Displacing Tasks: Understanding the Employment Effects of Offshoring*

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Abstract

This paper aims to understand the mechanism trough which offshoring, measured as imported intermediate goods, affects the allocation of job tasks in the economy. We first investigate the effect of firm-level offshoring on both the tasks and skill structure within firms. Next, we study the net effect of offshoring at industry level. We use Finnish longitudinal employer-employee data matched to detailed firm-level data on imports. We take into account the endogeneity of the offshoring variable by instrumenting it with a firm-product-level measure on exposure to increased world supply of intermediates. We find that firm-level offshoring has a positive impact on employment in general, and employment of production workers in particular, while the net effects of offshoring and increased import competition are the opposite at industry level.

Keywords: Offshoring, Polarization, Job Tasks, Education, Employment, Job Loss

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1 Introduction

During the last two decades the costs of offshoring have decreased due to falling transport costs, improvements in information and communication technologies and liberalized FDI regimes. The firms have reacted to these changes by forming increasingly sophisticated global production networks to maximize the different locational advantages around the globe. As a result a very high share of international trade today takes place within multinational firms (MNEs) and it increasingly entails the exchange of small parts of products and processes rather than finished goods or even complete intermediate goods. In many developed countries, growing imports from low-wage countries have been associated with losses of manufacturing jobs and increasing wage inequality. In a recent paper, Autor, Dorn and Hanson (2013) show that a higher exposure to import competition causes higher unemployment, lower labor force participation, and reduced wages for all workers in local labor markets that house import-competing manufacturing industries in the US.

An equally significant phenomenon is that job opportunities have sharply polarized in developed countries over the past two decades, that is, there has been a relative increase in high- and low-skill occupations relative to middle-skilled occupations. While the most common explanation for job polarization is technological change that reduces the cost of accomplishing routine and codifiable tasks (Autor et al. 2003, Acemoglu and Autor 2011, Autor and Dorn, 2013, Goos et al. 2010), an increased import competition and increased offshoring have also been associated with an increased disappearance of medium skill jobs in economy. Despite the growing literature on offshoring, wages and demand for labor, rather little is still known about the importance of offshoring for the increasing job polarization and the mechanism through which offshoring affects demand for certain type of job tasks and change the occupational structure of firms, industries and the whole economy.

In this paper, we argue that to understand the mechanism how offshoring impacts the demand for labor, skills and tasks it is essential to study the effects both within firms and industries. At firm level, the decision to offshore and to increase the use of imported intermediate inputs affects the firm productivity and competitiveness, which

may be crucial whether a firm survives and expands, or goes under. Hence, the offshoring decision of a firm affects its competitiveness and is likely to be associated with changes in the employment structure within the firm. At industry level, offshoring affects employment and task structure of industries both at intensive margin, through changes within surviving firms, and at extensive margin, through competition and firm turnover. The offshoring decision of a firm impacts other firms at least through two channels: i) if the offshoring firm replaces domestic suppliers of intermediates with cheaper imported products, the growth and survival of downstream firms both in the same industry and other industries may be affected and ii) if the offshoring improves the firm competitiveness, the competitors survival and market shares may be affected.

The main contribution of our paper to the literature is twofold. First, we provide new evidence on the mechanism how offshoring affects tasks structure within an economy by analyzing the effects of offshoring at firm and industry level. Previous studies have focused on the effects of offshoring either at industry or firm level neglecting the differential impact of offshoring within firms and within industries. Also, our study is one of the few studies that have examined the causal effect of offshoring by instrumenting firms' offshoring with a firm-product-country specific measure of world's relative supply of the imported products. Our study is related to the recent papers studying the effects of offshoring on wage premiums for different tasks and skills (e.g. Hummels et al. (2011), Firpo et al. (2011) and Baumgarten et al. (2013)) and the papers studying the effects of offshoring on task composition in home country operations (e.g. Becker et al. (2013) and Ehrl (2013)). We focus on employment effects and argue, in line with previous literature (e.g. Machin and Van Reenen, 1998; Anderton and Brenton, 1999; Strauss-Kahn, 2003; Hijzen et al. 2005), that the more powerful the wage-setting institutions are and the more rigid the labor market is, the more likely the changes in relative labor demand are demonstrated in terms of employment rather than wages.

We use a Finnish register based employer-employee data merged with firm-level imports by products and country of origin from 1999 to 2008. We first investigate how offshoring, or the use of imported intermediate products, affects different employment outcomes at firm-level; occupational, educational skill and task structure. Following Autor et al. (2013)

and Hummels et al. (2011), we take into account the endogeneity of the offshoring variable by instrumenting it with a firm-product-country-level measure on exposure to increased world export supply. We elaborate the world export supply measure of Hummels et al. (2011) into a world relative supply measure, which, we argue, better isolates world supply chocks from world demand shocks. After having examined the causal effect of firm's offshoring decision on employment decisions at firm-level, we move on to analyze the aggregate effect of import penetration at industy-level in order to assess how offshoring and import competition affects aggregate employment outcomes within industries. We use an instrumental variable for import competition also at industry level.

We focus on the employment structure in terms of occupations and job tasks, but we use also educational skill measures to establish whether the distinguishing employees by task and occupational categories capture a different aspect of labor demand or whether the mapping between skills and job tasks and occupation is close to one-to-one. We define task categories following the classification created by Autor et al. (2003) and Autor and Acemoglu (2011) for the US census of occupations.[1] Jobs that are intensive in routine tasks are subject to automatition but also to offshoring, which may also have contributed to the reduction of job opportunities in middle-skilled production and operative occupations. However, many jobs of low-skilled, carrying out routine tasks such as cleaning, warehouse and clerical work, cashiers, plumbers and sales staff, are less likely to be replaced by machines and computers, and also much less susceptible to offshoring due their geographical attachment to other operations and customers. Non-routine tasks, on the other hand, are described such that they cannot easily be codified and performed by computers. For the same reasons they most likely require some geographical proximity to the other operations and cannot easily be offshored.

Our preliminary findings suggest that firm-level offshoring increases employment in general, and in particular, employment of production workers within firms, but has the opposite effect on production workers at industry level. A plausible explanation for this seemingly paradoxical result is that while an increased use of intermediate inputs has a

[1] We use mapping between European occupational coding and US coding to merge the task-intensity measure to occupational level.

positive impact on the offshoring firms, it affects negatively domestic suppliers and non-offshoring competitors within the same industry.

The rest of the paper is organized as follows. Section 2 summarizes previous literature. Section 2 discusses the data and present recent trends. Section 3 describes the empirical framework. Section 4 presents the results and section 5 concludes.

2 Related Literature

Initially, the international trade literature on offshoring focused on the effects on skill composition of labor demand, measured by educational attainment or occupation (e.g. Feenstra and Hanson 1996, 1999, Ebenstein et al. 2009, Ekholm and Hakkala, 2005, and Falk and Koebel, 2002, Strauss-Kahn, 2004 Hijzen et al., 2005), rather than job tasks. The more recent literature in labour economics and international trade make a point of distinguishing between skills and tasks. Acemoglu and Autor (2011), for instance, argue that such a distinction is essential for understanding recent labor market trends.

In the international trade literature focusing on offshoring, the distinction between skills and tasks is highly relevant since it has been argued that characteristics other than skill intensity determine whether job tasks are offshorable (Blinder, Markusen, 2006). In particular, routine tasks and tasks that do not require personal interaction can more easily be offshored. More precisely, offshorable tasks can be described in deductive rules (Levy and Murmane, 2004); are defined by codifiable rather than tacit information (Leamer and Storper, 2001); and do not require physical contact or proximity (Blinder, 2006). Such job tasks are often, but not always, carried out by unskilled labor. Firms may thus offshore both high and low skill-intensive tasks if they fall within this category. For instance, computer programming and x-ray analysis are well-known examples of job tasks that require education at post-secondary level, but that can be easily offshored nonetheless. Many Indian radiologists and computer engineers who who perform job tasks for US and European firms witness to this effect. On the other hand, some tasks, carried out by low-skilled workers, require proximity to other parts of the production and are not easily offshored. For instance, maintenance and cleaning work exemplify job tasks that rely on

unskilled labor that cannot be carried out from a distance. It should be noted that many jobs are offshorable in principle, but have not been offshored. As Blinder and Krueger (2009) puts it; the *observable action of offshoring* must be distinguished from *offshorability* which is a job characteristics.

