Offshoring and labor market outcomes

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Abstract

This paper investigates empirically the effects of offshoring on plant survival probability and employment growth using data on the Danish manufacturing during the period 1995-2006. To control for the potential endogeneity of the offshoring decision the paper uses propensity matching technique and difference-in-difference matching estimator. The Danish data enable me to divide the offshoring activity to different regions which is shown in the analyses to be of crucial importance. The results reveals that while the survival prospect is higher in plants belonging to firms that mainly offshore to high-wage countries, the survival is not affected if the main offshoring is carried out in medium-wage countries and is negatively affected if the main offshoring is carried out in low-wage countries. The paper also finds that the growth rate of less-skilled employment is negatively affected by offshoring. Depending on where the main offshoring activity is carried out the magnitude of this negative growth rate is between 2 and 6 percent.

Keywords: Offshoring, Plant Survival, Employment Growth, DID Matching Estimator

JEL Codes: F16, F23, J24, L25

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1. Introduction

The volume of offshoring[1] has in the last decade increased at a rapid pace. This has resulted in growing attention both in the media and academia about the potential consequences on the domestic labor market. On one hand, there is a major concern that after the firm has decided to offshore some of their production lines abroad, they may either shut-down the entire domestic production plant(s) or fire domestic employees or exposes them to wage cuts. On the other hand, offshoring may generate substantial gains for the firms in form of higher productivity, better efficiency and faster economic growth that may increase the survival probability of their plants and or increase their demand for labor.

The purpose of this paper is to evaluate the effects of firms' offshoring activity on the plants survival and employment growth prospects. Firstly, the paper investigates whether the firms have made adjustment along the extensive margin, i.e. plant closures as a consequence of the offshoring activity. Secondly, the paper considers the intensive margin of adjustment by examining the effect on employment growth in surviving plants after the firms' offshoring activity. To this end, I use a unique and detailed plant level data (which also provide some information at the firm level) for the Danish manufacturing industries during the time period 1995-2006. The estimation strategy that I implement in this paper to control for the potential endogeneity of the offshoring decision, i.e. firm performance and offshoring activities are positively correlated, is to combine difference-in-differences with propensity score matching techniques.

This paper contributes to the literature in some important aspects. First, this is the first study, to my knowledge, that analyses the impact of offshoring on plant survival. Second, the data used in this paper include the entire population of plants in the manufacturing industry as opposite to some of the earlier studies that are based only on a sample of firms. Third, this study uses firm-level information on offshoring, unlike some of earlier research that uses industry-level proxies for the offshoring activity. Forth, I take particular account of the potential endogeneity of the offshoring decision by implementing matching method and a combined differences-in-differences (DiD) propensity score matching estimation.

[1] In line with Olsen (2006), I define offshoring as relocation of jobs and processes to any foreign country, which includes international outsourcing without distinguishing whether the provider is external or affiliated with the firm.

To preview the results; firstly, this paper provides empirical evidence that firms' offshoring activities have a positive effect on the plant survival. As compared to plants of non-offshoring firms, the probability of surviving is around 30 percent higher for plants of offshoring firms. However, separating the firms' offshoring activities to different regions, the result becomes more dispersed. While the survival prospect is higher in plants belonging to firms that mainly offshore to high-wage countries (as compared to plants of non-offshoring firms), the survival is not affected if the main offshoring is carried out in medium-wage countries and is negatively affected if the main offshoring is carried out in low-wage countries. These results are robust even after controlling for other plant-, firm- and industry characteristics that may affect the survival and also after using a matched sample constructed by propensity score matching technique in order to control for the possible endogeneity of the offshoring decision.

Secondly, the effect of offshoring on employment growth seems only to be on less-skilled employment. Implementing a combined DiD propensity score matching estimation, the result reveals that there is no significant effect of offshoring on either the growth rate of high skilled employment or on the growth rate of medium skilled employment and this no matter whether the offshoring is manly carried out in high-, medium- or low-wage countries. However, the growth rate of less-skilled employment is negatively affected by offshoring. Depending on where the main offshoring activity is carried out the magnitude of this negative growth rate is between 2 and 6 percent.

