Labor Demand, Offshoring and Inshoring: Evidence from Swedish Firm-Level Data*

by

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Abstract

The objective of this paper is to analyze effects on firm-level relative demand for skilled labor due to imports of intermediates (offshoring) and exports of intermediates (inshoring). The study is based on a dataset of Swedish manufacturing firms, 1997-2002, using actual trade flows in intermediate goods and services, respectively. Descriptive data show that goods inshoring is much larger than goods offshoring, while the reverse is true for services. There is however a strong increase in services inshoring over the study period. Controlling for potential endogeneity due to high-performing firms self-selecting into offshoring and inshoring, our results indicate that there is a positive effect of services offshoring while inshoring has no significant effect on the skill composition of workers in Swedish firms.

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1. Introduction

Offshoring, usually measured in terms of imports of intermediates, means that a firm may take advantage of gains from division of labor as the firm specializes and sources certain stages of the production process to other countries. National concerns have been raised against domestic firms exporting low-skilled jobs as production is located abroad. However, vertical fragmentation of production between countries may also substitute for other activities such as high-skilled labor at home when a foreign supplier is more efficient (OECD, 2005). In fact, during the last decade, in many industrialized countries the interest has shifted from the export of low skilled jobs towards potential effects on high-skilled labor (Markusen and Strand, 2008). Offshoring has received much attention both in media and in the international trade literature, while discussions on effects of inshoring, or firm-level exports of intermediate goods or services, have been rather silent. The latter may however be non-negligible and it is reasonable to expect that any firm-level effects from offshoring at least partly can be counter-acted or reinforced if the firm is also engaged in inshoring. The objective of this paper is to analyze compositional employment effects of fragmentation at the firm level accounting for both offshoring and inshoring, also distinguishing between trade in intermediate goods and services.

While concerns have been raised against labor market effects due to goods offshoring, the public discussion and academic interest have turned to service offshoring (UNCTAD, 2004). As a result of technological advances in information and communication technology (ICT) and lower costs for travel and transports, it has become easier to source business services, such as programming, design, accounting and medical services from foreign suppliers. The trend to move the provision of these services abroad, may potentially substitute for the labor engaged in these services at home.[5] As opposed to trade in services, trade in intermediate goods has existed for several decades and many manufacturing firms thus have already adapted their organization of the production to stay competitive on a global market. However, not much attention has been paid to service offshoring in the empirical literature. This is partly due to lack of data about trade in services but perhaps more importantly that many services are non-tradable. Some exceptions are Amiti and Wei (2005), Liu and Trefler (2008), and Andersson, Karpaty and Savsin (2014) that

[5] Lejour and Smith (2008) claim that in most OECD countries, as much as 40 percent of employment within the manufacturing industry could actually be working with services.

specifically analyze labor market effects from service offshoring. The conclusion from these studies is that international trade in services may have significant implications on the labor market in the home country. There is by now increasing concerns that newly industrialized countries such as China, India and transition economies in Central and Eastern Europe are accumulating an increasing number of highly educated labor and that these countries are becoming increasingly competitive in providing both goods and services. If firms move production of intermediate goods or services to these countries, one may expect both low and high skilled jobs to be exported (offshored) to these countries (Markusen and Strand, 2008; Chazaretta, 2011).

Even though any potential effects in a firm cannot easily be understood from offshoring only, there are, to the best of our knowledge, no previous study that attempts to separate between labor market effects due to inshoring and offshoring of intermediate goods and services, respectively. Using firm-level data for Denmark, Hummels, Jørgensen, Munch and Xiang (2014) identify net globalization effects using total export as a measure for inshoring. Liu and Trefler (2008) consider offshoring and inshoring of services, but only between the US and China and India. Both these studies find positive net effects on the demand for high skilled labor. Closely related is a survey of Danish firms by Ørberg Jensen, Kirkegaard and Søndergaard Laugesen (2006). Though the focus there is on general labor market effects the authors consider both offshoring and inshoring in order to establish firm-level net effects in the service and retail sectors. However, none of these studies have all the necessary firm-level data to thoroughly identify the net adjustments that firms make in terms of labor demand and skill composition as a response to offshoring and inshoring.

The intention with this paper is to expand the literature on within-industry effects due to trade competition by simultaneously analyzing the relationship between relative labor demand and both offshoring (imports of intermediates) and inshoring (exports of intermediates) using a full census panel data of firms, thus avoiding potential selection problems. We distinguish between trade in intermediate goods and services, which previously has been proven important by Andersson et al. (2014) regarding employment effects of offshoring. Our data also enables us to identify possible labor composition effects due to offshoring and inshoring after controlling for

other determinants such as firm-level R&D and capital stocks etc. The advantage of using firm-level data is that one can control for heterogeneity across firms.

To preview our results, the relative demand for high skilled labor tends to increase due to offshoring of services, while there is no significant effect of inshoring. This indicates a net increase in the relative demand for skilled workers due to services offshoring.

The paper is organized as follows. In Section 2 we review the literature and Section 3 describes the theoretical links between offshoring, inshoring and labor demand. Data are presented in Section 4 and Section 5 discusses patterns of inshoring and offshoring in Swedish manufacturing firms for the study period. The empirical specification, econometric considerations and the estimation results are presented and discussed in Section 6. The paper concludes with Section 7.

2. Literature review

Even though offshoring has been vividly debated recently, the 'fear' literature on the "Third World's" economic growth and their increasing market shares actually goes back to the 1990s. Krugman (1994) examines the increasing fears about the impact of competition from low-wage countries by examining patterns of wages and productivity in the industrialized countries. However, he finds that the effects of outsourcing (imports of multinationals) have been very small. Similarly, Berman, Bound and Griliches (1994) identify that sourcing parts and components from abroad can indeed affect the composition of labor demand for labor in manufacturing, but the effect is very small. In line with Berman et al. (1994), the seminal papers by Feenstra and Hanson (1996a, 1996b) started a large literature studying what impact offshoring may have on the observed rising relative wage for skilled workers (see, e.g., Egger and Egger, 2003; Ekholm and Hakkala, 2006; Strauss-Kahn, 2004). All of the above studies constitute one wing of the offshoring literature which links offshoring with wage inequality (between high-skilled and low-skilled workers); see Table A1 in Appendix. Most studies focusing on relative labor demand effects are based on industry-level data. The general conclusion is that offshoring, especially to low income countries, lowers the relative demand for low skilled labor, at least in manufacturing. To the best of our knowledge, Andersson et al. (2014) is the only study with a

similar focus but using firm-level data. Their results clearly indicate that it is important to distinguish between service and material offshoring. Relative demand for skilled labor increases as a response to service offshoring while there is no significant effect of material offshoring.

Due to more recent technological improvements the production of services, both in the service sector and services produced in manufacturing, has made offshoring of services more tangible. This has put the fear in developed countries of losing jobs to developing countries into a new perspective since the fear expanded from low-skilled to high-skilled intensive tasks being affected. As a second strand of the literature, more recent empirical studies have considered the total labor demand effect of offshoring, by including some of the services sectors; see Table A2 in Appendix. The overall results in this literature show that there is either no effect of service offshoring on total labor demand, or the effect is negative but only very small (smaller than effects from material offshoring).

Another newly emerging strand of the literature uses individual or occupational data matched with trade data to be able to control for heterogeneity. In fact, the studies presented in Table A3 in Appendix show that offshoring have different effects on different occupational groups or on different workers with different characteristics. Crinó (2010) finds that services offshoring has a positive effect on employment among high-skilled occupational groups, while it affects the low-skilled groups negatively. Regarding occupational groups, Civril (2011) also shows that routine task intensive occupations have been negatively affected by technology while non-routine intensive occupations ones are affected positively regardless of education level. However, the effect of offshoring is mostly insignificant. Ottaviano, Peri and Wright (2010), on the other hand, introduce differences between immigrant and native workers and find that offshoring pushes native US workers towards more communication intensive tasks and immigrant workers away from them.