The recent papers by Hummels et al. (2011), Firpo et al (2011) and Baumgarten et al. (2013) study the effects of offshoring for different tasks and skills in terms of wage premiums. Hummels et al. find that within job spells offshoring tends to increase the high-skilled wage and decrease the low-skilled wage and conditional on skill, the wage effect of offshoring exhibits additional variation depending on task characteristics. Baumgarten et al. (2013) find that wage effects of industry-level offshoring are fairly modest but depend significantly on the extent to which the respective task requires personal interaction or can be described as non-routine. When allowing for cross-industry movement of workers, i.e., looking at a situation closer to general equilibrium, they find more substantial wage effects of offshoring. Low- and medium-skilled workers experience significant wage cuts due to offshoring which, however, again strongly depend on the degree of personal interaction and non-routine content. Becker et al. (2013) use data for the home country and foreign operations of German multinationals find that the proportion of home country non-routine and interactive tasks increases with employment in the foreign affiliates. There is no statistically significant association between offshoring and the share of blue- and white-collar jobs in the home country wage bill, which indicates that defining employment in terms of job tasks may uncover effects that are not found by using traditional definitions of relative skills. Harrison and McMillan (2011) analyze the effect of (inhouse) offshoring decision of US based multinational. They show that while in general offshoring to low-wage countries substitutes for domestic employment, firms that do significantly different tasks at home and abroad, foreign and domestic employment are complements. Ehrl (2013) who find increases in imports to raise the intensity of manual tasks and decrease the intensity of non-routine cognitive tasks in production.

To summarize, the results from the previous studies on the effects of offshoring on relative labor demand are mixed. One explanation for the ambiguous results could be the fact that skills imperfectly proxy offshorability of jobs. The lack of consistent results

may also be due to differences in the used methods and data as well as the studied time period. With a few exceptions there has not been a serious attempt to instrument firm-level offshoring variable. Also, the firm-level analysis can give a incomplete picture of the offshoring effects if firms that begin to offshore initially bought the inputs from local suppliers.

3 Data and Recent Trends

3.1 Finnish Data

We use register-based matched employer-employee data set from Statistics Finland for the period 1999-2008. Data on firm-level imports that we use to construct measures of offshoring is collected by Finnish Customs. The data is available at product level by country of origin. Stemming from compulsory registration in Finnish Customs, data on imports from outside the EU consist of all trade transactions. Trade data for EU countries are available for all firms with a yearly import above 100 000 euro. According to figures from Finnish Customs, the data incorporates about 96.5 percent of total imports from other EU countries. To construct instruments for our offshoring variables, we use also data for commodity exports from UN COMTRADE database.

We restrict our analysis to manufacturing firms with at least 20 employees. The financial statement panel contains detailed firm-level information on all Finnish firms. Variables such as value added, capital stock (book value), number of employees, wages, sales, and industry are included. The employee statistics contain detailed information on individual characteristics including, education, occupation, wages, gender, family status and previous work history. All employees at the studied firms are included in the statistics. All data sets are linked together with unique identification numbers. In total we have about 15 000 firm-level observations and more than 2 million individual level observations (See tables A1, A2 and A3 in the appendix for descriptives statistics).

The occupational codes in our data come from two different sources. The FLEED statistics has a three digit ISCO-88 occupational code information for all employed indi-

viduals in years 2000, and 2004-2008. The payroll statistics has two digit ISCO codes for the entire time period, 1999-2008. However, the payroll statistics does not cover all the individuals in the sample.

3.2 Task Measures

In this paper, we use both occupational categories and classification of Autor et al (2003) and Acemoglu and Autor (2011) for studying the effect of offshoring on job structure. Using occupational categories provide transparency, while using task categories may better capture the offshorability. In their pioneering work, Autor et al. have classified job tasks according to their characteristics for the purpose of studying how computers have affected relative demand for job tasks. Acemoglu and Autor (2011) base their measures on Autor et al (2003) and define job tasks into the seven categories; non-routine cognitive personal, non-routine manual physical, non-routine cognitive analytical, non-routine manual personal, routine cognitive, routine manual and offshorable. Although the purpose is not to study the effects of offshoring, the definitions of different type of job tasks overlap with the descriptions of offshorable job tasks. For instance, routine tasks are described by Autor et al. such that they can be expressed as rules, making them easy to program and thus suitable for execution by computers or robots. Many such routine job tasks can also be carried out by workers located far from headquarters. Non-routine tasks, on the other hand, are described such that they cannot easily be codified and performed by computers. For the same reasons they most likely require some geographical proximity to the other operations and cannot easily be offshored.

To define the task content of jobs we classify occupations according to the intensity of routine, interactive or offshorable tasks using the mapping between US occupations and their task intensity measures used in Acemoglu and Autor (2011), which is in line with definitions used by Autor and Acemoglu (2010). The occupations are classified into according to the intensity of tasks that require interaction between individuals and by their routine-intensity. We use four of the categories defined by Acemoglu and Autor (2011): 1) Routine manual, 2) Routine cognitive, 3) Non-routine manual physical and 4) Non-routine

cognitive personal.[2] These are composite measures constructed from the U.S. Department of Labor's The occupational Information Network (O*NET) data, which assigns numerical values to occupations by how much certain tasks are needed in them. These measures are matched to the European International Standard Occupational Classification (ISCO-88) by using Crosswalk center's ready made mapping as used in Hummels et al. (2011). The indices are normalized to have a mean of zero and a standard deviation of one. So, a negative number scores lower than the mean and a positive number scores higher than the mean. Finally, we construct employment shares by summing all employees in occupations with a normalized index value of a certain index in the highest tertiary of the two-digit occupational categories and relating them to the total number of employees of the firm. It should be noted that the four task categories may be overlapping and the shares of employees belonging to the different categories do not sum to one, as for the shares of employees in occupational and educational categories.

3.3 Descriptives

We begin by analyzing recent trends in Finland during the period. Figure 1 presents the growth of value of imports by narrow definition (imports of goods by firms with the same 2-digit industry code) 2000-2008. During the years 2000-2008 there has been a rapid increase in the imports to Finnish firms.The figure confirms that Finland has had a similar growth in imports as many other developed countries during the time period. It may be noted that the largest share of imports by narrow definition comes from other high-income countries. However, the interesting part of the imports is the one coming from low-income countries as these imports are believed to replace domestic production using low-skilled labor.

Figure 1 here

A closer look at imports from some most important low income countries in Figure 2,

[2]The other three categories are Non-routine cognitive analytical, Non-routine manual personal and Offshorable, but choose not to use these for the clearness of analysis.

reveals that imports from Russia and other low-income countries has steadily grown and that imports from China make a strong growth spurt since 2004. In other words, this may indicate that offshoring of production from Finland to low-income countries has increased 2000-2008. In figure 3, we show mean value of imports by narrow definition related to sales (our main offshoring measure) at firm level for the manufacturing firms included in our estimations. Since both imports and sales have increased during the period, the offshoring measure has not grown as fast as the real value of imports.

Figure 2 here

We next analyze whether there has been a significant polarization in employment during the time period. Figure 3 plots the change in employment of different occupational groups, that are ranked by their mean wage in the beginning of the period. The figure provides clear evidence that labor market has polarized in Finland. The medium wage occupations have decreased employment during these years while both low-and high educational groups have gained. Parallel to technological changes, offshoring of jobs that are intensive in routine tasks may have contributed to the polarization of employment by reducing job opportunities in middle-skilled production and operative occupations. On other hand, many jobs of low-skilled, carrying out routine tasks are less likely to be replaced by machines and computers, and also much less susceptible to offshoring due their geographical attachment to other operations and customers. Similarly many jobs of high-skilled that are intensive in either abstract or non-routine manual tasks demand for problem-solving, judgment and creativity in the former case, and flexibility and physical adaptability in the latter are less likely to be offshored. In the next sections, we aim to analyze further whether and how these two phenomena: increased low-income imports and hollowing out the middle wage/skill occupations are related with each other.

Figure 3 here

4 Firm-level Analysis

4.1 Specifications

In the first part of the econometric analysis, we study the impact of offshoring on firm-level composition of tasks and educational skills. In order to take into account the endogeneity of the offshoring variable, we use instrumental-variable approach and instrument offshoring with variable that measures changes in world export supply. We follow the traditional approach and model the effect of offshoring on labor demand in a similar way as has previously been done for factor-biased technological change (FBTC). Similarly to FBTC, cost-reducing offshoring is assumed to increase the overall productivity but not necessarily in a uniform way across all factor inputs within the firm. For instance, when routine tasks using low-skilled labor, such as assembly activities, are being offshored, the productivity of workers involved in the remaining headquarters activities and intermediate input production is likely to increase through an increasing net revenue per unit of factor input. As with the introduction of new technologies, this might lead to changes in the relative demand for labor unevenly across skills and occupations.

