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Firm Level Effects of Offshoring of Goods and Services on Relative Labor Demand*

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Abstract

Based on firm level data for the Swedish manufacturing sector the objective of this paper is to analyze relative labor demand effects due to offshoring. Data allow us to distinguish between goods and service offshoring and from which country Swedish firms source their inputs. Overall, our results give no support to the fears that offshoring of goods or services lead to out-location of high-skilled activity in Swedish firms. Rather, this paper finds robust evidence that the aggregate effects from offshoring lead to increasing relative demand of high-skilled labor, mainly due to service offshoring.

JEL Classification: F14, F16

Keywords: Offshoring, firm level data, relative employment, translog cost function

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1 Introduction

A substantial reduction in transportation costs and the technological advance in and access to the new information and communication technology (ICT) have been important factors behind the increased internationalization. As part of this development firms see an opportunity to take advantage of lower costs in other parts of the world by sourcing production across national borders. Offshoring involves fragmentation of the production process across countries when there are differences in the relative endowments of skilled and unskilled labor or technology and natural resources between countries (Barba Navaretti et al., 2005; Dunning, 1993). This means that parts of the ongoing production of goods or services are moved abroad and long-term agreements are signed between firms in two or more countries. In contrast to so called international outsourcing which only refers to contracts between detached sub-contractors the broad term offshoring includes contracts with both detached (international outsourcing or outsourced offshoring) and majority owned affiliates abroad (so called inhouse offshoring). Offshoring is expected to lead to both efficiency gains and changes in the firm structure and labor force composition.

The objective of this paper is to analyze the relationship between goods and services offshoring and relative labor demand at the firm level in Swedish manufacturing. Due to advanced ICT and other factors, services output has become increasingly tradable. Though general trade in goods by and large dominates trade in services, Lejour and Smith (2008) point out that in many OECD countries almost 40 percent of manufacturing employment could actually be considered as working with services. So, even though we focus on the manufacturing sector, it is important to consider both goods and services offshoring. There is an increasing trend of offshoring both world wide and in Swedish firms. According to data used in this paper, offshoring of goods and services as a share of inputs in Swedish manufacturing firms has increased from 14 to 17 percent between 1997 and 2002. As in the US and several other OECD countries national

concerns have been raised against "the exports of jobs".[1]

Despite the media attention offshoring has created, there are still only a few studies that have analyzed the effects of offshoring on firms' efficiency and structure. International outsourcing, outsourcing abroad, is usually the focus of attention, where imports of intermediate goods and services are used as proxies for offshoring. Further, most of the empirical studies are based on industry level data instead of firm level data. The advantage of using firm level data is that one can control for heterogeneity across firms. It is reasonable to expect the relationship between offshoring and labor demand to be different for different firms, even within the same industry.

The classic references for empirical studies of the relationship between offshoring and labor market effects are Feenstra and Hanson (1996, 1999), who estimated effects on relative wage differentials at the industry level for non-production and production labor in the US. Following studies have used a similar approach also basing their results on industry level data but for various countries and with different extensions; see, e.g., Falk and Koebel (2002) for Germany, Egger and Egger (2003) for Austria, Strauss-Kahn (2004) for France, Hijzen et al. (2006) for the UK, and Ekholm and Hakkala (2006) for Sweden. The general finding is that the relative demand for unskilled labor falls, but the size of the effect is rather small. In this context, Egger and Egger (2003) is among the first studies to analyze how skill composition is affected by the origin of imported intermediates. They find a clear increase in the relative demand for skilled labor in Austria as an effect of outsourcing to Central and Eastern Europe. Allowing for more regions as well as more skill groups, Ekholm and Hakkala (2006) show that offshoring to low income countries shifts labor demand away from workers with an intermediate level of education.

[1] Grossman and Helpman (2005) analyze factors that are important for the firm's decision about where to outsource activities. Since finding an appropriate partner for outsourcing involves a search cost, they argue that country size is important in the sense that a larger (or more dense) market makes it easier for the firm to find an appropriate partner. In the same manner, highly developed infrastructure and communication technology will affect the search cost negatively and therefore facilitate outsourcing. It is also important that the suppliers are able to customize the product according to the outsourcing firm's needs, and that the partners are able to establish a dependable relationship.

They do however not find any significant effect on labor demand from offshoring to high income countries.[2]

Another approach in the literature is to consider total labor demand effects of offshoring. Estimating a conditional labor demand function on US industry level data, Amiti and Wei (2005) find that service outsourcing has no significant effect on total labor demand, while there is a positive effect of material outsourcing. For Belgium, Michel and Rycx (2012) cannot find any evidence that offshoring, neither service nor material, affects industry-level labor demand.

Senses (2010) estimates the relationship between plant level labor demand elasticities and various industry level proxies for the degree of offshoring. Her results show that an increase in offshoring has a robust positive impact on the elasticity of demand for production workers in the US manufacturing sector, indicating an increase in employment volatility for this group of workers. However, using industry level data on offshoring does not enable a full analysis on the heterogeneous effect of offshoring between firms (plants). Focusing on the occupational level of employment Crinó (2010) finds a small tendency for service offshoring to negatively affect tradeable occupations.

Another strand of the empirical literature has explored domestic employment effects of multinational firms and vertical FDI.[3] Hanson et al. (2003) find that there is complementarity (substitutability) between labor demand in foreign US affiliates located in high-income (low-income) countries and their parent firm. For Sweden, Hansson (2005) finds a clear positive effect on the share of skilled labor regarding foreign direct investments to non-OECD countries, but no significant relationship between skill-upgrading in parent firm and affiliates located in other OECD countries.

[2] Both Egger and Egger (2003) and Ekholm and Hakkala (2006) use input-output tables to calculate imported inputs. The authors then decompose the imported inputs into different regions of origin by using the share of total imports to these regions, thus assuming that imports of intermediates are proportional to overall imports.

[3] See Crinó (2009) for a review of the empirical literature.

The results presented in this paper are based on a relative labor demand model, similar to the original studies by Feenstra and Hanson (1996, 1999). Given this approach, our paper contributes to the literature in at least three ways. Firstly, to the best of our knowledge we are the first to report results on the relationship between offshoring (separating between goods and services) and relative labor demand using firm level data.[4] We distinguish between high and low skilled labor according to educational attainment of labor in firms located in Sweden. Secondly, we have access to actual data on imports of intermediate goods and services, respectively, at the firm level for each year of study, which are used as measures of offshoring. Most of the existing literature has used input-output (IO) tables or supply-use (SU) tables to calculate intermediates combined with total trade data to proxy for offshoring. However, this assumes that intermediates are imported in the same proportion from each country or region of origin as overall goods and services which is not necessarily true. In addition, since IO and SU tables are usually only available every few years, the proxy for offshoring is usually interpolated to obtain yearly values. Thirdly, similar to Amiti and Wei (2005), who study total labor demand, we are able to separate offshoring into intermediate goods and services. This distinction should allow us to determine whether any effects are general, in the sense that they have similar effects on relative labor demand, or if they depend on inherent differences between goods and services. For example, knowledge in the service sector is closely related to people and, therefore, relatively more difficult to protect by patents than is product innovation (Miles, 2006). Service activities are often non-storable and less tradable than material goods (Mattoo and Stern 2008; Miles, 2006). Services that are tradable tend to need less face-to-face interaction, they are codifiable, possible to standardize and modulate (fragment into different services). This means that firms may easily source routinized and simple tasks from abroad while the most skilled labor intensive

[4] Hijzen et al. (2011) is the first published paper to use actual firm-level trade data to account for the effect of service offshoring on the labor market. The authors find no statistical evidence that service offshoring increases job losses or worker turnover in the UK.

activities may remain at home. Further, we are able to distinguish country of origin for imports of intermediate goods and services, respectively. This is used to classify the imports according to high and low income countries and further disaggregating the latter mainly into Asia and Eastern Europe to analyze potentially different effects on relative labor demand. This has proven to be important in previous studies; see e.g., Egger and Egger (2003) and Ekholm and Hakkala (2006).