The overall literature on labor market effects of offshoring is rather voluminous. However, potential labor market effects of inshoring, the other side of the argument, have so far been surprisingly neglected. The loss of potential gains from supplying intermediate goods and services might be clouding the picture even more. There are only a few studies that consider the

total labor market effect of offshoring and inshoring; see Table A4 in Appendix. Hummels et al. (2014) is one of only few studies that refers to a net globalization effect. They investigate relative labor demand by using matched firm-worker data and use that term to describe the offsetting effect of exporting wage elasticity over offshoring wage elasticity. Their results show that for non-college-educated workers, the positive exporting wage elasticity is larger than the negative offshoring wage elasticity. Furthermore, for manufacturing workers, they find that 50 percent of these workers enjoy positive wage gains from net globalization. It is however important to stress that Hummels et al. (2014) use general exports to estimate the net effect and do not separate out inshoring, i.e., exports of intermediates. Amiti and Wei (2005), on the other hand, study total labor demand by using industry level data. Their study is based on data constructed using input-output tables for outsourcing intensity measures with certain restricting assumptions. They suggest that that jobs displaced by service outsourcing in a sector are likely to be offset by new jobs created within the sector.

Liu and Trefler (2008) specifically focus on China and India to analyze labor market effects of offshoring and inshoring in the US services sector. In general, small positive effects of inshoring and smaller negative effects of offshoring are found. Even if the overall net effect is positive; for workers in industries exposed to offshore outsourcing, Liu and Trefler (2008) assert that the effect tends to be less positive. They also asserted that the probability for workers to switch industry is raised by offshoring and lowered by inshoring; but, for non-collage workers and low-skilled white collar workers the effect of offshoring is negative without any positive effect from inshoring. The study by Ørberg Jensen et al. (2006) is based on a survey of companies in tradable goods and services sectors. They present globalization as being a 'two-way street' by considering the jobs created by inshoring in addition to eliminated jobs due to offshoring. According to their results for the period 2002-2005, jobs created by inshoring outnumber the jobs lost.

3. Theoretical links between offshoring, inshoring and labor demand

The theory on offshoring shows that the decision to vertically fragment production in different countries is a firm-level response to increased competition. If the production stages of a good or

service can be physically separated and when these stages contain different input mixes of high and low skilled labor, then firms can increase efficiency by specializing certain stages of the production process in different countries (Feenstra and Hanson, 1996a, 1996b). In Grossman and Rossi-Hansberg (2008) labor is not explicitly separated into high and low skilled labor, but rather with respect to different tasks. Due to general improvements in ICT and lower trade barriers firms may increasingly involve in offshoring different tasks. The efficiency gains that derive from these models focus its attention on the firms that decide to allocate some stages abroad and potential effects on different tasks or labor with different education levels. The gains in the receiving firm are much less developed, even though it's just the other side of the coin.

Inshoring, the reverse of offshoring, is intuitively due to firm-level economies of scale, reputation of quality and the supply of a specific variety of an intermediate good or a service. A firm that operates under monopolistic competition may supply a computer chip to many other firms and specialize in the production in which it has a comparative advantage. A firm may need to change its composition of labor as it specializes the production of goods or services. Thus, in general there should be similar reorganizations within firms, be it offshoring or inshoring. The relative demand for labor performing tasks that are most needed within the firm should increase as it receives orders from other (national or foreign) firms.

Does offshoring have any effect on the relative labor demand in Swedish firms? Will headquarter (HQ) activities remain in-house or will the incentives to do HQ-activities decrease as production is relocated abroad? Theoretical models on offshoring seem to assume that HQ-activities will remain in countries where skilled labor is cheap and the production will concentrate in countries where low skilled labor is cheap (Grossman and Helpman, 2002, 2003, 2005). More recent theory however does not focus primarily on the educational level of the labor, but rather on the degree of offshorability in different tasks (e.g. Grossman and Rossi-Hansberg, 2008, 2012). Offshorability differs a lot between tasks that need close interaction with the supplier and cannot easily be dispersed geographically from the HQ, and tasks that can be easily codified and produced anywhere (Autor, Levy and Murnane, 2003; Levy and Murnane, 2004). Many HQ-

activities are generally not assumed to be possible to codify or easy to document in manuals.[6] Offshoring of goods and services will generate a higher demand for coordination and management at home and provide greater scope to realize economies of scale in HQ-activities such as design and innovation and management. Thus, a positive effect on high skilled labor performing HQ-activities at home is expected.

Though most of the theoretical contributions (see, e.g., Antràs and Helpman, 2004; Grossman and Rossi-Hansberg, 2008) tell a story about high-tech firms in North offshoring production to South, more recent contributions (Grossman and Rossi-Hansberg, 2012) emphasize the importance of North - North offshoring. Their main proposition is that some tasks that are very costly to offshore will remain in the home country. However, tasks that are easily codified and that only demand limited interaction with the HQ will be offshored to countries with the lowest factor costs.[7] Finally, tasks that are difficult to offshore will be offshored to high wage countries, where producers supply the market with differentiated inputs for many producers. These high-wage countries (North) share an identical relative factor supply and technological capabilities.[8]

If the effect on relative labor demand from *offshoring* is positive, what can we say about potential effects on relative labor demand from *inshoring*, i.e. the demand of intermediate goods and services from Swedish firms? If the logic above were followed strictly, one would expect a negative effect on the relative demand of high skilled labor in Swedish firms as simple tasks are now produced here for firm's abroad that specializes in HQ-activities. Perhaps that would be a too strict interpretation since Sweden is also a "North" country with comparative advantage in high-tech production and thus the negative effect on relative labor demand may not be all that large. For example, in the industry for large civil aircraft, the production of Boeing and Airbus involves substantial geographical fragmentation of the value chain. High-tech inputs designed

[6] R&D consists of many activities and tasks such as product adaptation to local demands and horizontal product differentiation may involve tasks that can be offshored (Ali-Yrkkö and Deschryvere, 2008; Bardhan, 2006).
[7] The tasks that have a potential to be offshored vary in the transaction costs to do so. The more routine and the less the need for interaction the lower the transaction costs. The more tacit information involved, the higher are these transaction costs (Grossman and Helpman, 2008).
[8] The general idea in these theoretical models, is to describe the real world examples of Northern firms that develop technology and serve several other Northern countries, such as Intel that produces computer chip.

and produced by specialized suppliers abroad may substitute for innovation at home.[9] Boeing 787 Dreamliner is mainly produced in countries classified as ”North”. The doors are produced in Sweden and France, taking advantage of our advantages in high-tech production of composite parts and the R&D assets involved in the process of design and product development.[10] Following Grossman and Rossi-Hansberg (2012) there may be external economies of scale in the tasks that firms perform. A Swedish firm that has accumulated knowledge in producing parts to civil and military aircraft (for example aircraft parts made by composite materials) may generate complementarities in producing doors for Boeing 787 and Airbus.[11] The advantage of using a foreign specialized supplier abroad is the lower per unit costs in the production of the intermediate good or service. Thus, firms take advantage of *national* increasing returns to scale by allocating some tasks to a number of specialized suppliers abroad. There is always an extra cost of offshoring (transaction costs) that has to be weighed against the benefits of using a specialized supplier.[12]

In the theoretical models discussed above, there is hardly any discussion about potential differences between whether offshoring refers to goods or services. In the case of inputs to Boeing 787 deliveries consist of both material inputs and services, such as design, R&D, after sales services, transportation etc. These services are assumed to be more important the more advanced is the production of the inputs.

