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Offshoring, Occupations and Job Tasks:
Evidence from Swedish Manufacturing

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Abstract:

My purpose in this paper is to analyze how offshoring of intermediate goods affects different occupational groups in Swedish manufacturing firms using data for the period 2001-2008. Advances in ICT, along with improved infrastructure and lower cost of transportation have boosted the contracting and networking of firms in the global markets. A hot trend among firms is to scan the global economy for cost advantages in their domestic production of final goods. Such cost advantages can come in the form of offshoring, where imported inputs either substitute or complement specific job tasks in the domestic production. Occupations are distinguished by job tasks as cognitive (knowledge handling), management (information handling), social (service handling), and motoric (goods handling). The empirical results are in line with the stated hypotheses and show that more high-technology offshoring increases the cost share of employees with cognitive occupations. More low-technology offshoring positively influences the cost share of employees with motoric occupations.

Keywords: Offshoring, occupations, job tasks, Sweden, manufacturing

JEL classification: F14, J21, J23

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1 Introduction

Does it matter for employees' occupations and their associated job tasks what technological content the intermediate goods imports characterize when firms' engage in offshoring? The relevance of this question lies in that we lately have observed an ongoing shift in the landscape of producing goods and services in Sweden. Over the last decade the number of employees in business services in Sweden has increased with almost 30%. At the same time, the employment in Swedish manufacturing has been on a downturn and decreased with approximately 20% (SCB 2013). Such employment trends are also observed in a sequence of studies applied to Swedish functional regions, where the economic activities are large and growing (see e.g. Johansson and Klaesson (2007), (2011a), (2013)). A potential driver of these employment trends is the manufacturing firms' offshoring of production of both advanced and routine-based intermediate goods. Offshoring occurs when a firm allocates its source for intermediate goods to a foreign country by importing the intermediate goods from foreign affiliates and/or foreign non-affiliates, to later use them in its domestic production of final goods.

Five important developments have facilitated firms' strategies to perform offshoring. These developments have motivated a need for a reconsideration of the standard trade theory assumptions of fixed labor divisions. First, reduced transportation costs due to container shipping and other means of distribution have made it possible to globally move goods at a lower cost per unit transported. Second, advances in information and communications technology have made it easier for firms to communicate within their economic networks. Third, since the GATT was established in 1947 there has been an exponential increase in world merchandise trade as trade tariffs and trade quotas have been reduced drastically.[1] Fourth, the role of regional blocs (such as ASEAN, EU, MERCOSUR and NAFTA) further promote trade as they act to reduce further the import tariffs and trade quotas, and thus induce more countries to globally integrate with each other via trade links. Finally, the multinational firms have since the mid-1960s acted in favor of internationalizing their capital stocks through FDI and labor stocks by importing intermediate goods.

In this sense, offshoring is a microeconomic phenomenon that can have strong macroeconomic implications on, for example, the relative wage of workers of different skills (Feenstra 2010). Some important contributions that have modelled offshoring's effect on skills-biased change for workers and offshoring's effect on job tasks trade include Feenstra and Hanson (1995) and Grossman and Rossi-Hansberg (2006, 2008). In addition, the recent increase in firms' offshoring has induced various scholars to empirically analyze the offshoring phenomenon in terms of gains and losses in domestic jobs. A small portion of these studies analyze the offshoring phenomenon for the US (Feenstra and Hanson 1996, 1997, 1999), for France (Strauss-Kahn 2004), for the UK (Hijzen et al. 2005), for Sweden (Ekholm and Hakkala 2008) and for various OECD countries (Foster-McGregor et al. 2013). These studies have empirically examined the effect of offshoring on workers at the industry level. However, only a few studies have approached the offshoring phenomenon at the firm level (see e.g. Nilsson Hakkala et al. (2014)). In this field, Feenstra and Jensen (2009, 2012) have adapted a methodology that, similar to the industry level approach, successfully approximates input-output tables at the firm level. The firm-level approach provides a different perspective on offshoring across industries as it allows the researcher to examine the implications of offshoring at a finer level of analysis. This firm-level approach will thus be the focus in this paper.

[1] As of 1995, the General Agreement on Tariffs and Trade (GATT) is the main policy agreement of the World Trade Organization (WTO).

My purpose in this paper is to analyze how offshoring of intermediate goods affects different occupational groups in Swedish manufacturing firms using data for the period 2001-2008. I argue that a firm's decision to offshore affects certain labor occupations and job tasks in the firm differently depending on the technological content of the imported intermediate goods. As a case example I use Sweden, which is a country that is highly exposed to firms that perform offshoring. The background and motivation for this claim will be further discussed in the section that follows.

I use a unique database with export and import transactions, firm and employee data to fulfill the purpose of this paper. Occupations are classified by four categories. Cognitive employee occupations deal with knowledge-handling tasks, management employee occupations with information-handling tasks, social employee occupations with service-handling tasks, and motoric employee occupations deal with goods-handling tasks. The empirical results are in line with the stated hypotheses and show that more high-technology intermediate goods offshoring increases the cost share of employees with cognitive occupations, and decreases the cost share of employees with motoric occupations. More low-technology intermediate goods offshoring positively influences the cost share of employees with motoric occupations, whereas the cost share of employees with cognitive occupations is affected negatively.

This research comes with several contributions. First, the empirical results give a quantitative evaluation of what type of labor occupation, and its associated job tasks, is affected in offshoring firms. In addition, an increasing offshoring trend might also affect the sales and production of other domestic firms as offshoring firms establish sources for intermediate goods in foreign markets. This evaluation is thus important for politicians not only to form socially optimal policies for unemployed in Swedish manufacturing firms, but is also important in order to form future education and training policies. Second, my results contradict the insignificant offshoring firm-level estimates observed in previous research. A potential reason for the lacking evidence on the offshoring firm-level estimates is that both the offshoring variable and the way to classify offshoring according to high-income and low-income countries are miss-specified.[2] Instead, the offshoring variable should be measured as a share of firms' domestic input consumption and be classified based upon the technological content of the intermediate goods imports. Third, the methodology to proxy for firm-level offshoring followed in this paper is somewhat different compared to previous studies, and in this way it contributes to the existing literature that analyzes offshoring at the firm level.

2 Theoretical Background and Motivation

This section outlines the theoretical background on the ongoing trends in labor occupations and intermediate goods imports of firms in the Swedish manufacturing sector. The section also briefly reviews some of the previous offshoring studies and motivates the two hypotheses on offshoring that I empirically test in Section 5 of this paper.

2.1 Labor Occupations, Job Tasks and Education in Swedish Manufacturing

To be able to distinguish between different types of labor occupations, this paper makes use of the classification of occupations and tasks presented in Johansson and Klaesson (2011b: pp. 460-461). These occupations are referred to as cognitive, management, social and motoric.[3] Cognitive occupations consist of knowledge-handling tasks and to some extent of information- and goods-

[2] See e.g. Nilsson Hakkala et. al. (2014: p. 257)

[3] The classification of skills and their associated tasks are described in detail in Sub-section 4.1.

handling tasks. Management, social and motoric occupations all cover information-handling tasks, yet management occupations are to a greater extent than social and motoric occupations associated with information-handling tasks. Social occupations mostly involve service tasks, whereas motoric occupations typically are related to goods-handling tasks.

The current trend in employment in offshoring firms in Swedish manufacturing depicts some interesting patterns in terms of the occupation categories. The largest group of employed in this sector has a motoric occupation. In 2001, about two thirds of the total number of employees had a motoric occupation. At the end of the period, the share of employees with a motoric occupation decreased to almost half of the total employment (i.e. about 40000 jobs less). On the other hand, the share of employees with cognitive and management occupations increased by one third and one fifth, respectively. Moreover, social occupations have remained at an almost constant rate over the period, however, the rate is slightly falling in more recent years. Figure 1 shows the general trends in the occupation categories in offshoring firms in Swedish manufacturing 2001-08.

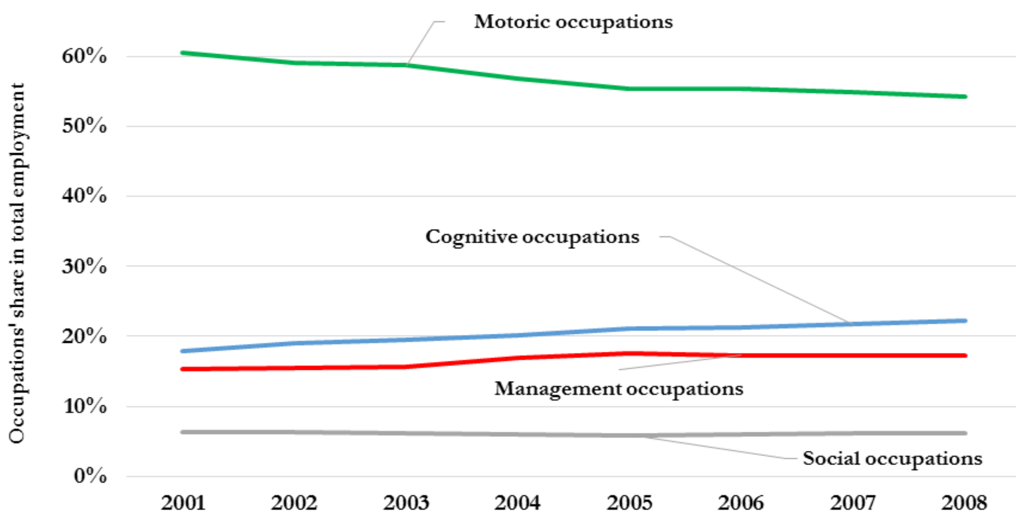

Figure 1 Occupations' share in total employment: Offshoring firms, Swedish manufacturing 2001-08 (SNI 15-36)

The occupation categories can also be examined in terms of education type depicted in the four panels in Figure 2. There is a clear ongoing pattern in all the occupation categories, namely that at least three years of tertiary education is becoming more important for offshoring firms in Swedish manufacturing.

In 2005, the share of employees with cognitive occupations and at least three years of tertiary education for the first time surpassed the share of employees with cognitive occupations and less than a high school diploma. Employees with cognitive occupations that have a high school diploma and a short tertiary education are becoming less important over time in this occupation category. In the management occupation category the share of employees with at least three years of tertiary education is growing stronger over time, whereas the share of employees holding a high school diploma and a short tertiary education is somewhat constant over the period. The share of employees with management occupations that did not graduate from high school is on a downturn.

The social occupations category shows similar trends in the shares as those observed for the management occupations category. Yet, different from the management occupations category, the social occupations category has a reversed magnitude between the share of employees with a high school diploma and a short tertiary education and the share of employees with at least three years of tertiary education. The lower right panel of Figure 2, shows that employees with motoric occupations are to a large extent low educated. However, the share of motoric employees with less than a high school diploma is falling over time. By cutting the vertical axis of this panel one can also observe that the share of employees with motoric occupations and at least three years of tertiary education is increasing. So is also the share representing motoric employees that hold a high school diploma and a short tertiary education.