The rest of the paper is organized as follows. In the next section we discuss the theoretical motives for the link between offshoring and effects on relative wages and labor demand in the home firm, and some descriptive statistics. In Section 3 we present the empirical specification, the dataset and the results. The paper concludes with Section 4.

2 Offshoring and labor demand

Firms are profit maximizers and strive to achieve efficiency in production. Firm level productivity can increase if increased competition on the product market induces firms to replace expensive and inefficient own production with intermediate goods and services or other purchases from domestic sub-contractors with cheaper imports. These efficiency gains arise when sub-contractors are specialized in the production of a certain good or service. The firm can thus focus on the main activity. According to the theory of comparative advantage such specialization will lead to mutual gains between countries when they engage in trade.[5] Offshoring can thereby imply

[5] Grossman and Rossi-Hansberg (2008) develop a theoretical framework where they analyze offshoring in terms of trade in tasks performed by high and low skilled labor. In their model, different trading costs (such as improvements in ICT) drive the firm's decision to offshore, not only differences in factor endowments between countries. The authors separate between three channels through which offshoring can affect wages: a productivity effect, a relative price effect, and a labor supply effect. The most interesting result is that the productivity effect moves in favor of the domestic labor type whose task more easily can be moved offshore. This means that when it becomes more beneficial for firms to offshore, e.g. low skilled tasks, then these cost savings will bring about an effect similar to a labor augmented technological progress. It is very well possible that the positive productivity effect dominates the other two effects which move in the opposite direction. In the case where the opportunities of offshoring e.g. low skilled tasks are concentrated to certain industries, the productivity effect will be analogous to a technological progress which is biased towards the labor type most intensively used in this industry (whether it be low skilled labor or high skilled labor). The results apply vice versa if high skilled tasks can be more easily offshored. However, it is important to point out that the results by Grossman and Rossi-Hansberg (2008) are based on the case where some offshoring already takes place at the outset.

that the firm is offered a wider variety in the choice of goods and services when production is moved abroad. Finally, offshoring can also be a necessary step for a firm who wishes to expand but lacks access to proper competence in the home country.

A Swedish firm can, e.g. offshore by signing a contract with suppliers in low-income countries to produce unskilled intense intermediate goods and services. In this way the firm can focus the domestic activity on production where it has a comparative advantage. Structural changes induced by offshoring can therefore lead to changes in productivity which in turn can affect labor demand, partly because the same amount of output now can be produced with less labor input, partly because domestic employment is substituted for less expensive intermediate imports. Thus, it is possible that offshoring will affect the relative demand for labor of different skill groups.[6] However, the size of the net effect is an empirical question to answer.

It is reasonable to believe that the factor content of offshoring differs between countries or regions. We expect that offshoring to countries with comparative advantage in labor intensive production will have a negative effect on relative demand for low skilled labor. However, offshoring to more developed countries is likely to have a similar factor content as domestic production which means that there may not be any particular impact on the relative demand for labor of various skills due to comparative advantage. Thus, in addition to analyzing the aggregate effect of offshoring we also study whether it matters where the firms offshore to by separating between high and low income countries. As an additional step, and similar to Ekholm and Hakkala (2006), we further divide low income countries into three separate regions: Eastern Europe, Asia and other low income countries. Eastern Europe is interesting in the sense that wages are relatively low even when controlling for productivity and level of education.[7] This is in

[6] It could be argued that the supply of labor has increased during the same time period, which would cloud the picture of whether demand has shifted due to e.g., offshoring. However, according to Bandick and Hansson (2009) it appears as if demand factors of labor are more important than supply factors explaining the increase in labor in Sweden.

[7] Hansson et al. (2007).

contrast to Asia where the level of education is lower and thus, unskilled labor more abundant. According to Barro and Lee (2000) the average level of education has increased in general across countries during the period 1975-2000. However, it appears as if, e.g. Japan and South Korea have caught up with Sweden while China and India are still lagging behind. In addition, public expenditures on education as a share of GDP is approximately 2.6 percent in China and India, as opposed to an average of 6.1 percent in Hungary and Poland and 7.5 percent in Sweden. This difference is also reflected in the share of university students. However, there is no apparent difference in R&D expenditures relative to GDP between countries in Asia (China and India) and Eastern Europe (Hungary and Poland); see Hansson et al. (2007).

In empirical work offshoring is often measured in terms of imports of intermediate inputs. Feenstra and Hanson (1999) argue that it is important to distinguish between a broad and a narrow definition of outsourcing. The narrow definition limits outsourcing to only include imports of intermediate goods for a firm in a given industry within the same two-digit industry, while the broad definition includes imported inputs from all industries. They argue that the narrow definition is preferred to a broader definition since the former is closer to what is thought of as fragmentation within industries. Though, the authors note that the distinction between the two definitions is not without problems. The narrow definition is sometimes too narrow in the sense that when a step in a firm's (a firm classified in a certain industry) production process is being offshored it may be re-classified into an other industry when it returns to the firm as an imported intermediate good. In the narrow definition such re-classifications cannot be accounted for. The subsequent empirical literature therefore often uses either or both the narrow and broad definitions. In this paper we will present results using the broad definition only since we believe that the shift of activities abroad can be related to more than only the core activities.[8]

[8] We note that there is a high correlation between the broad and narrow definitions of goods offshoring; the

Figure 1 shows total imports of intermediate goods and services in Swedish manufacturing firms. It is apparent that there is more imports of intermediate goods than services. Service offshoring has increased drastically over the period 1997-2002, while the degree of goods offshoring has been rather stable. With the results of Grossman and Helpman (2005) in mind, it is reasonable to expect that Swedish firms outsource activities to other developed and high income countries to a larger extent than to developing and low income countries. This is also in accordance with Figure 2 and Figure 3 which show offshoring of intermediate goods and services, respectively, divided according to four offshoring regions. High income countries is the dominant region for both material offshoring (mainly from Germany, the UK and Denmark) and service offshoring (mainly from the US, the UK and Germany). However, comparing the two figures reveals an interesting difference between material and service offshoring. Offshoring of services has more or less doubled in all regions over time[9], but the largest increase in material offshoring is related to an expansion into Asia (mainly China, Taiwan and India) and Eastern Europe (mainly Poland, Estonia and Russia).

