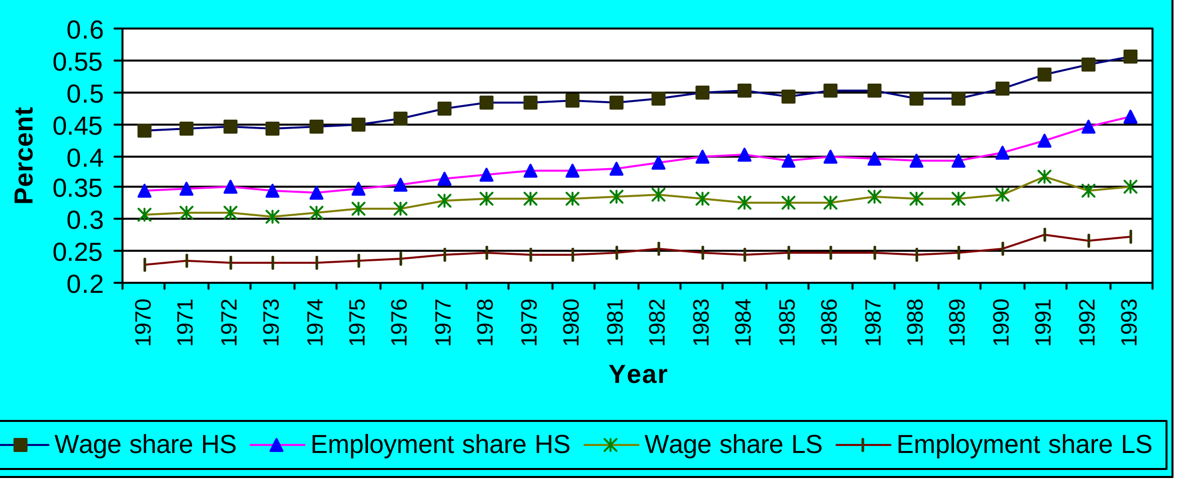
ISIC	Description	Total empl 1975	%	Rel emp NP/P	Total empl 1993	%	Rel emp NP/P
31	Food beverages and tobacco	72 076	7.8	0.33	59 583	10.9	0.38
32	Textile, wearing app and leather	57 066	6.2	0.23	12 332	2.3	0.35
33	Wood and wood products	76 758	8.3	0.20	38 427	7.1	0.25
34	Paper, paper prod, print and publishing	104 145	11.3	0.41	72 449	13.3	0.64
35	Chemicals, plastic prod and petroleum	68 372	7.4	0.53	49376	9.1	0.74
36	Non-metallic mineral products	33 127	3.6	0.33	14 823	2.7	0.42
37	Basic metal industries	70 702	7.6	0.34	31 505	5.8	0.33
381	Fabricated metal prod except mach and equip	87 175	9.4	0.29	47 988	8.8	0.35
382	Machinery and equipment	133 164	14.4	0.48	74534	13.7	0.70
383	El machinery, apparatus appliances and supplies	81 134	8.8	0.56	42 895	7.9	0.85
384	Transport equipment	124 963	13.5	0.41	81 840	15.0	0.51
385	Instruments and photo equipment	10 151	1.1	0.57	16 897	3.1	1.57
38	Fabricated metal prod	436 587	47.2	0.43	263 613	48.4	0.61
39	Other manufacturing	6 466	0.7	0.32	2 424	0.4	0.67
3	Manufacturing	925 299	100	0.38	544 532	100	0.54

Source: Manufacturing 1975 and 1993, Statistics Sweden.

Between 1975 to 1993, total employment in the manufacturing sector fell by 41 % and its share of total employment decreased to around 14 %. The reduction in employment was especially pronounced in Ship and boat building and repair (ISIC 3841) where the employment of production and non-production workers decreased by 90 and 80 % respectively. Another industry well known to face strong international competition is Textile, wearing apparel and leather industries (ISIC 32) where production worker employment decreased by 80 % and non-production worker employment by 70 % between 1975 and 1993. Expanding industries in terms of employment are hard to find, but examples are the low-skill-intensive industries Alcoholic beverages (ISIC 3131), Other paper and board products (ISIC 3419) and the higher-skill-intensive industries of Drugs and medicines (ISIC 3522) and Instruments and photo equipment (ISIC 3851 and 3852).