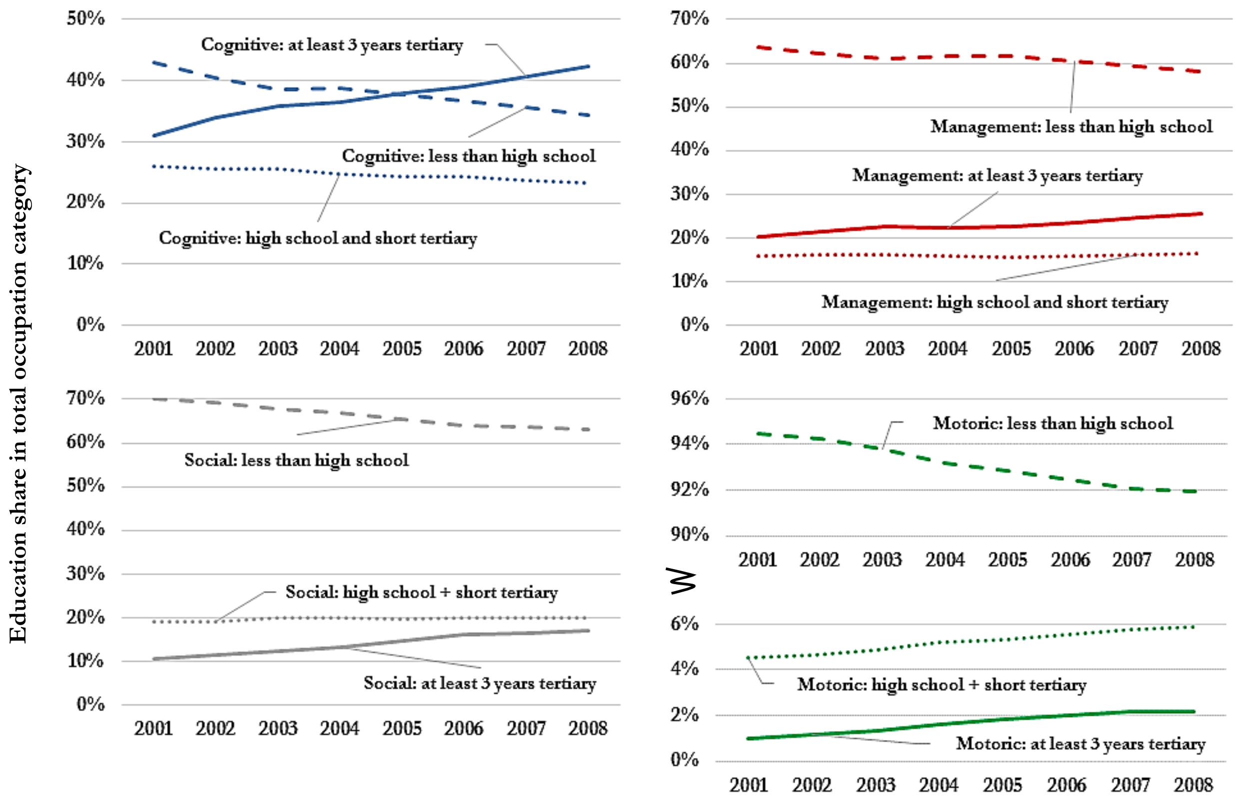

Figure 2 Education share in total occupation category: Offshoring firms, Swedish manufacturing 2001-08 (SNI 15-36)

The general trends in the occupation categories over the period analyzed show that there has been a shift away from motoric employees towards cognitive and management employees in offshoring firms in Swedish manufacturing. The majority of these employees has less than a high school diploma. However, the importance of tertiary education tends to grow stronger in all the four occupation categories over time. The changing production landscape in offshoring firms in Swedish manufacturing can be a possible reason for the change in these firms' labor occupations. The following sub-section outlines to what extent offshoring firms in Swedish manufacturing make use of the international division of labor. A common approach to do so is by analyzing the firms' intermediate goods that are contracted out abroad and imported back for use in the domestic production of final goods.[4]

2.2 Intermediate Goods Imports in Swedish Manufacturing

[4] Note that inputs and intermediate goods will be used interchangeable throughout the paper. Intermediate goods imports are reported in current values and current prices denoted in SEK. Moreover, FDI is reported in current values denoted in SEK. The inflation rate in Sweden for the period 2001-2008 has, on average, been at a level around 1.8%.

Intermediate goods imports are based on the Broad Economic Categories measurement (revision 4) published by the United Nations (UN 2002). It is important to note that the intermediate goods imports in the present paper exclude petroleum products (e.g. motor spirits and oil), as well as raw materials (such as various metals), since these intermediate goods are typically not related to firms' offshoring strategies (see e.g. Feenstra and Jensen (2009)).

The overall value of the intermediate goods imports has steadily increased for offshoring firms in Swedish manufacturing over the period 2001-08. In 2001, the value of intermediate goods imports was SEK 108358 million. The value had risen to SEK 190851 million in 2008, which is almost a doubling in eight years. Moreover, the total number of intermediate goods imports increased from 90644 in 2001 to 93995 in 2008.

Previous research has analyzed the effect of imports of intermediate goods (i.e. offshoring) on cost shares of workers by distinguishing the intermediate goods imports by high-income country and low-income country (see e.g. Nilsson Hakkala et al. (2014)). However, this procedure to distinguish between various firm strategies to offshore can be misleading due to the fact that the content of the intermediate goods imports from high income countries and/or low income countries have large variances within the income classification of the country-group. For example, the content of imported intermediate goods from two OECD members such as Germany and Greece differs quite substantially. Hence, the focus should be on the imported intermediate good itself rather than what income status the country has that the input originates from.

To better understand how intermediate goods imports can differ based on their content, I examine the price per weight unit and the quantity of each intermediate good. Following Aiginger (1997, 2000), I use unit values of imported intermediate goods to discriminate between price and quality. In addition to the price and quality discrimination, I also analyze the quantities (in terms of small or large) of the imported intermediate goods in order to proxy for their level of technology.

Table 1 presents the quartiles for the price per weight unit and the quantity of the intermediate goods imports of offshoring firms in Swedish manufacturing 2001-08. The quartiles are used to distinguish the intermediate goods imports by their technological content according to four technological classifications.

Table 1 Quartile ranges of price per weight unit (in SEK) and quantity (in kg) of intermediate goods imports

Quartiles	**Price range per weight unit (in SEK), intermediate goods imports**	**Quantity range (in kg), intermediate goods imports**
Quartile ≤ 25%	Low price range: $p \leq 58$	Small quantity range: $q \leq 99$
25% < Quartile ≤ 50%	Medium-low price range: $58 < p \leq 209$	
50% < Quartile ≤ 75%	Medium-high price range: $209 < p \leq 750$	Large quantity range: $q > 99$
Quartile > 75%	High price range: $p > 750$	

Note: The total number of intermediate goods imports for the whole period 2001-08 is 728059. Of these, 190262 are classified as high-technology inputs, 153270 as medium-high technology inputs, 160083 as medium-low technology inputs, and 224444 as low-technology inputs. About 3% of the intermediate goods imports with high price per weight unit fall in the category 'high price, large quantity'. 4% of the low-price per weight unit intermediate goods imports are classified as 'low price, small quantity'. A similar case applies to the intermediate goods imports with medium-high price per weight unit (approximately 3% are 'medium-high price, large quantity') and medium-low price per weight unit (about 5% are 'medium-low price, small quantity'). As the portion of these intermediate goods imports is small and contains many zeroes for a large majority of firms I decide to merge these intermediate goods imports into the four larger technology classifications of the total eight classifications.

Hence, an imported intermediate good with a high price per weight unit and a small quantity can proxy for an input with a high-technological content (e.g. components for the aeronautics industry typically have a high price per weight unit, yet are imported in small quantities). Conversely, an intermediate good import with a low price per weight unit and large quantity indicates that the input content is low on technology (e.g. processed meat variants for the food industry have a low price per weight unit and are often shipped in large quantities). Moreover, an intermediate good import with a medium-high price per weight unit and a small quantity is referred to as an input with medium-high technology. A medium-low technology input has a medium-low price per weight unit together with a large quantity.

Figure 3 illustrates the value of intermediate goods imports in SEK per technological classification 2001-08. The data for all the four technological classifications have been normalized by the number of intermediate goods imported in each technology class. It is obvious from the figure that intermediate goods imports classified as low-technology inputs have steadily increased over the whole period. Low-technology inputs correspond to about half the total value of the intermediate goods imports. Inputs with medium-low, medium-high and high-technological content are also increasing over time. However, imported inputs with medium-high technological content have experienced a decline in the crisis period post-2007. The normalized value of intermediate goods imports increases in all technology classifications, yet with low-technology imported inputs increasing the most.

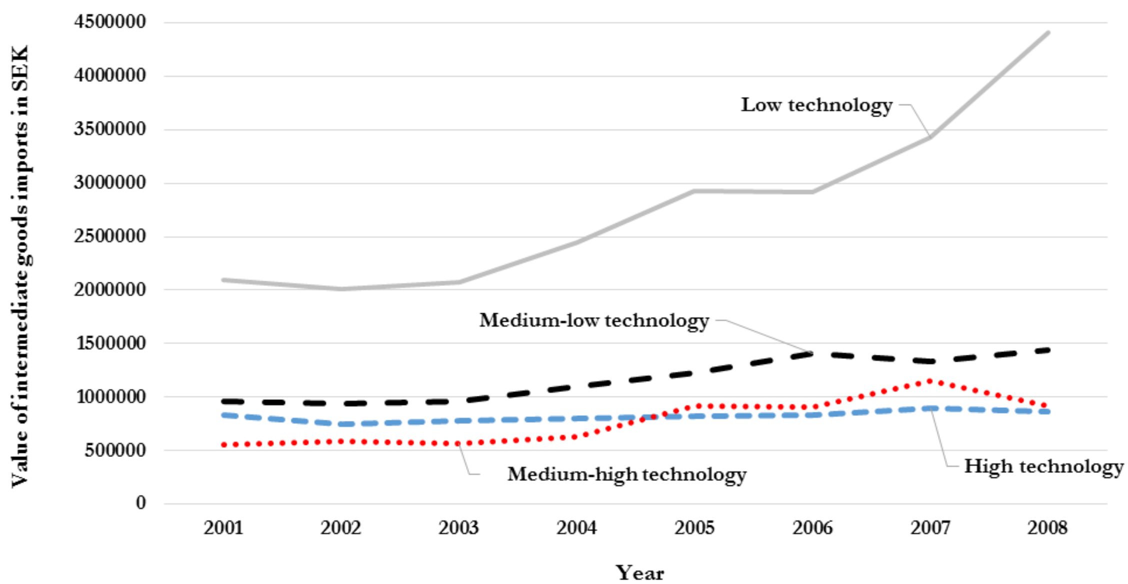

Figure 3 Value of intermediate goods imports in SEK normalized by the number of imported intermediate goods (excludes petroleum products and raw materials): Offshoring firms, Swedish manufacturing 2001-08 (SNI 15-36)

The imports of intermediate goods have steadily increased in Swedish manufacturing in the period 2001-08 and so has the firms' incentive to perform offshoring. That firms in Swedish manufacturing are using offshoring strategies is no news. Many reports have confirmed this ongoing trend. For example, the ITPS (2006) report shows that multinational firms (MNF) account for more than half of the Swedish manufacturing sector's total employment and investment. Moreover, the MNFs' share in total R&D in Swedish manufacturing is about 70 percent (Norbäck 2011). Another important indicator that accelerates firms' offshoring potential is reflected in the Swedish FDI made abroad. The Swedish FDI abroad in manufacturing amounted to SEK 683 billion (53.4% of total Swedish FDI) in 2001, compared to SEK 1175 billion (48% of total Swedish FDI) in 2008 (SCB 2009).

2.3 Offshoring Theories and Empirical Strategies

Theoretical and empirical research on the internationalization of manufacturing processes through FDI has been conducted for a rather long period.[5] However, the interest in this paper is to seek theoretical support in the literature that combines the theories of location, trade and production to arrive at various frameworks of offshoring.

The theoretical contributions in the research on offshoring include Feenstra and Hanson (1995), Arndt (1998a, 1998b), Jones and Kierzkowski (2001) and Grossman and Rossi-Hansberg (2008). This stream of research stresses the importance of advances in transportation and in information and communications technology, in combination with firms' aim to lower production costs by trading components and job tasks. Moreover, these developments have induced a faster and cheaper movement of components and unfinished goods. The adding of bits of value in various locations also emphasizes that today's trade has enabled the firms' division of labor to be highly international. Hence, the end results of this literature stream are offshoring theories that highlight the fragmentation trade in components and in job tasks. For example, Jones and Kierzkowski (2001) show that service links play a fundamental role in coordinating the fragmented production as technological advances stimulate imports of components, thus making the industry benefit from productivity gains. Different from Jones and Kierzkowski, Grossman and Rossi-Hansberg (2008) present a model that associate the productivity gains with the factor performing the tasks that become cheaper to trade (i.e. the productivity gains stem from a fall in factor costs by offshoring).

A related question concerns what bits of value the firm should keep in-house and what bits of value it should offshore to another location. Gereffi et al. (2005) note three important factors for how a firm decides to govern its value chain. The first factor deals with the complexity of the information and knowledge transfer required to sustain a particular transaction that involves a product specification. Second, the ability to decode this information and knowledge transfer efficiently with low transaction-specific costs. Third, the capabilities of the actual and the potential suppliers of the transaction's requirements.

