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The Effect of Offshoring on Labor Demand: Evidence from Sweden

by Karolina Ekholm and Katariina Hakkala

IUI, The Research Institute of Industrial Economics
P.O. Box 55665
SE-102 15 Stockholm
Sweden

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Karolina Ekholm[†] and Katariina Hakkala[‡]

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Abstract

We analyze the effects of offshoring of intermediate input production on labor demand in Sweden, distinguishing between workers with different educational attainments. The econometric results using data for the 1995-2000 period indicate that offshoring – in particular to low-income countries – tends to shift labor demand away from workers with an intermediate level of education. Offshoring to high-income countries, which is the largest component of overall offshoring, does not have any statistically significant effect on the composition of labor demand.

JEL Classification: F16

Keywords: offshoring, labor demand, translog cost function, factor-biased technological change

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[†]Stockholm School of Economics and the Centre for Business and Policy Studies (SNS). E-mail: Karolina.Ekholm@hhs.se

[‡]The Research Institute of Industrial Economics (IUI), Stockholm. E-mail: KatariinaH@iui.se

1 Introduction

The phenomenon of so-called offshoring to low-wage countries has recently generated a great deal of attention. In the US and Western Europe, media has been filled with reports about how firms move parts of their production or outsource to suppliers in China, India, and countries in Central and Eastern Europe. The activities concerned do not appear to be limited to labor-intensive manufacturing but also extend to skill-intensive services such as computer programming. This development has generated new worries about the consequences of globalization, i.e. worries about losing high-wage jobs rather than low-wage jobs.

In this paper, this issue is addressed by studying labor demand effects of offshoring. By offshoring we mean a shift from domestic to foreign suppliers of intermediate inputs and services. Using this definition, we include both international outsourcing proper, that is, situations where the firm decides to purchase inputs from independent foreign suppliers instead of producing them itself, and a relocation of the firm's own activities, so-called in-house offshoring. Thus, we focus on the *location* of intermediate input production rather than on the way these activities are organized, i.e. whether they take place in-house or are outsourced to other firms.

The first systematic analyses of the effect of offshoring on the demand for skilled and unskilled labor were carried out by Feenstra and Hanson in the 1990s (Feenstra and Hanson, 1996, 1999). They developed a methodology for estimating the effect of imported intermediate purchases on the relative wages of production versus non-production workers. Basically, the idea behind the methodology is to assess to what extent domestic workers have been substituted for workers abroad through increasing imports of intermediate goods. In the latter study (Feenstra and Hanson, 1999), they found that offshoring could account for about 15 percent of the observed increase in the relative wage of non-production workers in the US during the 1979-1990 period. A number of subsequent studies have used a similar methodology to study the effect of offshoring on labor demand (Falk and Koebel 2002, Strauss-Kahn 2004, Amiti and Wei 2005a, 2005b and Hijzen, Görg and Hine 2005). As Feenstra and Hanson (1999), Strauss-Kahn (2004), dealing with France, and Amiti and Wei (2005a, 2005b), dealing with the United Kingdom and the United States, lack direct information about imported inputs, but use information on import penetration in conjunction with information about input-output coefficients to construct proxies.[1] Falk and Koebel (2002) and Hijzen et al. (2005) have direct information on imported inputs and are also able to measure skills more precisely. Falk and Koebel (2002), dealing with Germany 1978-1990, find no evidence of labor with the lowest educational attainment being substituted for either imported materials or purchased services. Hijzen et al.(2005), on the other hand, dealing with the United Kingdom 1982-1996, find that offshoring had a strong negative impact on workers in occupations considered to be low-skilled.

With the exception of the study by Strauss-Kahn (2004), neither of these studies distinguishes between offshoring to low-income and high-income countries; a distinction that is likely to be important for the effect on the relative demand for skills.[2] Most imports of inputs to high-income countries probably stem from other high-income countries, since this is what the overall trade pattern looks like. This type of offshoring may not have any particular impact on the relative demand for skills since the offshored activities are likely to have similar factor intensities as the remaining activities. On the other hand, offshoring to low-income countries seems to have increased lately. To the extent that activities offshored to low-income countries have different skill-intensities than remaining activities, we would expect this development to lead to changes in the relative demand for skills.

In this paper, we use data for Sweden 1995-2000 to estimate the impact of offshoring on the relative demand for labor with different levels of educational attainment. As in

[1] Amiti and Wei (2005a, 2005b) study the effect on the overall labor demand rather than the relative demand for skilled and unskilled labor. Strauss-Kahn (2003) finds evidence of a negative impact of offshoring on the demand for non-production workers in France.

[2] That the source of imports is important for the effect of import penetration on the relative demand for production and non-production workers has been shown by e.g. Anderton and Brenton (1999) and Hansson (2000). Anderton and Brenton (1999) found that import penetration from low-income countries explained up to 40 percent of the observed increase in the cost share of skilled workers in textile industries in the United Kingdom, but not in the mechanical engineering industries. Import penetration from high-wage countries had no statistically significant impact in either industry. Hansson (2000) found that import penetration from non-OECD countries contributed to a decrease in the relative demand for skilled workers measured as workers with post secondary education in Sweden, although quantitatively the effect seem rather small.

Falk and Koebel (2002) and Hijzen et al. (2005) we use direct information on imported inputs from the input-output tables. We combine this information with information from the trade statistics to construct proxies of offshoring to different groups of countries. We distinguish between high-income and low-income countries as well as between countries belonging to different regions. Our analysis is closest to that of Hijzen et al.(2005) in that it uses a translog cost function approach to estimate the effect of offshoring on the relative demand for skill groups. However, we use information about educational attainment rather than occupational classification to allocate employees into different skill groups.

The remaining part of the paper is organized as follows: In the next section we explain how we measure offshoring and show descriptive evidence on the development of different measures of offshoring. We then proceed to presenting the econometric analysis in section 3 and the results in section 4. Finally, section 5 concludes.

2 Measuring Offshoring

Our measure of offshoring is based on information about imported inputs from the input-output tables and it captures both international outsourcing proper, that is, situations where the firm decides to purchase inputs from independent foreign suppliers instead of producing them itself, and a relocation of the firm's own intermediate input production, so-called in-house offshoring or vertical foreign direct investment. Following the terminology used by Feenstra and Hanson (1999), we distinguish between *narrow* and *broad* offshoring. Narrow offshoring only includes imported intermediate inputs from the importing industry, i.e. an industry's purchases of imported intermediate inputs produced in the same industry. Broad offshoring also includes imported non-energy intermediate inputs from all other industries. Feenstra and Hanson (1999) prefer the narrow to the broad measure, since it is closer to the phenomenon of fragmentation and vertical specialization that takes place within industries. For instance, in the car industry, imports of steel would not normally be considered to stem from offshoring, but the purchase of automobile parts would, particularly if the parts were formerly manufactured by the importing company. Moreover, a shift from a domestic to a foreign steel supplier would not affect the workers in the automobile industry but those in the steel industry. The rationale for using the broad measure is that the industry classification may be too narrow in the sense of classifying production processes formerly made within a firm into another industry when outsourced to a sub-contractor.

Both the *narrow* and the *broad* measures of offshoring are defined as imported intermediate inputs in relation to industry output:

$$z_i^N = \frac{m_{ii}}{Y_i} \tag{1}$$

$$z_i^B = \frac{\sum_{j=1}^{N} m_{ij}}{Y_i}, \tag{2}$$

where m_{ij} is industry i's use of imported intermediate inputs from industry j and Y_i is production.

Direct information about industry use of imported intermediates through input-output tables is only available for 1995 and 2000; the years for which detailed input-output tables have been constructed. However, by extrapolating information from these input-output tables, we can construct time series for offshoring. Constructing a time series for the narrow measure, we start from the observation that (1) can be rewritten as the product between the share of imported inputs in total imports and the ratio between imports and output:

$$z_i^N = \frac{m_{ii}}{M_i}\frac{M_i}{Y_i}, \tag{3}$$

where M_i is total imports in industry i. We observe the share of intermediate inputs in total imports in industry i, m_{ii}/M_i, in 1995 and 2000, while we observe imports in relation to domestic output every year during the period studied. To obtain imputed values of z_i^N for 1996-1999, we use a linear interpolation of m_{ii}/M_i based on the 1995 and 2000 values.

Constructing a time series for the broad measure, we proceed along similar lines. We start from the observation that (2) can be rewritten as:

$$z_i^B = \sum_{j=1}^{N} \frac{m_{ij}}{M_j} \frac{M_j}{Y_i}. \qquad (4)$$

We observe industry i's use of intermediate inputs in industry j as a share of total imports in industry j, m_{ij}/M_j, in 1995 and 2000 and the relation between imports in industry j and output in industry i every year during the period studied. To calculate values of z_i^B for 1996-1999, we now interpolate m_{ij}/M_j based on the 1995 and 2000 values. This procedure is based on the assumption that the relationship between an industry's use of imported inputs from its own and other industries and total imports in these industries change slowly and trendwise.