FIGURE 1 ABOUT HERE

FIGURE 2 ABOUT HERE

FIGURE 3 ABOUT HERE

simple correlation is 0.9916.

[9] The main suppliers of intermediate service inputs to Swedish manufacturing firms are found in Saudi Arabia, China and India (Asia), and Poland, Russia and the Czech Republic (Eastern Europe).

3 Empirical analysis

3.1 Empirical specification

We will apply the - by now - standard empirical specification suggested by Berman et al. (1994), which originates from a translog cost function.[10] By assuming that firms are cost minimizing, we can use Shepard's Lemma to transform the cost function into cost share functions. Here, high and low skilled labor are treated as variable inputs, while physical capital is treated as a fixed input. Thus, we have two cost share functions, the firm's wage bill share of skilled, S^h, and unskilled labor, S^l, which sum to one. Relative labor demand for skilled labor, S_{hit}, is estimated at the firm level by using the following equation

$$S_{it}^h = \alpha + \beta_1 \ln \left(w_s/w_u\right)_{jt} + \beta_2 \ln K_{it} + \beta_3 \ln Y_{it} + \beta_4 z_{it} + \varepsilon_{it} \tag{1}$$

where w_s/w_u is relative wages for skilled labor in industry j at time t, K_{it} is input of physical capital in firm i, Y_{it} is output in firm i, z_{it} is technological change in firm i, and ε_{it} is an error term. Wages can either be thought of as set economy wide or alternatively as industry or firm specific. If wages are set economy wide, or if there is perfect labor mobility, we would end up with one wage for each skill group and for each year. In that case, time specific effects would pick up this effect and wages would be redundant (or more correctly, wages and time specific effects would be linearly dependent). Since we're using firm-level data, it is however not realistic to assume fixed wages. Instead we have access to information on individual wages which are used to calculate relative wages in 23 manufacturing industries for each year.[11] Relative wages are then treated as exogenous for the firms in the various industries over time. As relative wages change the firm will alter its composition of skilled and unskilled labor (S_{it}^h), and estimates of

[10] See Berndt (1991) for more details on the translog cost function.

[11] We are grateful to Roger Bandick and Pär Hansson for providing us with industry-level relative wages. See Bandick and Hansson (2009) for a description of how these relative wages are constructed.

β_1 indicate the elasticity of substitution between the two factors of production. Note that a positive (negative) sign indicates an elasticity of substitution below (above) one.

Estimates of β_2 indicate that labor and capital are complements ($\beta_2 > 0$) or substitutes ($\beta_2 < 0$) in the production process, while β_3 shows whether or not an increase in output has any effect on the wage bill share of skilled labor. Estimates of β_4 indicate whether technological change is potentially biased towards ($\beta_4 > 0$) or against ($\beta_4 < 0$) skilled labor. In the empirical analysis we will use two measures of factor biased technological change, namely R&D intensity and offshoring. We distinguish between goods and services offshoring, which may potentially have different effects on the relative labor demand.

3.2 Data

Our final dataset includes firms in the manufacturing industry with an average number of employees of at least 50, for the period 1997-2002. This leaves us with an unbalanced dataset of between 1842 and 1941 unique manufacturing firms. Though these firms only represent 3.6 percent of all Swedish manufacturing firms, they are the most dominant firms shown by the fact that they contribute with 82 percent of total value added and 77.5 percent of total employment in the manufacturing sector; see Table 1. The reason for excluding smaller firms is that firm-level R&D data, which are used as a proxy for skill biased technological change, are only available for larger firms. Since skill biased technological change may have a similar effect on labor demand as offshoring, it is important to also control for the former in order to be able to separate between the two effects.[12] We use R&D intensity as a proxy for technological change. This is specified as

[12] As an alternative proxy for technological change we have used the firm level share of technicians, which would allow us to also include small firms in the dataset. However, this proxy is highly correlated with skilled labor, which makes it difficult to obtain reliable results.

$$z_{it,R\&D} = \frac{R\&D_{it}}{Q_{it}} \tag{2}$$

where $R\&D_{it}$ is R&D expenditures in firm i and Q_{it} is sales in firm i. Data on firm characteristics such as value added, physical capital, and R&D are provided in the Financial Statistics database compiled by Statistics Sweden. Relative wages are calculated using data from the annual study of wages in Sweden compiled by Statistics Sweden; see Bandick and Hansson (2009) for more details.

TABLE 1 ABOUT HERE

Data on imports of intermediate goods divided according to country of origin are available 1997-2002 and provided by Statistics Sweden.[13] Data on imports of intermediate private services are provided by the Swedish Central Bank (Riksbanken) for the period 1997-2002, and are also available according to country of origin. With the aim to distinguish between different effects from sourcing from high or low income, and also to study if the concerns in the debate of increased trade with Asia and Eastern Europe, specifically, is motivated, we divide offshoring of goods and services, respectively, into four different regions: region 1 includes Asian countries (except Japan which is included in region 3),[14] region 2 consists of Eastern Europe,[15] region 3 includes high income countries, and region 4 contains other low income countries[16]. More specifically offshoring, $z^r_{it,o}$, is measured as

[13] Unfortunately, as Sweden became a member of the European Union (EU) in 1995 the classification of origin of imports changed and imports originating from a country outside of the EU but cleared through customs in an other EU country are now registered as imports from the transit EU country. This means that imports from outside of EU are underestimated. This is especially important to keep in mind when we separate between high and low income countries, since imports from low income countries will probably be underestimated.

[14] According to the World Bank, Japan, Hong Kong, Singapore, and South Korea are classified as high income countries and therefore excluded from region 1 and instead included in region 3 (high income countries).

[15] Albania, Belarus, Bosnia-Hercegovina, Bulgaria, Czech Republic, Croatia, Estonia, Hungary, Latvia, Lithuania, Macedonia, Moldavia, Poland, Romania, Russia, Serbia and Montenegro, Slovakia, Slovenia, and the Ukraine.

[16] The dominant suppliers of intermediates in this group of countries are Portugal, Brazil, Chile, Mexico and the United Arab Emirates.

$$z^r_{it,o} = \frac{M^r_{it}}{Q_{it}} \tag{3}$$

where M^r_{it} is imports of non-energy intermediate goods and private services[17], respectively, originating from region r for firm i.[18] Unfortunately our dataset does not include information on whether or not the firms have a history of domestic outsourcing which is now fully or partially relocated to abroad.[19] Further, we are not able to capture so called merchanting, i.e., goods and service offshoring that does not re-enter Sweden but is intended for use in a third market. Thus, we are not able to capture the full net effect of offshoring in the economy. However, the contribution of this paper is to highlight the heterogeneous firm level response to an increasing global sourcing also measured at the firm level.

Employment and wage bill data originate from the Regional Labor Market Statistics database provided by Statistics Sweden. We divide labor into high skilled and low skilled based on the level of education.[20] The definition of the variables contained in our dataset is given in Table A1. Descriptive statistics are reported in Table 2.[21] The wage bill for unskilled labor constitutes approximately 80 percent of the total wage bill for firms in Swedish manufacturing. As already indicated in Figures 2 and 3, imported intermediate goods and services from high

[17] The categories of private services included are: 1. communication services; 2. industrial engineering; 3. insurance; 4. finance; 5. computer and information services; 6. licenses; 7. other business, professional and technical services.