One can use inputs in a firm's domestic production of final goods to illustrate how these three factors might cause cost conflicts that affect job tasks in the firm differently. Two examples regard simple assembly and product development (see e.g. Gereffi (1999) and Gereffi et al. (2005)). Simple assembly is usually associated with tasks that involve less information and knowledge and lower cost per employee (e.g. in terms of wages). In some activities, assembly can even be labor saving if the assembly tasks instead are performed by a technological attribute, such as an automated machine. However, assembly is both space and attribute driven and often requires high costs for buildings, land and machines. On the other hand, product development often requires more knowledge and information and higher cost per employee to carry out for the firm. A firm's investment in product development does increase the possibilities to earn more revenues, yet, is costly to perform since it requires a lot of effort in R&D.

The cost function in a firm's domestic production of final goods is typically economized upon, and is described in the literature as a main decision mechanism for a firm whether not to offshore, or to

[5] The outcome of this research has indicated a wide range of motives trying to explain the choice of international production. For example, Hymer (1960) focus on international firm advantages through market specific assets. Vernon (1966) advocates an institutional approach to explain differences in production structures, product cycles and gains from trade between countries. The empirical tests in Dunning (1980) suggest that international production is viable given that the firm has owner-specific advantages, manages to internalize its owner-specific rights and has specific localization factors to exploit.

offshore some (or all) fragments of its domestic production. Some related motives for firms to engage in offshoring include: to utilize a competitive advantage of an international labor division (Kinkel and Maloca 2009), to gain technological competence by locating the production close to, or within an industrial cluster (van Winden et al. 2011)), to access more lenient laws and regulations (Henderson et al. 2002)), to gain proximity to global markets (Bhagwati et al. 2004), to exploit the benefits of free trade zones and other benefits in terms of low trade tariffs and quotas in trading blocs (OECD 2010), to follow the lead partner (Eriksson et al. 2008), to achieve economies of scale in production (Doh 2005), or to procure suppliers' expertise, or capacity for specialization (Bunyaratavej et al. 2008).

Along with these theories and motives, many scholars have examined the role of offshoring on skill-biased change for workers and/or job tasks. A common approach to estimate skill-biased change in the empirical literature is to adapt a translog cost function presented in Berman et al. (1994). The assumptions underlying this model are that firms minimize costs in the choice of inputs and that there are constant returns to scale in production. The share equation in first differences that measures the change in non-production wages relative to total wages ($\mathrm{d}\omega_{\eta m}$) is:

$$\mathrm{d}\omega_{\eta m} = \alpha_1 + \alpha_2 \mathrm{d}\ln\left(\frac{w_{\eta m}}{w_{\psi m}}\right) + \alpha_3 \mathrm{d}\ln\left(\frac{K_m}{V_m}\right) + \epsilon_m \,,$$

where w_η and w_ψ are wages of non-production and production labor, respectively. m is the industry index, K is capital, V is value added, and ϵ is a stochastic error. Whether α_2 is positive, or not, depends on whether the elasticity of substitution between production and non-production labor is below, or above unity. If α_3 is greater than zero, then there is capital-skill complementarity.

The above share equation has commonly been adapted to examine the relationship between offshoring, technology and demand for worker skills. For example, Feenstra and Hanson (1996), Strauss-Kahn (2004) and Hijzen et al. (2005) use such a specification and find that offshoring augments the amount of high-skilled workers at the expense of low-skilled workers. In addition, Egger and Egger (2006) find that in the long-run, offshoring induces an increase in high-skilled workers relative to low-skilled workers. Other empirical studies do however show different results on the relationship between offshoring and high-skilled workers. For example, Foster-McGregor et al. (2013) find a negative relation between offshoring and high-skilled workers, whereas Piva and Vivarelli (2004) and Antonietti and Antoniolo (2011) find no empirical evidence.

The translog cost function has also been used in empirical research on how industry-level offshoring influences the cost shares of workers in Swedish manufacturing. Hansson (2005) analyzes the link between MNF transfers and within-industry shifts in labor demand of Swedish manufacturing MNF parents. The model is specified to measure the level of change in the industry's share of skilled workers in the total wage bill using physical capital, value added, technology and a relative wage regressor as explanatory variables. The empirical results show that increased employment shares in non-OECD affiliates are significantly related to skills upgrading in Swedish MNF parents within the industry.

Ekholm and Hakkala (2008) examine the effect of offshoring[6] on labor demand in Swedish manufacturing and services for the period 1995-2003. The study applies a translog cost share

[6] Offshoring is measured in broad terms as consumption goods and intermediate goods imports over total sales and in narrow terms as intermediate goods imports over total sales. The consumption goods and intermediate goods imports are distinguished by low- and high-income countries.

function that simultaneously estimates for three types of workers: unskilled, semi-skilled and skilled. In this context the industry cost share is given by the industry's capital stock, wages, value added and factor-biased technological change. The empirical analysis shows that offshoring of intermediate goods to low-income countries induces a shift in labor demand, from workers holding an intermediate level of education, to workers with a higher educational attainment. In addition, offshoring to high-income countries has the opposite effect.

In terms of offshoring[7] and job tasks, Nilsson Hakkala et al. (2014) note that offshoring has a neutral effect on the cost share for workers with non-routine job tasks. By separating high-income countries (OECD countries) from low-income countries (non-OECD countries) and re-estimating the model shows that the firm-level offshoring estimates remain unchanged.

2.4 Motivation

The descriptive data on employee occupations and intermediate goods imports, along with the theories and empirical results in previous research motivates a researcher to incline some questions that can be examined at the firm level. If a firm tends to offshore semi-finished goods, then how is its domestic production of final goods affected? Does its structure or composition change in terms of employees? Suppose that a firm uses input M coordinated by employees with occupations i and j ($i \neq j$) in its production of final good Y. Now, suppose that the firm decides to import M from abroad (e.g. by offshoring) and in the continuation the firm lets only employees with occupation i coordinate the process of M in order to produce Y. Then, does the firm need more of employee i? What type of employee is i? What type of employee is j?

I find it interesting to evaluate how various employee occupations, such as i and j, in Swedish manufacturing firms are affected by firms' offshoring strategies. Two main conjectures are drawn from the development in employees' occupations, the intermediate goods imports and the theories outlined in this section.

The first conjecture is on firms' intermediate goods imports with a high-technological content. High-technological inputs such as semi-conductors for the aeronautics, computers and motor vehicles industries usually are associated with job tasks that involve a lot of knowledge handling and less of information and goods handling, and hence should require more employees with cognitive occupations. Thus, Hypothesis 1 is as follows:

> **H_1:** More firm offshoring of high-technology intermediate goods, on average, positively affects employees with cognitive occupations.

Hypothesis 1 indicates that imports of intermediate goods that contain more technology-rich inputs in the final production require more employees with job tasks involving knowledge handling and to some extent information and goods handling in the manufacturing firm. In other words, employees with cognitive occupations benefit from complementarity effects in the production of final goods.

A second conjecture is on firms' intermediate goods imports with a low-technological content. Low-technological inputs usually are associated with routine-based job tasks in the production process. Inputs like these often require job tasks that involve a lot of goods handling and to some extent also with information and service handling, and thus should require more employees with motoric occupations. In this case, Hypothesis 2 is:

[7] The offshoring variable is constructed in a similar way as in Ekholm and Hakkala (2008).

H_2: More firm offshoring of low-technology intermediate goods, on average, positively affects employees with motoric occupations.

Imports of intermediate goods that have a low-technological content consist of more routine-based inputs in the final production. Therefore, Hypothesis 2 suggests that more employees associated with goods-handling tasks (and to some extent also with information- and service-handling tasks) are demanded by a manufacturing firm that performs offshoring of low-technology inputs.

Given this outline, Section 3 presents the empirical strategy that is followed in this paper in order to empirically test Hypotheses 1 and 2.

3 Empirical Application

The empirical model applied in this paper is based on a firm that uses technique θ in its production of Y final goods:

$$Y(\theta) = K^{\beta_1(\theta)} L_i^{\beta_2(\theta)} L_j^{\beta_3(\theta)} M_\tau^{\beta_4(\theta)} , \tag{1}$$

where K denotes physical capital, L_i is employees with tasks defined by occupation i, L_j is employees with tasks defined by occupation j, and M_τ is imports of intermediate goods with a technology-specific content τ. The exponents in Equation (1) are a function of the technique indicator, and technological development alters the exponents such that $\beta_3(\theta)/\beta_2(\theta)$ diminishes as technique τ improves.

The firm's location cost advantages are examined by the corresponding cost function:

$$C(\theta) = rK + w_i L_i + w_j L_j + p_\tau M_\tau , \tag{2}$$

where the first term on the right hand side of Equation (2) is the cost of physical capital at price r. The second and third terms on the right hand side are the employee cost of i and j at prices w_i and w_j. The last term represents the cost of intermediate goods imports containing technology τ at price p_τ.

Following Luenberger (1995: p. 39), a minimization of Equation (2) subject to Equation (1) yields the firm's cost expression:

$$C\big(Y(\theta)\big) = \sigma[Y(\theta)]^{1/\sigma} \left[\frac{r}{\beta_1(\theta)}\right]^{\beta_1(\theta)/\sigma} \left[\frac{w_i}{\beta_2(\theta)}\right]^{\beta_2(\theta)/\sigma} \left[\frac{w_j}{\beta_3(\theta)}\right]^{\beta_3(\theta)/\sigma} \left[\frac{p_\tau}{\beta_4(\theta)}\right]^{\beta_4(\theta)/\sigma} , \tag{3}$$

where $\sigma = \beta_1(\theta) + \beta_2(\theta) + \beta_3(\theta) + \beta_4(\theta)$. The conditional demands for employee i and for employee j can then be found by Shephard's lemma (see e.g. Luenberger (1995: p. 44)):

$$L_i = \left[\frac{\beta_1(\theta)}{r}\right]^{-\beta_2(\theta)/\sigma} \left[\frac{\beta_2(\theta)}{w_i}\right]^{\beta_2(\theta)/\sigma} \left[\frac{\beta_3(\theta)}{w_j}\right]^{-\beta_2(\theta)/\sigma} \left[\frac{\beta_4(\theta)}{p_\tau}\right]^{-\beta_2(\theta)/\sigma} Y(\theta)^{1/\sigma} , \tag{4}$$

$$L_j = \left[\frac{\beta_1(\theta)}{r}\right]^{-\beta_3(\theta)/\sigma} \left[\frac{\beta_2(\theta)}{w_i}\right]^{-\beta_3(\theta)/\sigma} \left[\frac{\beta_3(\theta)}{w_j}\right]^{\beta_3(\theta)/\sigma} \left[\frac{\beta_4(\theta)}{p_\tau}\right]^{-\beta_3(\theta)/\sigma} Y(\theta)^{1/\sigma} . \tag{5}$$

Equations (4) and (5) indicate that the conditional demands for employees i and j depend on the input prices. Then, by taking the derivatives $\partial L_i/\partial p_\tau$ and $\partial L_j/\partial p_\tau$ it is possible to examine how small changes in the price of intermediate goods imports affect the conditional demands. In the empirical application, this paper uses the following two reduced form regression model specifications:

$$\mathcal{L}_{k,i} = \gamma_0 - \gamma_1 O_{k,\tau} - \gamma_2 ln\left(\frac{K}{S}\right)_k + \gamma_3 lnw_{k,i} - \gamma_4 lnw_{k,j} - \gamma_5 X'_k + \varepsilon_k \ , \quad (6)$$

$$\mathcal{L}_{k,j} = \delta_0 - \delta_1 O_{k,\tau} - \delta_2 ln\left(\frac{K}{S}\right)_k - \delta_3 lnw_{k,i} + \delta_4 lnw_{k,j} - \delta_5 X'_k + u_k \ , \quad (7)$$

where $\mathcal{L}_i$ and $\mathcal{L}_j$ represent the cost shares of firm k's employees with occupations i and j, respectively. γ_0 and δ_0 are constants. O_τ denotes firm k's offshoring of intermediate goods containing technology τ. The negative sign of γ_2 and δ_2 indicates that if the quasi-fixed capital increases in firm k (i.e. the physical capital per sales value, K/S, increases), then technology (e.g. in terms of automated machines) substitutes for employees, whereas a positive sign would imply capital-skill complementarity. X is a vector of additional firm characteristics and ε and u are stochastic error terms that by assumption are normally distributed with zero mean.