[9] For a detailed study on offshoring in the civil aircraft industry, see Lei (2013). Other examples include the optoelectronics industry (Fuchs and Kirchain, 2010). For example Dell, Hewlett-Packard, Motorola and Philips needed to reduce their costs after the telecom bubble and relocated much of the production of intermediate goods to Asian countries. This relocation also meant that many high skilled tasks are performed in Asia (Naghavi and Ottaviano, 2009).

[10] Moreover, the wings are produced in Japan, the engines in the UK and the US, the flaps and ailerons in Canada and Australia, Fuselage in Japan, Italy and the USA, the horizontal stabilizer in Italy, the landing gear in France (Grossman and Rossi-Hansberg, 2012).

[11] Ngienthi, Ma and Dei (2013) further develop the theoretical model by Grossman and Rossi-Hansberg (2012). In this new model, the Boeing 787 Dreamliner will never be offshored to South since the production process is ”supermodular”, i.e. the production needs inputs produced by specialized supplier with complementary skills.

[12] There are several transaction costs associated with offshoring. First, the HQ must decide on where and by whom these tasks should be performed. The HQ is thus in the first step involved in finding a reliable and cost effective supplier. Second, contracts are hard to draft and may cause hold up problems. The contract should cover many aspects such as: investments in capital and R&D assets, the quality, and deliverance of the input and how to share the rents. Third, after the contract has been signed, both parties have incentive to monitor the production process. Finally, if any party doesn’t stick to the terms of the contract, enforcement costs for legal advice etc. arise (Williamson, 1985; Hennart, 1982; North 1990). These transaction costs are assumed to increase as the asset specificity increases, i.e., the more sophisticated input that is being produced (Williamson, 1985).

From the discussion above one may conclude that offshoring and inshoring may have different effects on the relative demand for skilled labor. While offshoring may boost the relative demand, inshoring may have a countervailing negative effect. This negative effect may again be countervailed if inshoring mainly involves North-North trade, i.e., trade between similar countries. Inshoring of high-tech goods and advanced services may increase the demand for both lower and higher skilled labor.

4. Data

In order to benchmark against results by Andersson et al. (2014) we use the same selective strategy for the dataset. The dataset includes firms in the Swedish manufacturing industry with an average number of employees of at least 50, for the period 1997-2002. The reason for excluding smaller firms is that firm-level data on research and development, R&D, which are used as a proxy for skill biased technological change, are only available for larger firms. The final dataset is an unbalanced panel and consists 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 (Andersson et al., 2014).

Factor biased technological change which may arise from R&D is measured as

$$z_{it,R} = \frac{R_{it}}{Q_{it}} \tag{1}$$

where R_{it} is R&D expenditures in firm *i* and Q_{it} is sales in firm *i* at time *t*. Data on firm characteristics such as sales, value added, physical capital, and R&D are provided in the Financial Statistics database compiled by Statistics Sweden (SCB). Relative wages are calculated using data from the annual study of wages in Sweden compiled by Statistics Sweden.[13]

[13] 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.

Data on imports and exports of intermediate goods are available 1997-2002 and provided by Statistics Sweden. Data on imports and exports of intermediate private services are provided by the Swedish Central Bank (Riksbanken) for the period 1997-2002. More specifically offshoring, $z^k_{it,Off}$, and inshoring, $z^k_{it,In}$, are measured as

$$z^k_{it,Off} = \frac{M^k_{it}}{Q_{it}} \qquad \text{and} \qquad z^k_{it,In} = \frac{E^k_{it}}{Q_{it}} \tag{2}$$

where M^k_{it} and E^k_{it} are imports and exports, respectively, of *k* which refers to either non-energy intermediate goods or intermediate private services for firm *i* in time period *t*. United Nation's Broad Economic Categories (BEC), 3rd revision, is used to assess intermediate goods in trade data. The BEC classification is mainly linked to the Harmonized System (HS) and Combined Nomenclature (CN) via the Standard International Trade Classification (SITC). By using time consistent concordance tables from Van Beveren, Bernard and Vandenbussche (2012) based on the Pierce and Schott (2012) algorithms to link HS and BEC for the whole study period, 6-digit HS codes are grouped according to their main end use into capital goods, intermediate goods and consumer goods. These are three basic classes of goods of System of National Accounts (SNA). Unfortunately, similar classification for services has not been finalized within BEC. The groups of services are defined more broadly into the following categories: insurance services, financial services, building services, communication services, data and information services, licenses/royalties, other business services and other services.[14] A correlation matrix over the offshoring and inshoring variables used in the estimations is provided in Table A5 in Appendix.

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. The data used to calculate variables contained in our dataset are described in Table A6 and summary statistics are reported in Table A7 in Appendix. The wage bill for unskilled labor constitutes approximately 80 percent of the total wage bill for firms in Swedish manufacturing. As reported in Andersson et al. (2014) there is a much larger share of imported

[14] See notes to Table A10 in Appendix for more detailed information on what is included in each category.

intermediate goods and services (as a share of total sales) from high income countries than from other regions.

5. Patterns of offshoring and inshoring in Swedish manufacturing firms 1997-2002

Figures 1 and 2 show the value of trade in intermediate goods and services, respectively, distinguishing between offshoring and inshoring. There are several interesting observations to be made. According to Figure 1 exports of intermediate goods (inshoring) are much larger than imports of intermediate goods (offshoring), and the two follow each other trend-wise over the study period. As a comparison, Figure 2 shows that trade in intermediate services is dominated by imports (offshoring). We note a large temporary increase in services offshoring in the years 2000 and 2001, after which imports of intermediate services returned to a level more in line with a steady positive trend. The value of Swedish exports of intermediate services was at a low level of 8 billion SEK (approx. 1.2 billion USD)[15] in 1997, but has increased steadily over the whole study period; see Figure 2. At the end of the time period, 2002, exports reached almost the same level as imports of services. Further, we note that trade in services has increased more rapidly than trade in goods, and that there is higher volatility in the mean value of services offshoring over time than either goods offshoring or inshoring of any kind.

So, judging from Figures 1 and 2 it appears as if inshoring is an important aspect of the production and organization of Swedish manufacturing firms, which, hence, may have implications for the skill composition in the firms. In addition, comparing the size of services inshoring and services offshoring shows that Swedish manufacturing firms are not yet major producers of business services on the world market, but the trend is interesting. The advantage of Swedish firms seems to have been in producing and exporting intermediated goods and not services but this may change quickly.

FIGURES 1 AND 2 ABOUT HERE

[15] Exchange rate SEK/USD = 6.656 reported by the Swedish Central Bank on May 30, 2014.

Let us next take a look at what characterizes Swedish manufacturing firms that engage in offshoring and inshoring as opposed to firms that do not. Table 1 reports the mean difference between offshoring firms vs non-offshoring firms and inshoring firms vs non-inshoring firms, separating between goods and services. 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 and non-inshoring firm, respectively, in the two-digit industry of firm *i* at time *t* according to

$$\sum_{i \in Off} \left(X_i - E(X)_{Non-Off} \right) / N_{Off} \qquad \text{and} \qquad \sum_{i \in In} \left(X_{it} - E(X)_{Non-In} \right) / N_{In} \tag{3}$$

where N_{Off} and N_{In} is the number of firms engaged in offshoring or inshoring, respectively. According to Table 1, firms that trade in intermediates have a significantly higher real value added (*Y*), higher R&D intensity, a larger share of skilled labor as well as larger capital stock (the latter is not significant for firms with goods offshoring) than firms that do not trade in intermediates. Thus, inshoring firms follow the same pattern as offshoring firms, where the latter is in line with results in previous studies by Kurz (2006), Wagner (2011), Görg et al. (2008) and Andersson et al. (2014). The mean values of these firm characteristics reported in Table A8 in Appendix, show that firms with trade in intermediate services are generally much larger in all aspects compared to firms with trade in intermediate goods, where it is especially interesting to note the much higher R&D intensity and skill share.