[18] Using imports of intermediates as a share of output, value added or total inputs is now the standard way of measuring the intensity of offshoring; see, e.g., the review by Crinò (2009).

[19] Becker et al. (2010) assert that a study of labor market effects of offshoring using firm level data may underestimate the total net effect, i.e., the effect on labor demand in both the individual firm and its potential initial domestic sub-contractor, of an increase in imported intermediates compared to an industry level study. Since we use manufacturing firms only, the potential problem is somewhat mitigated and refers only to the effect of imported intermediate goods and not to services.

[20] Though dividing skill according to educational attainment is probably more appropriate than using classification according to production/non-production workers or operatives/non-operatives, there are problems with using educational attainment as well. The main problem is concerned with work experience which is not included in such a measure and which would improve skill capacity. By dividing labor into only two groups, high and low skilled, we hopefully minimize the problem since it is reasonable to believe that there is a larger skill step between labor with and without post-secondary education than e.g., between labor with and without secondary education.

[21] According to descriptive statistics there are three observations with rather high values on offshoring of goods and one observation with a rather high value on service offshoring, which is evident in Table 2. To test the robustness of our results we also estimate equation (1) excluding these observations. It turns out that the results are not sensitive to these observations and we therefore include them in the estimations presented in the next section in Tables 4- 6.

income countries as a share of total inputs is much higher than from other regions.

TABLE 2 ABOUT HERE

Are there any characteristic differences between firms that offshore as opposed to firms that do not offshore? Table 3 gives the mean difference between an offshoring firms vs non offshorers. To allow for the large heterogeneity between firms in different industries we express the variables (X_i) as deviations from the average non-offshoring firm in the two-digit industry of firm i at time t according to:

$$\sum\nolimits_{i \in OFF} \left(X_i - E\left(X \right)_{NON-OFF} \right) / N_{OFF} \tag{4}$$

where N_{OFF} is the number of offshoring firms. Table 3 reports that offshoring firms have a significantly larger capital stock, higher value added, a larger share of high skilled labor, and a lower share of low skilled labor than the average non-offshoring firm. This is in line with findings by Kurz (2006), Wagner (2011), and Görg et al. (2008). Interestingly it appears as if service offshoring firms are more high skilled (less low skilled) labor intensive compared to non service offshoring firms than goods offshoring firms are compared to non goods offshoring firms. Taking a closer look at which industries that are most prone to offshore we find that goods offshoring is highest in the textile and apparel industry while service offshoring is highest in the telecommunication sector. Due to trade liberalization, the textile and apparel industry has experienced a substantial increase in import competition since the 1980s, first from Southern Europe, later from Asia and Central and Eastern Europe (Hansson et al., 2007).[22]

TABLE 3 ABOUT HERE

[22] There was a major structural change in the Swedish textile and apparel industry during the 1980s and 1990s. According to Gullstrand (2005) many jobs were destroyed and relocated to other sectors. The remaining and entering firms in this industry proved to be more skill intensive and productive than exiting firms.

3.3 Results

Equation (1) is estimated with time specific effects. We report results from three estimation methods; OLS, within estimates using ordinary panel data methods (FE), and finally an instrumental variable method combined with within estimates. According to a Lagrange-Multiplier test reported in the tables of results, it is important to control for firm specific effects. However, since our dataset consists of very few time periods in relation to the number of firms our estimations of the fixed effects may possibly not be efficient, which will translate into the covariance matrix. Though, the number of observations is high enough to give consistent estimates.

It can easily be argued that the causality between relative labor demand and offshoring goes in both directions. In order to control for potential endogeneity of offshoring we apply standard instrumental variable (IV) methods. Offshoring of goods and services are in a first stage equation estimated using the following instruments: firm-level number of employees, $\overline{L}_{it}$, as a measure of firm size; the tradability of goods and services at the industry level, measured as total imports plus exports as a share of output, interacted by time specific effects; the first lag of firm-level offshoring of goods and services. According to the Sargan test of overidentifying restrictions the instruments are valid in each specification. However, the reported values on the Durbin-Wu-Hausman endogeneity test shows that we cannot reject the null hypothesis, which indicates that the offshoring variables may be treated as exogenous. Thus, our preferred estimations are based on the within estimates which will be used as the base for our interpretation of the results.

Table 4 reports the estimation results from equation (1), separating between goods and service offshoring. The results suggest that physical capital is a substitute for high skilled labor; the coefficient is however not significant in the within estimation. Further, the elasticity of substitution between skilled and low skilled at the industry level is significantly below one. There is a positive and highly significant relationship between R&D intensity and high skilled

labor, which indicates an increased relative demand for high skilled labor due to skill biased technological change in line with evidence from previous studies by, e.g. Berman et al. (1994), Feenstra and Hanson (1999), Hansson (2005), Hijzen et al. (2005), and Ekholm and Hakkala (2006).

Further, the within estimates (column 2) in Table 4 report that there is a positive and significant relationship between service offshoring and relative demand for high skilled labor. The corresponding elasticity is however rather low (0.13 percent), which means that the economic effect of service offshoring appears to be relatively small; see Table A2 in Appendix. The effect of goods offshoring on the relative demand for skilled labor is not quite significant at the ten percent level, although surprisingly the coefficient has a negative sign. Since both the coefficient and corresponding elasticity for service offshoring are higher than the negative effect of goods offshoring, there is an overall positive effect on the demand for high skilled labor due to offshoring. This is also supported by a test of the linear combination of the coefficients.

Note that the elasticities reported here are much lower than those obtained by Ekholm and Hakkala (2006) using Swedish industry level data. As pointed out by Becker et al. (2010) there is a potentially important difference between using firm-level data compared to industry-level data, which has to do with the interpretation of the offshoring proxy. This arises in the case where a firm which previously outsourced production to a domestic subcontractor instead decides to outsource internationally. This decision does not necessarily imply any effect on the demand for labor in that specific firm, while a negative effect on labor demand is expected for the domestic subcontractor. At industry level - given a high aggregation level - this net effect is captured. However, using industry-level data, which is the dominant aggregation level of data in the existing literature, clouds the causal relationship between offshoring and labor demand, since one cannot control for the large heterogeneity among firms that exists even within the

same industry.

TABLE 4 ABOUT HERE

According to the discussion in Section 2, it is reasonable to believe that the factor content of offshoring differs between countries or regions. We therefore, in a next step, re-estimate equation (1) using offshoring of goods and services, respectively, decomposed into high and low income countries. As reported in Table 5, the positive effect of service offshoring mainly arises from contracting out services to low income countries even though there is a weakly positively significant effect also from offshoring to high income countries. One tentative explanation to this result is that when a firm re-organizes production it tends to keep the more human capital intensive jobs close to the original firm location, which possibly also is the headquarter. According to Birkinshaw et al. (2006) headquarter activities are focused on strategic planning and managing which requires entrepreneurial skills and other highly skilled labor. Service jobs in manufacturing that are contracted out to low income countries are likely routine and low skilled jobs. Overall, this leads to an increased relative demand for skilled due to service offshoring.