The cost share specifications in Equation (6) and Equation (7) suffer from a potential endogeneity problem in that wages and employment usually are determined simultaneously. A common praxis in the previous literature has been to omit the wage regressors when estimating the cost share equations of employees (see e.g. Berman et al. (1994), Slaughter (2000), and Nilsson Hakkala et al. (2014)). I follow this praxis and omit the wage regressors when estimating the main empirical models.[8]

4 Data, Variables and Descriptive Statistics

The data consist of publicly audited micro-level data collected by Statistics Sweden. The data on employees, firms and international trade are linked together through a key identification number. This convenient structure of the data makes it possible to link an employee to a specific firm, and a firm to what it exports and imports over time.

There are two important details on the data that need a discussion before the outline of the variables. First, SSYK codes on employees (i.e. job classification codes of employees) reported by Statistics Sweden are available in the database from 2001 and onwards. This data availability restricts the earliest reporting of an employee's occupation to 2001. Second, there are two distinct changes in the Swedish Industrial Classification of Industries (SNI) that somewhat complicate a firm-level analysis in the manufacturing sector. These appear when the industry classification changes from SNI1992 (reported until year 2002) to SNI2002 (reported from 2003 to 2008), and from SNI2002 to SNI2007 (reported from 2009 and onwards).

The first change, from SNI1992 to SNI2002, contains only deviations at the three-digit level for manufacturing firms. Since the two-digit level is enough for my analysis, the first industry classification change is of less importance. However, post-2008 the data is reported only with SNI2007. The difference between SNI2002 and SNI2007 is rather large at the two-digit level. Even after matching firms based on their key identification number, there is a significant part of the firms that seems missing (about 15 percent of the firms are lost in 2009). In order to avoid making the wrong inferences in the regression analysis, I decide to restrict the yearly observations of firms to the

[8] For comparison matters, Equations (6) and (7) will be estimated with the wage regressors as a robustness check.

period 2001-08. I then construct a panel consisting of 43263 observations on Swedish manufacturing firms that import intermediate goods.

4.1 Dependent Variables

The dependent variables consist of cost shares of different employee occupations that can be contrasted against their related job tasks. The occupation-classification is inspired by Bacolod et al. (2009), whereas the work tasks build upon the research of Andersson and Johansson (1984) and Andersson (1985). Moreover, the occupations and their associated tasks have been conceptualized in Johansson and Klaesson (2011b: pp. 460-461).

With this classification one can distinguish occupations in more aspects than do the current literature in the offshoring field. Previous research has approached the offshoring phenomenon by considering differences in skills-level, such as non-production and production workers or in terms of high-, semi- or low-skilled workers. For example, Autor et al. (2013) use a continuous measurement of routine task-intensity on a zero to ten scale, which produces a one-dimensional view on job tasks. On the other hand, Johansson and Klaesson (2011b) distinguish categorically between various employee occupations by using the SSYK coding reported by Statistics Sweden. The four main categories consist of employee occupations categorized as cognitive, management, social and motoric, and are associated with various job tasks related to knowledge, information, service and goods handling. Hence, categorical occupations like these can be used in a simplistic way in order to analyze employee occupations in more dimensions.

Table 2 shows that employees with cognitive occupations are associated mostly with tasks that involve knowledge handling, and to a small extent also with information- and goods-handling tasks. Management employees are assigned to tasks associated with information and service handling. The difference between knowledge and information in this context is that knowledge reveals itself in cognitive patterns that can be universally applied in explaining work tasks and in instruments designed for controlling some work tasks (an example is geometry). Note also that information can be carrier of knowledge messages. Hence, knowledge in this sense tends to be more durable, while information is perishable. Employees with social occupations are associated with service tasks that also involve information to some extent. Finally, employees with motoric occupations deal with goods-handling tasks that to some extent is combined with tasks associated with information and service handling (Johansson and Klaesson 2011b: 460-461).

Table 2 Classifications of occupations by job tasks: High and low refer to the employee's proportion of handling the task

		Task			
		Knowledge handling	**Information handling**	**Service handling**	**Goods handling**
Occupation	**Cognitive**	**High**	Low	-	Low
	Management	-	**High**	Low	-
	Social	-	Low	**High**	-
	Motoric	-	Low	Low	**High**

Source: Adapted from Johansson and Klaesson (2011b)

Based on the above classification, the dependent variables in this paper consist of firm k's cost shares of employee occupations and their associated job tasks presented in Table 2. The cost shares are denoted as follows: $\mathcal{L}_{cog}$ is the cost share of employees with cognitive occupations, $\mathcal{L}_{mgt}$ is the cost share of employees with management occupations, $\mathcal{L}_{soc}$ is the cost share of employees with social occupations, and finally $\mathcal{L}_{mot}$ is the cost share of employees with motoric occupations.

4.2 Explanatory Variables

Offshoring

The offshoring variable of the firm needs an explicit outline in its motivation and approximation. Firms that perform offshoring typically re-locate some stages in production to foreign countries. Instead of producing the goods domestically, firms' import semi-finished and final goods from cheaper or more attractive production sources abroad. Aside from cheaper input costs in production (e.g. employee costs, land rents and national tax rates), other attractive production sources for firms to offshore can be the technological know-how and expertise in the international division of labor and economies of scale. In this sense, I am interested in semi-finished goods that are used up in the domestic production of final goods (i.e. imported input costs relative to the domestic input consumption). Thus, the offshoring variable in this paper disregards capital goods and consumption goods, since most likely these types of goods are consumed by firms with or without offshoring strategies.[9]

To construct the offshoring variable I have used trade data in terms of exports and imports for the period 2001-08. I have followed three steps in the process to be able to distinguish which goods are consumer or capital goods, and which goods are intermediate goods. The trade data reported by Statistics Sweden follows the Combined Nomenclature at the eight-digit level (i.e. CN8).

Since product codes change from year to year, a first step is to transform the trade data into the same nomenclature throughout the period. By using concordances tables published by Eurostat, I have followed each product over the period and accounted for any change in the product code. In doing so, all products in this data set follow the latest CN8, i.e. they follow CN8 for 2008.

The second step, is to use concordances tables for matching the CN8 reported data with Harmonized System 2007 at the six-digit level (HS6). HS6 is an international classification that takes into account the nature of the product and gives a direct linkage to the use of broader economic product groups.

As a final step, I match the HS6 with the classification for Broad Economic Categories (BEC) revision four. The BEC follows 19 basic categories that can be approximated for the three classes of goods, namely consumption goods, capital goods and intermediate goods. I then categorize, at the firm level, the imports and exports that belong to each class of goods and calculate the offshoring variable according to Equation (11) below. Since I also have information on the price and quantity of each intermediate good, I can construct the offshoring variable based on different technological classifications.

In order to construct the offshoring variable for firm k, I first need the information on its cost of inputs. Firm k's cost of inputs can be obtained through its sales value (S_k), which is composed by value added (V_k) plus cost of inputs (I_k):

$$S_k = V_k + I_k \, , \tag{8}$$

Since both the value added and the sales value of firm k are observable, Equation (8) can be specified in terms of cost of inputs:

[9] Offshoring in this way is referred to as the narrow measurement (see e.g. Feenstra and Hanson (1996)). The intermediate goods in the present paper exclude fuels and lubricants and raw materials due to their ambiguous role in production (e.g. motor spirits can be classified both as an intermediate good and a consumer good, whereas raw materials are inputs required by firms with or without offshoring motives). Capital goods and consumer goods are excluded from the trade data.

$$I_k = S_k - V_k \ . \tag{9}$$

Firm-level Input-Output (I-O) tables are needed to find firm k's domestic input consumption in the production of final goods (ς_k). These I-O tables are then used to calculate the firm's total import excess of intermediate goods ($E_k - M_k$), which I then deduct from its cost of inputs:

$$\varsigma_k = I_k - (E_k - M_k) \ , \tag{10}$$

where M_k and E_k are firm k's total imports and total exports of intermediate goods.

I then sum the intermediate goods imports over k and τ, and divide this sum by firm k's domestic input consumption in the production of final goods. This procedure gives an approximated firm-level offshoring variable that takes into account the technological content of the imported input ($O_{k,\tau}$):

$$O_{k,\tau} = \frac{\sum M_{k,\tau}}{\varsigma_k} \ , \tag{11}$$

where τ denotes that the technological content being offshored can be high, medium-high, medium-low and low. $O_{k,\tau}$ decreases with more domestic input consumption by the firm and increases the higher is the firm's purchases of intermediate goods imports abroad.

Capital in sales value

I include a quasi-fixed input factor represented by firm k's physical capital (K_k) divided by its sales value (S_k). The physical capital variable consists of holdings of land, buildings, and machines in production (e.g. automated machines) and for administrational use (such as personal computers) denoted in SEK. The sales value is the net turnover of the firm reported in SEK. An argument for the inclusion of this quasi-fixed input factor is to capture effects on the cost shares of employees that indicate capital-skill complementarity or substitution within the firm.

Firm size

Some firms are much larger than the average firm and thus requires a variable that can control for size effects on the cost shares of employee occupations over the panel observations. In this case, the firm size variable (F_k) is represented by the total number of employees in firm k.

Exporter of intermediate goods

A control variable that enters the right hand side of the estimated model is importers of intermediate goods that also are exporters of intermediate goods. It might be the case that firms that have both imports and exports of intermediate goods are different from firms that only import intermediate goods. In this sense, if firm k is also an exporter of intermediate goods it is assigned a dummy variable ($D_{exporter}$) equal to 1, otherwise the dummy variable is equal to 0.

Offshoring persistency

Another control includes a persistency measure to account for persistent offshoring firms. Some firms engage in offshoring in only two periods, while other firms offshore every year in the period analyzed. The offshoring persistency dummy ($D_{persistent}$) is equal to 1 if firm k engages in offshoring in all the eight periods under analysis (i.e. 2001-08), otherwise the dummy variable is equal to 0.

Additional controls

Some additional controls are added to the regression model. These include industry dummies and year dummies. The industry dummies control for trends in employee occupations that are due to industry-specific trends in the cost shares of employees, whereas the time dummies account for trends in employee occupations that are due to time-specific changes in the economy that affect the cost shares of employees.

4.3 Descriptive Statistics

Table 3 presents the descriptive statistics for the offshoring firms in the panel (see Table A.1 in the Appendix for a correlations table). Employees with cognitive occupations correspond to about 13 percent of the total cost share. The cost share of management occupations is around 28 percent of the total cost share. Employees with social occupations have the smallest share of the four occupational categories, whereas employees with motoric occupations represent almost half of the total cost share.

All the offshoring variables have rather large variances and the mean values reported here should be treated with caution. Instead, I interpret the median as it sums up to the total offshoring variable. High-technology offshoring in firms is about 0.3 percent of the total domestic input consumption. Medium-high and medium-low technology offshoring corresponds to 0.4 and 0.9 percent of the firms' total domestic input consumption, respectively. The highest portion is observed for low-technology offshoring, where the median is almost 3 percent of the total domestic input consumption. Overall, offshoring corresponds to about 4 percent of the total domestic input consumption. Due to the large variances in the offshoring variables, all models will be estimated with firm-clustered robust standard errors in order to account for the wider tails in the distributions of the offshoring variables.

Moreover, a majority of the firms are exporters of intermediate goods, whereas only a third of the firms engage in offshoring in every year during the period 2001-08.

Table 3 Descriptive statistics for 11609 unique offshoring firms: the total number of observations is 43263

Variable	Obs.	Mean	Median	Standard deviation	Min	Max
Dependent						
Cost share cognitive: $\mathcal{L}_{cog}$	43263	0.132	0.055	0.201	0	1
Cost share management: $\mathcal{L}_{mgt}$	43263	0.285	0.241	0.216	0	1
Cost share social: $\mathcal{L}_{soc}$	43263	0.109	0.052	0.165	0	1
Cost share motoric: $\mathcal{L}_{mot}$	43263	0.474	0.524	0.289	0	1
Explanatory						
High-technology offshoring: $O_{hightech}$	22885	0.071	0.003	0.761	1.22e-07	43.316
Medium-high technology offshoring: $O_{medhightech}$	23619	0.053	0.004	0.460	1.32e-07	36.187
Medium-low technology offshoring: $O_{medlowtech}$	24281	0.069	0.009	0.516	2.44e-08	52.213
Low-technology offshoring: $O_{lowtech}$	26492	0.147	0.026	0.896	9.10e-09	83.839
Total offshoring: O_{total}	43263	0.195	0.042	1.213	2.10e-08	95.944

Capital in sales (ln): $\frac{K}{S}$	43263	1.255	1.262	0.089	0.427	2.736
Firm size (ln): F	43263	2.997	2.890	1.551	0	9.919
Exporting firm: $D_{exporter}$	43263	0.732	1.000	0.443	0	1
Persistent offshoring firm: $D_{persistent}$	43263	0.332	0.000	0.471	0	1

5 Empirical Results and Analysis

The empirical model is estimated for the cost shares of employees with cognitive, management, social and motoric occupations. Each cost share is then estimated in five different specifications based on the technological content being offshored. The first specification of the cost share examines high-technology offshoring, specifications two and three analyze medium-high technology and medium-low technology offshoring, respectively. The fourth specification examines low-technology offshoring. The final specification tests for the effect of total offshoring. All models presented here are estimated with a Generalized Linear Model (GLM) based on Papke and Wooldridge (1996) in order to account for the fractions and the many zeroes that enter the model as dependent variables. The main results are as follows.