We estimate a model where the dependent variable is defined either as a labor share or log employment for a educational skill group or task category.[3] If offshoring is associated with productivity and employment growth of a given firm, it may cause opposite changes in the employment share of certain task categories and the number of employees performing these tasks. In order to understand what drives the changes in the shares, we examine the effect of firm-level offshoring on employment levels by task/skill categories.We assume that firm i, $i = 1, ...I$, uses different types of labor, capital and intermediate inputs to produce an output. Firm i's share of labor belonging to skill or occupational group s is

[3]Our approach is similar to the translog cost function approach that was first introduced in the context of trade and demand for skills by Berman *et al.* (1994) and is used in a number of studies of offshoring and the relative demand for skills (e.g. Feenstra and Hanson 1996, Geishecker 2006, Strauss-Kahn, 2004, and Hijzen *et al.* 2005). We use employment shares rather than wage cost shares to avoid mixing wage and employment effects.

given by

$$E_{sit} = \lambda OFF_{it} + + \mathbf{X}'_{it}\beta + \alpha_i + \alpha_t + \alpha_j + \varepsilon_{ijt}$$

where E_{sit} is the employment share $L_{sit}/\sum_{s=1}^{S} L_{sit}$ or log employment $\log(L_{sit})$ of workers in skill or task category s in firm i at time t . OFF_{it} denotes the time and firm-specific offshoring variable and X_{it} is a vector of firm-specific variables including average wages per skill or task group, the capital to output and output.[4] $\alpha_{i,}$ $\alpha_{t,}$ and $\alpha_{j,}$ are firm-, time and industry-specific dummy variables.[5] The model includes firm-fixed effects in order to take firm-specific time-invariant effects into account. [6]

Our main firm-level offshoring variable is defined as

$$OFF_{it} = \frac{m_{ijt}}{y_{it}} \tag{1}$$

where m_{ijt} is firm i's use of imported goods from industry j in period t and Y_{it} is production. [7] An increase in the offshoring variable may caused both by *outsource offshoring* to external foreign suppliers and *in-house offshoring* to foreign affiliates to the extent that these phenomena involve imports back to home country for further processing or resales.[8] The values of parameter λ depend on whether technical change is biased towards or away

[4]The underlying cost function is for short-run and assumes capital to be a quasi-fixed factor.

[5]We include industry dummies in the OLS specification but not in the specification with firm-fixed effects.

[6]The labor share equations may be regarded as a system of several equation which is estimated as a seemingly unrelated regression (SUREG) model to take a possible correlation between the residuals of the equations. We do not estimate it as a system because it is shown that results from OLS and SUREG are identical if the explanatory variables are identical for each equation (Zellner, 1962 and Dwivedi and Srivastava (1978), see more in Greenaway (1997).

[7]Feenstra and Hanson (1999) distinguish between *narrow* and *broad* offshoring. Narrow offshoring only includes imported intermediate inputs from the importing industry, i.e. an industry's purchases of imported intermediate inputs produced in the same industry. Broad offshoring also includes imported non-energy intermediate inputs from all other industries. They prefer the narrow to the broad measure, since it is closer to the phenomenon of fragmentation and vertical specialization that takes place within industries.

[8]The measure does not capture offshoring of the final stages of production or other production that is not shipped back to home country for further processing.

from the usage of labor belonging to task/skill group s. In order to estimate the causal effect of offshoring on firm's task structure we employ instrumental-variable approach. Our instruments for offshoring are described in next section.

4.2 Firm-level Instruments

A firm's offshoring decisions are jointly determined with it's employment decisions. In order to investigate the causal effect of firm's offshoring decision on it's employment (task structure) we instrument firm's offshoring variable with a measure constructed of firm-level exposure to import competition. The instrument needs to be correlated with firm's offshoring decision (changes in offshoring), but it should not be correlated with factors that influence its productivity or demand for final products through any other way. Following Hummels et al. (2011) and Autor et al. (2013) we construct the instrument using differences in exposure to import competition.

More specifically, we use the changes in the world's relative export supply (WRES) at product-level in order to create some exogenous variation in firm's offshoring decision.The $WRES_{ckt}$ is country c's total supply of product k to the world market in year t, excluding the supply to Finland, divided by the aggregate supply of product k to the world market in year t, excluding the supply to Finland. As for the offshoring measure, we use the narrow concept of offshoring and include imports of products k from same industry as where the firm produces its output. Our measure is closest to the world export supply measure of Hummels et al. (2011), but by relating their WES_{ckt} to the aggregate supply of product k to the world market in year t we aim to exclude the effect of world demand shocks from the country-specific variation in export supply. For instance, an increase in the export supply of product k from country c to the world market in year t may increase due to an overall positive demand shock in the world market, rather than due to the increased efficiency in the production of the product k that would give an improved comparative advantage for the country c. It is important to distinguish these two effects since the idea of the instrument is to capture country-specific factors that would affect the firms' aptitude to

import product k from country c.[9]

The firm-level instrument variable is constructed from COMTRADE data at CN-6-digit level. We weight each firm's i product k from country c at time t with the share of $c-k$ product in firm's total material imports in the *first* sample year. We then generate the firm-level measure by aggregating across all products from all countries, and weighting each product c-k with its share in firm's imports in the first period firm is observed in the trade data. The time-varying instrument for each firm i in year t is

$$WRES_{it} = \sum_{c,k} s_{ick} WRES_{ckt} = \sum_{c,k} s_{ick} \frac{ES_{ckt}}{\sum_c ES_{ckt}}$$

where s_{ick} is the share of product k from country c in firm i's total imports in the first year of positive imports. ES_{ckt} is the country c's total supply of product k to the world market in year t. We divide this by the aggregate supply of product k to the world market in year t, excluding the supply to Finland, $\sum_c ES_{ckt}$ in order to get the world's relative export supply $WRES_{ckt}$ of each product.

This measure is used to instrument offshoring in the specification described above. Since the model includes firm fixed effects the instruments captures variation in offshoring that is due to the relative growth in supply of the product in a given country (and not differences in initial period import structure). We argue that the *relative* growth in imports of a given product from a given country reflects changes in the relative supply of this product, and should not affect directly the demand for firm's product in a home country (and thus employment). During the sample period, the relative supply of products was driven by a rising competitiveness of manufactures and lowering trade barriers in certain countries (such as China). These changes made the firms that already had imports from these countries much more likely to be exposed to increased import competition and affected their incentives to offshore production to these countries.

[9] For robustness, we also use WES measure by Hummels et al.

4.3 Results

Before investigating how offshoring is related to skill and task structure within firms, we estimate the effect of offshoring on some firm-level outcome variables. Table 1 reports the results for seven firm-level variables, log of total employment (Employment), log of total sales (Output), the share of purchased services to output (Services), capital to output ratio (Capital) and log of average wage for three different educational groups, low secondary (low), upper secondary (medium) and tertiary (high). We report the results for three different specifications: ordinary least squares (OLS), firm-fixed effects (FE) and two stage least squares with firm-fixed effects and offshoring instrumented with world relative export supply (FE-IV-WRES). The results in the first column show that offshoring affects firm-level employment positively. The effect is statistically significant and robust to all specifications. In column (2) the results indicate that offshoring has an positive effect also on output. The effect is statistically significant for OLS and and the specification with instrumented offshoring FE-IV-WRES. Offshoring is not found to have robust significant impact on the use of purchased services, but it has a negative significant impact on capital intensity and the average wage of medium skill group. From these results we may conclude that firm-level offshoring causes firms to expand employment and output, and to reduce capital intensity and the average wage of medium skilled employees.

The results in Table 2 indicate that offshoring affects most of the variables that are commonly included as controls to labor demand equations. Since offshoring is likely to affect both control variables and dependent variables, we exclude these control variables in the regression model to avoid selection bias.[10]

Table 1 here

Next, we analyze how offshoring is related to employment of different skill and occupational groups using the data for the years for which the occupational codes are available (2000, 2004-2008). Table 2 reports the coefficient on firm-level offshoring variable on

[10]By including controls that are dependent variables we risk having a selection bias and no causal interpretation for offshoring. See more about bad control in Angrist and Pischke (2009).

log of employment in seven different occupational groups (clerical, service, production, construction, managerial and professional) and three different specifications: Panel A, ordinary least squares (OLS), Panel B, firm-fixed effects (FE) and Panel C, two stage least squares with firm-fixed effects and offshoring instrumented with world relative export supply (FE-IV-WRES). The OLS results in Panel A indicate that offshoring is positively associated to employment in all occupational categories, only suggesting that offshoring firms are larger. In order to control for permanent differences between offshoring and non-offshoring firms, we include firm-fixed effects into the regression. The FE results in panel B indicate that firm-level offshoring is statistically significantly associated with an increase in employment of professional/technical workers. All other occupational categories have positive, but imprecisely estimated coefficients.