In Table 1, we show how different measures of offshoring changed between 1995 and 2000. We use both the narrow and the broad definition of offshoring, i.e., a definition based on an industry's imported inputs from the industry itself (narrow) and a definition based on an industry's imported inputs from all industries (broad). These measures are put both in relation to the industry's total use of inputs (from the industry itself in the narrow measure and from all industries in the broad measure), as well as in relation to the industry's output. All of these measures indicate that offshoring increased between 1995 and 2000. The share of imported inputs in total inputs increased by 4-7 percentage points in manufacturing. The imports of services account for the largest percentage increases both in manufacturing (31 percent) and in the service sector (25-30 percent). The increase in imports of intermediate goods is, however, much more important than the increase in service imports in absolute terms.

We construct proxies of offshoring to different country groups by assuming that the country distribution of imports in industry i is the same for intermediate inputs as for final products. Whereas this assumption is unlikely to hold in a strict sense, there is no obvious reason for these country distributions to differ in a systematic way. On average, intermediate inputs make up about 40 percent of overall imports in Sweden, implying that the weight of the country distribution of intermediates in the distribution for overall imports is about 0.4.[3]

[3]Imports of intermediate inputs excluding crude oil and petroleum products make up 37 percent of

Table 1. Offshoring in 1995 and 2000, imported inputs as a percentage share of output and inputs.

Measure		**1995**	**2000**	**Change** (perc. points)	(percent)
Share in output					
All industries	Narrow	4.0	4.2	0.2	5.0
	Broad	8.8	9.6	0.8	9.1
Manufacturing	Narrow	9.1	9.8	0.7	7.7
	Broad	22.1	25.9	3.8	17.2
Services	Narrow	1.0	1.3	0.3	30.0
	Broad	6.7	8.4	1.7	25.4
Services within manuf.		10.0	13.1	3.1	31.0
Share in inputs					
All industries	Narrow	37.3	39.1	1.8	4.8
	Broad	17.6	19.1	1.5	8.5
Manufacturing	Narrow	46.7	53.3	6.6	14.4
	Broad	33.6	38.1	4.5	13.4
Services	Narrow	16.3	16.8	0.5	3.1
	Broad	16.5	19.1	2.6	15.8

Note: The narrow measure consists of imported inputs within the industry whereas the broad measure consists of imported inputs from all industries. Source: Input-output tables collected by Statistics Sweden.

Figure 1 shows narrow offshoring to different regions in 1995 and 2000. It is clear from this figure that the main part of narrow offshoring takes place in Western Europe, but that it is offshoring to Asia and, in particular, Central and Eastern Europe that has increased over time. It should be noted that price changes and exchange rates may have an impact on import-based measures. For example, a shift of intermediate goods production from Western Europe to low-income countries in Asia may have been larger than indicated by the import statistics. Lower production costs imply that similar goods can be imported at lower prices from Asia than from Western Europe, leading to an underestimation of any

total imports in 2000. Information about the share of intermediate inputs in trade is available on the web site of the National Institute of Economic Research in Stockholm (see www.konj.se).

shift in production.

Figures 2 and 3 show the development of offshoring to high-income and low-income countries, respectively, for six broad industry groups.[4] Offshoring to high-income countries has decreased in the transport and textile industries and has not increased distinctly in any of the other industries. Offshoring to low-income countries has also decreased in the textile sector, whereas there has been an increase in the transport sector (very large in percentage terms but relatively small in absolute values). This suggests that some of the purchases of intermediate inputs in the transport sector have shifted from high-income to low-income countries. The most eye-catching development, however, is the quadrupling of offshoring to low-income countries in electrical machinery since 1995. The largest increase (389 percent between 1995 and 2002) has taken place in the sector containing manufacturing of cell phones (SNI 32, which consists of manufacturing of radio, television and communication equipment and apparatus).

Our measure of offshoring excludes the situations where the final stages of production or the production of intermediate inputs intended for use in third-country export production by foreign affiliates of multinational firms are offshored abroad. For a country such as Sweden, offshoring of the final stages of production may be particularly important since multinationals constitute an important part of total production, while the Swedish market for final goods is rather small. According to the data for Swedish multinational firms collected by the Research Institute of Industrial Economics (Industriens Utredningsinstitut), the largest part of affiliate sales of Swedish multinational firms in 1998 was sales in the local market (64 percent of total sales), while the smallest category was sales back to Sweden (11 percent of total sales).[5] The remaining quarter of affiliate sales was exports to third countries.

Hansson (2004, 2005) examines the effect of a transfer of production within multina-

[4] High-income and low-income country groups are defined according to World Bank classification (World Development Indicators). Industry groups are defined as Textiles (SNI 17-19), Wood and Paper (SNI 20-22), Metal and Machinery (SNI 27-29) Electric Machinery (SNI 30-33) Transport (SNI 34-35) and Other (SNI 24-26, 36).

[5] The situation is similar for affiliate sales from US MNEs. Local sales are somewhat less important, accounting for 56 percent of the total sales. Exports back to the US account for 16 percent, while 28 percent are exports to other countries in 1998 (computed from BEA statistics).

tional firms on relative demand for unskilled workers, defining unskilled workers as workers with less than tertiary education. He finds that an expansion into non-OECD countries has a negative effect. We introduce a similar measure in some of the regressions below.

3 Econometric Analysis

3.1 Econometric specification

In the econometric analysis, we model the impact of offshoring on labor demand in a similar way as has previously been done for factor-biased technological change (FBTC). The underlying assumption is that technological change as well as offshoring will affect productivity, but not necessarily in a uniform way across all factor inputs. For instance, the introduction of new computer-based technologies will increase the productivity of labor with computer skills, but may leave the productivity of other types of labor unaffected. Such technological development may lead to increased relative demand for skilled versus unskilled labor. In a similar manner, cost-reducing offshoring will increase productivity in the sense of increasing the net revenue per unit of factor input. However, when labor intensive assembly activities are being offshored, the productivity of workers involved in headquarters activities and intermediate input production is likely to increase, whereas the productivity of domestic assembly workers is unaffected. As with FBTC, this might lead to a reduction in the relative demand for assembly workers.

We carry out the analysis based on a translog cost function, first introduced in the context of trade and demand for skills by Berman et al. (1994) and used in the literature by e.g. Feenstra and Hanson (1996), Gieshecker (2002), Strauss- Kahn (2004) and Hijzen et al. (2005). Following Gieshecker (2002) and Hijzen et al (2005), we treat offshoring as a factor that changes the technology with which the domestic industry operates and thus, this potentially affects the demand for various domestic factors of production. To control for any FBTC induced by domestic innovation, we also include the industry's R&D intensity. We assume firms to be price takers in the factor markets. Industry i, $i = 1, ...I$ produces an output using different types of labor, capital and intermediate inputs. Intermediate inputs are either sourced domestically or from abroad. By differentiating such a cost function and applying Shephard's lemma, we can express the cost share of factors as a function of factor prices, output levels and technical change (see the appendix).

Under a common short-run translog cost function, where capital is considered to be a quasi-fixed factor, industry i's cost share of labor belonging to skill group j is given by

$$\theta_{ij} = \alpha_j + \sum_{s=1}^{S} \gamma_{js} \ln w_s + \phi_j \ln Q_i + \delta_j \ln K_i + \sum_{r=1}^{R} \lambda_{jr} z_{ir} \quad (5)$$
$$(j = 1, ...S, s = 1, ...S, r = 1, ...R),$$

where $\theta_{ij} \equiv w_j L_{ij} / \sum_{s=1}^{S} w_s L_{is}$, K_j is the capital stock, Q_i is value added, and z_{ir} variables capturing factor-biased technical change in the industry.

The value of parameters γ_{js} will depend on whether different types of labor tend to be substitutes for or complements to one another, while the value of δ_j will depend on whether capital tends to substitute or complement labor belonging to skill group j. The values of parameters λ_{jr} depend on whether technical change is biased towards or away from the usage of labor belonging to skill group j.

In the main part of the analysis, we distinguish between three different skill groups based on educational attainment: workers with at most lower secondary, upper secondary, and tertiary education.[6] This results in a system of three equations such as (5); one for each skill group. Homogeneity in prices implies $\sum_{s=1}^{S} \gamma_{js} = 0$ and symmetry of the underlying translog cost function that $\gamma_{st} = \gamma_{ts}$; restrictions imposed in the analysis.

As noted above, we consider mainly two measures of FBTC: offshoring (denoted z_{i1}^{h}, $h = N, B$) and R&D intensity (denoted z_{i2}). The latter variable is defined as:

$$z_{i2} = \frac{R_i}{Y_i}, \quad (6)$$

where R_i is total expenditures on R&D and Y_i is total output in industry i. We also consider a measure of inhouse offshoring, i.e. transfer of production within multinationals:

[6] Lower secondary education corresponds to 9 years of schooling while upper secondary education corresponds to 11-13 years of schooling.

$$z_{i3} = \frac{L_{iF}^M}{L_{iS}^M}, \tag{7}$$

where L_{iF}^M is the number of employees in foreign affiliates of multinationals in industry i and L_{iS}^M the number of employees at the Swedish parents belonging to industry i.[7] Employment is here used as a proxy for sales since sales figures are unavailable at a disaggregated industry level. Our main measures of offshoring capture in-house offshoring to the extent it concerns a relocation of the firm's own intermediate input that is imported back to Sweden for further processing. Thus, the offshoring measures (1) and (2) may be overlapping with the inhouse offshoring measure (7). However, correlation between the two types of measures is low.