The employment reductions were more extensive for production workers than for non-production workers. The skill upgrading was particularly evident in the high-skill sectors such as Machinery and equipment (ISIC 382), Electrical machinery, apparatus appliances and supplies (ISIC 383) and Instruments and photo equipment (ISIC 385) as well as in the lower-skill sector of Textile, wearing apparel and leather (ISIC 32). The pronounced skill-upgrading in high-skill sectors is illustrated in Figure 2, which shows that the wage and employment share for skilled-workers (i.e. non-production) increased by a greater extent within high-skill industry groups when compared to low-skill industry groups, particularly at the end of the period (i.e. 1990-1993). This important feature of the Swedish experience is captured in the empirical analysis that we report below.

Figure 2: Wage and employment shares for non-production workers within Swedish manufacturing 1970-93, high-skill sectors (HS) and low-skill sectors (LS)



Source: Manufacturing, various issues, Statistics Sweden.

Note: High-skill industries are ISIC 342, 35, 382, 383 and 385.

The increase in skill intensity in Swedish manufacturing can be decomposed into a between industry component and a within industry component. The between industry effects are caused by shifts in the relative size of skilled intensive and unskilled intensive sectors over time, while the within industry effects are caused by skill upgrading within each industry. Previous work on the Swedish manufacturing sector has shown that the vast majority of the increased skill intensity has been generated by skill upgrading within industry and even within plants (Hansson 1997 and 2000, Machin et al.,1998).

International trade can cause both of these effects. The traditional explanation is that trade with low-wage countries shifts production from unskilled intensive sectors to sectors intensive in skilled workers via ‘Stolper-Samuelson’ effects (see Anderton and Brenton, 1998a and Sachs and Schatz, 1996). But international trade may also stimulate specialisation within industries, either with respect to activities or goods through outsourcing (see Anderton and Brenton, 1998b and 1999; and Feenstra and Hanson, 1996). An industry is composed of a whole range of production activities that vary in skill intensity and an industry can also produce a range of goods from high- to low-skill- intensive. Outsourcing is one way for the firm to take advantage of low foreign wage costs by moving the low-skill intensive parts of production to low wage countries, then importing the goods back and using them either as intermediate inputs or to sell them as final goods.

In their case study analysis, Anderton and Schultz (1999) find that outsourcing of production to low-wage countries is quite common in the medical equipment industry in both Germany and the UK and that the emergence of the new-democracies of eastern Europe has created further outsourcing opportunities for Germany because of the geographical proximity of these low-wage countries. With regard to more sophisticated medical equipment – such as diagnostic, monitoring and therapy equipment – it seems that the basic parts of production (such as metal casings) are sometimes outsourced to low-wage countries, while the more complex parts of the production process are performed domestically. By contrast, the domestic production by some firms of lower-tech medical equipment, such as simple surgical instruments, was frequently supplemented by importing similar finished products from low-wage countries and reselling them on the domestic market after carrying out simple tasks such as quality control procedures and packaging. Some of the price differentials in this sector are extremely large; for example, simple scalpels sold by one UK firm for 25 pounds can be purchased from Pakistani companies for one pound! Hence the price incentives to outsource can be quite significant.

Previous studies have found only small effects of trade on wages and employment in Sweden. Machin, Ryan and Van Reenen (1996) study the period 1973-89 and find evidence of capital-skill complementarity, meaning that increases in the wage bill and employment shares of skilled workers are positively correlated with investments in physical capital. There is also evidence of new technology and skills complementarity, where new technology is measured as the ratio of R&D expenditures to value added. In that study over 80 % of the increase in the wage bill share of skilled workers is attributed to the R&D effect in Sweden. The study also finds weak evidence that import intensive industries had a faster increase in the wage bill share of skilled workers.[1]

Hansson (2000) concludes that the decline in relative wages for skilled labour during 1970-85 was caused by growth in the relative supply of skilled labour outstripping the relative demand.[2] Whereas during 1986-93 both relative wages and the rate of skill upgrading increased, which suggest an increase in the relative demand for skilled labour within Swedish manufacturing. Hansson claims that this coincides with a stronger complementarity between knowledge (R&D) capital and skills, and large investments in R&D during the same period. The study also finds that the impact of intensified competition from the South (non-OECD countries) on the relative demand for skilled labour was small and the effect was limited to the textile industry.