TABLE 1 ABOUT HERE

So, what kind of intermediate goods and services make up the bulk of trade volume for Swedish firms and what implications may that have for the demand for different skills? The top 8 intermediate goods traded (offshoring and inshoring) by Swedish firms are reported in Table A9 in Appendix. Broadly speaking it appears to be two-way trade, where Swedish firms import and export rather similar kind of goods, which makes us suspect that the main part of trade takes place with similar countries. This is also confirmed by a closer look at data, where firms located

in Germany and the UK are the most important trade partners (in terms of trade volume) for intermediate goods. [16]

Table A10 in Appendix reveals that trade in services (both offshoring and inshoring) is dominated by the item denoted 'other business services', which includes services connected to trade in goods (merchanting and commissions), operational leasing, other business and technical services (legal services, accounting, management consulting, marketing and advertising, R&D, technical and engineering services, services connected to internal business group). The first thing to notice is that services included in this item seem to be high skilled intensive. When manufacturing firms let a foreign agent perform services it is likely that some are relatively routine non-core activities. But it may also be non-routine services that a foreign agent (service provider) has natural comparative advantage in producing, such as setting up legal contracts or after sales services in environments that are unfamiliar to the firm and requires high sunk cost investments. If the services provided by the foreign agent are complementary to the activities that the Swedish firm already produces, the effect on the skill composition in the firm should be nonnegative. Though, if they substitute for high skilled services provided by the Swedish firm, some high skilled workers in Sweden may find themselves redundant. However, Swedish manufacturing firms also export services (inshoring), services such as the design or blueprint of machines or technical equipment (licenses/royalties). Some of these may substitute for similar services otherwise produced abroad and accordingly increase the relative demand for skilled in those Swedish firms. Table A10 also reveals that legal and financial services, for which Swedish firms have developed skills, are inshored to a large extent. These services are perhaps complementary to the foreign firms' activities in their home countries.

6. Empirical analysis

The empirical specification originates from a translog cost function, which for cost minimizing firms can be transformed into cost share functions for each variable input factor by using

[16] The top 5 intermediate trade partner countries for Swedish manufacturing firms (ranked by value of trade volume) are the following: Goods offshoring (Germany, the UK, France, the US, Finland); services offshoring (the US, the UK, Germany, Netherlands, Canada); goods inshoring (Germany, the UK, the US, Netherlands, Belgium); services inshoring (the US, France, the UK, Denmark, Japan).

Shepard's Lemma.[17] Here, high skilled labor and low skilled labor are treated as variable inputs, while physical capital is treated as a fixed input. This latter assumption may be considered unrealistic at the firm-level, as opposed to studies using industry-level data. However, considering the short time period of study (1997-2002) it is, perhaps, less of a restriction. Given the two variable inputs, we have two cost share functions, the firm's wage bill share of skilled, S^h, and low skilled labor, S^l, which sum to one. We therefore omit one equation and estimate relative labor demand for skilled labor, S_{it}^h, at the firm level by using the following equation

$$S_{it}^h = \alpha + \beta_1 \ln\left(w_s / w_u\right)_{jt} + \beta_2 \ln K_{it} + \beta_3 \ln Y_{it} + \beta_4 z_{it} + \varepsilon_{it} \tag{4}$$

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. Since we do not have access to firm-level wages, relative wages are assumed to be industry-specific and then thereby 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^h_{it}), and estimates of 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 three measures of factor biased technological change, namely the intensity of research and development (R&D), offshoring and inshoring.[18] We distinguish between goods and services inshoring and offshoring, which may potentially have different effects on relative labor demand.

[17] See Berndt (1991) for more details on the translog cost function. This specification is ever since Berman et al. (1994) standard in the literature in the analysis of relative demand for labor and other variable input factors.

[18] This is in line with how offshoring is modelled in Feenstra and Hansen (1996b), and the subsequent literature on relative labor demand, who pointed out that effects of offshoring are similar to effects of a skill biased technological change, i.e., offshoring gives rise to within industry effects on labor demand.

6.1 Econometric considerations

One of the advantages of our study is that we are able to control for unobserved firm-level heterogeneity by exploiting the panel aspect[19] of the data. For this purpose we use fixed effects model as our base case. In addition to our base case, there are concerns about simultaneous causality of wage structure and intermediate trade intensity of the firm, together with the possible existence of omitted variables that explain the selection into R&D expenditure and trade in intermediates, as discussed by Kurz (2006) and Wagner (2011) for offshoring. Controlling for firm-level fixed-effects may help to solve this issue only partially. Firms with ex ante higher productivity or better knowledge of doing business abroad may self-select into trade in intermediates. Thus, the potential reverse causality between high skilled wages and offshoring due to omitted variables that explain the selection into both R&D expenditures and offshoring may cause further endogeneity issues affecting our estimates in various directions.

To address this potential endogeneity problem, instrumental variable estimation is used to provide a closer look to the causal relationship in addition to just controlling unobserved firm-level heterogeneity and time effects by fixed effect (within) estimation. We follow Hummels et al. (2014) and Balsvik and Birkeland (2012) in constructing firm-level instruments correlated with each firm's offshoring and/or inshoring intensity and uncorrelated with the wage structure of the firm, other than the specified connection with trade in intermediates. In order to capture shocks in world supply or demand of a product from the partner country that Swedish firms having trade relations for that specified product, world export supply (*WES*) and demand (*WID*)[20] are chosen to be the instruments for firm-level offshoring intensity of goods and inshoring

[19] We formally test whether a panel data model performs better than pooled estimates by using Breusch and Pagan (1980) Lagrange multiplier (LM) test for omitted variables. We are unable to reject the null hypothesis that the omitted regressors do not belong to the model. In addition, a Hausman specification test indicates that fixed effects model performs better than random effects model in our case. The large difference between these two panel data model specifications indicates a sizeable correlation between unobserved firm-level characteristics and the observed characteristics. The related test results are reported under Table 2.

[20] World export supply and demand are both used to be able to instrument inshoring and offshoring variables separately. Due to correlation between these instruments (0.48), specifications 2 and 4 in Table 3 are re-estimated with either *WES_tot* or *WID_tot* reconstructed by linking all the trade in intermediates of the firm. The significance of services trade is found to be robust.

$$WES\_tot_{it} = \sum_{cp} \frac{M_{i,t-1,c,p} + E_{i,t-1,c,p}}{Q_{i,t-1}} \times WE_{t,c,p} \text{ and } WID\_tot_{it} = \sum_{cp} \frac{M_{i,t-1,c,p} + E_{i,t-1,c,p}}{Q_{i,t-1}} \times WI_{t,c,p}$$

intensity of goods respectively. The trade shock for that particular product from that country can affect imports and exports of a Swedish firm, without a direct link to the firm's wage structure.