Only two of the three cost share equations are independent, since the third cost share is one minus the sum of the other two. (Note that $\sum_{j=1}^{S} \theta_{ij} = 1$ implies that parameters γ_{js}, ϕ_j, δ_j, and λ_{jr} sum to zero across the S equations.) Therefore, we only estimate two equations. To take a possible correlation between the residuals of the two equations into account, we estimate the system using a seemingly unrelated regression (SUR). More specifically, we use iterated SUR (ISUR) to ensure that estimates are independent of the choice of which equation to exclude. Concavity of the cost function in wages requires that labor demand elasticities on the diagonal be negative.

3.2 Data

Our information about employees and wages stems from a database called RAMS (Regional Arbetsmarknadsstatistik). Industry and country distributed trade data for 1993–2002, collected by Statistics Sweden, are available. Input-output tables containing information about imports, however, are only available for 1995 and 2000 (through Statistics Sweden). This information is combined to create time series of imports of intermediate inputs at the country-industry level.

[7] This measure is somewhat different from that used by Hansson (2001, 2004) in that we use the ratio between affiliate and parent employees rather than the share of affiliate employees in total employment. The reason for our using the ratio between foreign and home employment is that, for a particular region, this measure is independent of the firms' employment in other regions.

Industry-distributed data on output, capital stocks and R&D expenditures have been provided by Statistics Sweden as well. Industry-distributed information about employment at Swedish multinationals have been provided by the Swedish Institute for Growth Policy Studies (ITPS), Stockholm. More detailed information about the data used can be found in one of the appendices.

4 Results

4.1 Main analysis

In addition to total offshoring, we use offshoring measures distinguishing between imports from low-income and high-income countries. Due to differences in the labor-content of imported intermediate goods, the two offshoring measures are expected to have different effects on relative labor demand. We carry out two sets of estimations: (1) one where we assume wages to be set economy-wide and (2) one where we allow them to differ across industries. With economy-wide wages, we get a set of three wages for each year, which will be linearly dependent on time dummies if we include such dummies. Thus, we have a choice of estimating the system with either wages or time dummies. Since we believe time dummies to be important for capturing a trendwise increase in the cost share of workers with tertiary education and a trendwise decrease in the cost share of workers with lower secondary education, we choose the latter. Specification (2) allows us to include wages in the estimation and thereby obtain an estimate of wage elasticities. However, this specification suffers from a potential endogeneity problem; industry wages may be affected by the industry's wage cost shares for different workers.

Our statistical inference is based on bootstrapped standard errors, i.e. standard errors based on the distribution of estimates from repeated regressions on samples created by resampling from the data. The reason for choosing this method is that the only available analytically derived standard errors are based on the assumption of normally distributed errors; an assumption which is violated in this case.[8]

[8] Our standard errors are based on 1,000 bootstrap replications, using the same sample size as the

We start by presenting the results for the narrow measure of offshoring. Tables 2A and 2B show the elasticities derived from the regression results (see the Appendix for the derivation of the elasticities).[9] Table 2A shows the results from regressions with a measure of overall offshoring included and Table 2B shows the results from regressions with separate measures of offshoring to high-income and low-income countries, respectively. In Table 2A we have included our measure of inhouse offshoring as well, while this measure is absent from Table 2B; the reason being that the two offshoring measures become highly correlated when we divide them into different country groups.

[Table 2A-2C about here]

According to the results in Table 2A, overall offshoring tends to shift labor demand away from workers with upper secondary education. For a given level of output and capital, a one percentage point increase in the offshoring measure decreases demand for workers with upper secondary education by 0.6 percent based on the regression assuming economy-wide wages (the elasticity is significant at the 10 percent level). The estimated elasticities for the other skill groups are positive, but only significant at the 10 percent level in the regression with economy-wide wages for employees with tertiary education. The estimated elasticities with respect to inhouse offshoring are insignificant, with the exception for the elasticity for workers with tertiary education in the specification with economy-wide wages, which is positive and significant at the 10 percent level. This estimate, however, indicates a quantitatively small effect; a one percentage point increase in foreign employment as a share of parent employment (which may very well be above 100 percent) is associated with an increase in the demand for workers with tertiary education with 0.01 percent.

We see a similar pattern for offshoring to low-income countries in Table 2B; the estimated elasticities indicate a shift of demand away from workers with upper secondary education. Here, the positive elasticities for workers with tertiary education are significant, indicating that this demand shift mainly benefits workers in the highest skill group. A one percentage point increase in the measure of offshoring to low-income countries is estimated

regressions.

[9] The regression results may be obtained from the authors upon request.

to reduce the demand for workers with secondary education by about 3.5 percent and increase the demand for workers with tertiary education by 5-6 percent. The magnitude of these elasticities may seem large, but it should be noted that a one percentage point increase in offshoring to low-income countries would, in fact, imply a doubling from the present level.

It is useful to compare these elasticities with those obtained for R&D, our other measure of factor-biased technological change. For a given level of output and capital, increases in R&D quite clearly shift labor demand away from workers with lower secondary and upper secondary education and towards workers with tertiary education. This is consistent with results from Machin and Van Reenen (1998), Haskel and Heden (1999), Hansson (2005) and Hijzen et al. (2005).

In Table 2C, we show results distinguishing between offshoring to different regions, more precisely Western Europe (WE), Central and Eastern Europe (CEE), Asia (AS) and North America (NA). We find a negative and significant elasticity for workers with upper secondary education and a positive and significant elasticity for workers with tertiary education with respect to offshoring to Central and Eastern Europe. As is evident from the table, there is a negative elasticity for workers with tertiary education with respect to offshoring to Asia. However, while the results for Central and Eastern Europe are robust to alternative groupings of countries (see Table A1A in the appendix), the result for Asia is not.[10]

To include region-specific measures of inhouse offshoring in these regressions is difficult, since the measures of inhouse offshoring are highly correlated with offhoring. We have run specifications where inhouse offshoring divided into one region and the rest of the world are included along with total offshoring. In these specifications, only the estimates for inhouse offshoring to Asia turn out significant, with positive signs for workers with upper secondary education (significant at the 5 percent level) and negative signs for workers

[10]Since the correlation between different offshoring measures is relatively high, multicolinearity is a concern here. We have dealt with this by running specifications where offshoring has been divided into offshoring to one region and the rest of the world. In these specifications, the results shown in Table A1A in the appendix are the only ones where the elasticities with respect to the region are significant. The elasticities for workers with tertiary education with respect to offshoring to Asia are statistically insignificant. These results will be provided by the authors upon request.

with lower secondary education (significant at the 10 percent level, see Table A1B in the appendix). The impact of the Swedish multinationals' expansion into Asia thus seems to be in line with what we might expect from an expansion into low-wage countries; a shift of demand away from workers with the lowest level of education.

Tables 3A-3C show similar results based on the broad measure of offshoring. Table 3A shows results for the overall measure of offshoring, while 3B shows results for separate measures of offshoring to high and low income countries. As before, inhouse offshoring is included in Table 3A, but not in Table 3B. The results in these tables also reveal a tendency for overall offshoring and offshoring to low-income countries to shift labor demand away from workers with upper secondary education. Few of the elasticities are significant in Table 3A, but the elasticities of offhshoring to low-income countries with respect to workers with upper secondary education in Table 3B are negative and significant at the 10 percent level. In terms of magnitudes, a one percentage point increase in the broad measure of offshoring to low-income countries tends to decrease demand for workers with upper secondary education by about 1.6-2.1 percent. Interestingly, according to Table 3B, offshoring to low-income countries actually tends to increase demand for workers with only lower secondary education. In Table 3A, inhouse offshoring is estimated to increase demand for workers with tertiary education, but as before the effect is quantitatively very small. In Table 3C, the estimated elasticities of offshoring to Central and Eastern Europe are now only significant for workers with tertiary education (with positive signs). The negative effect on demand for workers with upper secondary education now seems to be mainly picked up by offshoring to North America. Once more, the negative elasticity for workers with tertiary education with respect to offshoring to Asia is not robust to alternative groupings of countries.[11]

[Table 3A-3C about here]

Thus, the effect on the composition of labor demand is estimated to be one where demand is primarily shifted away from workers with intermediate education. The elasticity

[11] The results will be provided by the authors upon request.

in terms of total offshoring is close to that of Hijzen et al. (2005) for unskilled workers in the UK.[12] However, unlike in the analysis by Hijzen et al. (2005), we find this effect on the demand for semi-skilled labor. The difference in results may partly be explained by the different definitions of skills; Hijzen et al. use occupations to define skill groups while we use educational attainment. Many of the workers in plant and machine occupations, defined as unskilled by Hijzen et al., are likely to have upper secondary education in Sweden. Falk and Koebel (2002), who also use educational attainment as a measure of skill, find no evidence that the lowest skill group can be substituted for imported materials in Germany. At the same time, however, they find complementarity between semi-skilled workers and imported materials – the opposite result to ours.