However, the perhaps more interesting result is that we can now distinguish a negative and significant effect of goods offshoring to high income countries on the relative demand for high skilled labor. The corresponding elasticity in absolute values is also much higher (though, still rather low) than the one reported for service offshoring. In addition it is interesting to compare the effects of offshoring and firm level R&D intensity. The latter variable is included to capture an increased demand for skilled labor due to skill biased technological change. According to Table 5 this increase in demand dominates the shift away from skilled labor that arises when firms contract out parts of the production process to other high income countries and rather complements the positive effect of service offshoring.

TABLE 5 ABOUT HERE

To distinguish whether offshoring affects firms differently in different industries we have re-run (1) dividing data into four broad industry groups; Basic, Chemicals, Engineering and Other.[23] Focusing on the within results it appears as if there is a negative and significant effect on the relative demand skilled for labor from goods offshoring to high income countries in the Basic industry. High skilled labor in the Engineering industry is on the other hand positively and weakly significantly affected by goods offshoring to Asian countries. The demand for skilled labor tends to increase as a result of contracting out service production but this is outweighed by a fall in the relative demand due to goods offshoring. However, we find no effect of offshoring in the Chemicals industry.[24]

In a next set of estimations we further decompose offshoring into four different regions; Asia, Eastern Europe, high income countries, and other low income countries. Due to high correlation between service offshoring to Asia and the category other countries, we exclude the latter group in the estimations to avoid problems of multicollinearity. The results in Table 6 confirm those we previously obtained regarding offshoring to high income countries and the relative demand of skilled. According to the within estimations, the positively significant effect of service offshoring to low income countries identified in Table 5 can be traced to trade with Asia. However, there is no evidence that neither service nor goods offshoring to Eastern Europe has any effect on the relative demand for skilled labor in firms located in Sweden.

TABLE 6 ABOUT HERE

As a test for robustness it is common in the literature to re-run the regressions using employment shares instead of cost shares to accentuate labor market effects in the presence of labor

[23] The following SNI92 (NACE) industries are included: Basic (21, 27-28), Chemicals (23-25), Engineering (29-35), and Other (15-20, 22, 26, 36).

[24] The results are not shown in the paper but can be obtained from the authors upon request.

market rigidities; see e.g. Hijzen et al. (2005) and Ekholm and Hakkala (2006) and in single relative demand equations, e.g. Machin and van Renen (1998), Anderton and Brenton (1999), and Strauss-Kahn (2004). According to Table A2 in Appendix the elasticities reported on employment shares are in general both quantitatively and qualitatively similar to those reported on cost shares.

4 Concluding remarks

The objective of this paper is to analyze relative labor demand effects in Sweden due to offshoring. Since employment is one of the key concerns in the debate on the effects of globalization in general and of the enlargement of the European Union (EU) specifically, this paper offers an important contribution. The analysis is based on an administrative dataset containing between 1842 and 1941 Swedish manufacturing firms, 1997-2002. For this time period we have access to actual firm level trade data with information on country of origin of imported goods and services, respectively, that are subject to offshoring. This facilitates to specifically analyze labor demand effects of offshoring to countries in the enlarged EU as opposed to countries in other parts of the world. Employment is divided according to two levels of education, which makes it possible to at a more detailed level analyze relative effects on labor with or without post upper secondary education depending on where the firms offshore to.

Three main results come out of the analysis. First, distinguishing between service and goods offshoring is important. Contracting out service production tends to increase the relative demand for skilled labor in firms located in Sweden, while, on the aggregate level, there is no significant effect of goods offshoring. Second, distinguishing between offshoring regions is important. This distinction reveals a negative effect of goods offshoring to high income countries and low income countries other than Asia and Eastern Europe. There is a consistent positive effect of service

offshoring to both high and low income countries. Third, even though fragmentation in terms of offshoring has an overall positive effect on the relative demand for skilled labor for the average manufacturing firm in Sweden, the size of this effect is rather small.

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Table 1: Employment and value added for the sample and for total manufacturing sector 1997

Item	Sample	Total population	Percent covered
Employment	531,011	685,382	77.5 %
No. of firms	1,842	51,427	3.6 %
Value added (billion SEK)	290.0	353.5	82.0 %
Value added per firm (billion SEK)	0.16	0.01	...
Employment per firm	288.3	13.3	...

Notes: The sample values are derived from the FIEF database, which contains data from e.g., the Financial Statistics database compiled by Statistics Sweden, and the totals from the NV 19 SM 0201 (SCB). The manufacturing sector contains SNI92 industries 15-36. The sample covers firms with 50 employees or more.

Table 2: Descriptive statistics 1997-2002

Variable	No. of obs.	Mean	Std. Dev.	Min.	Max.
S^h	11191	0.198	0.144	0.000	1.000
S^l	11191	0.802	0.144	0.000	1.000
w_h/w_l	11191	1.381	0.070	1.172	1.715
$z_o^{tot,\ goods}$	11191	0.097	0.165	0.000	9.670
$z_o^{tot,\ services}$	11191	0.006	0.051	0.000	4.629
$z_{o,\ n}^{hi,\ goods}$	11191	0.084	0.120	0.000	1.418
$z_o^{hi,\ services}$	11191	0.006	0.034	0.000	2.360
$z_o^{li,\ goods}$	11191	0.013	0.098	0.000	8.869
$z_o^{li,\ services}$	11191	0.001	0.022	0.000	2.269
$z_o^{1,\ goods}$	11191	0.003	0.016	0.000	0.365
$z_o^{2,\ goods}$	11191	0.009	0.094	0.000	8.869
$z_o^{3,\ goods}$	11191	0.084	0.120	0.000	1.418
$z_o^{4,\ goods}$	11191	0.002	0.018	0.000	0.558
K	11191	122217.400	546192.900	45.000	1.27E+07
Y	11191	172957.200	723496.500	137.939	2.60E+07
$z_{R\&D}$	11191	0.013	0.040	0.000	0.701

Note: Unweighted averages of each variable.