In construction of our main instruments *WES* and *WID*, import and export statistics from around 200 countries by product groups (in HS 4-digits level)[21] are taken from the United Nations Commodity Trade Statistics Database (COMTRADE) for each country-year observation. To obtain firm-level instrument, we multiply world export supply (demand) in year *t* with the offshoring (inshoring) intensity in year *t*-1 for each firm *i* matched at the country, *c*, and product level, *p*.

$$WES_{it} = \sum_{cp} \frac{M_{i,t-1,c,p}}{Q_{i,t-1}} \times WE_{t,c,p} \qquad WID_{it} = \sum_{cp} \frac{E_{i,t-1,c,p}}{Q_{i,t-1}} \times WI_{t,c,p} \tag{5}$$

Due to lack of similar information for trade flows in services, we search elsewhere for an instrument to trade in intermediate services. Freund and Weinhold (2002) find a significant relationship between number of internet users in a country and growth in services trade for the US, which is interpreted as evidence that trade in intermediate services depends on access to information and communication technologies. Following this finding and applying a similar construction method as for goods instruments in (5), we multiply the firm-level intermediate trade intensity on the country level with information available from The World Bank Indicators on the number of individuals (per 100 people) with access to the worldwide network in the corresponding trading country. Thus, a time-varying firm-level instrument for trade in intermediate services is constructed as follows

$$WIU\_tot_{it} = \sum_{c} \frac{M_{i,t-1,c} + E_{i,t-1,c}}{Q_{i,t-1}} \times IU_{t,c} \tag{6}$$

[21] Same instruments are also constructed in HS 2-digits level to be able to reduce the number of unmatched products. The estimation results are found to be the same. The missing instruments are due to firms reporting zero sales, difference in country specifications between COMTRADE and firm-level trade data and lack of estimates for unreported trade statistics for some years in COMTRADE. We also cannot produce instruments for the year 1997 as a result of using one year lagged information of offshoring and inshoring. Using same information twice is avoided by doing that.

Furthermore, to be able to identify the equations we add the first lag of firm-level offshoring and inshoring variables, and also firm-level average number of employees, $\overline{L}_{it}$, as a measure of firm size. Even if our main instruments perform better than these latter instruments, the F-statistics is larger than 10 indicating identification of the effect in each specification. Table A11 in Appendix reports additional test results for each instrument for the specifications where fixed effect estimation results can be followed through.[22] Regarding exogeneity of the instruments, the difference in Sargan statistics (C-statistics) are also reported. Instruments can be considered as arguably exogenous given the null hypothesis is not rejected at the 5 percent level.

6.2 Estimation results

Tables 2 and 3 present results where we empirically test whether trade in intermediate goods and services has any labor composition effects in Swedish manufacturing firms, 1997-2002. We are mainly interested in analyzing whether effects of inshoring are different from effects of offshoring on the composition of high and low skilled labor. In other words, can any substitution effects from offshoring be compensated or counter-acted by inshoring?

Table 2 reports estimation results from equation (4) using the within estimator, and Table 3 presents corresponding results based on IV estimation. The instruments are validated by a Sargan-Hansen test of the over identifying restrictions and a Hausman test (IV vs. OLS) points us to the results in Table 3 as the preferred ones. The share of high skilled labor increases with the industry-level relative wages, $\ln(w_s/w_u)_{jt}$, i.e. the average elasticity of substitution is below 1. This indicates that there is complementarity between high and low skilled workers.[23] According to the IV estimations physical capital and the proportion of high skilled labor are substitutes, i.e., the coefficient is negatively significant.[24] The coefficient for value added, $\ln Y$, is negative and highly significant through all estimations indicating that the elasticity of substitution is greater than one. Finally, the effect of R&D intensity of the firm is positive and strongly significant which would indicate that technology is a complement to high skilled labor.

[22] We obtain robust results for services offshoring which are stable even after controlling for unobserved firm-level factors and possible endogeneity.

[23] The relative demand for skilled labor falls, but by proportionally less than the rise in the relative wages (at the industry level), so that relative expenditures on high skilled labor rises.

[24] The within estimation results suggest that there is no statistically significant relationship between physical capital and the proportion of high skilled.

In the literature this result has been interpreted as evidence of skill biased technological change and has previously been documented by, e.g., Berman et al. (1994), Feenstra and Hansson (1999), Hansson (2005), Hijzen et al. (2006), Ekholm and Hakkala (2006), Bandick and Hansson (2009) and Andersson et al. (2014).

TABLES 2 AND 3 ABOUT HERE

Next, let us focus on the impact on relative labor demand from the in- and outflow of intermediate goods and services. According to the within estimations presented in Table 2, there is a negatively significant effect on the relative demand for skilled labor as a result of trade in intermediate goods and that more specifically arises from goods inshoring. Though, when we control for the selection into offshoring and inshoring using an IV approach, the effects disappear; see Table 3. However, a robust finding according to both the within and IV estimations is a positive and significant relationship between trade in intermediate services (inshoring plus offshoring) and the relative demand for high skilled labor. Disaggregating the variable into offshoring and inshoring shows that the effect arises from offshoring only. Hence, it seems as if inshoring of services does not alter the composition of the labor force at the firm level. This result is close to Liu and Trefler (2008) who find a small but positive net effect on skilled labor in the US from the trade in intermediate services between the US and China and India. A possible interpretation of our result is that offshored non-routine high skilled services are complements to activities within the firm, while routine less skilled activities substitute for less skilled service activities at home, both of which increase the relative demand for skilled labor in Swedish manufacturing firms.

7. Concluding remarks

Offshoring of intermediate goods and services is widely believed to have negative effects on employment in the home country. This conclusion may be erroneous if potential benefits from simultaneous reverse trade flows are not considered. Based on a rich firm-level dataset for Swedish manufacturing, 1997-2002, the objective of this paper is to add to the existing literature by explicitly analyzing how both offshoring (imports of intermediates) and inshoring (exports of intermediates) of goods and services affect the firms' composition of high and low skilled labor. National concerns about offshoring have predominantly been focusing on potential negative labor market effects in the home country. Results presented in this paper show that the relative demand for high skilled labor increases due to offshoring of services, while there is no significant effect of inshoring neither material nor services. This indicates a net increase in the relative demand for skilled workers due to services offshoring in Swedish manufacturing firms.

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Figure 1. Imports (offshoring) and exports (inshoring) of intermediate goods in Swedish manufacturing firms, 1997-2002, billion SEK