4.2 Robustness checks

To check the robustness of the these results, we use employment shares instead of cost shares as dependent variables. This procedure is used to check robustness by Hijzen et al. (2005) and in earlier studies with single equation relative factor demand (e.g. Machin and Van Reenen 1998, Anderton and Brenton, 1999 and Strauss-Kahn, 2003). In countries with rigid labour markets, employment shares may reveal more about the effects of a shock since wages do not adjust fully to clear the labor market. Instead, a shock to relative labor demand will result in an increase in unemployment of the labor whose relative demand falls. Moreover, there might be a simultaneity bias between labor costs shares and wages that leads to upward biased estimates in cost share regressions (see e.g. Hijzen et al., 2005).

Table A2A-A2C in the appendix report the main results using the narrow measure of offshoring and employment shares. We do not find any important differences compared to the results based on cost shares. In Table A2A, total offshoring has no significant impact on relative labor demand, while inhouse offshoring appears to have a positive but small impact on the demand for labor with tertiary education. Results in Table A2B show that offshoring to low-income countries still has a negative and significant impact on the

[12] The elasticity was -0.44 with respect to unskilled labor in the specification with cost shares as dependent variables and -0.36 in the specification with employment shares for the 1982-1996 period.

demand for labor with upper secondary education and positive and siginificant impact on the demand for labor with tertiary education. Finally, Table A2C confirms that these effects stem mainly from offshoring to Central and Eastern Europe (CEE). As before, the results for Central and Eastern Europe are found to be robust to alternative groupings of countries, whereas the results for Asia are not.[13] Compared to the elasticities reported in Tables 2A-2C, the elasticities in the employment regression tend to be smaller, which suggests that the former estimates are biased upward because of simultaneity. Particularly, this is the case for the elasticities for workers with upper secondary education.

Workers with higher education seem to be those benefitting the most in terms of increased relative demand from offshoring to low-income countries within industries, while workers with only lower secondary education seem to benefit from offshoring across all industries to low-income countries. The result that offshoring to low-income countries tends to increase the relative demand for workers with lower secondary education is somewhat surprising, considering that we would expect offshoring to partly substitute for this type of worker. The characteristics of the Swedish labor market might explain this result. As seen in Figure 4, a large share of the Swedish labor force has upper secondary education. However, older cohorts of workers are more likely to only have lower secondary education. These older cohorts may be in a better position to keep their jobs, thanks to longer experience and the fact that Swedish labor market legislation provides job security based on tenure.

To explore whether an age effect is underlying the results presented in Tables 2-3, we carry out a similar econometric analysis defining the different worker groups on basis of age instead of education. We define three age groups; workers aged 25-39, 40-54 and 55-65. However, we do not find any robust pattern in the results for the narrow and broad measures of offshoring. Thus, offshoring does not seem to have any differential impact on demand for workers in the three age groups. Arguably, categorizing workers only according to age generates groups that are too heterogenous with respect to education to properly disentangle a possible age effect. Unfortunately, our data do not allow us to differentiate with respect to both age and education, so we cannot investigate this possible

[13]These results are available on request.

interpretation of the results any further.

Since offshoring to low-income countries has increased so much more in the electronic industry than in the rest of the manufacturing sector we need to check whether the results are entirely driven by this sector. We have therefore run regressions where we have allowed the parameter λ_2 to differ between the electronic industry and the other industries. We cannot reject the hypothesis that the parameters are the same.[14]

4.3 Quantifying the results

Our regression analysis for educational groups yields rather large elasticities, in particular for offshoring to low wage countries. However, as noted above, a one percentage point increase in offshoring to low-income countries would, in fact, imply a doubling from the present level. To analyze the economic importance of the results, we use the elasticities to calculate an estimate of the number of employees affected by the change in offshoring between 1995 and 2000, which is evident from Table 1. We mainly focus on the negative estimates for workers with upper secondary education, since this is the group for which we get consistent and significant elasticities across the different specifications. According to our estimates, the actual change in total offshoring in 1995-2000 was associated with a reduction in the demand for workers with upper secondary education by 1866 (narrow measure) to 3073 (broad measure) workers. The actual change in offshoring to low-income countries was associated with a reduction in the demand for workers with upper secondary education by 6678 (broad measure) to 6972 (narrow measure) workers (see Table 4). According to our calculations, this change was, at the same time, associated with an increase in the demand for workers with tertiary education by 3801 workers. Whether these effects are large or small is difficult to judge. Considering that the total number of unemployed decreased by 129,700 between 1995 and 2000 – leaving 203,100 still registered as unemployed in 2000 – we would argue that the figures are relatively small.[15]

[14] All of these results can be obtained from the authors upon request.

[15] Source: AKU statistics, Statistics Sweden.

Table 5. Implied changes in demand for workers with upper secondary education of actual increase in offshoring 1995-2000

Measure		Estimated elasticity	Change in offshoring	Perc. change. in demand	Implied change in demand
All countries	Narrow	-0.629	0.007	-0.004	-1866
	Broad	-0.203	0.038	-0.012	-3073
Low-income	Narrow	-3.631	0.002	-0.009	-6972
countries	Broad	-2.126	0.004	-0.008	-6678

Note: Starting point is the number of workers with secondary eduction employed in the manufacturing industry in 1995 (396,480). Source: authors' own calculations.

5 Conclusions

In this paper, we have used a cost function approach to estimate the effect of offshoring of intermediate input production on the composition of labor demand. We find that overall offshoring as well as offshoring to low-wage economies tend to shift demand away for workers with upper secondary education. This effect is robust to controlling for offshoring of final goods production. It contrasts with the estimated effect of R&D investments, which tend to shift demand away from workers with lower secondary education and towards workers with tertiary education. On the other hand, we do not find any statistically significant effect of offshoring to high-income countries. We interpret this as evidence of offshoring to high-income countries – which constitutes the main part of measured offshoring from Sweden – being related to a more general fragmentation of production, rather than as a tendency for labor intensive activities to be re-located in response to labor cost differentials.

A decomposition of offshoring to different geographical regions yields results suggesting that the negative effect on workers with upper secondary education is mainly driven by offshoring to Central and Eastern Europe. Our estimated elasticities are fairly large, but they translate into rather small numbers of lost jobs to workes with upper secondary education from actual offshoring 1995–2000. It should be noted, however, that our analysis does not take into account that offshoring may have affected growth of output and capital accumulation; factors that in quantitative terms might be more important for employment growth than any substitution between domestic workers and imported inputs.

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A Appendix: Data

The trade data along with input-output tables, price deflators and other industry-specific variables have been provided by Statistics Sweden. Data on number of employees, wages and educational attainment have been collected from the RAMS database (Regional Arbetsmarknadsstatistik). Information about employment of Swedish multinationals at the industry level has been provided by the Swedish Institute for Growth Policy Studies (ITPS) in Stockholm.

The basic industry classification used is based on three-digit SNI92 (which corresponds to three-digit NACE). There are some instances where three-digit industries have been lumped together because of suppression of data at a more detailed level. All in all, we have data on 89 different manufacturing industries in most of the trade and industry statistics. Information about capital stocks, however, is only available at a higher level of aggregation – roughly at the two-digit level. Moreover, the input-output tables use an industry classification corresponding to two-digit NACE. Therefore, the analysis is carried a broader industry classification including 20 industries.

Table 6. Summary statistics

Variable	Mean	Std. Dev.	Min	Max
Cost share of workers with				
primary education	0.2777	0.1062	0.0782	0.4920
secondary education	0.4893	0.0517	0.3777	0.6080
tertiary education	0.2330	0.1277	0.0711	0.5441
Employment share of workers with				
primary education	0.3069	0.0989	0.1121	0.5142
secondary education	0.5141	0.0431	0.4192	0.6167
tertiary education	0.1790	0.1023	0.0655	0.4346
Log of wages of workers with				
primary education	-1.7263	0.1739	-2.2064	-1.4381
secondary education	-1.6504	0.2074	-2.3200	-1.3679
tertiary education	-1.3259	0.2445	-2.1557	-1.0148
Log of capital stock	9.5764	1.1125	6.8865	11.3503
Log of value added	9.2908	1.2591	5.9231	10.8891
Log of R&D expenditure per gross output	0.04084	0.0478	0.0002	0.2753
Narrow offshoring	0.0755	0.0558	0.0065	0.1999
Broad offshoring	0.2275	0.1721	0.0466	0.7495
Inhouse offshoring	1.3416	1.1496	0.0607	5.8750

Note: 120 observations.