If firms' increase high-technology offshoring by 10 percent (the median in Table 3 goes from 0.0030 to 0.0033), on average, the cost share of employees with cognitive occupations increases by 0.17 percent (the mean in Table 3 goes from 0.1320 to 0.1337). This finding is highly significant and in line with Hypothesis 1, as more high-technology offshoring has a complementarity effect on cognitive occupations in firms' domestic production of final goods. In addition, more high-technology offshoring implies that job tasks associated with knowledge handling, and to some extent with information and goods handling increase. On the other hand, more low-technology offshoring, on average, lowers the cost share of employees with cognitive occupations. This finding indicates that if the content of the offshored input is low on technology, then firms substitute for cognitive employees in the domestic production of final goods. By contrasting these findings with the employment trends for cognitive occupations depicted in Figure 1 and the top left panel in Figure 2, and the increase in high- and low-technology intermediate goods imports depicted in Figure 3, these results are somewhat expected.

A general note on the cost shares of employees with cognitive occupations is that if firms are persistent offshorers (which applies to about one third of the firms), then on average, the cost share of employees with cognitive occupations decreases no matter what type of technology is offshored by firms.

Turning to the cost share of employees with motoric occupations, one can observe that more high-technology offshoring in firms, on average, decreases the cost share of employees with motoric occupations. A similar relationship, yet with a lower magnitude, is observed for medium-low technology offshoring. However, if firms' increase low-technology offshoring by 10 percent (i.e. the median in Table 3 goes from 0.0260 to 0.0286), then on average, the cost share of employees with motoric occupations increases by 0.12 percent (the mean in Table 3 goes from 0.4740 to 0.4752). The latter result corresponds to the conjecture outlined in Hypothesis 2. In this case, job tasks associated with goods handling, and to some extent also with information and service handling, gain from complementarity effects in firms' domestic production of final goods. The falling share of employees with motoric occupations is associated with employees that have less than a high school degree, whereas employees with at least a high school diploma are increasing (see the lower right panel in Figure 2). One possible reason for the positive relationship between low-technology offshoring and the cost share of employees with motoric occupations is that this type of offshoring strategy suits well for employees that have stayed in school a little longer or spent some time at the university after high school. In other words, the higher the technology content being offshored by firms, the more likely it is that employees with less than a high school diploma are replaced by employees with at least a high school diploma.

Another interesting finding for the cost share of employees with motoric occupations is that there is capital-skill complementarity in firms' domestic production of final goods. However, the overall offshoring performed by firms, on average, decreases the cost share of employees with motoric occupations. Furthermore, if firms export intermediate goods the cost share of motoric occupations decreases in all the model specifications.

More high-technology offshoring, on average, induces a higher cost share of employees with management occupations. In this sense, more offshoring of high-technological intermediate goods is strongly associated with a higher demand for job tasks that deal with information handling, and that to some extent also deal with service handling. A positive relationship is also observed between the cost share of management employees and medium-low technology offshoring. Offshoring strategies involving high-technology and medium-low technology inputs might possibly suit well for management employees with at least a high school diploma. Moreover, there is strong empirical evidence that the overall impact of offshoring come with a complementarity effect for employees with management occupations in firms' domestic production of final goods.

If firms' offshore in all periods, the cost share of employees with management occupations increases irrespective of what technology the intermediate goods imports contain. Also, the cost share of management employees increases if firms are exporters of intermediate goods. A possible reason for this result might be that exports of intermediate goods are associated with information and service activities in firms that require more managerial effort.

The estimated models for technology-based offshoring work rather poorly for the cost shares of employees with social occupations. The only observed evidence is found for the model with low-technology offshoring. In this case, if low-technology offshoring increases, on average, the cost share of employees with social occupations decreases. Thus, low-technology offshoring substitutes for job tasks dealing with service handling in firms' domestic production of final goods. Similar to the model that examines the cost share of employees with management occupations, firms that export intermediate goods, on average, increase the cost share of employees with social occupations.

5.1 Robustness Checks

For comparison matters I have estimated all the models via Ordinary Least Squares (OLS). The OLS estimation procedure is, however, not the optimal way to examine the cost share functions due to the characteristics of the dependent variable. The least squares estimates for the panel (not presented here) report the same significance and signs, but are clearly downwards biased as the estimation technique fails to account for the many zero values contained in the fractions that represent the dependent variables in the main model.

As a first robustness check I estimate the main model by including all the zeroes of the different offshoring measures in order to run them simultaneously in one estimation for each cost share. Table A.2 presents the regression results for the cost shares distinguished by occupation of the employees. For the cost share of employees with cognitive occupations I find that both the significance and sign of the high-technology offshoring estimate are still in line with what I expected in Hypothesis 1. A similar case applies to the model specification with the cost share of employees with motoric occupations and low-technology offshoring (i.e. Hypothesis 2). Note that the economic significance of the two estimates (grey shaded in Table A.2) grows stronger as the size of the coefficients is larger than those obtained in Table 4.

Some firms offshore in all the periods under analysis and might be different from firms that engage in offshoring only a few periods. As such, I construct a balanced panel and drop the persistency measure in the main model. Moreover, I run the models with all the offshoring variables simultaneously in one estimation for each cost share. This procedure reduces the panel size from 43263 observations to 14688 observations and the number of unique firms from 11609 to 1836. As can be seen in Table A.3, Hypotheses 1 and 2 still hold. In addition, an interesting observation regards the model specification with the cost share of employees with motoric occupations. The statistical significance of the low-technology offshoring estimate not only improves, but also the size of the estimate (0.154) has a higher economically significance compared to the model specifications in Table 4 (0.011) and in Table A.2 (0.024). Hence, an increase in low-technology offshoring by 10 percent (i.e. the median in Table 3 goes from 0.0260 to 0.0286), on average, increases the cost share of employees with motoric occupations by 1.54 percent (i.e. the mean goes from 0.4740 to 0.4894).

As an additional robustness check I also compare the results of the main model by a model that uses an alternative dependent variable. In this case, the re-specified dependent variable is in the form of cost shares of i) employees with at least three years of tertiary education, ii) employees with less than a high school diploma, and iii) employees with a high school diploma and a short tertiary education. Tables A.4 and A.5 in the Appendix show the regression results for the model with a re-specified dependent variable. A brief outline of these results is as follows:

i) More high-technology offshoring, on average, increases the cost share of employees with at least three years of tertiary education, whereas more low-technology offshoring has a neutral effect on the high-educated employees. Total offshoring has a positive effect on employees in this category.

ii) If firms' engage in more high-technology and medium-high technology offshoring, on average, the cost share of employees with less than a high school diploma decreases. Moreover, low-technology offshoring has a neutral effect on low-educated employees. If overall offshoring increases, on average, the cost share of low-educated decreases.

iii) The cost share of employees with a high school diploma and a short tertiary education is positively influenced by high-technology and medium-high technology offshoring. Similar to i) and ii), the coefficient for low-technology offshoring is insignificant.

The model with the alternative dependent variable is partly supporting the results obtained from estimating the main model. The alternative model shows that high-technology offshoring is important for employees that are more educated, whereas the role of low-technology offshoring is more ambiguous. In terms of total offshoring, the results clearly depict the ongoing trends in Figure 2.

I also estimate the main model and the model with an alternative dependent variable with a re-specified offshoring variable that group countries according to income and region (see Table A.6 in the Appendix for a list of countries included in each bloc). Table A.7 summarizes the results only for the various offshoring variables categorized after the country bloc that the intermediate goods imports originate from. In general, the model including the re-specified offshoring variable performs worse than both the main model and the model with an alternative dependent variable. Even if I treat the BRICS countries and Central and East Europe as a single bloc of countries, the performance of the re-specified offshoring variable remains poor.

A final robustness check is to include firm k's wage of employee i relative to the average wage of employee j in the main model. A model specification like this suffers from a potential endogeneity problem, however, is of importance in order to check the robustness of the main model. After including the relative wage in the main model, the significance and sign of the various offshoring estimates remain unchanged compared to the estimates of the main model (see Tables A.8 and A.9). The relative wage coefficient is very small, however, negative and highly significant for all models. The significance and sign of the estimates for capital in sales and firm size remain unchanged, whereas there are some slight differences in the estimates for exporters of intermediate goods, and offshoring persistency. These results indicate that changing the specification of the main model by including the relative wage of the firm still produces robust offshoring estimates that are in line with Hypotheses 1 and 2.

6 Concluding Remarks

My purpose in this paper has been to analyze how offshoring of intermediate goods affects different occupational groups in Swedish manufacturing firms using data for the period 2001-2008. In this paper, I have argued that the technological content in the offshoring of manufacturing firms plays an important role for what occupations and job tasks are demanded by firms in their domestic production of final goods. The empirical regularity shows that offshoring an intermediate good with a high-technological content requires someone in the firm that have similar characteristics in terms of knowledge, and that to some extent also can master the handling of both information and goods. These characteristics are typically found among employees with cognitive occupations. On the other hand, offshoring an intermediate good with a low-technological content requires someone in the firm that can handle the good accordingly, and that is able to follow up on information and service related to such an input. In this case, employees with motoric occupations seem to be a match.

Previous research that has analyzed how the cost shares of worker skills and/or job tasks are influenced by offshoring in Swedish manufacturing firms has neither acknowledged the differences contained in the inputs offshored by firms, nor properly accounted for what offshoring actually is approximated for. Hence, the way to proxy for firm-level offshoring needs to be reconsidered, especially when dealing with manufacturing firms. This paper suggests two recommendations to be followed in the future research on firm-level offshoring and job tasks trade. First, the technological aspect of the input needs to be better integrated in the firm's offshoring, a simple division of countries based on income does not suffice. When the firm-level offshoring variable is based on countries grouped by their income levels, the performance of the measure is rather poor. The bad performance might be due to the fact that high-income and low-income country groups have large within group variances in terms of the technological content of the inputs. Second, we need to reconsider what is actually examined in terms of offshoring. Offshoring should not be based on how large a firm's share is of intermediate goods imports in its total sales, or in its value added. Rather, offshoring should be based on how large the firm's share is of intermediate goods imports in its domestic input consumption in the production of final goods. The latter way of proxying for offshoring does, both theoretically and empirically, make more sense. Whether this share is high or low relates much better to the research question we are interested in, that is, whether a firm's offshoring affects the cost share of employees in its domestic production of final goods.

Offshoring comes with both complementarity and substitution effects on the occupational groups and their associated job tasks. The offshoring strategy of a firm does not necessarily need to affect the firm's domestic employees negatively. Hence, offshoring can also act beneficial for the firm's domestic employees. The main message in this paper is that what we put into the domestic production of final goods requires the 'right' employees to figure things out. If an input is of complex standards, then the firm demands employees that can deal with the complex standards. If the input is simple by its nature to process in the domestic production of final goods, then the firm demands employees that associate with such processes. Thus, what we need is to better integrate the technological contribution of the input itself into our approximation of offshoring. Since in the end, it is the 'right' employee that needs to put the inputs together in order to produce the firm's output.