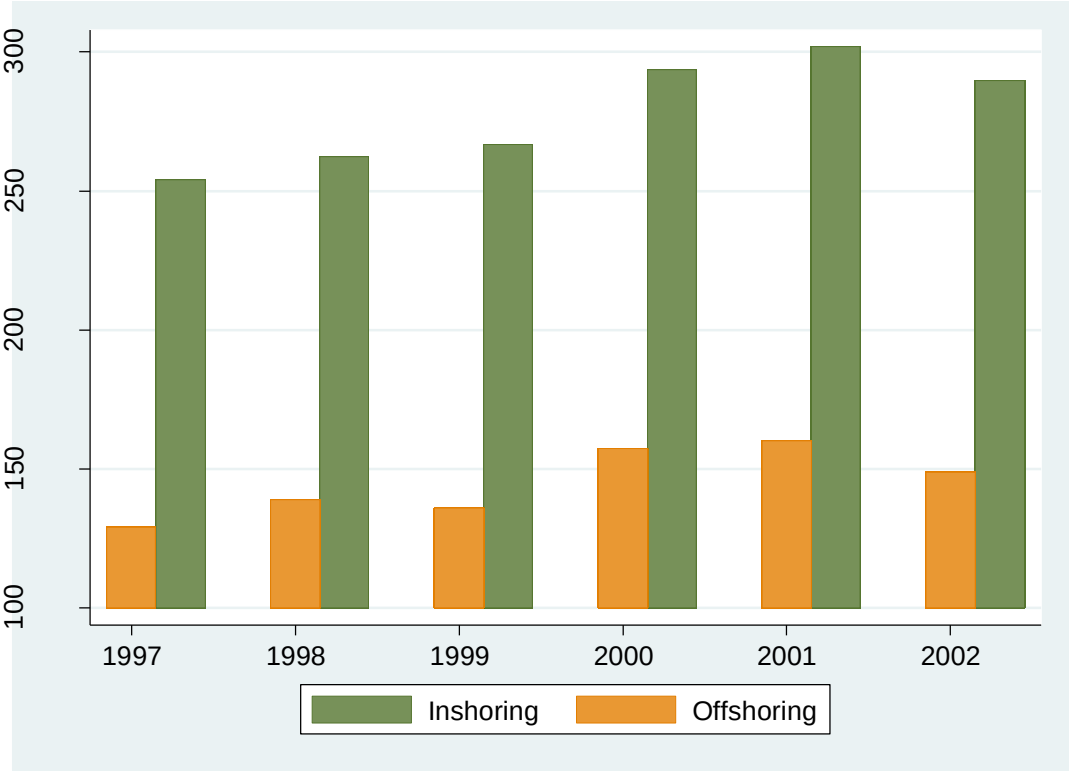
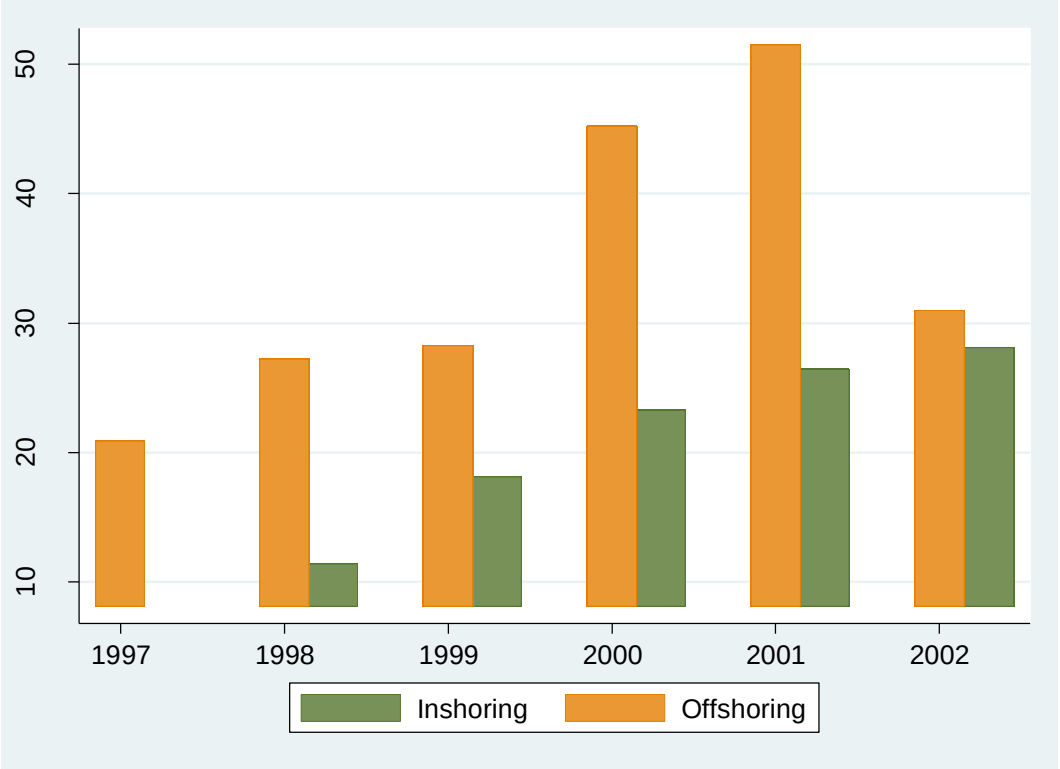


Figure 2. Imports (offshoring) and exports (inshoring) of intermediate services in Swedish manufacturing firms, 1997-2002, billion SEK



Note: The value of services inshoring in 1997 is 8 billion SEK, which does not show in the figure.

Table 1. Characteristics of firms with offshoring and inshoring relative to firms with no offshoring or inshoring

	Offshoring		Inshoring	
	Goods	Services	Goods	Services
Variables	mean difference	mean difference	mean difference	mean difference
K	917.65	198252.00	24200.30	239534.60
	(0.12)	(15.47)***	(3.33)***	(10.42)***
Y	19467.09	251849.00	89112.56	363738.00
	(2.10)**	(14.71)***	(10.52)***	(10.81)***
$z_{R\&D}$	0.012	0.016	0.013	0.015
	(28.15)***	(20.53)***	(28.91)***	(11.82)***
S^h	0.042	0.085	0.054	0.099
	(25.72)***	(38.97)***	(33.59)***	(28.06)***
S^l	-0.042	-0.085	-0.054	-0.099
	(25.72)***	(38.97)***	(33.59)***	(28.06)***
No. of obs.	8908	4288	8825	2065

Notes: The mean difference is calculated as the deviation for offshoring firms minus the corresponding value for the average non-offshoring (non-inshoring) firm in industry *j* and represents the differences in means for goods (or services) offshorers (inshorers) and non-goods (or services) offshorers (inshorers), respectively. t-values are reported within parentheses, and *, **, *** refer to significance on the 1%, 5% and 10% levels.

Table 2. Estimation results of wage bill share for high skilled labor in Swedish manufacturing firms with more than 50 employees, 1997-2002. Results based on within estimator.

Dep. variable: S^h	(1)	(2)	(3)	(4)
ln w_h/w_l	0.031***	0.030***	0.031***	0.029***
	(0.011)	(0.011)	(0.011)	(0.011)
ln K	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
ln Y	-0.010***	-0.010***	-0.010***	-0.010***
	(0.001)	(0.001)	(0.001)	(0.001)
$z_{R\&D}$	0.122***	0.125***	0.124***	0.125***
	(0.015)	(0.015)	(0.015)	(0.015)
$z_{Off\&In}^{goods\&\,services}$	-0.000			
	(0.002)			
$z_{In}^{goods\&services}$			-0.010***	
			(0.004)	
$z_{Off}^{goods\&services}$			0.012***	
			(0.005)	
z_{Off}^{goods}				-0.000
				(0.006)
$z_{Off}^{services}$				0.036***
				(0.008)
z_{In}^{goods}				-0.007*
				(0.004)
$z_{In}^{services}$				0.021
				(0.014)
$z_{Off\&In}^{goods}$		-0.004**		
		(0.002)		
$z_{Off\&In}^{services}$		0.030***		
		(0.006)		
No. of obs.	11,191	11,191	11,191	11,191
R^2 (within)	0.131	0.134	0.132	0.135
LM test	13415.38***	13402.75***	13355.96***	13397.05***
Hausman (FE vs RE)	2306.22***	2275.81***	2408.99***	2288.20***

Notes: All estimations include time and firm specific effects. Standard errors are shown in parentheses, and ***, **, * refer to 1%, 5% and 10% significance levels.

Table 3. Estimation results of wage bill share for high skilled labor in Swedish manufacturing firms with more than 50 employees, 1997-2002. Results based on instrumental variable (IV) estimator.