In this study we use an approach first introduced by Berman, Bound and Grilliches (1994) where a reduced form labour demand equation at the industry level is estimated. This approach was later elaborated upon by Feenstra and Hanson (1995, 1996), and has been widely used by among others Machin et al (1996, 1998), Anderton and Brenton (1998b, 1999) and Hansson (1997, 2000). This paper advances on existing work in this area by using highly disaggregated industry, trade, wage and employment data. The data are for individual industries at the 4 digit ISIC-level, covering 41 manufacturing industries, which allows for a far more accurate distinction between high-skill and low-skill intensive industries in comparison to an analysis of broad industrial sectors. Our trade data are also disaggregated by import suppliers which, in contrast to most other studies in this area, allows us to distinguish imports from low-wage countries. In addition, we also investigate the specification of the import penetration term that is typically used to proxy the impact of international outsourcing.

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[1] In the later study by Machin and Van Reenen (1998) that result is however not statistically significant.

[2] Hansson refers to standardised relative wages for skilled and unskilled workers based on educational levels.

Previous studies have all specified this term in values. Here we suggest that it is more appropriate to measure import penetration in volume terms and also experiment with a relative import price term. Another innovative aspect of this study is that we use patenting activity, as well as R&D expenditure, as our proxy for new technology and innovation.

3. The empirical model

In this section, we outline the theoretical model underlying our empirical specifications and then econometrically estimate the impact of trade with low-wage countries and changes in technology on the Swedish wage-bill and employment shares for non-production workers. We use highly disaggregated wage, employment and production data and define non-production workers as skilled and production workers as less skilled. We experiment with two alternative proxy variables for technological change: first, patenting activity; second, R&D expenditure as a proportion of sales. The capital stock data are from Statistics Sweden. The bilateral Swedish imports data were obtained from the OECD on an SITC basis and converted to the ISIC REV2 classification. Trade, production, wage and employment data are all disaggregated to the 4-digit ISIC level (hence all variables are on an ISIC basis and further details of the 4-digit sectors used in the analysis are given in the data appendix). In order to provide enough observations for 'panel estimation', we pool the data across 4-digit ISIC sectors using annual data for the sample period 1975-1993 (imposing, in effect, the same parameters across the different 4-digit sectors).

Following Feenstra and Hanson (1995 and 1996), we seek to assess whether increased competition from low-wage countries has contributed significantly to the determination of the within-sector wage bill and employment shares of low-skilled workers in Sweden. We start from a variable cost function in translog form and assume capital to be a fixed factor of production (see Berman et al. (1993, 1994)):

$$\ln C_i = \boldsymbol{a}_0 + \boldsymbol{a}_y \ln Y_i + \frac{1}{2}\boldsymbol{a}_{YY} \ln\left(Y_i\right)^2 + \boldsymbol{b}_K \ln K_i + \frac{1}{2}\boldsymbol{b}_{KK} \ln\left(K_i\right)^2$$

$$+ \sum_j \boldsymbol{g}_j \ln W_{ij} + \frac{1}{2}\sum_j \sum_k \boldsymbol{g}_{jk} \ln W_{ij} \ln W_{ik} + \sum_j \boldsymbol{d}_{Yj} \ln Y_i \ln W_{ij}$$

$$+ \sum_j \boldsymbol{d}_{Kj} \ln K_i \ln W_{ij} + \boldsymbol{r} \ln Y_i \ln K_i +$$

$$\boldsymbol{l}_T T_i + \frac{1}{2}\boldsymbol{l}_{TT}(T_i)^2 + \boldsymbol{l}_{YT} T_i \ln Y_i + \boldsymbol{l}_{KT} T_i \ln K_i + \sum_j \varnothing_{TW_j} T_i \ln W_{ij} \tag{1}$$

where C_i is variable costs in industry i,

Y_i is output in industry i,

K_i is the capital stock in industry i,

W_{ij} is the price of variable factor j and

T_i represents technology in industry i.

Cost minimisation generates the following linear equations for the factor shares (S):

$$S_{ij} = \mathbf{g}_j + \mathbf{d}_{Yj} \ln Y_i + \mathbf{d}_{Kj} \ln K_i + \sum_k \mathbf{g}_{jk} \ln W_{ik} + \varnothing_{Tw_j} T_i \qquad (2)$$

whilst differencing (denoted by d) generates

$$dS_{ij} = \varnothing_{Tw_j} dT_i + \mathbf{d}_{Yj} d\ln Y_i + \mathbf{d}_{Kj} d\ln K_i + \sum_k \mathbf{g}_{jk} d\ln W_{ik} \qquad (3)$$

assuming homogeneity of degree one in prices imposes

$$\sum_k \mathbf{g}_{jk} = \sum_j \mathbf{g}_{jk} = \sum_j \mathbf{d}_{Kj} = \sum_j \mathbf{d}_{Yj} = 0 \qquad (4)$$

which generates with two variable factors, j and k

$$dS_{ij} = \varnothing_{Tw_j} d\,T_i + \mathbf{d}_{Kj} d\ln K_i + \mathbf{d}_{Yj} d\ln Y_i + \mathbf{g} d\ln\left(\frac{W_j}{W_k}\right) \qquad (5)$$