Figure 1: Imports of intermediate goods and services in Swedish manufacturing firms, 1997-2002, billion SEK

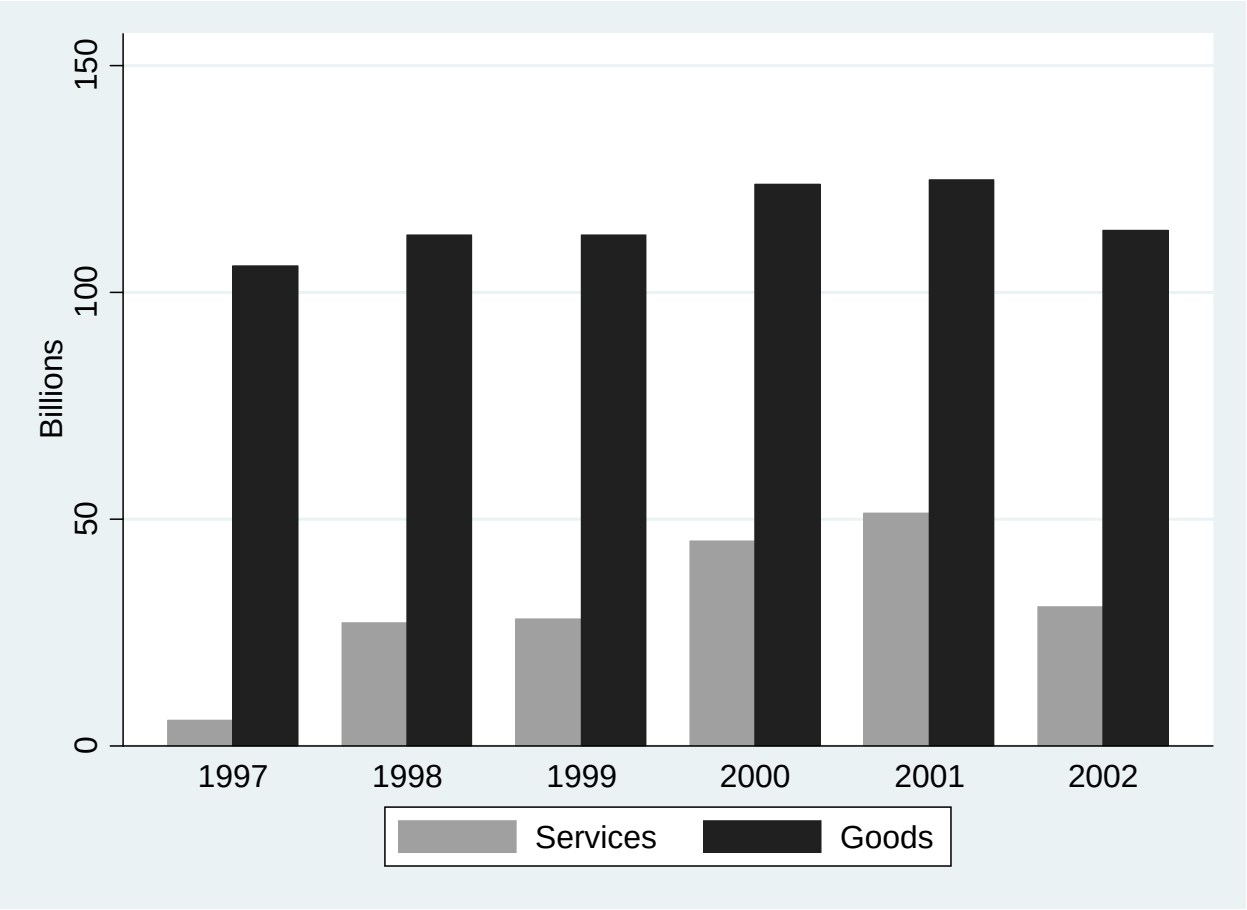

Figure 2: Imports of intermediate goods according to offshoring region in Swedish manufacturing firms, 1997-2002, billion SEK

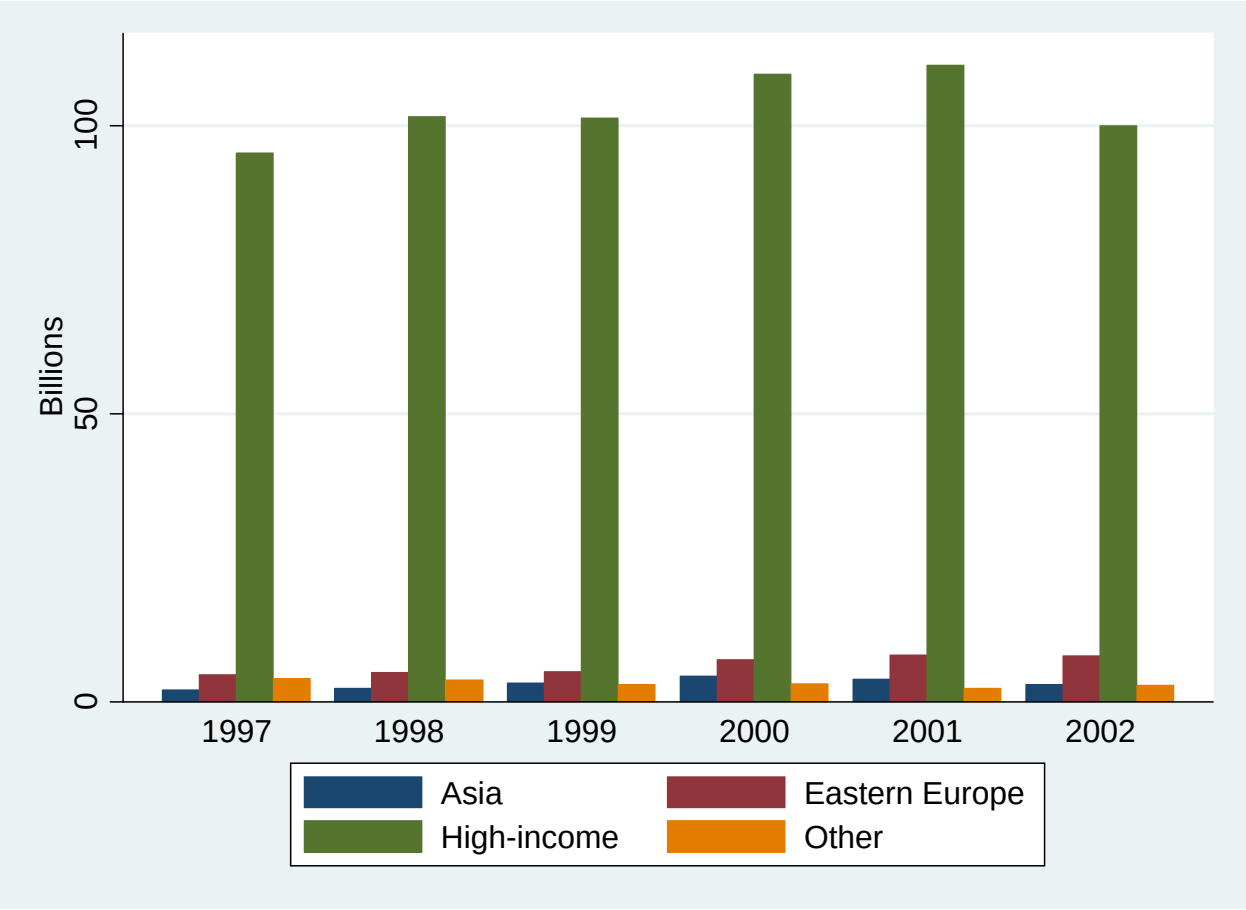

Figure 3: Imports of intermediate services according to offshoring region in Swedish manufacturing firms, 1997-2002, billion SEK