Dep. variable: S^h	(1)	(2)	(3)	(4)
ln w_h/w_l	0.033**	0.030**	0.033**	0.031**
	(0.013)	(0.013)	(0.013)	(0.013)
ln K	-0.004***	-0.003**	-0.004***	-0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
ln Y	-0.008***	-0.008***	-0.008***	-0.008***
	(0.001)	(0.001)	(0.001)	(0.001)
$z_{R\&D}$	0.122***	0.133***	0.125***	0.131***
	(0.017)	(0.018)	(0.017)	(0.017)
$z_{Off\&In}^{goods\&services}$	0.010			
	(0.012)			
$z_{In}^{goods\&services}$			-0.003	
			(0.017)	
$z_{Off}^{goods\&services}$			0.027	
			(0.019)	
z_{Off}^{goods}				0.010
				(0.023)
$z_{Off}^{services}$				0.094**
				(0.040)
z_{In}^{goods}				-0.004
				(0.017)
$z_{In}^{services}$				-0.128
				(0.149)
$z_{Off\&In}^{goods}$		-0.002		
		(0.013)		
$z_{Off\&In}^{services}$		0.090***		
		(0.030)		
No. of obs.	8,055	8,055	8,055	8,055
R^2 (centered)	0.147	0.131	0.145	0.141
Sargan test: χ^2 (4)	8.961*	1.169	7.698	4.888
Hausman (IV vs OLS)	2306.22***	2275.81***	2408.99***	2288.20***

Notes: All estimations include time and firm specific effects. Standard errors are shown in parentheses, and ***, **, * refer to 1%, 5% and 10% significance levels. Instruments: firm-level average number of employees, $\bar{L}_{it}$, the first lag of firm-level offshoring and inshoring variables both for goods and services; world export supply, WES_{it}; world import demand, WID_{it} and world internet users, WIU_{it}.

Table A1. Literature review

A.Offshoring					
	1. Relative Labor Demand Effect				
	a) Industry-level Data for Offshoring				
	AUTHORS	*COUNTRY*	*PERIOD*	*COVERAGE*	*RESULTS*
	Feenstra and Hanson[1] [1996b]	US	1972-1990	Manufacturing	Offshoring => 31-51% ↑ in wage share of skilled workers
	Ekholm and Hakkala[2] [2006]	Sweden	1995-2000	Manufacturing	Offshoring to low income countries => ↓ demand for workers with intermed. level of educ.
	Egger and Egger[3] [2003]	Austria	1990-1998	Manufacturing	Offshoring to Central and Eastern Europe => ↑ in the relative demand for skilled labor
	Senses [2010]	US	1980-1995	Manufacturing	Offshoring => ↑plant level labor demand elasticities for unskilled labor
	b) Firm-level Data for Offshoring				
	Andersson, Karpaty and Savsin [2014]	Sweden	1997-2002	Manufacturing	Service offshoring to middle income countries=> ↑ relative demand for skilled labor No evidence of effect from goods offshoring

Notes:

[1] For similar results see Feenstra and Hanson (1999) for US

[2] For similar results see Falk and Koebel (2002) for Germany; Hijzen, Görg and Hine (2006) for UK

[3] For similar results see Strauss-Kahn (2004) for France

Table A2. Literature review

A.Offshoring					
	2. Total Labor Demand Effect				
	a) Industry-level Data for Offshoring				
	AUTHORS	*COUNTRY*	*PERIOD*	*COVERAGE*	*RESULTS*
	Amiti and Wei [2006]	US	1992-2000	Manufacturing and Services	Service offshoring => small (-) effect on employment for 450 disaggregated manufacturing industries, but no effect on 96 aggregate industries
	Michel and Rycx [2012]	Belgium	1995-2003	Manufacturing and Buss. Services	No evidence for business services and material offshoring => industry-level labor demand both for manufacturing and service sectors
	b) Firm-level Data for Offshoring				
	Hijzen, Pisu, Upward and Wright [2011]	UK	1997-2005	Services	No evidence for service offshoring => job losses or worker turnover in the UK Offshoring firms => faster employment growth in some specifications due to cost saving effects
	Görg and Hanley [2005] (Plant level)	Ireland	1990-1995	Manufacturing and Services (only electronics firms)	Service offshoring => smaller (-) effects on labor demand than material offshoring
	La Turco and Maggioni [2012]	Italia	2000-2004	Manufacturing	Offshoring to low income countries => (-) effect on employment No evidence for offshoring to high income countries

Table A3. Literature review

A.Offshoring					
	3. Other				
	a) Industry-level Data for Offshoring				
	AUTHORS	*COUNTRY*	*PERIOD*	*COVERAGE*	*RESULTS*
	Crino [2010]	US	1997-2002	Services (with disaggregate occupational data)	Service offshoring => ↑ employment among high-skilled occupational groups ↓ employment among medium and low skilled groups
	Ottaviano, Peri and Wright [2010]	US	2000-2007	Manufacturing (with employment shares and task analysis)	No evidence for offshoring => native employment Offshoring => pushed natives towards communication intensive tasks pushed immigrants away from them
	Geishecker and Görg [2008]	Germany	1991-2000	Manufacturing (combined with household panel)	1% point ↑ in international outsourcing => up to 1.5%↓ the wage for low-skilled workers up to 2.6%↑ the wages for high-skilled workers
	Egger, Pfaffermayr and Weber [2007]	Austria	1988-2001	Manufacturing (with individual male workers data)	↑ in offshoring intensity => ↓ individual's probability of staying in or changing into the sector
	Civril [2011]	US	1980 1990 2000	Manufacturing (with occupational data)	Offshoring (being mostly insignificant) => (+) effects on relatively offshorable occupations
	b) Firm-level Data for Offshoring				
	Balsvik and Birkeland [2012]	Norway	1996-2007	Manufacturing (matched worker-firm data)	Offshoring to low income countries => (+) effect on wages of employees in offshoring firms (but no significant effect on high-skilled wages)
	b) Other				
	Grossman and Rossi-Hansberg [2008]	Theoretical		Task Analysis	↓ in the cost of offshoring tasks performed by low skill workers=>↑productivity of low skilled labor (can be applied to high skilled tasks too)

Table A4. Literature review

B. Inshoring					
	a) Industry-level Data for Offshoring				
	AUTHORS	*COUNTRY*	*PERIOD*	*COVERAGE*	*RESULTS*
	Liu and Trefler [2008]	US	1996-2005	Services (matched worker-industry data)	Offshoring => ↑ probability of industry switching Inshoring => ↓ probability of industry switching (not for low skilled labor)
	Van Welsum and Reif [2006]	US, Canada, Australia, EU15--(except 4)	1996-2003	Other business computer and information services	No evidence for imports of business services => share of employment potentially affected by offshoring. Exports of business services => ↑share of employment potentially affected by offshoring.
	Amiti and Wei [2005]	UK	1995-2001	Manufacturing and Services	No evidence for offshoring => total labor demand Jobs displaced by service offshoring likely to be offset by => new jobs created in the business and computing services by exports in related sectors.
	b) Firm-level Data for Offshoring				
	Hummels, Jørgensen, Munch and Xiang [2014]	Denmark	1995-2006	Manufacturing (matched worker-firm data)	(-) offshoring elasticity < (+) exporting wage elasticity for non-college-educated workers
	c) Survey of Firms				
	Ørberg Jensen, Funk Kirkegaard and Søndergaard Laugesen [2006]	Denmark	2002-2005	Manufacturing and utilities, transportation, business services.	Jobs created as a result of inshoring > jobs eliminated due to offshoring

Table A5. Correlation matrix over offshoring and inshoring variables used in the estimations

	$z_{Off\&In}^{goods}$	$z_{Off\&In}^{services}$	$z_{Off}^{goods\&\,services}$	$z_{In}^{goods\&services}$	z_{Off}^{goods}	$z_{Off}^{services}$	$z_{In}^{services}$	z_{In}^{goods}
$z_{Off\&In}^{goods}$	1							
$z_{Off\&In}^{services}$	0,0204	1						
$z_{Off}^{goods\&services}$	0,7440	0,2894	1					
$z_{In}^{goods\&services}$	0,9264	0,1074	0,4906	1				
z_{Off}^{goods}	0,7749	0,0437	0,9559	0,4971	1			
$z_{Off}^{services}$	0,0111	0,8334	0,2941	0,0497	0,0032	1		
$z_{In}^{services}$	0,0207	0,7152	0,1483	0,1205	0,0723	0,2712	1	
z_{In}^{goods}	0,9310	0,0028	0,4734	0,9900	0,4906	0,0134	-0,0132	1