Finally, in panel C of Table 2 we acknowledge that even with firm-fixed effects there may be some unobservable time varying factors that are correlated with both firm's decision to locate production abroad and it's decisions to employ workers in home country. In order to take into account the endogeneity of offshoring variable, we employ instrumental variable approach. As an instrument for offshoring we use the relative export supply-variable (WRES), the construction of which is explained in section 4.2. Since we include firm-fixed effects into the regression, we can claim that the variation in the instrument stems entirely from the changes in the relative supply of the products from different locations and not from differences in import structure within firms. The FE-IV results show that firm-level offshoring increases employment of all occupational groups. Firm-level offshoring seems to have a largest impact on Production workers. The effect of offshoring is statistically significant all other occupational groups except managerial occupations.

Table 2 here

We found that offshoring is associated with increase in the employment in all occupational groups. However, if offshoring increases employment of some occupations disproportionately, it will result in changes of occupational structure within firms. Table 3 reports the results where we estimate the effect of firm-level offshoring on share of each

occupational category of firm's total employment. The OLS results in panel A show that offshoring is associated with a higher share of Service and Professional/Technical workers and a lower share of Construction/Machinery workers in total firm-level employment. However, when we take into account firm-fixed effects (FE) results in panel B, firm-level offshoring is not associated with any significant changes in occupational composition within firms.

The instrumental variable results for employment shares in panel C of Table 3 indicate that offshoring significant decreases the share of Managerial and Professional/Technical workers and increases the share of Service and Production/Operators workers. The largest is the positive effect on the share of Production/Operators workers which was also indicated by the results in Table 2 panel C that showed that offshoring increases the employment of production workers more than of the other groups. It should be noted that some of the positive effects on log employment reported in Table 2 turn into negative effects on the shares, this is the case particularly for Professional/Technical and Managerial occupational categories. This means that despite the positive effect of offshoring on employment, the composition of employment is changed as other groups increases relatively more.

Table 3 here

In Table 4, we analyze how offshoring affects employment by educational groups.[11] Columns one to three in Table 4 reports the effect of offshoring on log of employment in three different educational groups (low, medium and high). The next three columns (4 to 6) show the results for employment shares. The OLS results in panel A indicate that offshoring firms are larger and that they employ relatively more highly educated workers. The firm fixed effect results in panel B show that change in firm-level offshoring is not associated changes in skill structure within firms. The instrumental variable estimation results in panel C indicate that firm-level offshoring increases employment of all educational groups, with the largest impact for medium educated workers. However, while the share of

[11] In these estimations we use data for the entire 2000-2008 period since educational measures are available every year. We have also checked that the results are robust to using the same sample as for regresssion using occupational data, that is, 2000, 2004-2008.

low educated is increased by offshoring, the share of highly educated workers is decreased. Overall the results in Tables 2, 3 and 4 suggest that offshoring increases the firm-level scale of operations positively leading to larger economies of scale at the level using less highly educated managers and professional workers and more low-educated Production workers.

Table 4 here

The splitting of workers by rough occupational classes or educational categories may hide some important heterogeneity in the effects of offshoring. In Table 5, we report the results were we define the workforce into four different task categories (routine cognitive, routine manual, non-routine manual physical and non-routine cognitive personal) based on their occupational codes using the mapping by Autor and Acemoglu (2011) as explained in Section 3. Note that the different task groups do not sum to one, that is, there are employees that can be found in different categories. The OLS results in panel A indicate that offshoring firms tend to employ lower shares of workers conducting routine manual and non-routine manual physical job tasks. The FE results in panel B indicate that firm-level offshoring has no statistically significant associations with any task categories when firm-fixed effects, controlling for some unobservable time varying factors, are included. The instrumental variable results in panel C suggest that offshoring increases the log employment of all type of workers, but changes the composition by increasing only the share of workers performing routine manual tasks. These results are consistent with the ones for occupational and educational categories, where we found a positive impact on Production and Service workers with a lower education.

Table 5 here

To sum up, the findings indicate that firm level offshoring increases employment, and that there is no net job losses occurring within firms even tough some categories decrease their relative share in employment. The result that may strike as unexpected is that offshoring decreases the share of highly educated in Managerial and Professional occupations performing non-routine cognitive personal tasks and increases the share of low

educated in Production and Service occupations carrying out routine manual tasks. One plausible explanation, which is consistent with the finding, is that firm-level offshoring is associated with a positive productivity effect, leading to an expansion of production and larger economies of scale at the level of operations using professional workers. Our results certainly contrast the results of Becker et al. (2013) who found offshoring to increase the share of highly educated in white collar occupations carrying out non-routine tasks in German MNEs. However, the results of Becker et al. are not directly comparable since they analysed in-house offshoring captured as employment changes in the foreign affiliates of German MNEs. Our results are in the line with the findings of Ehrl (2013) who find increases in imports to raise the intensity of manual tasks and decrease the intensity of non-routine cognitive tasks in production.

5 Industry-level Analysis

5.1 Specification

Next, we analyze the effect of offshoring at industry-level. The argument to analyze the impact at industry level is twofold. Firstly, there may be no change in employment in an offshoring firm if the firm switches buying the inputs from local producer to a producer overseas. Instead the domestic firms that were specialized in producing intermediate inputs may downsize or even close down after the other firm's offshoring decision. Secondly, employment changes at firm level may not be driven by the offshoring decision of the firm but by the offshoring decisions of the competing firms in the same industry. We model the effect of offshoring on labor demand industry-level in similar way as at firm-level:

$$E_{sjt} = \delta_1 OFF_{jt} + (\delta_2 IMP_{jt}) + \mathbf{X}'_{jt}\beta + \alpha_j + \alpha_t + \varepsilon_{jt}$$

where E_{sjt} is the employment share $L_{sjt}/\sum_{s=1}^{S} L_{sjt}$ or log employment $\log(L_{sjt})$ of workers in skill or task category s in industry j at time t . X_{it} is a vector of industry-specific variables, OFF_{jt} and IMP_{jt} denote two different the time and industry-specific offshoring/import competition variables. $\alpha_{t,}$ and $\alpha_{j,}$ are time and industry-specific dummy variables.

At industry-level, we define two import variables. First one, is similar to the firm-level variable and captures the effect of the increased use of intermediates in the industry:

$$OFF_{jt} = \frac{M_{jjt}}{Y_{jt}} \tag{2}$$

where where M_{jjt} is industry j's imported goods by industry j (three-digit NACE rev 1.1) in period t and Y_{jt} is production. The second measure, we define more broadly to capture the effect of overall import competition:

$$IMP_{jt} = \frac{M_{jt}}{Y_{jt}} \tag{3}$$

where M_{jt} is all imported goods in the economy from industry j in period t and Y_{jt} is production. By including all imports by industry j to Finland, the measure captures changes in import competition at large, rather than the mere impact of imported intermediates.

We estimate various alternative specifications drawn from basic models above. First, we distinguish between the offshoring to low- and high-income countries. We take into account the endogeneity of the firm- and industry-level offshoring variables by using instrumental variable approach. We explain the construction of the instruments in next section.

5.2 Industry-level Instruments

Since changes in industry-level offshoring and import competition may well be associated with demand shocks affecting the demand for products in the industry j, we want to instrument our industry-evel offshoring variable. We define two industry-level instrument variables. The first one is similar to the firm-level instrument $WRES_{it}$ constructed from COMTRADE data at CN-6-digit level. In order to generate an industry-level instrument, we weight each industry's j import product k from country c at time t with the share of $c-k$ product in industry's total material imports in the *first* sample year. We then generate the industry-level measure by aggregating across all products from all countries, and weighting each product c-k with its share in the industry's imports in the first period

industry is observed in the trade data. The time-varying instrument for each industry j in year t is

$$WRES_{jt} = \sum_{c,k} s_{jck} WRES_{ckt} = \sum_{c,k} s_{jck} \frac{ES_{ckt}}{\sum_c ES_{ckt}}$$

where j is a three-digit industry, s_{jck} is the share of product k from country c in industry j's total imports in the first year of positive imports. ES_{ckt} is the country c's total supply of product k to the world market in year t. We divide this by the aggregate supply of product k to the world market in year t, excluding the supply to Finland, $\sum_c ES_{ckt}$ in order to get the world's relative export supply $WRES_{ckt}$ of each product.