In our empirical application of the above model we have two variable factors of production, low-skilled (production) workers and higher-skilled (non-production) workers, and adopt a similar approach to Machin et al (1996) and Anderton and Brenton (1998, 1999) and estimate the following Swedish wage bill and employment share equations:

$$\mathrm{d}SW_{it} = \mathbf{a}\,\mathrm{d}\ln K_{it} + \mathbf{b}\,\mathrm{d}\ln Y_{it} + \mathbf{r}\,TECH_{it} + \mathbf{l}\,\mathrm{d}\ln MS_{it} + \mathbf{g}D_t + U_{it} \qquad (6)$$

$$\mathrm{d}SE_{it} = \mathbf{a}\,\mathrm{d}\ln K_{it} + \mathbf{b}\,\mathrm{d}\ln Y_{it} + \mathbf{r}\,TECH_{it} + \mathbf{l}\,\mathrm{d}\ln MS_{it} + \ell\,\mathrm{d}\ln(W^{hs}/W^{ls})_{it} + \mathbf{g}D_t + U_{it} \qquad (7)$$

Where: SW_{it} is the share of the wage bill of the high skilled $\left(\frac{WBit^{hs}}{\left(WBit^{hs} + WBit^{ls}\right)}\right)$

SE_{it} is the employment share of the high skilled (similarly derived as SW_{it}).

$WBit^{hs}$ is the wage bill of the higher skilled (i.e. non-production workers).

WB_{it}^{ls} is the wage bill of the lower skilled (i.e. production workers).

W^{hs}/W^{ls} = relative wage rates of high and low-skilled workers.

K_{it} is the capital stock.

Y_{it} is real output.

$TECH_{it}$ proxy variable for technological change.

MS_{it} is the share of the value of domestic demand for the output of industry i accounted for by imports from low-wage countries,

D_t is a set of time dummies included to capture any company preferences for non-manual or manual workers common across industries for a given year,

U_{it} is an error term.

Subscript represents industry i.

Note that in the wage share equation the relative wage term is dropped due to potential endogeneity and the problem of the definitional relationship between the dependent variable (the share of the wage bill) and relative wage rates. The time dummies capture any changes in firm-level preferences for non-production or production workers common across industries in each year. In this paper we also experiment with patenting activity as a proxy for technological change, while previous work tends to use R&D expenditure. One advantage of using patents is that they are an output of the innovation process, whereas R&D expenditure is simply an expenditure input, which may never come to fruition in terms of practical application.

The MS term represents Swedish import penetration from low-wage countries and can be interpreted as a proxy for outsourcing.[3] In this paper, we follow the approach of Feenstra and Hanson (1995, 1996) and justify the inclusion of the MS term in the wage bill share equation by arguing that merely including the factors derived from a traditional translog production function will not capture other factors – such as outsourcing – which may influence a firm's demand for skilled labour. Given that outsourcing to low-wage countries is claimed to push the range of activities performed by domestic industry away from low-skill towards high-skill

[3] Low-wage countries are defined as non-OECD countries, with the OECD taken as those members prior to 1994 (i.e. excluding recent members such as the Czech Republic, Hungary, Poland, South Korea and Mexico).

tasks, the MS term can be interpreted as representing a reduced-form relationship between outsourcing and a firm's unit input requirement for skilled labour.

Most studies that use this approach specify the import penetration variable as the value of imports divided by the value of domestic sales plus imports. An increase in import penetration is deemed to reflect greater competitive pressure from external suppliers. However, if import prices fall, the estimated sign of the parameter for the change in this import penetration values term will depend upon the magnitude of the demand elasticities. In addition, if domestic producers respond to greater import competition by increasing the quality of the products that they produce then it is feasible that greater import competition could be accompanied by a fall in import penetration in value terms.[4] Import penetration measured in volume terms does not suffer from these problems: a fall in import prices will always lead to an increase in import penetration. Here we include an index of import penetration in volume terms in our estimating equations as an alternative to the value term.