Table A6. Data description and sources

Variable	Description	Source
Wage sum W	Total wages for all employees	SCB, Regional Labor Statistics
Wage sum for high skilled labor W^s	Wage incomes for employees with post-secondary education	SCB, Regional Labor Statistics
Wage sum for low skilled labor W^u	Wage incomes for employees with no post-secondary education	SCB, Regional Labor Statistics
Employment L	Number of employees	SCB, Regional Labor Statistics
High skilled employment L^s	Number of employees with post-secondary education	SCB, Regional Labor Statistics
Low skilled employment L^u	Number of employees with no post-secondary education	SCB, Regional Labor Statistics
Physical capital K	Book value of machinery, inventories and buildings	SCB, Structural Business Statistics
Real output Y	Value added in 2000-prices, deflated by the producer and services price indices	SCB, Financial Statistics
Sales Q	Net turnover (sales), excluding value added tax and excise tax	SCB, Financial Statistics
R&D	Expenditures on research and development (R&D)	SCB, Structural Business Statistics
Imports (M^{goods}) and exports (E^{goods}) of goods	Import and export of intermediate goods (see note)	SCB, International Trade Statistics
Imports ($M^{services}$) and exports ($E^{services}$) of services	Import and export of intermediate services (see note)	Swedish Central Bank (Riksbanken)

Notes: Intermediate goods are defined according to the Broad Economic Categories (BEC) classification scheme to differentiate intermediate goods from capital and consumption goods for the following five categories: food, industrial supplies, capital equipment, consumer durables and consumer non-durables. Intermediate services include insurance services, financial services, building services, communication services, data and information services, licenses/royalties, other business services and other services.

Table A7. Summary statistics over variables used in the estimations, 1997-2002

Variable	No. of obs.	Mean	Std. Dev.	Min.	Max.
S^h	11191	0.198	0.144	0.0000	1.0000
w_h/w_l	11191	1.381	0.070	1.172	1.715
$z_{Off\&In}^{goods\& services}$	11191	0.328	0.412	0.0000	22.449
$z_{Off\&In}^{goods}$	11191	0.315	0.402	0.0000	22.449
$z_{Off\&In}^{services}$	11191	0.013	0.075	0.0000	5.279
$z_{In}^{goods\& services}$	11191	0.218	0.295	0.0000	12.754
$z_{Off}^{goods\& services}$	11191	0.110	0.177	0.0000	9.696
z_{Off}^{goods}	11191	0.103	0.169	0.0000	9.696
$z_{Off}^{services}$	11191	0.006	0.052	0.0000	4.629
z_{In}^{goods}	11191	0.211	0.292	0.0000	12.754
$z_{In}^{services}$	11191	0.005	0.039	0.0000	1.215
K	11191	122217.4	546192.9	45.000	1.27E+07
Y	11191	172957.2	723496.5	37.9387	2.60E+07
$z_{R\&D}$	11191	0.0134	0.04	0.0000	0.701

Note: All monetary values are reported in thousand SEK.

Table A8. Mean values for characteristics of Swedish manufacturing firms with offshoring and/or inshoring, 1997-2002

	Goods			Services	
Variable	Offshorers	Inshorers	Both	Offshorers	Both
K	37550.61	39444.36	137514.70	150986.30	325334.00
Y	58946.07	76897.19	193242.90	183993.30	476492.70
$z_{R\&D}$	0.002	0.002	0.016	0.020	0.028
S^h	0.173	0.141	0.203	0.218	0.296
No. of employees	148.503	145.692	327.713	320.561	680.018

Notes: All monetary values are denoted in thousand SEK. All firms with services inshoring also have services offshoring.

Table A9. Content of goods offshoring and inshoring in Swedish manufacturing firms, top 8 products ranked according to total value of trade volume for the period 1997-2002 (billion SEK)

Product group	Offshoring	Product group	Inshoring
Chemicals and chemical products	140.694	Pulp, paper and paper products	315.487
Metal and steel production	126.539	Metal and steel production	240.575
Manufacture of motor vehicles, trailers and semi-trailers	123.972	Manufacture of motor vehicles, trailers and semi-trailers	231.214
Manufacture of telecommunication equipment	97.903	Chemicals and chemical products	154.956
Manufacture of other machinery	79.565	Manufacture of other machinery	152.714
Manufacture of electrical machinery and articles	49.113	Manufacture of telecommunication equipment	141.278
Manufacture of fabricated metal products, except machinery and equipment	34.433	Manufacture of wood, products of wood, cork, straw and plaiting materials, except furniture	97.407
Manufacture of rubber and plastic products	32.670	Manufacture of electrical machinery and articles	80.618

Note: goods are reported at the 2-digit Swedish standard classification of products by activity (SPIN 2002), which is the Swedish application of the EU Classification of Products by Activity (CPA 2002).

Table A10. Content of services offshoring and inshoring in Swedish manufacturing firms, ranked according to total value of trade volume for the period 1997-2002 (billion SEK)

Services	Offshoring	Inshoring
Other business services	167.049	59.058
Other services	15.105	5.602
Data and information services	7.170	11.215
Building services	2.745	5.509
Licences/royalties	1.044	33.668
Financial services	0.879	0.126
Communication services	0.468	0.174
Insurance	0.131	0.023

Notes: The item 'other business services' includes services connected to trade in goods (merchanting and commissions), operational leasing, other business and technical services (legal services, accounting, management consulting, marketing and advertising, R&D, technical and engineering services, services connected to internal business group). The item 'other services' includes cultural services (production and broadcasting rights to movies, audio recordings, radio- and TV-programs, services in connection with various cultural and recreational events), education and health care. The item 'data and information services' includes data services such as data systems analysis, programming and data processing, as well as information services such as database services, news agency and subscriptions, and also software licenses. The item 'building services' includes construction and installation services. The item 'licenses/royalties' includes the right to use trademarks, industrial licenses, patents and franchising. The item 'financial services' includes fees and commissions regarding services provided by banks, brokers and management. The item 'communication services' includes mail and courier services, telecommunication, transmissions over the telephone network, computer network and satellite. The item 'insurance' includes only the part of the premium which can be considered real services and not savings. More detailed information on the contents of the different items in the services data is found in Statistics Sweden (2008, 2011).

Table A11. Test results for instruments used in IV regression, specifications 2 and 4 in Table 3

	Specification (2)	Specification (4)
Andersson-Canon (under-identification test)	245.958***	102.064***
Cragg-Donald Wald F-statistic (weak identification test)	42.611	12.940
C-statistics (diff. in Sargan) for the following instruments:		
$\bar{L}$	0.005	3.838*
$z_{Off\&In}^{goods}$, first lag	0.058	.
$z_{Off\&In}^{services}$, first lag	0.651	.
z_{Off}^{goods}, first lag	.	0.119
$z_{Off}^{services}$, first lag	.	1.214
z_{In}^{goods}, first lag	.	0.019
$z_{In}^{services}$, first lag	.	1.835
WES	0.099	0.036
WID	0.045	0.010
WIU_tot	0.161	0.048
WES_tot	0.020	0.013
WID_tot	0.001	0.000

Note: ***, **, * refer to 1%, 5% and 10% significance levels.