To define the second industry-level instrument, we exploit the significant growth of imports from China all over the world during the period. The increase of Chinese imports was driven by a rising competitiveness of manufactures and lowering trade barriers in China rather than due to demand factors (Autor, Dorn and Hanson, 2013). China's accession to WTO in 2001 is also driving the surge of Chinese exports on the world market. Thus, the increase in imports from China can be used as an instrument for industry-level offshoring in Finland, if we can argue that the growth was driven by supply side factors in China and not factors related to demand of the products. The instrument for industry j in year t is defined as both in relative and absolute terms. The relative measure is defined as:

$$CRES_{jt} = \sum_{k} s_{jk} \frac{CES_{kt}}{\sum_c ES_{kt}}$$

where j is a three-digit industry, s_{jk} is the share of product k in industry j's total imports in the first year of positive imports. CES_{jt}, China's total export supply of products from industry j (three-digit NACE rev 1.1) in year t excluding the supply to Finland and $\sum_c ES_{jt}$ is the sum of world export supply of products from industry j.[12] The absolute measure is CES_{jt}. In order for the instrument to work, we need to assume that the changes in relative Chinese export supply of the product do not directly affect demand for labor

[12]Our identification strategy is related to that used by Autor, Dorn and Hanson (2012) and Bloom, Draca, and Van Reenen (2009).

at industry level in Finland. Admittedly, Chinese export supply may affect directly the competitiveness and demand for labor in industries which are competing with Chinese exports. Therefore, we should be cautious with the interpretation of the results for log employment. However, we have no cogent reason to believe that Chinese export supply would directly affect the relative demand for labor within industries.

5.3 Results

The firm-level analysis suggest that offshoring has a positive effect on overall employment within firms. Firm-level regressions may well hide some industry level restructuring where offshoring firms remain competitive, survive and expand while non-offshoring firms and firms competing with imports in local market contract and close down their operations. In order to further scrutinize this, and the net effects of employment in different occupational/skill/task categories, we first analyze how the use of imported products impact employment and employment composition at industry-level and then proceed to individual-level analysis studying how firm-level versus industry-level offshoring affects the risk of loosing a job. At industry-level we are interested in the effect of import competition at large and therefore, we use a measure which includes all imports by industry j to Finland, rather than the mere impact of imported intermediates.[13]

Table 6 reports the coefficient on industry-level import variable on log of employment and the share of employment in the six different occupational groups and two different specifications; industry-fixed effects (FE) and two stage least squares with industry-fixed effects and offshoring instrumented with China export supply (FE-IV-CES).

The industry-level results confirm the common belief that there is a negative association between offshoring and import competition and losses of production jobs in manufacturing as seen in the column for production workers. The results for two stage least squares with industry-fixed effects and imports instrumented with China export supply (FE-IV-CES) suggests further that there is a causal effect of industry-level offshoring on log employment

[13] As comparision, we estimate the regressions also with a narrow measure of offshoring including only the imports of products from the same industry.

of production workers (Panel B) and the share of production workers (Panel D). Overall, the net impact of offshoring is associated with employment reductions at industry level, as indicated by the negative signs on all occupation categories in Panel A. The increased use of imported products shifts the employment composition from production occupations towards professional and managerial occupations. The results for educational shares are in line with the occupational categories, that is, use of imported products at industry level has a negative impact on the share of medium educated and a positive impact on the share of highly educated workers, of which the former are typically production workers and the latter professional workers and managers (Table 7).

Table 6 here

Table 7 here

Finally, we analyse how industry-level import use impacts the tasks composition within industries in Table 8. The results for industry-fixed effects (FE) estimations (Panel A) and for instrumented with China export supply (FE-IV-CES) results suggest that offshoring and import penetration reduces the employment in occupations where routine manual, routine cognitive and non-routine manual physical task are intensive. The results of employment shares indicate that offshoring and import penetration impact the composition of job tasks by reducing the share of occupations where non-routine manual physical task are intensive and by increasing the share of occupations where non-routine cognitive personal tasks are intensive.

Table 8 here

Taken together, we find opposite effects at the firm and industry level: import use increases employment of most type of workers within firms, even the employment of production workers, but offshoring and import competition decreases the employment level and share of production workers at industry level. A plausible explanation for this seemingly paradoxical result is that if offshoring at firm level is associated with productivity

increases and expansion, it may be associated with firm survival and turnover at industry level. In other words, firms that are not fully utilizing the offshoring possibilities or firms that face import competition to their intermediate goods, may contract or close down leading to aggregate negative effects on employment in industries with other offshoring firms.

6 Conclusions

This paper analyzes how offshoring, measured by use of imported intermediates, and import penetration at large affect different employment outcomes within firms and industries. By analyzing the effects both at firm- and industry-level, we aim to understand the mechanism how offshoring affects the structure of employment by occupations, tasks and educational skills.

Among few previous studies, our paper contributes to literature by analyzing the causal effect of offshoring by carefully constructed instrumental variables for the use of imported products. We instrument firms' offshoring with a measure of world's relative export supply of the products that the firm imported during the first year of the studied period. At industry-level, we exploit the idea that Chinese manufacturing has experienced supply shocks affecting the use of imported products in Finland and elsewhere, and construct a measure using information of Chinese exports and Finnish imports at product level.

Our findings suggest that firm-level offshoring increases employment within firms in general, and employment of low educated, production workers, workers carrying out routine manual tasks in particular, but it has the opposite effect decreasing the employment of production workers at the industry level. We propose that a mechanism which is consistent with these seemingly paradoxical results is the following: while an increased use of intermediate inputs has a positive impact on the offshoring firms, it affects negatively domestic suppliers and non-offshoring competitors within the same industry. More specifically, offshoring firms may improve productivity and remain competitive by replacing domestically produced intermediates by cheaper imports, leading to an expansion of market shares and employment. At the same time, the aggregate employment, and employment of produc-

tion workers in particular, is affected negatively as domestic suppliers and non-offshoring competitors lose market shares within the same industry. In order to establish the exact mechanism would require a further analysis of the interaction between firms' offshoring choices and industry dynamics. This is, however, beyond the scope of our study.

References

[1] Acemoglu, D. and D.H. Autor (2011) "Skills, Tasks and Technologies: Implications for Employment and Earnings" Handbook of Labor Economics Volume 4, Orley Ashenfelter and David E. Card (eds.), Amsterdam: Elsevier.

[2] Anderton, B. and P. Brenton (1999), "Outsourcing and Low-Skilled Workers in the UK", Bulletin of Economic Research 51(4), 267-285.

[3] Autor D.H. , D. Dorn (2013) "The Growth of Low-Skill Service Jobs and the Polarization of the U.S. Labor Market" American Economic Review, vol. 103(5), pages 1553-97, August.

[4] Autor D.H. , D. Dorn and G. Hanson (2013), "The China Syndrome: Local Labor Market Effects of Import Competition in the United States" *American Economic Review*, vol. 103(6), pages 2121-68, October.

[5] Autor D.H. , F. Levy and R.J. Murmane (2003),"The Skill Content of Recent Technological Change: An Empirical Exploration," Quarterly Journal of Economics 118(4), 1279–1333.

[6] Baumgarten, D., I. Geishecker and H. Görg (2013). "Offshoring, tasks, and the skill-wage pattern," *European Economic Review*, Elsevier, vol. 61(C), pages 132-152.

[7] Becker S.O. , K. Ekholm and M.-A. Muendler (2013), "Offshoring and the Onshore Composition of Occupations, Tasks and Skills", *Journal of International Economics*, Elsevier, vol. 90(1), pages 91-106.

[8] Blinder A.S. (2006), "Offshoring: The Next Industrial Revolution" Foreign Affairs 85 (2), 113–128.

[9] Blinder A.S., A.B. Krueger (2009) "Alternative Measures of Offshorability: A Survey Approach" NBER Working Paper No. 15287.

[10] Ebenstein,A., A. Harrison, M. McMillan and S. Phillips "Estimating the Impact of Trade and Offshoring on American Workers Using the Current Population Surveys" NBER Working Paper No. 15107. Forthcoming in *the Review of Economics and Statistics*

[11] Falk, M. and B. M. Koebel (2002), "Outsourcing, Imports and Labour Demand", *Scandinavian Journal of Economics*, 104, 567-586.

[12] Feenstra, R.C. and G.H. Hanson (1996), "Globalization, Outsourcing, and Wage Inequality", *American Economic Review*, 86, pp. 240-45.

[13] 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", *The Quarterly Journal of Economics*,114, pp. 907-41.

[14] Goos M., A. Manning and A. Salomons, (2009) "Job Polarization in Europe", *American Economic Review*, American Economic Association, vol. 99(2), pages 58-63.

[15] Goos M., A. Manning and A. Salomons, (2010) "Explaining Job Polarization: The Roles of Technology, Offshoring and Institutions", CEP Discussion Paper No 1026

[16] Grossman, G. and E. Rossi-Hansberg (2006) "The Rise of Offshoring: It's Not Wine for Cloth Anymore" The New Economic Geography: Effects and Policy Implications. Ed. Federal Reserve Bank of Kansas City.