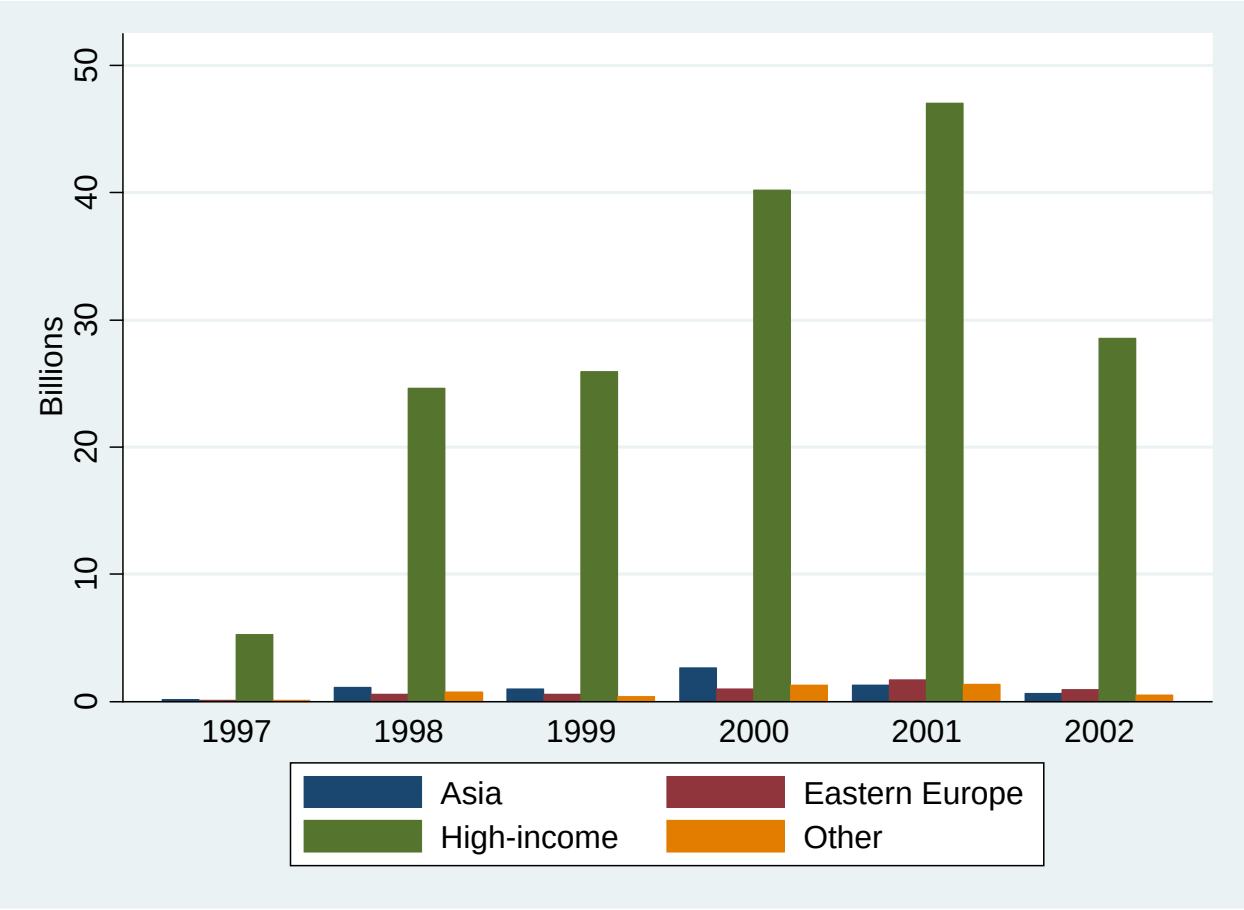

Table 3: Characteristics of offshoring firms relative to firms with no offshoring

	Goods offshoring	Service offshoring
Variables	mean diff	mean diff
Capital	69038.0	198252.0
	(10.66)***	(15.47)***
Y	85092.0	251849.0
	(9.38)***	(14.71)***
R&D intensity	0.011	0.016
	(27.01)***	(20.53)***
S^h	0.047	0.085
	(28.97)***	(38.97)***
S^l	-0.047	-0.085
	(28.97)***	(38.97)***
No. of obs.	8769	4288

Notes: The mean difference is calculated as the deviation for offshoring firms minus the corresponding value for the average non-offshoring firm in industry j and represents the differences in means for goods (or services) offshorers and non-goods (or services) offshorers, respectively. t-values are reported within parentheses.

Table 4: Regression results of wage bill share for manufacturing firms with more than 50 employees, goods and service offshoring, 1997-2002

Dependent variable	High skilled labor OLS	High skilled labor Within	High skilled labor IV
$\ln w_h/w_l$	-0.076	0.029	0.033
	(0.024)***	(0.011)***	(0.013)**
$\ln K$	-0.021	-0.001	-0.003
	(0.001)***	(0.001)	(0.001)***
$\ln Y$	0.044	-0.010	-0.008
	(0.002)***	(0.001)***	(0.001)***
$z_{R\&D}$	1.540	0.125	0.128
	(0.030)***	(0.015)***	(0.017)***
$z_o^{tot,\ goods}$	-0.003	-0.008	-0.035
	(0.007)	(0.005)	(0.028)
$z_o^{tot,\ services}$	0.220	0.039	0.058
	(0.023)***	(0.008)***	(0.028)**
No. of obs.	11191	11191	8081
R^2	0.30	0.13	0.15
LM test	.	13386.69***	.
Hausman test (FE vs. RE)	.	12192.08***	.
Sargan; $\chi^2(11)$	.	.	17.25
Endogeneity test; $\chi^2(2)$	.	.	2.44

Notes: All estimations include time and firm specific effects. Standard errors are shown in parentheses, and ***, **, * refer to 1%, 5% and 10% significance levels. R^2 refers to adjusted R^2 for OLS estimations, within R^2 for the within estimations and centered R^2 for the IV estimations. IV estimations are conducted using the following instruments: firm-level average number of employees, $\overline{L}_{it}$, as a measure of firm size; the tradability of goods and services at the industry level, measured as total imports plus exports as a share of output, interacted by time specific effects; the first lag of firm-level offshoring of goods and services. The endogeneity test refers to Durbin-Wu-Hausman with the null hypothesis of exogeneity.