B Appendix: Deriving elasticities

In this section, we shall show how the elasticities calculated in the paper are derived from the translog cost function. The starting point is the following cost function for industry i:

$$C_i = \beta_i + \sum_{j=1}^{S} \alpha_j \ln w_j + \sum_{j=1}^{S} \sum_{s=1}^{S} \gamma_{js} \ln w_j \ln w_s + \phi \ln Q_i \tag{8}$$

$$+ \sum_{j=1}^{S} \phi_j \ln Q_i \ln w_j + \delta \ln K_i + \sum_{j=1}^{S} \delta_j \ln K_i \ln w_j \tag{9}$$

$$+ \eta \ln Q_i \ln K_i + \sum_{r=1}^{R} \kappa_r z_{ir} + \sum_{j=1}^{S} \sum_{r=1}^{R} \lambda_{jr} z_{ir} \ln w_j \tag{10}$$

$$(j = 1, ...S, s = 1, ...S, r = 1, ...R),$$

where the variables are as defined in the main text. By differentiating (8) with respect to

w_j we get:

$$\theta_{ij} = \alpha_j + \sum_{s=1}^{S} \gamma_{js} \ln w_s + \phi_j \ln Q_i + \delta_j \ln K_i + \sum_{r=1}^{R} \lambda_{jr} z_{ir}, \tag{11}$$

where

$$\theta_{ij} \equiv \frac{\partial C_i}{\partial w_j} \frac{w_j}{C_j}.$$

and $\frac{\partial C_i}{\partial w_j} = L_{ij}$ according to Shephard's lemma. Industry i's demand for factor j can then be written as:

$$L_{ij} = \frac{C_j}{w_j} \left[\alpha_j + \sum_{s=1}^{S} \gamma_{js} \ln w_s + \phi_j \ln Q_i + \delta_j \ln K_i + \sum_{r=1}^{R} \lambda_{jr} z_{ir} \right]. \tag{12}$$

Differentiation of expression (12) yields:

$$\widehat{L}_{ij} = \widehat{C}_j - \widehat{w}_j + \frac{1}{\theta_{ij}} \left[\sum_{s=1}^{S} \gamma_{js} \widehat{w}_s + \phi_j \widehat{Q}_i + \delta_j \widehat{K}_i + \sum_{r=1}^{R} \lambda_{jr} dz_{ir} \right] \tag{13}$$

utilizing the equality in (11).

Substituting $\widehat{C}_j$ in (13) for $\sum_{s=1}^{S} \theta_{is} \widehat{w}_s$ and collecting terms result in:

$$\widehat{L}_{ij} = \left(\frac{\gamma_{jj} + \theta_{ij}^2}{\theta_{ij}} - 1 \right) \widehat{w}_j + \sum_{k=1}^{S-1} \left(\frac{\gamma_{jk} + \theta_{ik}\theta_{ij}}{\theta_{ij}} \right) \widehat{w}_k + \frac{1}{\theta_{ij}} \left[\phi_j \widehat{Q}_i + \delta_j \widehat{K}_i + \sum_{r=1}^{R} \lambda_{jr} dz_{ir} \right], \tag{14}$$

where $k \neq j$ and a hat above a variable indicates relative change (i.e. $\widehat{x} \equiv dx/x$). From this expression, it is easily seen that Hicksian wage elasticities can be expressed as:

$$\frac{\widehat{L}_{ij}}{\widehat{w}_j} = \frac{\gamma_{jj} + \theta_{ij}^2}{\theta_{ij}} - 1$$

$$\frac{\widehat{L}_{ij}}{\widehat{w}_k} = \frac{\gamma_{jk} + \theta_{ik}\theta_{ij}}{\theta_{ij}}.$$

The technology variables, z_{ir}, are expressed as shares. Therefore, we will report the results for them as semi-elasticities:

$$\frac{\widehat{L}_{ij}}{dz_{ir}} = \frac{\lambda_{jr}}{\theta_{ij}}.$$

These will tell us the percentage response in labor demand to a one-percentage point change in the technology variable. In our calculations, we evaluate these elasticities using parameter estimates and sample means.

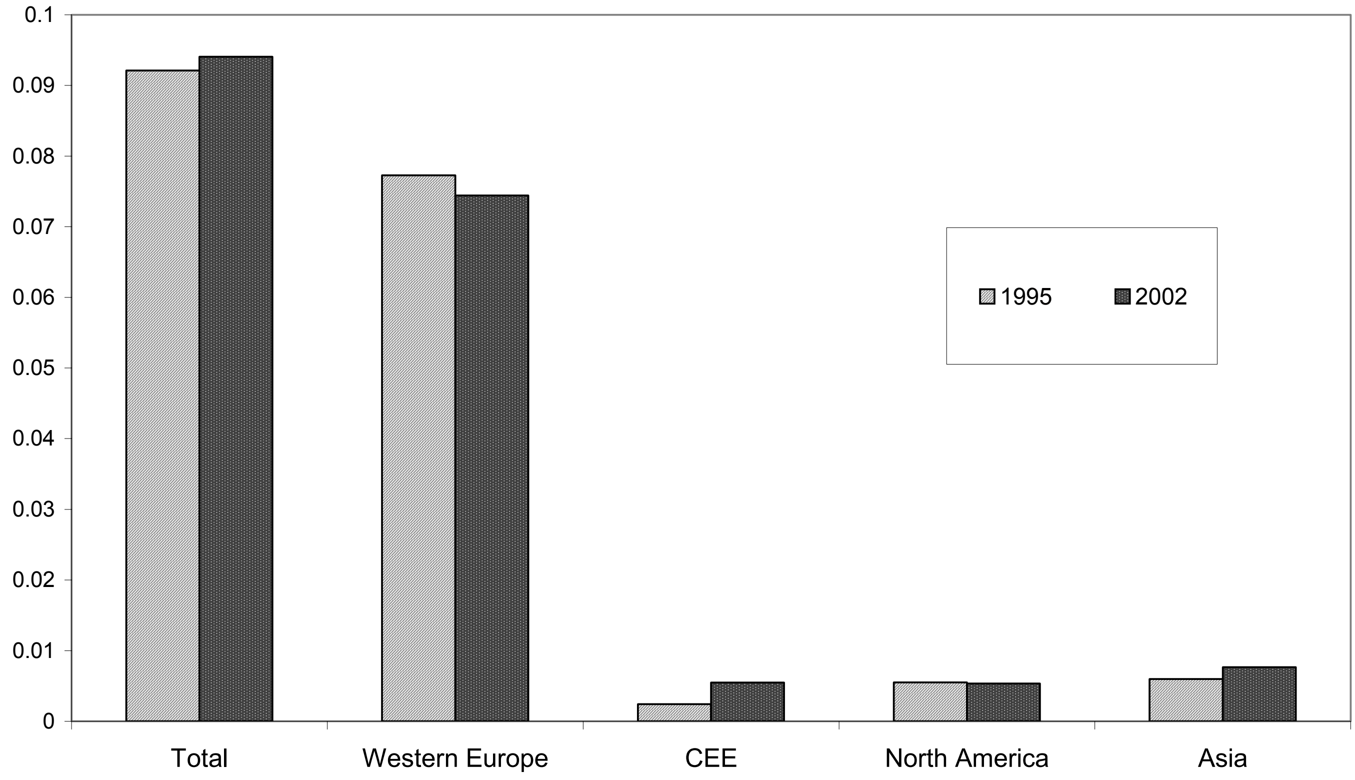

Figure 1: Narrow offshoring to different regions, 1995 and 2002.

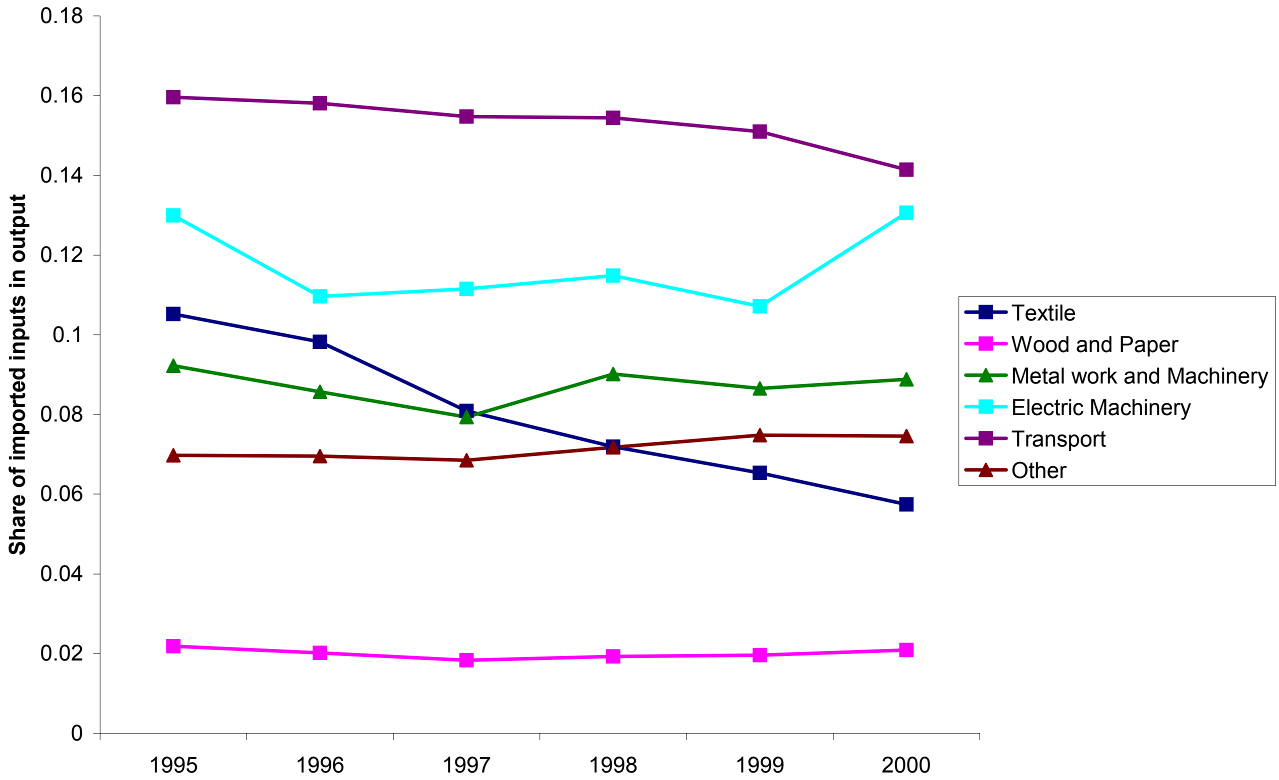

Figure 2: Offshoring to high-income countries by sector.