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

[18] Harrison, A. and M. McMillan (2011) "Offshoring Jobs? Multinationals and U.S. Manufacturing Employment" *The Review of Economics and Statistics*, 93(3): 857–875

[19] Hijzen, A. and Görg, H. and R.C. Hine (2005) "International Outsourcing and the Skill Structure of Labor Demand in the United Kingdom", *Economic Journal,* 115, 506, pp. 860-78.

[20] Hummels, D., R. Jørgensen, J. Munch, and C. Xiang (2011) The Wage Effects of International Offshoring: Evidence from Danish Matched Worker-Firm Data (with D. Hummels, R. Jørgensen and C. Xiang), NBER Working Paper No. 17496.*American Economic Review, forthcoming*

[21] Leamer, E. and M. Storper (2001), "The Economic Geography of the Internet Age", Journal of International Business Studies 32(4), 641-665.

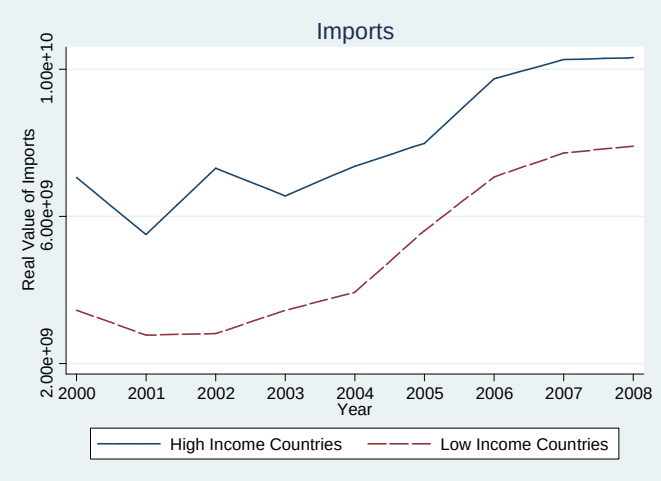
[22] Levy, F. and R.J. Murmane (2004), The New Division of Labor: How Computers Are Creating the Next Job Market, Princeton and Oxford: Princeton University Press.

[23] Machin, S. and J. van Reenen (1998), "Technology and Changes in Skill Structure: Evidence form Seven OECD Countries", *Quarterly Journal of Economics* 113, 1215-1244.

[24] Markusen J.R. (2006): 'Modeling the Offshoring of White-Collar Services: From Comparative Advantage to the New Theories of Trade and FDI' in Brainard, S. Lael and Susan Collins (eds.) in "Brookings Trade Forum 2005: Offshoring White-Collar Work," Washington: The Brookings Institution.

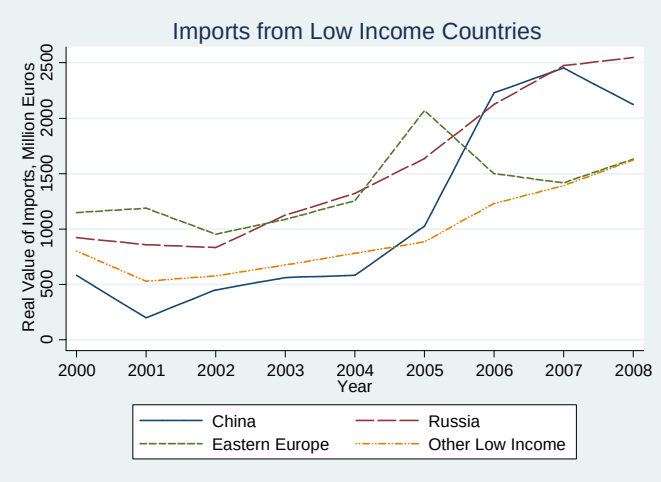
[25] Strauss-Kahn, V. (2004), "The Role of Globalization in the Within-Industry Shift Away from Unskilled Workers in France", Chapter 6 in R. E. Baldwin and L. A. Winters (eds.), *Challenges to Globalization: Analyzing the Economics*, NBER Conference Report, University of Chicago Press, Chicago.

Figure 1. Imports of intermediate goods from same 2-digit industry from high- and low-income countries.



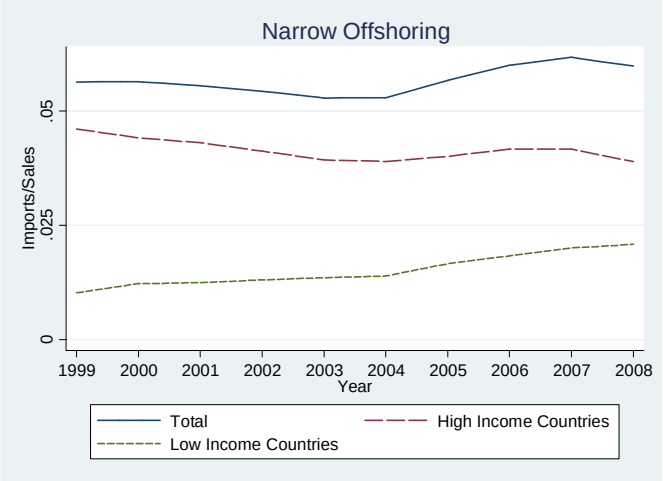
Source: Computed from Finnish Custom's statistics.

Figure 2. Imports of intermediate goods from same 2-digit industry by low-income country.



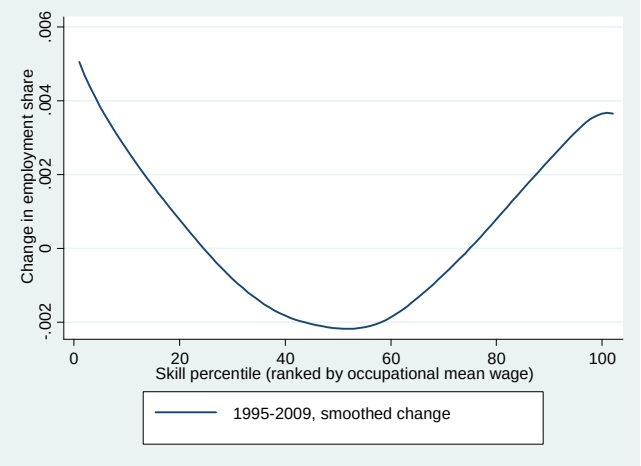
Source: Computed from Finnish Custom's statistics.

Figure 3. Narrow offshoring (imports of intermediate goods from same 2-digit industry to sales).



Source: Computed from Finnish Custom's statistics.

Figure 4. Change in occupational (3-digit ISCO) employment 1995-2009 ranked by their mean wage in the beginning of the period.



Source: Computed from Statistics Finland data

Appendix tables

Table A1.Summary statistics -firm level for years 2000, 2004-2008.

Control Variable	Obs	Mean	Std. Dev.	Min	Max
Offshoring narrow	8743	0.0576	0.1442	0	4.0935
Any offshoring	8743	0.5930	0.4923	0	1
Ever-offshored	8743	0.7143	0.4518	0	1
WRES_narrow	8743	0.016	0.0350	0	0.5019
WES_narrow	8743	1.31e+08	8.34e+08	0	2.54e+10
Size	8743	188.384	750.9345	1	24984
Wage	8743	29089	8394.7	860	141780
Log. Output	8719	16.0942	1.5959	6.9077	24.1956
Capital-intensity	8719	1.555	33.5099	0	2271
Service/output	8719	0.0793	0.1077	0	1.4506
Share variables					
Education, secondary	8743	0.2272	0.1341	0	1
Education, upper secondary	8743	0.5248	0.1523	0	1
Education, tertiary	8743	0.2479	0.1691	0	1
Clerks	8743	0.0395	0.0548	0	1
Service	8743	0.0968	0.1159	0	1
Production	8743	0.5849	0.2332	0	1
Managerial or Professional	8743	0.2788	0.2035	0	1
Log variables					
Education, secondary	8743	2.6117	1.3193	0	1
Education, upper secondary	8743	3.4956	1.3022	0	1
Education, tertiary	8743	2.6413	1.4675	0	1
Clerks	8743	1.1974	1.1326	0	1
Service	8743	1.8441	1.3520	0	1
Production	8743	3.5761	1.3726	0	1
Managerial or Professional	8743	2.7117	1.4724	0	1

Table A2.Summary statistics firm-level by offshoring status 2000, 2004-2008.