The paper is structured as follows; Section 2 reviews the related theoretical and empirical literature and section 3 describes the econometric methodology employed in this paper. Section 4 presents the data and illustrates how the offshoring activities from different regions have developed in the Danish manufacturing during the period 1995-2006. Section 5.1 presents the results for the effect of offshoring on plant survival, while section 5.2 focusses on employment growth effects. Section 6 concludes.

2. Theoretical and empirical overview

3. Estimation strategy

To investigate whether the survival ratio of plants within offshoring firms differ from their counterparts that are within non-offshoring firms I first turn to a non-parametric approach to estimate the survivor functions for the two different types of plants. The Kaplan—Meier estimate of the survivor function is given by:

$$S(t) = \prod_{j|t_j<t} \frac{n_j - d_j}{n_j} \qquad (1)$$

where $S(t)$ denotes the probability of surviving past time t. n_j stands for the number of plants that have survived and d_j for the number of plants that died at time t.

However, the Kaplan—Meier survivor functions do not consider other factors that may affect plant survival, i.e. plant-, firm-, and industry-specific factors such as plant size, age and productivity. As discussed above, a more or less established stylized fact is that smaller and younger plants have lower probabilities of survival than larger and older plants (Dunne et al., 1988, 1989; and Disney et al., 2003).

To disentangle the effect of various plant-, firm-, and industry-specific factors on plant survival from offshoring activity, I turn to the semi-parametric complementary log-log model (cloglog).[2] The underlying assumption in this model is that the hazard ratio $\theta(t,X)$, the rate at which the plants exit in interval t to t+1, depends only on time at risk, $\theta_0(t)$ (the so-called baseline hazard), and on explanatory variables affecting the hazard independently of time, $\exp(\beta' X)$. The hazard ratio is then given by:

$$\theta(t,X) = \theta_0(t)\exp(\beta' X) \qquad (2)$$

The discrete-time hazard function is then given by the following equation:

[2] Given that the data I use are collected on a yearly basis it is more appropriate to apply the discrete time model cloglog than the continues time model Cox proportional hazard that are used in earlier related IO literature (e.g., Audretsch and Mahmood, 1995, Disney et al., 2003)

$$h(j, X) = 1 - exp\left[-\exp(\beta' X + \gamma_j)\right] \quad (3)$$

where $h(j, X)$ shows the interval hazard for the period between the beginning and the end of the j[th] year after the first appearance of the plant and $\gamma_j = log \int_{\alpha_{j-1}}^{\alpha_j} \theta_0(t)dt$ capture, within each interval, period specific effects on the hazard. The β parameter show the effects of the explanatory variables X on the hazard rate. The covariate X includes variables at the plant-, firm-, and industry level. The main variable in the analyze is a dummy variable showing whether a plant is within an offshoring firm or not. In section 4, I will return to all these variables and discuss more in detail the theoretical and empirical implication behind them. The final baseline hazard model can then be written as:

$$h(j, X) = 1 - exp\begin{bmatrix} -\exp(\beta_0 + \beta_1 Offshoring + \beta_2 plant_{controls} \\ +\beta_3 firm_{controls} + \beta_4 industry_{controls} + \gamma_j \end{bmatrix} \quad (4)$$

Offshoring measure at the firm level is considered to be involved with estimation errors due to endogeneity in the sense that firms that relocated parts of their activities abroad are “better” than non-offshoring firms in terms of productivity, size and human capital intensity (Görg et. al., 2008) This however is not reflected in equation (4) since the underlying assumption on coefficient β_1 for the offshoring dummy is that, conditional on plant, firm and industry controls, offshoring is exogenous. If this is not true, then the stochastic dependence between the offshoring dummy and the error term may bias the estimates. To alleviate this problem, I use a selection of a control group based on propensity score matching technique. The aim of this approach is to find, for every offshoring firm, a similar firm that is not involved in offshoring activity. Thus, the matching technique enables me to construct a sample of offshoring and non-offshoring firms with similar characteristics X such as productivity, size etc. Conditional on these characteristics I can estimate the firms’ probability (or propensity score) to engage in offshoring using the following probit model:

$$P(Offshoring_{it} = 1) = F(X_{it-1}, I_j, T_t) \quad (5)$$

where X_{it-1} is a vector of relevant firm specific characteristics in year t-1 which may affect the firms probability to engage in offshoring in year t. I and T control for fixed industry and time effects.