Diehl (1999) has argued that in a proper application of the cost function framework it should be the relative price of internationally outsourced products that enter the estimating equation rather than the import penetration ratio. However, in an application to German manufacturing industries Diehl concludes that the import penetration ratio (in value terms) is a better indicator of competitive pressures than relative import prices, although in his application the relative price of imported intermediate imports from all sources is used, while the import penetration variable measures only the share of low-wage countries. In an application to data for UK textiles and engineering sectors, Anderton and Brenton (1999) also find that import penetration terms provide a statistically significant contribution to rising wage inequality whilst relative import prices are insignificant. Here again we experiment with an import price term defined as the price of imports from low-wage countries relative to Swedish producer prices (PM/PD) for each ISIC sector. Thus, we assess three proxies for the impact of globalisation: relative import prices, import values and import quantities.

4. Econometric results

During our econometric analysis, we consistently found that import penetration by low-wage countries measured in value terms was not statistically significant in any of our regressions. This is consistent with previous studies of the impact of globalisation in Sweden. By contrast,

[4] That is, if the value of the denominator of the import penetration term increases due to an increase in the quality of domestic production, then an import penetration term defined in values may decline despite a rise in imports.

import penetration measured as an index of relative volumes as well as the relative price of imports from low-wage countries tended to be statistically significant throughout our analysis. By contrast, the relative price of imports from high-wage OECD countries was not statistically significant when separately included whilst, interestingly, import penetration in volume terms by OECD countries was estimated to have a negative effect on the share of skilled workers in employment and total remuneration. Hence, it would appear that skilled workers in Sweden are in direct competition with other skilled workers in OECD countries, whilst what matters for unskilled workers are imports from developing countries. We now present the results in detail.

Columns (A) and (B) in Table 2 show our results for the initial specifications of equation (6), for the wage-bill share, whilst the second and third columns of Table 3 show the results for equation (7), the employment share equation. We show separately, the results with the inclusion of the import penetration variable in volume terms and the relative import price. All variables are correctly signed and significant in the wage-bill share specification. The change in output is negatively signed which is in line with our expectation that a short-run decline in output tends to reduce the demand for the less skilled relative to the skilled. The capital stock term is positively signed and confirms our prior that complementarities exist between capital and skill. Similarly, the technology term is also positively signed and statistically significant, implying that an increase in technology will lead to a rise in the ratio of skilled workers in the production process.

The relative price of imports from low-wage countries is also statistically significant and negatively signed, implying that a decline in the price of imports from low-wage countries relative to the price of Swedish products, results in a decline in the wage-bill and employment share of the less-skilled. The import volume penetration term also has a sign consistent with our a priori expectations and is statistically significant. An increase in the quantity of imports from low-wage countries relative to the quantity of sales produced domestically raises the share of total remuneration going to skilled workers.

Similar results hold for the employment share specification (columns A and B of Table 3), that is, the technology and relative import price terms are statistically significant and correctly signed - with the exception that the change in output is not statistically significant. As expected, the relative wage term in the employment share equation is negatively signed and statistically significant.

Table 2. Results from the Swedish Wage-bill Equations

Equation	(A)	(B)	(C)	(D)	(E)	(F)
C	0.005 (2.52)	0.008 (4.28)	0.001 (0.33)	0.004 (1.68)	0.002 (0.85)	0.004 (1.77)
$dlnY_{it}$	-0.016 (2.17)	-0.013 (1.75)	-0.025 (3.29)	-0.023 (2.89)	-0.022 (2.94)	-0.020 (2.55)
$dlnK_{it}$	0.062 (3.21)	0.064 (3.34)	0.054 (2.84)	0.056 (2.94)	0.054 (2.87)	0.057 (2.97)
PAT/Y	0.483 (3.59)	0.341 (2.50)	0.455 (3.43)	0.310 (2.31)	0.402 (3.07)	0.247 (1.81)
R&D*D90-93	-	-	0.065 (4.31)	0.071 (4.62)	0.067 (4.44)	0.072 (4.74)
$dln(QM/QD)_{it}$		0.009 (4.46)		0.009 (4.68)		0.008 (3.58)
$dln(PM/PD)_{it}$	-0.018 (5.51)		-0.018 (5.43)		-0.012 (3.59)	
DUM_{HS}* $dln(QM/QD)_{it}$						0.013 (2.59)
DUM_{HS}* $dln(PM/PD)_{it}$	-	-	-	-	-0.038 (4.81)	
N R^2 SEE	721 0.3320 0.0212	721 0.3224 0.0213	721 0.3492 0.02091	721 0.3424 0.0210	721 0.3702 0.0206	721 0.3487 0.0209