Control Variable	All	Offshoring	Not-offshoring
Offshoring narrow	0.0576	0.0972	0
Any offshoring	0.5930	1	0
Ever-offshored	0.7143	1	0.2979
WRES_narrow	0.016	0.0246	0.000
WES_narrow	1.31e+08	2.20e+08	206820.9
Size	188.384	278.664	56.822
Wage	29089	30296	27332
Log. Output	16.0942	16.699	15.2067
Capital-intensity	1.555	0.4554	3.1685
Service/output	0.0793	0.0659	0.099
Share variables			
Education, secondary	0.2272	0.2189	0.2394
Education, upper secondary	0.5248	0.5105	0.5456
Education, tertiary	0.2479	0.2705	0.2149
Clerks	0.0395	0.0360	0.0446
Service	0.0968	0.0962	0.0977
Production	0.5849	0.5709	0.6053
Managerial or Professional	0.2788	0.2969	0.2524
Log variables			
Education, secondary	2.6117	2.9867	2.0476
Education, upper secondary	3.4956	3.8942	2.9072
Education, tertiary	2.6413	3.1742	1.8327
Clerks	1.1974	1.3970	0.8021
Service	1.8441	2.1373	1.3281
Production	3.5761	3.97088	2.9783
Managerial or Professional	2.7117	3.2383	1.9203
Observations	8743	5185	3558

Table A3. Summary statistics: individual level (updated)

Control Variable	All workers	Workers in offshoring firms	Workers in not-offshoring firms
Separation (from firm)	0.174	0.172	0.190
Separation (from plant)	0.186	0.184	0.200
Displaced (due to closure/mass dismissal from plant)	0.045	0.044	0.047
Offshoring (imports/sales)	0.082	0.093	0.011
Any offshoring	0.88	1	0
Offshoring_industry (imports/sales)*	0.391	0.432	0.088
WRES_narrow	0.025	0.029	0.000
Firm size	3174	3573	207
Worker Age	40.74	40.73	40.85
Female	0.30	0.30	0.29
Children und 7	0.40	0.40	0.38
Log.output	18.988	19.338	16.396
Tenure*	4.83	4.84	4.83
Low educated	0.207	0.202	0.238
Med. educated	0.484	0.476	0.541
High. educated	0.328	0.341	0.237
Clerk	0.037	0.035	0.050
Service	0.079	0.079	0.083
Production	0.338	0.336	0.350
Construction	0.197	0.191	0.237
Professional	0.297	0.309	0.214
Managerial	0.038	0.038	0.040
Observations	2198438	9450540	262116

Sample: workers in manufacturing firms 2000-2007. tenure* categories: 1,2,3,4,5 ,6,7,8,10-15,more than 15. *Calculated as total imports of products of industry j divided by total output of industry j.

Table A4. Shares of finer occupational categories, within the main groups in the sample of manufacturing employees (2000)

Clerical, Sales		Service		Production		Operators		Professional, Technical		Managerial	
isco-2	%	isco-2	%	isco-2	%	isco-2	%	isco-2	%	isco-2	%
41 General and keyboard clerks	95.67	51 Personal service workers	6.74	73 Handicraft and printing workers	3.32	71 Building and related trades workers, excluding electricians	10.81	22 Health professionals	0.44	11 Chief executives, senior officials and legislators	0.08
42 Customer services clerks	4.33	52 Sales workers	11.01	74 Electrical and electronic trades workers	7.97	72 Metal, machinery and related trades workers	81.90	23 Teaching professionals	0.50	12 Administrative and commercial managers	98.94
		91 Cleaners and helpers	15.78	81 Stationary plant and machine operators	35.20	83 Drivers and mobile plant operators	7.29	24 Business and administration professionals	20.72	13 Production and specialised services managers	0.99
		92 Agricultural, forestry and fishery labourers	0.13	82 Assemblers	53.51			31Science and engineering associate professionals	47.68		
		93 Labourers in mining, construction, manufacturing and transport	55.28					32 Health associate professionals	2.87		
								33Business and administration associate professionals	0.00		
								34 Legal, social, cultural and related associate professionals	27.78		
Obs	11885		25994		108629		66355		89045		10098

Table 1.The effect of offshoring on firm-level outcomes.

Dependent variable:	**Employment (log)**	**Output (log)**	**Service intensity**	**Capital intensity**	**Average wage low education (log)**	**Average wage medium education (log)**	**Average wage high education (log)**
Panel A: OLS							
	0.849***	1.402***	-0.027***	1.311*	0.099**	0.083**	0.178**
	(0.133)	(0.357)	(0.010)	(0.737)	(0.043)	(0.040)	(0.078)
R-squared	0.087	0.143	0.145	0.003	0.176	0.308	0.232
Panel B: FE							
	0.233*	1.193	-0.005	-14.125	0.005	0.018	0.006
	(0.136)	(0.130)	(0.008)	(11.491)	(0.034)	(0.022)	(0.020)
R-squared	0.013	0.100	0.011	0.015	0.223	0.430	0.290
Nr of firm id	1,992	1,992	1,992	1,992	1,980	1,988	1,973
Panel C: FE-IV- WRES							
First stage							
WRES	0.323***	0.323***	0.323***	0.323***	0.319***	0.319***	0.321***
	(0.032)	(0.032)	(0.032)	(0.032)	(0.033)	(0.032)	(0.033)
Second stage							
	4.710***	4.197***	0.027	-64.598*	-0.234	-0.409**	0.371
	(0.783)	(0.741)	(0.088)	(38.233)	(0.322)	(0.184)	(0.258)
Nr of firm id	1,992	1,992	1,992	1,992	1,980	1,988	1,973
Observations	15,051	15,051	15,051	15,051	14,589	14,960	14,654

Note: Sample includes firms with at least 20 employees for years, 2000, 2004-2008. Industry and year fixed effects are included in all specifications. Standard errors in parentheses (robust clustered by firms). p<0.01 *** p<0.05 **, p<0.1*

Table 2.The effect of offshoring on firm-level employment in occupational categories.

Dependent variable: Log employment	**Clerical, Sales**	**Service**	**Production, Operators**	**Construction, Machinery**	**Professional**	**Managerial**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Offshoring	0.618***	0.911***	0.796***	0.228	1.342***	0.665***
	(0.117)	(0.152)	(0.167)	(0.154)	(0.320)	(0.130)
R-squared	0.110	0.118	0.183	0.260	0.153	0.123
Offshoring	0.204	0.241	0.316	0.119	0.622***	0.068
	(0.143)	(0.172)	(0.207)	(0.169)	(0.190)	(0.141)
R-squared	0.070	0.034	0.016	0.031	0.016	0.090
Nr of firm id	1,722	1,774	1,855	1,725	1,867	1,808
First stage(WRES)	0.231***	0.171***	0.193***	0.248***	0.259***	0.229***
	(0.043)	(0.038)	(0.037)	(0.041)	(0.037)	(0.038)
Second stage (Offshoring)	3.201*	6.620**	8.221***	3.704*	7.212***	1.529
	(1.695)	(2.995)	(2.697)	(1.918)	(1.656)	(0.591)
Nr of firm id	1,722	1,774	1,855	1,725	1,867	1,808
Observations	6,482	6,868	7,922	7,203	8,207	7,700

Note: Sample includes firms with at least 20 employees for years, 2000, 2004-2008. Industry and year fixed effects included. Standard errors in parentheses (robust clustered by firms in panel A and B). p<0.01***, p<0.05 **, p<0.1*

Table 3.The effect of offshoring on firm-level employment shares in occupational categories.

Dependent variable: employment share	**Clerical, Sales**	**Service**	**Production, Operators**	**Construction Machinery**	**Professional**	**Managerial**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Mean share	0.040	0.082	0.360	0.234	0.214	0.070
Std dev	(0.054)	(0.110)	(0.263)	(0.253)	(0.179)	(0.087)
Panel A: OLS						
Offshoring	0.013	0.031**	0.023	-0.153***	0.091*	-0.005
	(0.008)	(0.014)	(0.035)	(0.040)	(0.048)	(0.009)
R-squared	0.091	0.204	0.346	0.527	0.277	0.055
Panel B: FE						
Offshoring	0.003	0.007	0.040	-0.016	-0.017	-0.017
	(0.009)	(0.013)	(0.026)	(0.024)	(0.030)	(0.024)
R-squared	0.013	0.017	0.011	0.027	0.034	0.069
Nr of firm id	1,908	1,908	1,908	1,908	1,908	1,908
Panel C: FE-IV-WRES						
First stage	0.234***					
(WRES)	(0.034)					
Second stage	-0.095	0.553***	0.628*	-0.059	-0.575**	-0.452**
(Offshoring)	(0.107)	(0.186)	(0.327)	(0.262)	(0.231)	(0.185)
Nr of firm id	1,908	1,908	1,908	1,908	1,908	1,908
Observations	8,719	8,719	8,719	8,719	8,719	8,719

Note: Sample includes firms with at least 20 employees for years 2000, and 2004-2008. Industry and year fixed effects included.
Standard errors in parentheses (robust clustered by firms in panel A and B). p<0.01*** p<0.05 ** p<0.1*

Table 4.The effect of offshoring on firm-level employment and employment shares in educational categories.