Table 4 Regression results for the cost shares of employees with cognitive (estimations 1-5) and motoric (estimations 6-10) occupations

Explanatory variable	**GLM - Fractional response estimation (maximum likelihood)**									
	Cost share of *cognitive* occupations (dependent)					Cost share of *motoric* occupations (dependent)				
	1 (H_1)	2	3	4	5	6	7	8	9 (H_2)	10
High-technology offshoring: $O_{hightech}$	0.017*** (0.006)					-0.048* (0.026)				
Medium-high technology offshoring: $O_{medhightech}$		-0.005 (0.014)					-0.005 (0.018)			
Medium-low technology offshoring: $O_{medlowtech}$			-0.016 (0.020)					-0.012** (0.006)		
Low-technology offshoring: $O_{lowtech}$				-0.031* (0.016)					0.011** (0.004)	
Total offshoring: O_{total}					-0.004 (0.004)					-0.010** (0.004)
Capital in sales (ln): $\frac{K}{S}$	-0.577*** (0.152)	-0.518*** (0.153)	-0.951*** (0.149)	-1.289*** (0.142)	-0.699*** (0.112)	2.916*** (0.119)	3.153*** (0.116)	3.679*** (0.106)	3.667*** (0.106)	3.102*** (0.082)
Firm size (ln): F	0.078*** (0.008)	0.127*** (0.008)	0.152*** (0.008)	0.178*** (0.008)	0.099*** (0.007)	0.211*** (0.006)	0.218*** (0.006)	0.220*** (0.006)	0.210*** (0.005)	0.237*** (0.005)
Exporting firm: $D_{exporter}$	-0.193*** (0.032)	-0.163*** (0.034)	-0.029 (0.036)	-0.033 (0.033)	-0.152*** (0.022)	-0.353*** (0.022)	-0.319*** (0.022)	-0.308*** (0.021)	-0.259*** (0.019)	-0.273*** (0.014)
Persistent offshoring firm: $D_{persistent}$	-0.152*** (0.019)	-0.144*** (0.019)	-0.120*** (0.018)	-0.093*** (0.018)	-0.124*** (0.016)	0.052*** (0.014)	0.027** (0.013)	0.002 (0.013)	-0.048*** (0.012)	-0.076*** (0.011)
Constant	-2.462*** (0.203)	-2.724*** (0.203)	-2.414*** (0.191)	-2.157*** (0.190)	-2.635*** (0.152)	-4.121*** (0.160)	-4.555*** (0.157)	-5.158*** (0.143)	-4.993*** (0.142)	-4.309*** (0.111)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unique firms in panel	7009	7151	7085	7365	11609	7009	7151	7085	7365	11609
Observations (firm observations over panel years)	22885	23619	24281	26492	43263	22885	23619	24281	26492	43263
R^2_{OLS}	0.18	0.16	0.17	0.22	0.18	0.30	0.30	0.31	0.31	0.30

Note: Firm-clustered robust standard errors within parenthesis. The GLM is estimated with the link (logit) family (binomial) command since the dependent variable is a fraction containing many zeroes. The offshoring variables exclude intermediate goods imports such as energy and raw material. ***, **, * denote significant at the 1%, 5% and 10% level, respectively. Year and industry dummies are included in all estimations.

Table 5 Regression results for the cost shares of employees with management (estimations 11-15) and social (estimations 16-20) occupations

Explanatory variable	GLM - Fractional response estimation (maximum likelihood)									
	Cost share of *management* occupations (dependent)					Cost share of *social* occupations (dependent)				
	11	12	13	14	15	16	17	18	19	20
High-technology offshoring: $O_{hightech}$	0.018*** (0.007)					0.001 (0.010)				
Medium-high technology offshoring: $O_{medhightech}$		0.011 (0.013)					-0.007 (0.012)			
Medium-low technology offshoring: $O_{medlowtech}$			0.020** (0.009)					-0.007 (0.011)		
Low-technology offshoring: $O_{lowtech}$				0.005 (0.003)					-0.038* (0.023)	
Total offshoring: O_{total}					0.011*** (0.003)					0.000 (0.004)
Capital in sales (ln): $\frac{K}{S}$	-1.189*** (0.098)	-1.374*** (0.094)	-1.576*** (0.092)	-1.576*** (0.092)	-1.315*** (0.071)	-2.775*** (0.165)	-2.774*** (0.153)	-2.847*** (0.149)	-3.061*** (0.145)	-2.850*** (0.117)
Firm size (ln): F	-0.211*** (0.006)	-0.231*** (0.005)	-0.240*** (0.006)	-0.259*** (0.006)	-0.246*** (0.005)	-0.163*** (0.008)	-0.177*** (0.008)	-0.178*** (0.008)	-0.150*** (0.008)	-0.157*** (0.007)
Exporting firm: $D_{exporter}$	0.343*** (0.021)	0.317*** (0.021)	0.232*** (0.020)	0.213*** (0.018)	0.258*** (0.014)	0.387*** (0.035)	0.276*** (0.034)	0.282*** (0.033)	0.267*** (0.031)	0.286*** (0.023)
Persistent offshoring firm: $D_{persistent}$	0.038*** (0.012)	0.059*** (0.011)	0.081*** (0.011)	0.090*** (0.011)	0.121*** (0.009)	0.007 (0.019)	-0.006 (0.018)	-0.029* (0.018)	0.039** (0.018)	0.072*** (0.016)
Constant	1.176*** (0.133)	1.532*** (0.127)	1.785*** (0.124)	1.785*** (0.123)	1.361*** (0.096)	1.954*** (0.220)	2.157*** (0.201)	2.261*** (0.197)	2.268*** (0.192)	1.992*** (0.156)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unique firms in panel	7009	7151	7085	7365	11609	7009	7151	7085	7365	11609
Observations (firm observations over panel years)	22885	23619	24281	26492	43263	22885	23619	24281	26492	43263
R^2_{OLS}	0.13	0.16	0.18	0.18	0.13	0.08	0.09	0.10	0.09	0.07

Note: Firm-clustered robust standard errors within parenthesis. The GLM is estimated with the link (logit) family (binomial) command since the dependent variable is a fraction containing many zeroes. The offshoring variables exclude intermediate goods imports such as energy and raw material. ***, **, * denote significant at the 1%, 5% and 10% level, respectively. Year and industry dummies are included in all estimations.

References

Aiginger, K. (1997). "The use of unit values to discriminate between price and quality competition." Cambridge Journal of Economics **21**(5): 571-592.

Aiginger, K. (2000). "Europe's Position in Quality Competition." Enterprise DG Working Paper European Commission and Austrian Institute for Economic Research.

Andersson, Å. E. (1985). Kreativitet - Storstadens Framtid. Stockholm, Prisma.

Andersson, Å. E. and B. Johansson (1984). Industrial Dynamics, Product Cycles and Employment Structure. Working Paper 84-9, International Institute for Applied Systems Analysis.

Antonietti, R. and D. Antonioli (2011). "The Impact of Production Offshoring on the Skill Composition of Manufacturing Firms: Evidence from Italy." International Review of Applied Economics **25**(1): 87-105.

Arndt, S. W. (1998a). Globalization and the Gains from Trade, in K. J. Koch and K. Jaeger (eds.). Trade, Growth, and Economic Policy in Open Economies: Essays in Honour of Hans-Jürgen Vossgerau. New York, NY, Springer-Verlag: pp. 3-12.

Arndt, S. W. (1998b). "Super-Specialization and the Gains from Trade." Contemporary Economic Policy **16**(4): 480-485.

Autor, D. H., Dorn, D., and G. H. Hanson (2013). "Untangling Trade and Technology: Evidence from Local Labor Markets." Discussion Paper Series Forschunginstitut zur Zukunft der Arbeit No. 7329.

Bacolod, M., Blum, B. S. and W. C. Strange (2009). "Skills in the city." Journal of Urban Economics **65**(2): 136-153.

Becker, S. O., Ekholm, K., and M.-A. Muendler (2005). "Location Choice and Employment Decisions: A Comparison of German and Swedish Multinationals." Weltwirtschaftliches Archiv **141**(4): 693-731.

Berman, E., Bound, J., and Z. Griliches (1994). "Changes in the Demand for Skilled Labor within US Manufacturing: Evidence from the Annual Survey of Manufactures." Quarterly Journal of Economics **109**(2): 367-397.

Bhagwati, J., Panagariya, A. and T. N. Srinivasan., (2004). "The Muddles over Outsourcing." Journal of Economic Perspectives **18**(4): 93-114.

Bunyaratavej, K., Hahn, E. D. and J. P. Doh (2008). "Multinational Investment and Host Country Development: Location Efficiencies for Services Offshoring." Journal of World Business **43**(2): 227-242.

Doh, J. P. (2005). "Offshore Outsourcing: Implications for International Business and Strategic Management Theory and Practice." Journal of Management Studies **42**(3): 695-704.

Dunning, J. H. (1980). "Towards an Eclectic Theory of International Production: Some Empirical Tests." Journal of International Business Studies **11**(1): 9-31.

Egger, H. and P. Egger (2006). "International Outsourcing and the Productivity of Low-Skilled Labor in the EU." Economic Inquiry **44**(1): 98-108.

Ekholm, K. and K. Hakkala (2008). The Effect of Offshoring on Labor Demand: Evidence from Sweden. CEPR Discussion Paper No. 5648.

Eriksson, S., Backman, M., Balkow, J., and J. Dahlkild., (2008). Varför producera utomlands? 11 Fallstudier från Jönköpings län om outsourcing och offshoring. JIBS Research Reports. Jönköping, Sweden. **No. 2008-3**.

EU Commission (2003). Commission recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises. Official Journal of the European Union C(2003) 1422.

Feenstra, R. C. (2010). Offshoring in the Global Economy: Microeconomic Structure and Macroeconomic Implications. Cambridge, MA, MIT Press.

Feenstra, R. C. and G. H. Hanson (1995). "Foreign Investment, Outsourcing and Relative Wages." NBER working paper No. 5121 Cambridge, MA.

Feenstra, R. C. and G. H. Hanson (1996). "Globalisation, Outsourcing and Wage Inequality." American Economic Review **86**(2): 240-245.

Feenstra, R. C. and G. H. Hanson (1997). "Foreign direct investment and relative wages: Evidence from Mexico's maquiladoras." Journal of International Economics **42**(3-4): 371-393.

Feenstra, R. C. and G. H. Hanson (1999). "The Impact of Outsourcing and High-Technology Capital on Wages: Estimates for the United States, 1979-1990." Quarterly Journal of Economics **114**(3): 907-940.

Feenstra, R. C. and J. B. Jensen (2009). Evaluating Estimates of Materials Offshoring from U.S. Manufacturing. NBER working paper University of California at Davis and Georgetown University.

Feenstra, R. C. and J. B. Jensen (2012). "Evaluating Estimates of Materials Offshoring from U.S. Manufacturing." Economics Letters **117**(1): 170-173.

Foster-McGregor, N., Stehrer, R., and G. J. de Vries (2013). "Offshoring and the Skill Structure of Labour Demand." Review of World Economics **149**(4): 631-662.

Gereffi, G. (1999). A Commodity Chains Framework for Analysing Global Industries. Brighton, UK, Institute of Development Studies in Brighton.

Gereffi, G., Humphrey, J., T. Sturgeon (2005). "The Governance of Global Value Chains." Review of International Political Economy **12**(1): 78-104.

Grossman, G. M. and E. Rossi-Hansberg (2006). The Rise of Offshoring: It's Not Wine for Cloth Anymore. Symposium sponsored by the Federal Reserve Bank of Kansas City Jackson Hole, WY, National Science Foundation.

Grossman, G. M. and E. Rossi-Hansberg (2008). "Trading Tasks: A Simple Theory of Offshoring." American Economic Review **98**(5): 1978-1997.

Hansson, P. (2005). "Skill Upgrading and Production Transfer within Swedish Multinationals." Scandinavian Journal of Economics **107**(4): 673-692.

Henderson, J., Dicken, P. Hess, M., Neil, C., and H. W.-C. Yeung (2002). "Global Production Networks and the Analysis of Economic Development." Review of International Political Economy **9**(3): 436-464.

Hijzen, A., Görg, H. and R. C. Hine (2005). "International Outsourcing and the Skill Structure of Labour Demand in the United Kingdom." Economic Journal **115**: 860-878.

Hymer, H. S. (1960). The International Operations of National Firms: A Study of Direct Foreign Investment. Cambridge MA, MIT Press.

ITPS (2006). Strukturstudie av näringslivet i Sverige 2003. Östersund, Sweden, Institutet för tillväxtpolitiska studier.