Notes: The dependent variable is dWS, the change in wage bill share of non-production workers; (i) OLS estimation for annual data sample period of 1976-1993 (full set of time dummies included); (ii) ‘t’ statistics are in parentheses; (iii) QM/QD is an index of the volume of non-OECD imports relative to the volume of domestic output, the former is measured in tonnes, the latter is derived as the value of domestic output divided by the producer price index for each sector (iv) PM/PD= import price of goods from non-OECD countries relative to Swedish producer prices. DUM_{HS}=dummy variable with value of 1 when sector is high-skill-intensive and zero otherwise. All regressions use the Least Squares Dummy Variables technique (LSDV) weighted by annual employment shares in manufacturing for each industry to minimise the impact of small industries. Time dummies are included but their parameter estimates are not presented here.

Given the data analysis in the previous section, which showed a sharp rise in both inequality and R&D expenditure during 1990-93, we experimented by dummying the technology terms over these last few years of the sample period in order to evaluate whether or not there was an additional technology effect over these years. Although we could not find any additional effect from patenting activity, the dummied R&D term was statistically significant in both the wage-bill and employment share equations (see equations C and D in Tables 2 and 3). This suggests a much stronger impact of technology on inequality during the recession years of 1990-93. Given that this period was extremely unusual – that is following a long period of stable unemployment the number of people without jobs increased dramatically – it seems likely that this was an opportunity for a substantial restructuring of production, probably associated with an increase in the intensity of competition between firms as they attempted to sustain demand for their products in a shrinking domestic market.

Consequently, one explanation for the greater impact of technology on inequality over this period might be that firms had to become more high-tech which necessitated increased R&D expenditure along with complementary, and rapid, skill-upgrading. An alternative interpretation might be that this was simply a compositional effect within sectors whereby the severe recession and increased competition resulted in the survival of the 'better' firms, which in this case are high-tech/high R&D/high-skill-intensive firms, while the low-tech/low R&D/low-skill-intensive firms simply went out of business. Under such a scenario, the rise in R&D expenditure during 1990-1993 would also be associated with an increase in the wage-bill and employment shares of the higher skilled.

Table 3. Results for Swedish Employment Share Equations

Equation	(A)	(B)	(C)	(D)	(E)	(F)
C	0.007 (4.39)	0.009 (5.85)	0.004 (2.13)	0.006 (3.24)	0.004 (2.39)	0.006 (3.35)
$dlnY_{it}$	-0.002 (0.28)	-0.002 (0.28)	-0.009 (1.39)	-0.009 (1.36)	-0.008 (1.22)	-0.006 (0.98)
$dlnK_{it}$	0.042 (2.64)	0.045 (2.76)	0.036 (2.32)	0.039 (2.42)	0.037 (2.35)	0.039 (2.45)
$dln\ RW_{it}$	-0.071 (7.22)	-0.072 (7.11)	-0.075 (7.62)	-0.076 (7.56)	-0.080 (8.10)	-0.075 (7.57)
PAT/Y	0.567 (5.10)	0.485 (4.28)	0.544 (4.94)	0.458 (4.08)	0.511 (4.66)	0.40 (3.50)
R&D*D90-93	-	-	0.049 (3.94)	0.053 (4.17)	0.051 (4.07)	0.055 (4.32)
$dln(QM/QD)_{it}$		0.005 (2.73)		0.005 (2.96)		0.003 (1.81)
$dln(PM/PD)_{it}$	-0.013 (4.64)		-0.012 (4.58)		-0.009 (3.35)	
DUM_{HS}* $dln(QM/QD)_{it}$	-	-	-	-		0.013 (3.05)
DUM_{HS}* $dln(PM/PD)_{it}$	-	-	-	-	-0.021 (3.11)	
N R^2 SEE	721 0.3964 0.0175	721 0.3844 0.0177	721 0.4097 0.0173	721 0.3994 0.0175	721 0.4178 0.0172	721 0.4073 0.0174

Notes: The dependent variable is dES, the change in employment share of non-production workers; see notes to Table 2

Finally, recalling our earlier charts that showed that the largest rises in inequality actually occurred in the high-skill sectors, we decided to test whether the above estimated parameters differ across sectors. Accordingly, we created a dummy variable (DUM_{HS}) which has a value of 1 for the high-skill sectors and zero otherwise. We then re-estimated equations (6) and (7) and added extra terms by multiplying each variable by DUM_{HS}. The only statistically significant dummy variables were those on the import penetration variables (DUM_{HS}*dln$(PM/PD)_{it}$ and DUM_{HS}*dln$(QM/QD)_{it}$). These results suggest that the impact of trade with low-wage countries on Swedish inequality is larger for high-skill sectors compared to low-skill sectors (see columns E and F of Tables 2 and 3).