Once the propensity scores are calculated, I can select the nearest control firms in which the propensity score falls within a pre-specified radius as a match for a firm that is engaged in offshoring.[3] Moreover, I check whether the balancing condition is verified, that is each independent variable does not differ significantly between offshoring and non-offshoring firms. Another condition that must be fulfilled in the matching procedure is the so-called common support condition[4]. The constructed matched sample is then used to estimate equation (4), similar to Greenaway and Kneller (2007) and Bandick and Görg (2010)

The next step of the analyses is to evaluate the effect of offshoring on employment growth. I use difference-in-differences propensity score matching as described by Blundell and Costa Dias (2000) and recently employed by, for example, Arnold and Javorcik (2009) and Girma and Görg (2007) to estimate the impact of offshoring on employment growth.

The difference-in-differences matching estimator can be expressed as:

$$\beta = \sum_{i \in A} \left(\Delta y_i - \sum_{j \in C} g(p_i, p_j) \Delta y_j \right) w_i \,. \tag{6}$$

where p_i, generated by using equation (5), denote the predicted probability for firm *i* that is included in the treated group (offshoring firms), to engage in offshoring and p_j is the predicted probability for firm *j* in the control group (non-offshoring firms) to engage in offshoring. Δy is the log difference between the level of employment before and after the offshoring activity. g(.) is a function assigning the weights to be placed on the comparison firm *j* while constructing the counterfactual for the offshoring firm *i*. In the case of nearest neighbor matching as employed in

[3] This is done using the "caliper" matching method. The procedure I utilize to match offshoring and non-offshoring firms is the PSMATCH2 routine in Stata version 10 described in Leuven and Sianesi (2003). In the analysis, the pre-specified radius is set to 0.001.

[4] This criterion implies that at each point in time, a newly firm engaged in offshoring is matched with non-offshoring firms with propensity scores only slightly larger or smaller than the former firm. Note that some offshoring firms may be matched with more than one non-offshoring firm, while offshoring firms not matched with a non-offshoring firm are excluded.

this paper, g(.) = 1 for the pair with the minimum difference between p_i and p_j, and 0 for all other pairs. w_i is the weight used in the construction of the outcome distribution for the treated sample (1/N in the case of nearest neighbour matching).

4. Data description

The data used in this paper consist of register-based data assembled annually over the period 1995-2006 by Statistic Denmark. The information for the entire manufacturing industries at the plant and firm levels are linked together by a unique identification code. Firms with less than 10 employees (and their plants) are excluded from the analysis due to information inconsistency.

The variables extracted at the plant-level are total employment, the number of employees with different education levels and the age of the plant. I define a worker as high-skilled if she/he has a tertiary education corresponding to categories 5 (first stage of tertiary education) or 6 (second stage of tertiary) in the International Standard Classification of Education (ISCED) and medium skilled if she/he has upper secondary or post-secondary non-tertiary education, i.e. category 3 and 4 in ISCED. The other workers are defined as less-skilled. In using the unique plant code identifying each plant I can assign the plants to be new entrant, in case when new identification number appears from one period to another, exited, in case when previous number disappears, and survived, in case when the number remains the same in subsequent periods. The firm code attached to each plant enables me to match data from Firm Statistics Register, FirmStat.

FirmStat contains general firm information including accounting statistics such as total employment, value added, turnover, export capital stock and industry code. From this information I can generate other variables such as labor productivity, defined as value added per employee, and capital intensity, defined as capital stock divided by turnover. Also I can extract whether a firm is a multi- or single plant simple by counting the number of plants in each firm. Firms with more than one plant are then defined as multi-plant firms.

The trade data is at firm-level and comes from the Danish Foreign Trade Register. Data on trade, both export and import, is disaggregated by destination/origin and products. Measured at the eightdigit Combined Nomenclature, the value, in Danish Kroner (DKK), and weight, in kilos, are reported for each trade flows. The information on firms import captures both international outsourcing, that is inputs are purchased from foreign suppliers instead of producing them in-house, and offshoring, that is relocation of processes previously undertaken in-house to foreign affiliate. In this paper I follow Olsen (2006) and define offshoring as the relocation of jobs and processes to any foreign country, which includes international outsourcing without distinguishing whether the provider is external or affiliated with the firm.