Johansson, B. and J. Klaesson (2007). Infrastructure, Labour Market Accessibility and Economic Development, in Anderson, W. P., Johansson, B., Karlsson, C., and K. Kobayashi (eds.). The Management and Measurement of Infrastructure: Performance, Efficiency and Innovation. Northampton, MA, Edward Elgar.

Johansson, B. and J. Klaesson (2011a). "Agglomeration Dynamics of Business Services." The Annals of Regional Science **47**(2): 373-391.

Johansson, B. and J. Klaesson (2011b). Creative milieus in the Stockholm region, in Andersson, D. E., Andersson Å. E., and C. Mellander (eds.). Handbook of Creative Cities. Cheltenham, UK, Edward Elgar.

Johansson, B. and J. Klaesson (2013). Urban Growth: Co-evolution of Producer Services and Other Sectors, in Klaesson, J., Johansson, B., and C. Karlsson (eds.). Metropolitan Regions: Knowledge Infrastructures of the Global Economy. Berlin, Germany, Springer-Verlag: pp. 47-72.

Jones, R. W. and H. Kierzkowski (2001). A Framework for Fragmentation, in S. W. Arndt, and H. Kierzkowski (eds.). Fragmentation: New Production Patterns in the World Economy. New York, NY, Oxford University Press: pp. 17-34.

Kinkel, S. and S. Maloca (2009). "Drivers and Antecedents of Manufacturing Offshoring and Backshoring: A German Perspective." Journal of Purchasing and Supply Management **15**(3): 154-165.

Luenberger, D. G. (1995). Microeconomic Theory. New York, NY, McGraw-Hill.

Norbäck, P.-J. (2011). "Subsidizing Away Exports? A Note on R&D Policy Towards Multinational Firms." Journal of Industry, Competition and Trade **11**(1): 25-42.

OECD (2010). Measuring Globalisation: OECD Economic Globalisation Indicators. Paris, France, OECD Publishing.

Papke, L. and J.M. Wooldridge (1996), "Econometric methods for fractional response variables with an application to 401(K) plan participation rates." Journal of Applied Econometrics **11**(6): 619-32.

Piva, M. and M. Vivarelli (2004). "The Determinants of the Skill Bias in Italy: R&D, Organisation or Globalisation?" Economics of Innovation and New Technology **13**(4): 329-347.

SCB (2009). Foreign Direct Investment: Assets and Income 2007. Stockholm, Statistics Sweden.

SCB (2013). "Antal förvärvsarbetande (natt- och dagbefolkning) efter näringsgren (SNI 2007) åren 2000-2010." data retrieved from www.scb.se on November 12, 2013.

Nilsson Hakkala, K., Heyman, F. and F. Sjöholm (2014). "Multinational Firms and Job Tasks." European Economic Review **66**: 248-265.

Slaughter, M. J. (2000). "Production Transfer within Multinational Enterprises and America Wages." Journal of International Economics **50**(2): 449-472.

Strauss-Kahn, V. (2004). "The Role of Globalization in the Within-Industry Shift Away from Unskilled Workers in France." Challenges to Globalization: Analyzing the Economics 0-262-03615-4: 209-233.

UN (2002). Classification by Broad Economic Categories. Series M No. 53 Rev. 4 New York, NY, Department of Economic and Social Affairs.

van Winden, W., van den Berg, L., Carvalho, L. and E. van Tuijl (2011). Manufacturing in the New Urban Economy: Regions and Cities. Abingdon, UK, Routledge.

Vernon, R. (1966). "International Investment and International Trade in the Product Cycle." The Quarterly Journal of Economics **80**(2): 190-207.

Appendix

Table A.1 Correlations table for the dependent and explanatory variables that enter the main model

	$\mathcal{L}_{cog}$	$\mathcal{L}_{mgt}$	$\mathcal{L}_{soc}$	$\mathcal{L}_{mot}$	$O_{hightech}$	$O_{medhightech}$	$O_{medlowtech}$	$O_{lowtech}$	O_{total}	$\ln \frac{K}{S}$	$\ln F$	$D_{exporter}$	$D_{persistent}$
$\mathcal{L}_{cog}$	1												
$\mathcal{L}_{mgt}$	-0.099	1											
$\mathcal{L}_{soc}$	-0.151	0.089	1										
$\mathcal{L}_{mot}$	-0.481	-0.644	-0.506	1									
$O_{hightech}$	0.089	0.022	-0.012	-0.063	1								
$O_{medhightech}$	0.027	0.018	-0.001	-0.028	0.292	1							
$O_{medlowtech}$	-0.005	0.008	-0.012	0.005	0.084	0.234	1						
$O_{lowtech}$	-0.024	-0.023	-0.037	0.051	0.018	0.121	0.413	1					
O_{total}	0.025	0.002	-0.030	-0.001	0.502	0.494	0.692	0.760	1				
$\ln \frac{K}{S}$	-0.182	-0.182	-0.191	0.337	-0.015	-0.012	0.022	0.050	0.028	1			
$\ln F$	0.219	0.419	-0.295	0.299	0.007	-0.020	-0.001	0.038	0.020	0.045	1		
$D_{exporter}$	0.081	0.015	0.003	-0.062	0.018	0.027	0.022	0.028	0.037	-0.055	0.151	1	
$D_{persistent}$	-0.018	-0.126	-0.122	-0.160	-0.003	0.000	0.019	0.037	0.027	0.086	0.213	0.066	1

Table A.2 Regression results for the cost shares of employees, estimations include zero values of offshoring by input content: full panel, observations = 43263

Explanatory variable	**GLM - Fractional response estimation (maximum likelihood)**			
	Cost share of *cognitive* occupations (dependent)	Cost share of *motoric* occupations (dependent)	Cost share of *management* occupations (dependent)	Cost share of *social* occupations (dependent)
High-technology offshoring: $O_{hightech}$	0.024*** (0.008)	-0.064* (0.035)	0.018** (0.008)	0.000 (0.011)
Medium-high technology offshoring: $O_{medhightech}$	-0.016 (0.022)	-0.007 (0.026)	0.012 (0.014)	0.014 (0.016)
Medium-low technology offshoring: $O_{medlowtech}$	-0.004 (0.041)	-0.039*** (0.011)	0.028** (0.011)	0.050*** (0.017)
Low-technology offshoring: $O_{lowtech}$	-0.072** (0.036)	0.024** (0.009)	-0.001 (0.004)	-0.045* (0.024)
Capital in sales (ln): $\frac{K}{S}$	-0.696*** (0.111)	3.097*** (0.082)	-1.313*** (0.071)	-2.848*** (0.117)
Firm size (ln): F	0.100*** (0.007)	0.237*** (0.005)	-0.246*** (0.005)	-0.157*** (0.007)
Exporting firm: $D_{exporter}$	-0.151*** (0.022)	-0.272*** (0.014)	0.258*** (0.014)	0.286*** (0.023)
Persistent offshoring firm: $D_{persistent}$	-0.121*** (0.16)	-0.077*** (0.011)	0.121*** (0.010)	0.073*** (0.016)
Constant	-2.639*** (0.152)	-4.304*** (0.111)	1.359*** (0.096)	1.988*** (0.156)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Unique firms in panel	11609	11609	11609	11609
Observations (firm observations over panel years)	43263	43263	43263	43263
R^2_{OLS}	0.18	0.30	0.13	0.07

Note: Firm-clustered robust standard errors within parenthesis. Hypotheses 1 and 2 are grey shaded in Table A.2. The GLM is estimated with the link (logit) family (binomial) command since the dependent variable is a fraction containing many zeroes. The offshoring variables exclude intermediate goods imports such as energy and raw material. ***, **, * denote significant at the 1%, 5% and 10% level, respectively. Year and industry dummies are included in all estimations.

Table A.3 Regression results for the cost shares of employees, estimations include zero values of offshoring by input content: balanced panel, observations = 14688

Explanatory variable	GLM - Fractional response estimation (maximum likelihood)			
	Cost share of *cognitive* occupations (dependent)	Cost share of *motoric* occupations (dependent)	Cost share of *management* occupations (dependent)	Cost share of *social* occupations (dependent)
High-technology offshoring: $O_{hightech}$	0.025** (0.011)	-0.001 (0.022)	-0.005 (0.011)	-0.031* (0.018)
Medium-high technology offshoring: $O_{medhightech}$	-0.294*** (0.106)	0.004 (0.038)	0.028 (0.020)	0.052 (0.042)
Medium-low technology offshoring: $O_{medlowtech}$	-0.030 (0.062)	-0.072* (0.039)	0.065* (0.034)	0.047* (0.025)
Low-technology offshoring: $O_{lowtech}$	-0.179** (0.078)	0.154*** (0.042)	0.031 (0.020)	-0.635*** (0.063)
Capital in sales (ln): $\frac{K}{S}$	-1.498*** (0.177)	3.595*** (0.131)	-1.320*** (0.112)	-2.994*** (0.188)
Firm size (ln): F	0.150*** (0.010)	0.229*** (0.006)	-0.264*** (0.006)	-0.174*** (0.009)
Exporting firm: $D_{exporter}$	-0.147*** (0.047)	-0.261*** (0.026)	0.230*** (0.024)	0.337*** (0.041)
Constant	-1.691*** (0.236)	-5.124*** (0.177)	1.640*** (0.152)	2.336*** (0.254)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Unique firms in panel	1836	1836	1836	1836
Observations (firm observations over panel years)	14688	14688	14688	14688
R^2_{OLS}	0.23	0.35	0.23	0.11

Note: Firm-clustered robust standard errors within parenthesis. Hypotheses 1 and 2 are grey shaded in Table A.3. Balanced panel only includes firms that engage in offshoring in every year in the period 2001-08, as such the variable $D_{persistent}$ is dropped from the model specification. The GLM is estimated with the link (logit) family (binomial) command since the dependent variable is a fraction containing many zeroes. The offshoring variables exclude intermediate goods imports such as energy and raw material. ***, **, * denote significant at the 1%, 5% and 10% level, respectively. Year and industry dummies are included in all estimations.

Table A.4 Regression results for the cost shares of employees with at least three years of tertiary education (estimations 1-5) and employees with less than a high school diploma (estimations 6-10)

Explanatory variable	GLM - Fractional response estimation (maximum likelihood)									
	Cost share of *at least 3 years tertiary* employees (dependent)					Cost share of *less than high school* employees (dependent)				
	1	2	3	4	5	6	7	8	9	10
High-technology offshoring: $O_{hightech}$	0.034*** (0.009)					-0.045*** (0.014)				
Medium-high technology offshoring: $O_{medhightech}$		0.015 (0.017)					-0.043* (0.022)			
Medium-low technology offshoring: $O_{medlowtech}$			0.026*** (0.009)					-0.018** (0.008)		
Low-technology offshoring: $O_{lowtech}$				0.004 (0.004)					-0.002 (0.003)	
Total offshoring: O_{total}					0.017*** (0.004)					-0.018*** (0.004)
Capital in sales (ln): $\frac{K}{S}$	-1.650*** (0.182)	-2.027*** (0.197)	-2.745*** (0.158)	-2.934*** (0.167)	-2.313*** (0.135)	1.647*** (0.129)	1.979*** (0.135)	2.483*** (0.118)	2.543*** (0.117)	2.102*** (0.095)
Firm size (ln): F	0.057*** (0.008)	0.078*** (0.008)	0.095*** (0.008)	0.078*** (0.009)	0.030*** (0.007)	-0.007 (0.006)	-0.009 (0.006)	-0.027*** (0.006)	-0.020*** (0.006)	0.016*** (0.005)
Exporting firm: $D_{exporter}$	0.302*** (0.036)	0.265*** (0.037)	0.175*** (0.038)	0.179*** (0.035)	0.214*** (0.026)	-0.271*** (0.025)	-0.192*** (0.025)	-0.220*** (0.026)	-0.191*** (0.024)	-0.210*** (0.017)
Persistent offshoring firm: $D_{persistent}$	-0.118*** (0.020)	-0.147*** (0.019)	-0.091*** (0.018)	-0.028 (0.018)	-0.030* (0.017)	0.085*** (0.015)	0.073*** (0.014)	0.043*** (0.014)	0.013 (0.013)	-0.002 (0.012)
Constant	-0.739*** (0.239)	-0.260 (0.254)	0.528** (0.208)	0.780*** (0.219)	0.120 (0.178)	-0.409** (0.171)	-0.876*** (0.176)	-1.353*** (0.155)	-1.389*** (0.155)	-0.915*** (0.126)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	22885	23619	24281	26492	43263	22885	23619	24281	26492	43263
R^2_{OLS}	0.13	0.13	0.13	0.13	0.11	0.16	0.15	0.16	0.17	0.15

Note: Firm-clustered robust standard errors within parenthesis. The GLM is estimated with the link (logit) family (binomial) command since the dependent variable is a fraction containing many zeroes. The offshoring variables exclude intermediate goods imports such as energy and raw material. ***, **, * denote significant at the 1%, 5% and 10% level, respectively. Year and industry dummies are included in all estimations.