Ostensibly, this seems a somewhat surprising result as one might expect low-skill sectors to be more affected than high-skill sectors by relatively lower-priced goods from low-wage countries. This expectation seems reasonable if firms can substitute low-skilled workers with outsourcing by importing the necessary semi- or finished products from low-wage countries. Firms can easily do this regardless of whether they are low-skill/low-profit or high-skill/high-profit. By contrast, if outsourcing requires foreign direct investment in low-wage countries – involving the manufacture of specific components/products possibly requiring supervision and technical expertise from the investing company – then this may only be possible for high-skill/high-profit firms. In other words, under these circumstances, high-skill/high-profit firms would have a greater ability to outsource – which is consistent with the larger parameter for relative import prices for the high-skill sectors.

In addition, the scope for outsourcing depends upon the degree to which production of the final product can be fragmented into discreet stages with substantially different factor intensity ratios. This will be determined by technological conditions in the industry. Thus, although the incentive to outsource will be greater in low-skill intensive sectors where low-skilled workers comprise a substantial portion of total production costs, the capacity and ability to outsource may be greater in high technology, skill intensive sectors.

5. Conclusions

Many studies suggest that there has been a decline in the demand for less-skilled labour across OECD countries. In the case of Sweden, there is evidence to support this view as both the wage-bill and employment shares of high-skilled labour rose from the mid-1970’s to early 1990s. However, this rise in Swedish inequality is primarily due to a sharp increase in the relative employment of the higher-skilled as, in contrast to other countries such as the U.S. and UK, relative wages between non-production and production workers remained fairly stable. Labour market rigidities, associated with high trade union density and centralised wage bargaining, may explain why most of the adjustment took place on the employment side.

This paper has sought to statistically assess the factors responsible for this increase in inequality, and particularly to what extent it represents a decline in demand for the less-skilled due to trade and technology effects. In contrast to the majority of other studies on Sweden, our econometric results show that trade with low-wage countries has significantly contributed to the rise in inequality in Swedish manufacturing. We believe that there are two main features of our approach that may explain this difference. First, we apply a now fairly standard model of outsourcing but at a much more disaggregate level than in previous studies. Thus, our data allow for a more accurate identification of the determinants of the within sector shifts in relative demands for skilled and unskilled workers in OECD countries which appear to characterise the recent period of globalisation. Second, our proxy for outsourcing is specified in terms of relative prices or the level of import penetration in volumes terms. Previous studies have used import penetration in value terms. However, this may not be a good proxy for increased incentives to outsource. Firstly, if short-run demand elasticities are such that a fall in import prices is accompanied by a decline in the value of import penetration. Secondly, if domestic firms respond by raising the quality of the products they produce, such that the value of domestic sales rises faster than the value of imports even though the relative quantity of imports has increased. In the data used in this exercise there is a very low correlation (-0.09) between the proportionate change in relative import prices for low-wage countries and the proportionate change in import penetration measured in value terms. On the other hand, the correlation between changes in relative import prices and changes in import penetration measured in volume terms is much higher (-0.54).

We also find evidence to suggest that imports from low-wage countries have a larger impact on inequality in the higher-skill industries when compared with the low-skill industries. We suggest some reasons why this maybe the case, such that the financial resources of high-skill sectors are such that they are better able to incur the fixed costs that may arise with a switch to outsourcing overseas, but this is an issue which requires some further research.

Finally, whilst we do find that trade with low-wage countries has been an important determinant of rising inequality in Swedish manufacturing sectors, our results also demonstrate that technological change, as proxied by patenting activity and expenditures on R and D in the 1990s, also played a major role. Our results suggest that outsourcing to low-wage countries accounted for around 25 % of the average sectoral increase in the wage share of skilled workers in Sweden over our sample period; and for around 15 % of the increase in the employment share. Technological change on the other hand was the dominant factor accounting for well over half of the average increase in wage and employment inequality in Sweden.

Data Appendix

Employment and wages

To categorise labour into different skill groups is problematic. Skills are difficult to measure and there is an ongoing discussion about the problems related to the use of various variables. In this study manufacturing data are used where the workers are categorised as non-production and production workers respectively.[5]

The manufacturing data come from an annual survey where the information is collected from all establishments with 10 or more employees.[6] The following variables are used

- number of production workers
- number of non-production workers
- wage sum for production workers excluding payroll taxes
- wage sum for non-production workers excluding payroll taxes.