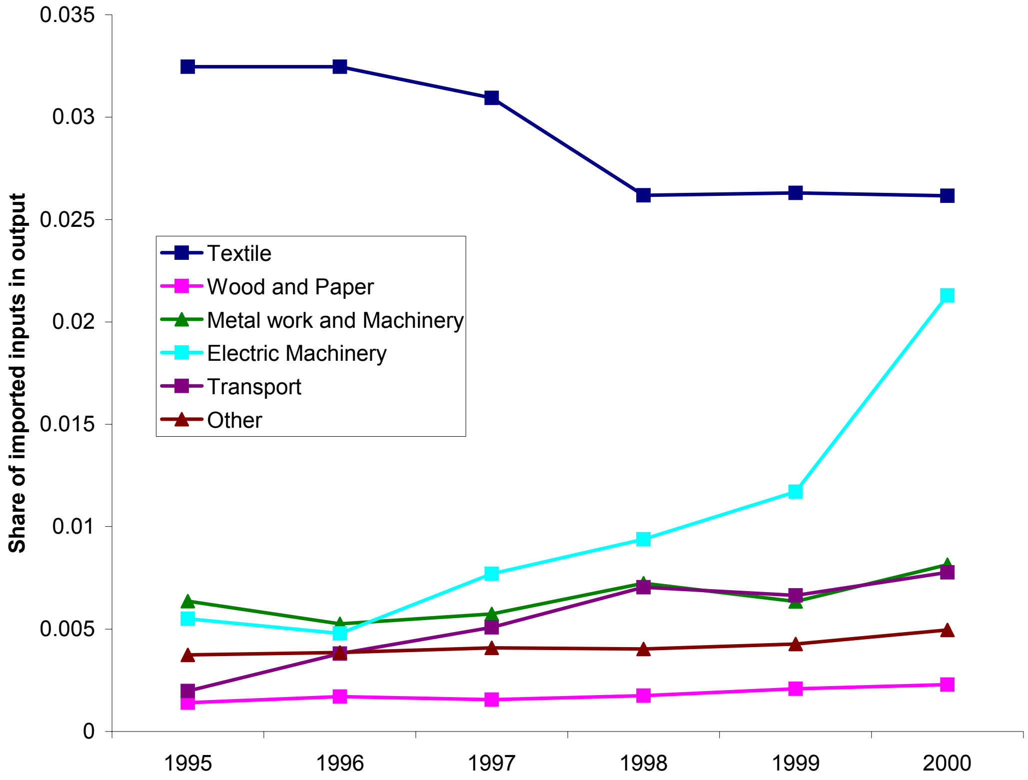

Figure 3: Offshoring to low-income countries by sector.

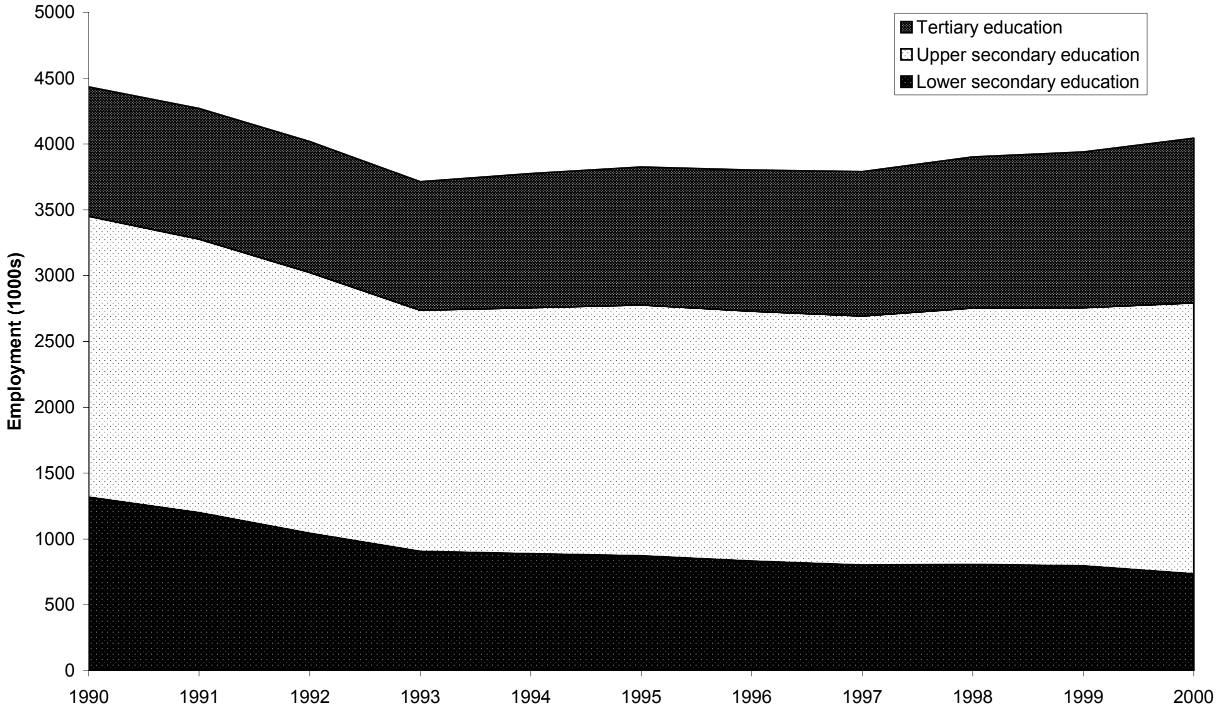

Figure 4: Employment trends for different educational groups in the manufacturing sector.

Table 2A. Elasticities calculated from estimations of translog cost functions. Narrow measure of offshoring

Demand for labor with:	*Spec.*	Changes in: Capital	Value added	R&D	Off-shoring	Inhouse Off-shoring	Wages lower sec.	upper sec.	tertiary
Lower sec.	*(1)*	0.155	-0.072	-0.864	0.467	-0.005			
education		(0.075)**	(0.046)	(0.438)*	(0.342)	(0.006)			
	(2)	0.161	-0.073	-0.784	0.421	-0.005	-0.531	0.236	0.295
		(0.075)**	(0.047)	(0.424)*	(0.355)	(0.007)	(0.503)	(0.516)	(0.248)
Upper sec.	*(1)*	-0.113	0.026	-0.095	-0.629	-0.004			
education		(0.068)	(0.028)	(0.185)	(0.374)*	(0.008)			
	(2)	-0.123	0.035	-0.224	-0.463	-0.003	0.134	-0.014	-0.221
		(0.066)*	(0.026)	(0.208)	(0.378)	(0.008)	(0.293)	(0.282)	(0.158)
Tertiary	*(1)*	0.052	0.030	1.229	0.765	0.014			
education		(0.077)	(0.049)	(0.484)**	(0.414)*	(0.008)*			
	(2)	0.067	0.013	1.405	0.470	0.011	0.352	-0.252	-0.100
		(0.067)	(0.052)	(0.487)***	(0.439)	(0.009)	(0.281)	(0.314)	(0.302)

Note: Specification (1) is without wages on the assumption that wages are set economy-wide, whereas specification (2) includes industry-distributed wages. Standard errors in parenthesis are based on bootstrapping. Significance at the 1, 5, and 10 percent level is indicated by ***, **, and *, respectively.