Table A.5 Regression results for the cost share of employees with a high school diploma and short tertiary education (estimations 11-15)

Explanatory variable	**GLM - Fractional response estimation (maximum likelihood)**				
	Cost share of *high school and short tertiary* employees (dependent)				
	11	12	13	14	15
High-technology offshoring: $O_{hightech}$	0.021*** (0.007)				
Medium-high technology offshoring: $O_{medhightech}$		0.040*** (0.013)			
Medium-low technology offshoring: $O_{medlowtech}$			-0.002 (0.009)		
Low-technology offshoring: $O_{lowtech}$				-0.001 (0.004)	
Total offshoring: O_{total}					0.011*** (0.003)
Capital in sales (ln): $\frac{K}{S}$	-1.139*** (0.125)	-1.373*** (0.130)	-1.599*** (0.121)	-1.561*** (0.118)	-1.367*** (0.097)
Firm size (ln): F	-0.059*** (0.007)	-0.051*** (0.007)	-0.036*** (0.007)	-0.032*** (0.007)	-0.048*** (0.006)
Exporting firm: $D_{exporter}$	0.175*** (0.027)	0.095*** (0.028)	0.210*** (0.028)	0.164*** (0.026)	0.158*** (0.019)
Persistent offshoring firm: $D_{persistent}$	-0.028* (0.014)	0.012 (0.015)	0.010 (0.014)	0.006 (0.014)	0.029** (0.013)
Constant	-0.698*** (0.168)	-0.344** (0.171)	-0.211 (0.160)	-0.356** (0.156)	-0.562*** (0.130)
Industry dummies	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Observations	22885	23619	24281	26492	43263
R^2_{OLS}	0.07	0.07	0.07	0.07Taböes	0.06

Note: Firm-clustered robust standard errors within parenthesis. The GLM is estimated with the link (logit) family (binomial) command since the dependent variable is a fraction containing many zeroes. The offshoring variables exclude intermediate goods imports such as energy and raw material. ***, **, * denote significant at the 1%, 5% and 10% level, respectively. Year and industry dummies are included in all estimations.

Table A.6 Countries included in each bloc of the re-specified offshoring variable: percentages in the parentheses represent the share of firms that import intermediate goods from the various country blocs during the period 2001-08, offshoring firms in Swedish manufacturing (SNI 15-36)

Brazil, Russia, India, China and South Africa	Central and East Europe	East and Southeast Asia	Organization for Economic Co-operation and Development	Rest of the world
BRICS (20 %)	**CEE (31 %)**	**ESA (18 %)**	**OECD (70 %)**	**ROW (26 %)**
Brazil	Albania	Indonesia	Australia	Includes all other countries that the offshoring firms in Swedish manufacturing have imported intermediate goods from.
China	Bosnia and Herzegovina	Hong Kong	Austria	
India	Bulgaria	Korea	Belgium	
Russia	Belarus	Malaysia	Canada	
South Africa	Croatia	Philippines	Denmark	
	Czech Republic	Singapore	Finland	
	Estonia	Taiwan	France	
	Hungary	Thailand	Germany	
	Latvia	Vietnam	Iceland	
	Lithuania		Ireland	
	Macedonia		Italy	
	Moldova		Israel	
	Montenegro		Japan	
	Poland		Luxembourg	
	Romania		Mexico	
	Serbia		Netherlands	
	Slovakia		New Zealand	
	Slovenia		Norway	
	Turkey		Portugal	
	Ukraine		Spain	
			Switzerland	
			UK	
			USA	

Table A.7 Regression results for the cost share of employees based on occupation and education with the offshoring variable re-specified to account for countries based on income and region

Explanatory variable	GLM - Fractional response estimation (maximum likelihood)				
	Cost share of employees' *occupation* (dependent)				
	Cognitive	Motoric	Management	Social	Observations
BRICS offshoring	-0.094 (0.074)	-0.051 (0.055)	0.076* (0.043)	-0.037 (0.054)	8610
Central and East Europe offshoring	0.004 (0.006)	0.011** (0.004)	-0.007 (0.006)	-0.039** (0.017)	13594
East and Southeast Asia offshoring	0.013 (0.040)	-0.006 (0.008)	0.001 (0.004)	-0.023* (0.012)	8030
OECD offshoring	0.0003 (0.0003)	0.0007** (0.0002)	-0.0004 (0.0003)	-0.002 (0.002)	30187
ROW offshoring	0.009* (0.005)	0.003 (0.004)	-0.002 (0.005)	-0.041** (0.020)	11383
Industry dummies	Yes	Yes	Yes	Yes	
Year dummies	Yes	Yes	Yes	Yes	

	Cost share of employees' *education* (dependent)			
	At least three years tertiary	High school and short tertiary	Less than high school	Observations
BRICS offshoring	0.120 (0.077)	-0.019 (0.036)	-0.085 (0.059)	8610
Central and East Europe offshoring	-0.003 (0.004)	-0.004 (0.005)	0.004 (0.004)	13594
East and Southeast Asia offshoring	0.0160** (0.0070)	-0.001 (0.005)	-0.012* (0.007)	8030
OECD offshoring	0.0004 (0.0005)	0.0005** (0.0002)	-0.0005 (0.0004)	30187
ROW offshoring	0.009** (0.004)	0.005 (0.004)	-0.010* (0.005)	11383
Industry dummies	Yes	Yes	Yes	
Year dummies	Yes	Yes	Yes	

Note: For convenience, only the estimates for the offshoring variable are presented here.

Table A.8 Regression results for the cost shares of employees with cognitive (estimations 1-5) and motoric (estimations 6-10) occupations, with relative wages

Explanatory variable	GLM - Fractional response estimation (maximum likelihood)									
	Cost share of *cognitive* occupations (dependent)					Cost share of *motoric* occupations (dependent)				
	1 (H_1)	2	3	4	5	6	7	8	9 (H_2)	10
High-technology offshoring: $O_{hightech}$	0.021*** (0.007)					-0.047* (0.026)				
Medium-high technology offshoring: $O_{medhightech}$		-0.004 (0.012)					-0.006 (0.019)			
Medium-low technology offshoring: $O_{medlowtech}$			-0.015 (0.018)					-0.014*** (0.006)		
Low-technology offshoring: $O_{lowtech}$				-0.033* (0.017)					0.010** (0.004)	
Total offshoring: O_{total}					-0.003 (0.004)					-0.010** (0.004)
Relative wage (ln): w_i/w_j	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)
Capital in sales (ln): $\frac{K}{S}$	-0.762*** (0.151)	-0.795*** (0.154)	-1.028*** (0.137)	-1.302*** (0.134)	-0.927*** (0.109)	2.787*** (0.113)	3.088*** (0.111)	3.479*** (0.099)	3.629*** (0.099)	2.985*** (0.076)
Firm size (ln): F	0.167*** (0.007)	0.194*** (0.007)	0.206*** (0.007)	0.230*** (0.007)	0.201*** (0.006)	0.272*** (0.005)	0.270*** (0.005)	0.272*** (0.005)	0.264*** (0.005)	0.327*** (0.004)
Exporting firm: $D_{exporter}$	-0.067** (0.031)	-0.044 (0.033)	0.047 (0.034)	-0.006 (0.031)	-0.049** (0.022)	-0.286*** (0.020)	-0.247*** (0.020)	-0.269*** (0.019)	-0.216*** (0.018)	-0.217*** (0.013)
Persistent offshoring firm: $D_{persistent}$	-0.175*** (0.018)	-0.153*** (0.018)	-0.118*** (0.018)	-0.097*** (0.018)	-0.155*** (0.015)	0.070*** (0.013)	0.047*** (0.013)	0.026** (0.012)	-0.033*** (0.012)	-0.068*** (0.011)
Constant	-2.678*** (0.202)	-2.745*** (0.205)	-2.589*** (0.183)	-2.392*** (0.179)	-2.776*** (0.148)	-4.317*** (0.152)	-4.793*** (0.150)	-5.197*** (0.133)	-5.278*** (0.132)	-4.630*** (0.103)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	22885	23619	24281	26492	43263	22885	23619	24281	26492	43263
R^2_{OLS}	0.39	0.35	0.33	0.35	0.40	0.41	0.40	0.40	0.40	0.44

Note: Firm-clustered robust standard errors within parenthesis. Differences between the main model and the model for the balanced panel are grey shaded. The GLM is estimated with the link (logit) family (binomial) command since the dependent variable is a fraction containing many zeroes. The offshoring variables exclude intermediate goods imports such as energy and raw material. ***, **, * denote significant at the 1%, 5% and 10% level, respectively. Year and industry dummies are included in all estimations.

Table A.9 Regression results for the cost shares of employees with management (estimations 11-15) and social (estimations 16-20), with relative wages

Explanatory variable	GLM - Fractional response estimation (maximum likelihood)									
	Cost share of *management* occupations (dependent)					Cost share of *social* occupations (dependent)				
	11	12	13	14	15	16	17	18	19	20
High-technology offshoring: $O_{hightech}$	0.019*** (0.007)					0.001 (0.009)				
Medium-high technology offshoring: $O_{medhightech}$		0.009 (0.012)					-0.015 (0.011)			
Medium-low technology offshoring: $O_{medlowtech}$			0.018** (0.009)					-0.009 (0.010)		
Low-technology offshoring: $O_{lowtech}$				-0.001 (0.003)					-0.057* (0.031)	
Total offshoring: O_{total}					0.008*** (0.003)					-0.004 (0.004)
Relative wage (ln): w_i/w_j	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)
Capital in sales (ln): $\frac{K}{S}$	-1.045*** (0.087)	-1.222*** (0.084)	-1.328*** (0.082)	-1.342*** (0.080)	-1.070*** (0.062)	-2.745*** (0.140)	-2.907*** (0.128)	-2.813*** (0.129)	-3.022*** (0.130)	-2.912*** (0.100)
Firm size (ln): F	-0.133*** (0.005)	-0.155*** (0.005)	-0.160*** (0.005)	-0.172*** (0.005)	-0.132*** (0.004)	-0.086*** (0.007)	-0.105*** (0.006)	-0.102*** (0.006)	-0.082*** (0.006)	-0.050*** (0.005)
Exporting firm: $D_{exporter}$	0.350*** (0.019)	0.342*** (0.019)	0.267*** (0.018)	0.216*** (0.017)	0.265*** (0.013)	0.481*** (0.033)	0.352*** (0.032)	0.328*** (0.031)	0.309*** (0.029)	0.333*** (0.022)
Persistent offshoring firm: $D_{persistent}$	0.028** (0.011)	0.042*** (0.011)	0.053*** (0.010)	0.062*** (0.010)	0.081*** (0.009)	0.021 (0.019)	0.009 (0.018)	-0.020 (0.017)	0.040** (0.018)	0.064*** (0.015)
Constant	0.629*** (0.118)	0.982*** (0.114)	1.126*** (0.111)	1.154*** (0.108)	0.624*** (0.085)	1.508*** (0.188)	1.960*** (0.172)	1.872*** (0.172)	1.927*** (0.174)	1.652*** (0.135)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	22885	23619	24281	26492	43263	22885	23619	24281	26492	43263
R^2_{OLS}	0.36	0.37	0.39	0.39	0.40	0.35	0.33	0.34	0.31	0.37

Note: Firm-clustered robust standard errors within parenthesis. Differences between the main model and the model for the balanced panel are grey shaded. The GLM is estimated with the link (logit) family (binomial) command since the dependent variable is a fraction containing many zeroes. The offshoring variables exclude intermediate goods imports such as energy and raw material. ***, **, * denote significant at the 1%, 5% and 10% level, respectively. Year and industry dummies are included in all estimations.