From these data annual wages are calculated for production workers and non-production workers respectively. In the analysis annual data is used covering the period 1975-93 for industries at the 4-digit ISIC code level.

Import prices

The Centre for Economic Policy Studies (CEPS) has recently produced unit values using the OECD trade database.[7] The trade data is converted from product categories in the trade classification (SITC) to industrial sectors (4-digit ISIC code level).

Producer prices

Producer price index from Statistics Sweden at the 4-digit ISIC code level.

Sales

Sales values from Statistics Sweden at the 4-digit ISIC code level. Sales values are defined as total operating income from industrial production.

[5] Wage earners and salaried employees respectively.

[6] Manufacturing, various issues, Statistics Sweden. Starting in 1992 the first 14 days of an employee's illness are covered by "sick-wages" from the employer and not by the social insurance system. These "sick-wages" are included in the wage sums for 1992-93 which disturbs comparison of wages per employee over time somewhat. However, leave-of-absence due to illness decreased a lot at the same time, which diminishes the problem to some extent.

[7] Globalisation and Social Exclusion project, funded by the EC under the TSER programme.

Capital stocks

Stocks of fixed assets at replacement costs from Statistics Sweden. They include buildings and machinery. The level of aggregation varies between 2- and 4-digit ISIC codes.

Patent data

The original patent data were supplied by the US dept of Commerce, Patent and Trademark Office. They were converted from the US patent classification system to the ISIC system. The converted data provide information on twenty ISIC categories. The level of aggregation varies between 2- and 4-digit ISIC codes. Five year averages are used. The patent data are "whole counts" by "date of patent grant".

R&D investments

Expenditure on research and development by sector from the OECD ANBERD database. It covers around 35 industries. The level of aggregation varies between 2- and 4-digit ISIC codes.

Import penetration

Import penetration in value terms is measured as imported value from non-OECD countries in relation to domestic demand (sales plus imports minus exports) per industry (4-digit ISIC code level). Imported and exported value is from the CEPS trade data set and the sales value from Statistics Sweden.

Import penetration in volume terms is derived as an index of imported volume, initially measured in tonnes and taken from the CEPS trade data set based on OECD data, divided by an index of the volume of domestic sales, taken as the value of domestic sales divided by the producer price index for each sector.

Industries included in the regression analysis

<u>High-skill sectors (HS)</u>:

3522 Manufacture of drugs and medicines

3825 Manufacture of office, computing and accounting machinery

3831 Manufacture of electrical industrial machinery and apparatus

3832 Manufactures of radio, television and communication equipment and apparatus

3833 Manufacture of electrical appliances and housewares

3839 Manufacture of electrical apparatus and supplies not elsewhere specified

Low-skill sectors (LS):

3111 Slaughtering, preparing and preserving of meat

3112 Manufacture of dairy products

3113 Canning and preserving of fruit and vegetables

3114 Canning, preserving and processing of fish, crustacea and similar foods

3115 Manufacture of vegetable oils and fats

3116 Grain mill products

3117 Manufacture of bakery products

3118 Sugar

3119 Manufacture of cocoa, chocolate and sugar confectionery

3121 Manufacture of food products not elsewhere specified

3122 Manufacture of prepared animal feeds

3133 Malt liquors and malt

3134 Carbonated water industries and soft drinks

3140 Tobacco manufactures

3211 Spinning, weaving and finishing of textiles

3212 Manufacture of made-up textile goods other than clothing

3213 Knitted goods

3214 Manufacture of carpets and rugs

3215 Cordage, rope and twine industries

3219 Manufacture of textiles not elsewhere specified

3220 Manufacture of wearing apparel except footwear

Low-skill sectors (LS) (continued):

3233 Manufacture of leather products except footwear and apparel

3240 Manufacture of footwear except rubber or plastic footwear

3610 Manufacture of pottery, china and earthenware

3620 Manufacture of glass and glass products

3691 Manufacture of structural clay products

3692 Manufacture of cement, lime and plaster

3699 Manufacture of non-metallic mineral products, not elsewhere specified

3710 Iron and steel basic industries

3720 Non-ferrous metal basic industries

3811 Manufacture of cutlery, hand-tools and general hardware

3812 Manufacture of furniture and fixtures primarily of metal

3813 Manufacture of structural metal products

3819 Manufacture of fabricated metal products except machinery and equipment, not elsewhere classified

3843 Manufacture of motor vehicles and parts

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