Table 2B. Elasticities calculated from estimations of translog cost functions. Narrow measure of offshoring

Demand for labor with:	*Spec.*	Changes in: Capital	Value added	R&D	Offshoring HI	LI	Wages lower sec.	upper sec.	tertiary
Lower sec.	*(1)*	0.138	-0.069	-0.841	0.425	1.144			
education		(0.081)*	(0.046)	(0.439)*	(0.522)	(2.095)			
	(2)	0.146	-0.072	-0.681	0.248	1.661	-0.320	0.035	0.284
		(0.079)*	(0.045)	(0.400)*	(0.511)	(2.360)	(0.481)	(0.487)	(0.236)
Upper sec.	*(1)*	-0.102	0.039	-0.146	-0.046	-3.631			
education		(0.068)	(0.030)	(0.193)	(0.441)	(1.570)**			
	(2)	-0.112	0.046	-0.308	0.095	-3.398	0.237	0.069	-0.190
		(0.072)	(0.029)	(0.225)	(0.436)	(1.752)*	(0.276)	(0.259)	(0.156)
Tertiary	*(1)*	0.049	0.001	1.310	-0.410	6.263			
education		(0.082)	(0.048)	(0.477)***	(0.543)	(2.239)***			
	(2)	0.062	-0.010	1.458	-0.494	5.157	0.339	-0.187	-0.152
		(0.079)	(0.051)	(0.476)***	(0.528)	(2.731)*	(0.271)	(0.307)	(0.286)

Note: Specification (1) is without wages on the assumption that wages are set economy-wide, whereas specification (2) includes industry-distributed wages. Standard errors in parenthesis are based on bootstrapping. Significance at the 1, 5, and 10 percent level is indicated by ***, **, and *, respectively.

Table 2C. Elasticities calculated from estimations of translog cost functions. Narrow measure of offshoring

		Changes in:									
Demand for			**Value**			**Offshoring**				**Wages**	
labor with:	*Spec.*	**Capital**	**added**	**R&D**	**WE**	**CEE**	**NA**	**AS**	**lower sec.**	**upper sec.**	**tertiary**
Lower sec.	*(1)*	0.116	-0.064	-0.882	-0.348	-2.463	2.883	4.437			
education		(0.080)	(0.043)	(0.435)**	(0.579)	(5.066)	(2.443)	(3.063)			
	(2)	0.125	-0.066	-0.747	-0.461	-1.464	2.857	4.282	-0.336	0.110	0.226
		(0.084)	(0.046)	(0.369)**	(0.580)	(5.234)	(2.690)	(3.269)	(0.505)	(0.519)	(0.250)
Upper sec.	*(1)*	-0.109	0.042	-0.054	-0.015	-7.708	-3.720	0.893			
education		(0.062)*	(0.026)	(0.184)	(0.418)	(3.192)**	(2.232)	(1.729)			
	(2)	-0.120	0.047	-0.192	0.030	-7.531	-3.296	1.250	0.062	-0.034	-0.129
		(0.065)*	(0.026)*	(0.213)	(0.412)	(3.191)**	(2.444)	(1.747)	(0.294)	(0.262)	(0.138)
Tertiary	*(1)*	0.091	-0.011	1.164	0.447	19.126	4.376	-7.165			
education		(0.079)	(0.046)	(0.442)***	(0.638)	(4.966)***	(3.449)	(2.857)**			
	(2)	0.103	-0.021	1.293	0.488	17.563	3.519	-7.729	0.270	-0.060	-0.209
		(0.080)	(0.052)	(0.403)***	(0.622)	(5.210)***	(3.3737)	(2.927)***	(0.282)	(0.312)	(0.288)

Note: Specification (1) is without wages on the assumption that wages are set economy-wide, whereas specification (2) includes industry-distributed wages. Standard errors in parenthesis are based on bootstrapping. Significance at the 1, 5, and 10 percent level is indicated by ***, **, and *, respectively.

Table 3A. Elasticities calculated from estimations of translog cost functions. Broad measure of offshoring

Demand for labor with:	Spec.	Changes in: Capital	Value added	R&D	Off-shoring	Inhouse Off-shoring	Wages lower sec.	upper sec.	tertiary
Lower sec.	*(1)*	0.164	-0.079	-0.832	0.142	-0.006			
education		(0.075)**	(0.046)*	(0.423)**	(0.182)	(0.006)			
	(2)	0.166	-0.079	-0.680	0.163	-0.005	-0.337	0.025	0.312
		(0.079)**	(0.046)*	(0.400)*	(0.195)	(0.007)	(0.480)	(0.496)	(0.239)
Upper sec.	*(1)*	-0.123	0.036	-0.140	-0.203	-0.003			
education		(0.064)*	(0.029)	(0.183)	(0.165)	(0.008)			
	(2)	-0.126	0.042	-0.305	-0.191	-0.003	0.014	0.111	-0.125
		(0.062)**	(0.027)	(0.212)	(0.158)	(0.008)	(0.281)	(0.270)	(0.152)
Tertiary	*(1)*	0.062	0.019	1.285	0.258	0.013			
education		(0.075)	(0.048)	(0.471)***	(0.231)	(0.008)*			
	(2)	0.067	0.006	1.451	0.207	0.011	0.372	-0.263	-0.109
		(0.094)	(0.031)	(0.258)***	(0.109)*	(0.001)***	(0.229)	(0.419)	(0.175)

Note: Specification (1) is without wages on the assumption that wages are set economy-wide, whereas specification (2) includes industry-distributed wages. Standard errors in parenthesis are based on bootstrapping. Significance at the 1, 5, and 10 percent level is indicated by ***, **, and *, respectively.

Table 3B. Elasticities calculated from estimations of translog cost functions. Broad measure of offshoring

Demand for labor with:	Spec.	Changes in: Capital	Value added	R&D	Offshoring HI	Offshoring LI	Wages lower sec.	upper sec.	tertiary
Lower sec.	*(1)*	0.122	-0.083	-0.785	-0.119	2.079			
education		(0.082)	(0.045)*	(0.439)*	(0.247)	(1.121)*			
	(2)	0.126	-0.082	-0.595	-0.117	2.379	-0.156	-0.042	0.199
		(0.076)*	(0.044)*	(0.338)*	(0.249)	(1.227)*	(0.433)	(0.466)	(0.253)
Upper sec.	*(1)*	-0.101	0.046	-0.161	0.083	-2.126			
education		(0.074)	(0.032)	(0.206)	(0.156)	(0.810)**			
	(2)	-0.112	0.048	-0.319	0.015	-1.621	-0.024	0.090	-0.066
		(0.074)	(0.030)	(0.218)	(0.160)	(0.908)*	(0.267)	(0.255)	(0.166)
Tertiary	*(1)*	0.067	0.002	1.273	-0.032	1.989			
education		(0.084)	(0.048)	(0.481)***	(0.243)	(1.229)			
	(2)	0.085	-0.004	1.379	0.109	0.568	0.237	-0.138	-0.099
		(0.080)	(0.050)	(0.420)***	(0.243)	(1.441)	(0.236)	(0.289)	(0.307)

Note: Specification (1) is without wages on the assumption that wages are set economy-wide, whereas specification (2) includes industry-distributed wages. Standard errors in parenthesis are based on bootstrapping. Significance at the 1, 5, and 10 percent level is indicated by ***, **, and *, respectively.

Table 3C. Elasticities calculated from estimations of translog cost functions. Broad measure of offshoring

Demand for labor with:	Spec.	Changes in: Capital	Value added	R&D	Offshoring WE	CEE	NA	AS	Wages lower sec.	upper sec.	tertiary
Lower sec.	*(1)*	0.106	-0.075	-0.795	-0.618	-1.233	0.412	4.088			
education		(0.075)	(0.045)*	(0.399)**	(0.299)**	(3.510)	(2.835)	(1.657)**			
	(2)	0.111	-0.075	-0.652	-0.593	-0.444	0.460	3.947	-0.273	0.094	0.179
		(0.076)*	(0.044)*	(0.381)*	(0.363)	(3.952)	(3.121)	(1.888)**	(0.473)	(0.499)	(0.251)
Upper sec.	*(1)*	-0.103	0.049	-0.101	0.315	-3.803	-2.320	-0.847			
education		(0.062)*	(0.030)*	(0.200)	(0.274)	(2.774)	(1.361)*	(1.230)			
	(2)	-0.113	0.051	-0.234	0.189	-3.537	-2.125	-0.361	0.054	-0.020	-0.033
		(0.069)*	(0.028)*	(0.219)	(0.280)	(2.828)	(1.244)*	(1.291)	(0.283)	(0.271)	(0.163)
Tertiary	*(1)*	0.090	-0.013	1.161	0.077	9.458	4.383	-3.094			
education		(0.076)	(0.048)	(0.424)***	(0.322)	(3.631)***	(2.692)*	(1.606)*			
	(2)	0.105	-0.019	1.269	0.308	7.958	3.915	-3.947	0.213	-0.070	-0.143
		(0.076)	(0.048)	(0.432)***	(0.338)	(4.033)**	(2.931)	(1.741)**	(0.267)	(0.314)	(0.305)

Note: Specification (1) is without wages on the assumption that wages are set economy-wide, whereas specification (2) includes industry-distributed wages. Standard errors in parenthesis are based on bootstrapping. Significance at the 1, 5, and 10 percent level is indicated by ***, **, and *, respectively.