Dependent variable:	**Log Employment**			**Employment shares**		
	Low educated	**Medium educated**	**High educated**	**Low educated**	**Medium educated**	**High educated**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Mean share				0.242	0.520	0.238
Std dev				(0.137)	(0.149)	(0.161)
Panel A: OLS						
Offshoring	0.783***	0.686***	1.218***	-0.006	-0.075**	0.081**
	(0.143)	(0.143)	(0.205)	(0.143)	(0.035)	(0.032)
R-squared	0.109	0.070	0.142	0.216	0.131	0.186
Panel B: FE						
Offshoring	0.143	0.183	0.253*	-0.002	-0.001	0.002
	(0.095)	(0.121)	(0.136)	(0.007)	(0.008)	(0.010)
R-squared	0.070	0.010	0.018	0.015	0.0002	0.0002
Nr of firm id	1,980	1,988	1,973	1,922	1,922	1,922
Panel C: FE-IV-WRES						
First stage	0.318***	0.318***	0.321***	0.323***		
(WRES)	(0.033)	(0.032)	(0.033)	(0.032)		
Second stage	4.305***	4.640***	3.397***	0.299***	0.145	-0.444***
(Offshoring)	(0.811)	(0.819)	(0.648)	(0.087)	(0.100)	(0.104)
Nr of firm id	1,980	1,988	1,973	1,922	1,922	1,922
Observations	14,589	14,960	14,654	15,051	15,051	15,051

Note: Sample includes firms with at least 20 employees for years, 2000-2008. Industry and year fixed effects included.
Standard errors in parentheses (robust clustered by firms in panel A and B). p<0.01 *** p<0.05 ** p<0.1*

Table 5.The effect of offshoring on firm-level employment and employment shares in task categories.

Dependent variable:	**Log Employment**				**Employment shares**			
	Routine manual	**Routine cognitive**	**Non-routine manual physical**	**Non-routine cognitive personal**	**Routine manual**	**Routine cognitive**	**Non-routine manual physical**	**Non-routine cognitive personal**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Mean share					0.426	0.467	0.443	0.123
Std dev					(0.265)	(0.242)	(0.279)	(0.139)
Panel A. OLS								
Offshoring	0.392**	1.322***	1.074***	1.146***	-0.140***	0.156***	-0.139***	0.012
	(0.154)	(0.250)	(0.307)	(0.259)	(0.033)	(0.037)	(0.040)	(0.017)
R-squared	0.150	0.107	0.151	0.172	0.356	0.176	0.477	0.237
Panel B: FE								
Offshoring	0.182	0.465**	0.471***	0.378**	0.021	0.022	-0.006	-0.010
	(0.191)	(0.196)	(0.148)	(0.156)	(0.033)	(0.036)	(0.032)	(0.028)
R-squared	0.001	0.022	0.000	0.013	0.077	0.053	0.237	0.019
Nr of firm id	1,880	1,902	1,890	1,887	1,908	1,908	1,908	1,908
Panel C: FE-IV-WRES								
First stage	0.186***	0.230***	0.213***	0.266***	0.234***			
(WRES)	(0.036)	(0.034)	(0.036)	(0.036)	(0.034)			
Second stage	6.348**	7.960***	4.108**	7.508***	0.632**	-0.041	0.199	-0.331
(Offshoring)	(2.495)	(1.903)	(1.661)	(1.577)	(0.323)	(0.332)	(0.293)	(0.216)
Nr of firm id	1,858	1,857	1,868	1,887	1,908	1,908	1,908	1,908
Observations	8,157	8,616	8,248	8,493	8,719	8,719	8,719	8,719

Note: Sample includes firms with at least 20 employees for years, 2000, 2004-2008. Industry and year fixed effects included.
Standard errors in parentheses (robust clustered in panel A and B). p<0.01***, p<0.05 ** p<0.1*.

Table 6. The effect of industry-level offshoring on employment shares in occupational categories at industry level.

Dependent variable: Log Employment	**Clerical, Sales**	**Service**	**Production, Operators**	**Construction Machinery**	**Professional**	**Managerial**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Panel A:FE						
Offshoring	-0.043***	-0.045**	-0.053***	-0.047***	-0.056*	-0.030***
	(0.015)	(0.018)	(0.016)	(0.014)	(0.030)	(0.008)
R-squared	0.382	0.118	0.091	0.302	0.159	0.408
Panel B: FE-IV-CES						
First stage	9.79e-11***	9.78e-11***	9.78e-11***	9.78e-11***	9.78e-11***	9.78e-11***
(CES)	(1.81e-11)	(1.79e-11)	(1.79e-11)	(1.79e-11)	(1.79e-11)	(1.79e-11)
Second stage	-0.088***	-0.062	-0.127***	-0.050	-0.043	0.005
(Offshoring)	(0.033)	(0.042)	(0.038)	(0.036)	(0.029)	(0.028)
Nr of industry id.	85	85	85	85	85	85
Observations	506	510	510	510	510	510
Dependent variable: Employment share						
Mean share	0.046	0.125	0.512	0.238	0.350	0.078
Std dev	(0.031)	(0.081)	(0.214)	(0.216)	(0.322)	(0.054)
Panel C: FE						
Offshoring	0.000	0.001	-0.003	-0.000	0.002	0.002**
	(0.003)	(0.001)	(0.002)	(0.001)	(0.004)	(0.001)
R-squared	0.238	0.020	0.095	0.200	0.064	0.355
Panel D: FE-IV-CES						
First stage	9.78e-11***					
(CES)	(1.79e-11)					
Second stage	-0.001	-0.000	-0.017**	-0.001	0.030***	0.019***
(Offshoring)	(0.002)	(0.004)	(0.008)	(0.006)	(0.011)	(0.004)
Nr of industry id	85	85	85	85	85	85
Observations	510	510	510	510	510	510

Note: Industry and year fixed effects included. Standard errors in parentheses (robust clustered by industries in panel A and C). p<0.01***, p<0.05 ** p<0.1*.

Table 7.The effect of industry-level offshoring on employment and employment shares in educational categories at industry-level.

Dependent variable:	**Log Employment**			**Employment share**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	Low educated	Medium educated	High educated	Low educated	Medium educated	High educated
Panel A: FE						
Offshoring	-0.038**	-0.044***	-0.048***	0.001	-0.000	-0.001
	(0.016)	(0.016)	(0.017)	(0.001)	(0.001)	(0.001)
Panel B: FE-IV						
First stage (CES)	9.78e-11***			9.78e-11***		
	(1.79e-11)			(1.79e-11)		
Second stage	-0.072***	-0.094***	-0.043*	0.004*	-0.013***	0.009***
(offshoring)	(0.026)	(0.026)	(0.023)	(0.002)	(0.004)	(0.004)
Nr of observations	510	510	510	510	510	510

Note: Sample includes firms with at least 20 employees for years, 2000, 2004-2008. Industry and year fixed effects included.
Standard errors in parentheses (robust clustered by industries in panel A). p<0.01, *** p<0.05,* * p<0.1.

Table 8.The effect of industry-level offshoring on employment and employment shares in task categories at industry-level.

Dependent variable:	**Log Employment**				**Employment shares**			
	Routine manual	**Routine cognitive**	**Non-routine manual physical**	**Non-routine cognitive personal**	**Routine manual**	**Routine cognitive**	**Non-routine manual physical**	**Non-routine cognitive personal**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Panel A: FE								
Offshoring	-0.051**	-0.047***	-0.057***	-0.035***	-0.002	-0.001	-0.004*	0.002**
	(0.024)	(0.018)	(0.019)	(0.012)	(0.002)	(0.002)	(0.002)	(0.001)
Panel B: FE-IV								
First stage (CES)	9.78e-11***				9.78e-11***			
	(1.79e-11)				(1.79e-11)			
Second stage (offshoring)	-0.102***	-0.065**	-0.092***	0.019	0.001	-0.004	-0.012**	0.012***
	(0.036)	(0.027)	(0.033)	(0.030)	(0.005)	(0.006)	(0.005)	(0.003)
Nr of observations	509	510	510	510	510	510	510	510

Note: Sample includes firms with at least 20 employees for years, 2000, 2004-2008. Industry and year fixed effects included.
Standard errors in parentheses (robust clustered by industries in panel A). p<0.01, *** p<0.05,* * p<0.1.