Table 5: Regression results of wage bill share for manufacturing firms with more than 50 employees, goods offshoring to high and low income countries, 1997-2002

Dependent variable	High skilled labor OLS	High skilled labor Within	High skilled labor IV
$\ln w_h/w_l$	-0.078	0.029	0.035
	$(0.024)^{***}$	$(0.011)^{***}$	$(0.013)^{***}$
$\ln K$	-0.022	-0.001	-0.003
	$(0.001)^{***}$	(0.001)	$(0.001)^{***}$
$\ln Y$	0.044	-0.010	-0.008
	$(0.002)^{***}$	$(0.001)^{***}$	$(0.001)^{***}$
$z_{R\&D}$	1.514	0.126	0.131
	$(0.030)^{***}$	$(0.015)^{***}$	$(0.017)^{***}$
$z_o^{hi,\ goods}$	0.023	-0.019	-0.029
	$(0.010)^{**}$	$(0.008)^{**}$	(0.038)
$z_o^{li,\ goods}$	-0.041	-0.003	-0.065
	$(0.012)^{***}$	(0.006)	$(0.035)^{*}$
$z_o^{hi,\ services}$	0.517	0.030	-0.030
	$(0.046)^{***}$	$(0.018)^{*}$	(0.072)
$z_o^{li,\ services}$	-0.260	0.051	0.152
	$(0.068)^{***}$	$(0.024)^{**}$	$(0.075)^{**}$
No. of obs.	11191	11191	8081
R^2	0.30	0.13	0.14
LM-test	.	13338.06^{***}	.
Hausman test (FE vs. RE)	.	16743.11^{***}	.
Sargan; $\chi^2(11)$	.	.	15.64
Endogeneity; $\chi^2(4)$	.	.	6.06

Notes: All estimations include time and firm specific effects. "hi" refers to offshoring to high income countries, "li" to low income countries.Standard errors are shown in parentheses, and ***, **, * refer to 1%, 5% and 10% significance levels. R^2 refers to adjusted R^2 for OLS estimations, within R^2 for the within estimations and centered R^2 for the IV estimations. IV estimations are conducted using the following instruments: firm-level average number of employees, $\overline{L}_{it}$, as a measure of firm size; the tradability of goods and services at the industry level, measured as total imports plus exports as a share of output, interacted by time specific effects; the first lag of firm-level offshoring of goods and services. The endogeneity test refers to Durbin-Wu-Hausman with the null hypothesis of exogeneity.

Table 6: Regression results of wage bill share for manufacturing firms with more than 50 employees, goods offshoring to four regions, 1997-2002

Dependent variable	High skilled labor OLS	High skilled labor Within	High skilled labor IV
$\ln w_h/w_l$	-0.079	0.029	0.030
	(0.024)***	(0.011)***	(0.013)**
$\ln K$	-0.022	-0.001	-0.003
	(0.001)***	(0.001)	(0.001)***
$\ln Y$	0.044	-0.010	-0.008
	(0.002)***	(0.001)***	(0.001)***
$z_{R\&D}$	1.514	0.125	0.128
	(0.030)***	(0.015)***	(0.017)***
$z_o^{1,goods}$	-0.204	0.051	-0.011
	(0.073)***	(0.049)	(0.395)
$z_o^{2,goods}$	-0.039	-0.001	-0.011
	(0.012)***	(0.006)	(0.038)
$z_o^{3,goods}$	0.025	-0.021	-0.042
	(0.010)***	(0.008)**	(0.039)
$z_o^{4,goods}$	0.011	-0.108	-0.285
	(0.062)	(0.038)***	(0.092)***
$z_o^{1,services}$	-0.435	0.088	-0.034
	(0.107)***	(0.037)**	(0.112)
$z_o^{2,services}$	1.405	-0.318	3.506
	(0.836)*	(0.314)	(2.136)*
$z_o^{3,services}$	0.500	0.034	-0.064
	(0.046)***	(0.018)*	(0.075)
No. of obs.	11191	11191	8081
R^2	0.30	0.14	0.14
LM-test	.	13355.95***	.
Hausman test (FE vs. RE)	.	21107.14***	.
Sargan; $\chi^2(12)$	.	.	16.89
Endogeneity; $\chi^2(7)$	.	.	7.48

Notes: All estimations include time and firm specific effects. "z_o^1" refers to offshoring to Asian countries, "z_o^2" to countries in Eastern Europe, "z_o^3" to high income countries, and, "z_o^4" to other low income countries. Standard errors are shown in parentheses, and ***, **, * refer to 1%, 5% and 10% significance levels. R^2 refers to adjusted R^2 for OLS estimations, within R^2 for the within estimations and centered R^2 for the IV estimations. IV estimations are conducted using the following instruments: firm-level average number of employees, $\overline{L}_{it}$, as a measure of firm size; the tradability of goods and services at the industry level, measured as total imports plus exports as a share of output, interacted by time specific effects; the first lag of firm-level offshoring of goods and services. The endogeneity test refers to Durbin-Wu-Hausman with the null hypothesis of exogeneity.

Table A1: Variables and sources

	Description:	Source:
Wage incomes W:	Total wage incomes for all employees	SCB, Regional Labor Statistics
Wage high skilled labor W^h:	Wage incomes for employees with post-secondary education	SCB, Regional Labor Statistics
Wage low skilled labor W^l:	Wage incomes for employees with less than post-secondary education	SCB, Regional Labor Statistics
Employment E:	Number of employees	SCB, Regional Labor Statistics
High skilled employment E^h:	Number of employees with post-secondary education	SCB, Regional Labor Statistics
Low skilled employment E^l:	Number of employees with less than post-secondary education	SCB, Regional Labor Statistics
Technicians T:	Number of employees with technical post-secondary education	SCB, Regional Labor Statistics
Physical capital K:	Stocks of fixed assets at book value, 2000 prices	SCB, Structural Business Statistics
Real output Y:	Value-added, 2000 prices	SCB, Structural Business Statistics
R&D intensity $z_{R\&D}$:	R&D expenditures divided by sales	SCB, Structural Business Statistics
Imports, $M^{services}$:	Import of services	Riksbanken
Imports, M^{goods}:	Import of intermediate goods	SCB, International Trade Statistics

Notes: Offshoring is also divided according to region: 1. Asia; 2. Eastern Europe; 3. high income countries; 4. other low income countries. In the case where we only distinguish between high and low income countries, regions 1, 2 and 4 have been aggregated to constitute low income countries.

Table A2: Elasticietes related to the results in Tables 5-7, 1997-2002

	Cost share of skilled		Employment share of skilled	
Variable	Elasticity	Std.err.	Elasticity	Std.err.
$z_o^{tot,goods}$	-0.0039	0.0024	-0.0028	0.0025
$z_o^{tot,services}$	0.0013	0.0003***	0.0015	0.0003***
	.	.	.	.
$z_o^{hi,goods}$	-0.0078	0.0036**	-0.0077	0.0038**
$z_o^{li,goods}$	-0.0002	0.0004	5.0E-05	0.0004
$z_o^{hi,services}$	0.0009	0.0005*	0.0013	0.0006**
$z_o^{li,services}$	0.0002	0.0001**	0.0002	0.0001**
	.	.	.	.
$z_o^{1,goods}$	0.0007	0.0007	0.0412	0.0417
$z_o^{2,goods}$	-2.3E-05	0.0003	0.0020	0.0053
$z_o^{3,goods}$	-0.0089	0.0036**	-0.0163	0.0072**
$z_o^{4,goods}$	-0.0012	0.0004***	-0.0729	0.0321**
$z_o^{1,services}$	0.0002	0.0001**	0.0739	0.0315**
$z_o^{2,services}$	-0.0002	0.0002	-0.2910	0.2653
$z_o^{3,services}$	0.0010	0.0005*	0.0380	0.0152**

Notes: All the shown elasticities are obtained from the within estimations. "z_o^1" refers to offshoring to Asian countries, "z_o^2" to countries in Eastern Europe, "z_o^3" to high income countries, and, "z_o^4" to other low income countries. ***, **, * refer to 1%, 5% and 10% significance levels.