C Appendix Results

Table A1A. Elasticities calculated from estimations of translog cost functions. Narrow measure of offshoring

		Changes in:							
Demand for			**Value**		**Offshoring**			**Wages**	
labor with:	*Spec.*	**Capital**	**added**	**R&D**	**Other**	**CEE**	**lower sec.**	**upper sec.**	**tertiary**
Lower sec.	*(1)*	0.145	-0.066	-0.860	0.586	-0.379			
education		(0.080)*	(0.046)	(0.431)**	(0.420)	(3.495)			
	(2)	0.153	-0.069	-0.734	0.480	0.156	-0.413	0.109	0.304
		(0.080)*	(0.045)	(0.363)**	(0.424)	(3.960)	(0.471)	(0.480)	(0.231)
Upper sec.	*(1)*	-0.109	0.038	-0.130	-0.183	-6.948			
education		(0.067)***	(0.030)**	(0.200)	(0.366)	(2.789)***			
	(2)	-0.119	0.044	-0.275	-0.057	-6.459	0.062	0.024	-0.186
		(0.071)*	(0.029)	(0.210)	(0.363)	(3.084)**	(0.272)	(0.261)	(0.158)
Tertiary	*(1)*	0.057	0.000	1.297	-0.315	15.046			
education		(0.084)	(0.046)	(0.468)***	(0.454)	(3.781)***			
	(2)	0.067	-0.011	1.453	-0.453	13.380	0.363	-0.179	-0.184
		(0.077)	(0.051)	(0.445)***	(0.469)	(4.495)***	(0.264)	(0.303)	(0.273)

Note: Specification (1) is without wages on the assumption that wages are set economy-wide, whereas specification (2) includes industry-distributed wages. Standard errors in parenthesis are based on bootstrapping. Significance at the 1, 5, and 10 percent level is indicated by ***, **, and *, respectively.

Table A1B. Elasticities calculated from estimations of translog cost functions. Narrow measure of offshoring

		Changes in:								
Demand for			**Value**		**Off-**	**Inhouse Offshoring**			**Wages**	
labor with:	*Spec.*	**Capital**	**added**	**R&D**	**shoring**	**Other**	**ASIA**	**lower sec.**	**upper sec.**	**tertiary**
Lower sec.	*(1)*	0.168	-0.070	-0.904	0.553	0.003	-0.159			
education		(0.072)**	(0.047)	(0.419)**	(0.360)	(0.006)	(0.092)*			
	(2)	0.172	-0.071	-0.851	0.514	0.002	-0.156	-0.610	0.316	0.293
		(0.074)**	(0.048)	(0.377)**	(0.376)	(0.007)	(0.093)*	(0.475)	(0.491)	(0.233)
Upper sec.	*(1)*	-0.120	0.025	-0.073	-0.671	-0.008	0.077			
education		(0.066)*	(0.028)	(0.193)	(0.384)*	(0.009)	(0.060)			
	(2)	-0.129	0.034	-0.189	-0.505	-0.006	0.071	0.180	-0.059	-0.121
		(0.064)**	(0.027)	(0.199)	(0.391)	(0.009)	(0.061)	(0.279)	(0.271)	(0.167)
Tertiary	*(1)*	0.078	0.024	1.180	0.783	0.020	0.068			
education		(0.084)	(0.048)	(0.472)**	(0.467)*	(0.017)	(0.089)			
	(2)	0.066	0.012	1.410	0.450	0.010	0.037	0.350	-0.254	-0.096
		(0.077)	(0.054)	(0.460)***	(0.476)	(0.012)	(0.097)	(0.263)	(0.312)	(0.291)

Note: Specification (1) is without wages on the assumption that wages are set economy-wide, whereas specification (2) includes industry-distributed wages. Standard errors in parenthesis are based on bootstrapping. Significance at the 1, 5, and 10 percent level is indicated by ***, **, and *, respectively.

Table A2A. Elasticities calculated from estimations of translog cost functions with employment shares
Narrow measure of offshoring

		Changes in:							
Demand for			**Value**		**Off-**	**Inhouse Off-**		**Wages**	
labor with:	*Spec.*	**Capital**	**added**	**R&D**	**shoring**	**shoring**	**lower sec.**	**upper sec.**	**tertiary**
Lower sec.	*(1)*	0.111	-0.066	-0.588	0.298	-0.003			
education		(0.067)*	(0.043)	(0.409)	(0.326)	(0.006)			
	(2)	0.108	-0.071	-0.659	0.252	-0.004	-1.019	0.655	0.364
		(0.068)	(0.045)	(0.405)	(0.345)	(0.006)	(0.401)**	(0.433)	(0.219)
Upper sec.	*(1)*	-0.108	0.035	-0.177	-0.414	-0.003			
education		(0.054)**	(0.022)	(0.140)	(0.304)	(0.007)			
	(2)	-0.109	0.039	-0.182	-0.357	-0.002	0.391	-0.418	0.027
		(0.056)*	(0.022)*	(0.162)	(0.322)	(0.007)	(0.258)	(0.257)	(0.113)
Tertiary	*(1)*	0.120	0.013	1.518	0.678	0.013			
education		(0.064)*	(0.043)	(0.429)***	(0.411)	(0.008)*			
	(2)	0.130	0.010	1.654	0.593	0.013	0.624	0.077	-0.701
		(0.066)*	(0.047)	(0.437)***	(0.441)	(0.008)*	(0.220)***	(0.228)	(0.235)***

Note: Specification (1) is without wages on the assumption that wages are set economy-wide, whereas specification (2) includes industry-distributed wages. Standard errors in parenthesis are based on bootstrapping. Significance at the 1, 5, and 10 percent level is indicated by ***, **, and *, respectively.

Table A2B. Elasticities calculated from estimations of translog cost functions with employment shares
Narrow measure of offshoring

		Changes in:							
Demand for			**Value**		**Offshoring**			**Wages**	
labor with:	*Spec.*	**Capital**	**added**	**R&D**	**HI**	**LI**	**lower sec.**	**upper sec.**	**tertiary**
Lower sec.	*(1)*	0.099	-0.065	-0.569	0.222	0.984			
education		(0.073)	(0.043)	(0.382)	(0.451)	(2.234)			
	(2)	0.099	-0.067	-0.603	0.288	0.310	-0.889	0.518	0.371
		(0.073)	(0.043)	(0.384)	(0.469)	(2.397)	(0.419)	(0.417)	(0.214)
Upper sec.	*(1)*	-0.099	0.045	-0.218	0.042	-2.780			
education		(0.057)*	(0.023)*	(0.154)	(0.348)	(1.295)**			
	(2)	-0.101	0.047	-0.244	0.053	-2.525	0.309	-0.359	0.050
		(0.060)*	(0.023)**	(0.173)	(0.364)	(1.426)*	(0.249)	(0.236)	(0.123)
Tertiary	*(1)*	0.113	-0.016	1.603	-0.502	6.299			
education		(0.067)*	(0.044)	(0.403)***	(0.490)	(2.471)**			
	(2)	0.120	-0.019	1.734	-0.646	6.724	0.636	0.144	-0.780
		(0.069)*	(0.045)	(0.424)***	(0.496)	(2.775)**	(0.238)***	(0.240)	(0.232)***

Note: Specification (1) is without wages on the assumption that wages are set economy-wide, whereas specification (2) includes industry-distributed wages. Standard errors in parenthesis are based on bootstrapping. Significance at the 1, 5, and 10 percent level is indicated by ***, **, and *, respectively.

Table A2C. Elasticities calculated from estimations of translog cost functions with employment shares
Narrow measure of offshoring

		Changes in:									
Demand for			**Value**				**Offshoring**			**Wages**	
labor with:	*Spec.*	**Capital**	**added**	**R&D**	**WE**	**CEE**	**NA**	**AS**	**lower sec.**	**upper sec.**	**tertiary**
Lower sec.	*(1)*	0.081	-0.060	-0.611	-0.439	-2.550	2.569	3.812			
education		(0.072)	(0.042)	(0.378)	(0.530)	(4.973)	(2.607)	(2.964)			
	(2)	0.079	-0.062	-0.648	-0.370	-3.473	2.363	3.748	-0.897	0.571	0.326
		(0.072)*	(0.043)	(0.352)*	(0.550)	(4.867)	(2.657)	(2.844)	(0.457)*	(0.459)	(0.217)
Upper sec.	*(1)*	-0.103	0.046	-0.146	0.118	-5.174	-2.820	0.250			
education		(0.052)*	(0.022)**	(0.151)	(0.323)	(2.665)*	(2.006)	(1.453)			
	(2)	-0.104	0.047	-0.153	0.103	-4.871	-2.702	0.316	0.341	-0.441	0.100
		(0.058)*	(0.021)**	(0.166)	(0.350)	(2.788)*	(1.958)	(1.481)	(0.274)	(0.259)*	(0.120)
Tertiary	*(1)*	0.157	-0.028	1.468	0.414	19.237	3.696	-7.255			
education		(0.070)**	(0.042)	(0.391)***	(0.559)	(4.770)***	(3.721)	(2.514)***			
	(2)	0.162	-0.028	1.551	0.338	19.948	3.712	-7.334	0.559	0.288	-0.847
		(0.067)**	(0.046)	(0.380)***	(0.585)	(5.129)***	(3.463)	(2.507)***	(0.248)**	(0.253)	(0.226)***

Note: Specification (1) is without wages on the assumption that wages are set economy-wide, whereas specification (2) includes industry-distributed wages. Standard errors in parenthesis are based on bootstrapping. Significance at the 1, 5, and 10 percent level is indicated by ***, **, and *, respectively.