Furthermore, in line with Feenstra and Hanson (1999), I distinguish between two different types of offshoring; narrow offshoring, that is intra-industry offshoring, and broad offshoring, that is inter-industry offshoring. In other words, narrow offshoring is defined as purchases of inputs belonging to the same industry as that of producing firms while broad offshoring is defined as the total value of imports by a firm. Narrow offshoring is then the sum of imports in the same HS2 category as goods sold by the firm either domestically or in exports[5]. In the regression analyses below, I will use both an indicator whether the firm is engaged in offshoring according to the narrow definition and an intensity of the offshoring activity. In the former case the indicator equals to one if the firm is engaged in offshoring and zero if the firm is not engaged in offshoring. In the latter case the intensity will be based on the total value of offshoring over sales and the analyses will be based only on firms that are engaged in offshoring.

Given that the Danish trade data give access to country-of-origin import, I am able to separate the firms' offshoring activities to different regions, high-, medium- and low-wage countries. In the paper I define developed countries to be high-wage countries, while developing countries as medium-wage countries and East-Asian countries as low-wage countries. The offshoring dummy is then divided into three dummies; *offshoring high-wage*, *offshoring medium-wage* and *offshoring low-wage*. The first dummy equals to one if the main offshoring activity (more than 50 percent of the total offshoring value) by the firm is carried out in developed countries, while the second and third offshoring dummies equals to one if the main offshoring activity is carried out in developing and East-Asian countries, respectively.

[5] Narrow offshoring based on HS4 category yields similar regression results.

Table 1 shows the number of firms and plants per year and the share of offshoring firms to different region. There are a total of 46,764 observations in my dataset, 8,432 of which are unique plants. Of those 4,318 plants that existed from the beginning 2,135, or 49 percent, remained at the end of the sample period in 2006. Table 1 also shows that the share of offshoring firms in the Danish manufacturing industries increased by almost 6 percent between the period 1995 and 2002. However, the share of offshoring firms steadily decreased between the period 2002 and 2006. At the end of the sample period the share of offshoring firms were around 32 percent. The last 3 columns in *Table 1* show the development of the share of offshoring firms to different regions. While the majority of the offshoring activities by the firms are carried out in high-wage countries, around 96 percent of the offshoring firms, the offshoring activities in both medium- and low-wage countries have increased substantially over the sample period. The share of firms with offshoring activity mainly carried out in medium- and low-wage countries increased three- and fourfold over the period 1995-2006, respectively.

Figure 1 displays the predicted import value over the period 1995 to 2006 from different regions. The predicted import value is calculated from a linear regression of total import value on the sample time period. As shown in the figure, there has been a substantial increase in import activity from all the three regions. The aggregate value of imports by Danish manufacturing firms tripled in the analyzed period. However, the shaded area in the figure, representing the 95 percent confidence interval, provides evidence that there is substantial variation in the import values across firms and the different regions.

Table 2 present the Kaplan-Meier estimates of the survivor function for offshoring and non-offshoring firms. As shown there are some differences in survival probabilities among the different plants. For instance, after five years plants within firms mainly offshoring to high-wage countries experienced almost 7 percent higher survival ratio than plants within non-offshoring firms. Plants within firms mainly offshoring to medium- and low-wage countries, however, had similar survival ratio as their non-offshoring counterparts. At the end of the period, almost 65 and 63 percent of the plants within offshoring firms to high- and medium-wage countries survived, whereas 60 percent of the non-offshoring plants survived and only 55 percent of the plants within offshoring firms to low-wage countries survived. The log-rank test allows me to reject the hypothesis that the survival functions across the different plants are equal.

Figure 2 illustrates the development of the plant-level mean employment in the Danish manufacturing sector during the period 1995-2006. First, the figure makes clear that the level of the mean employment in plant of offshoring firms is much higher than in plants within non-offshoring firms. The mean employment for the former plants is around 80 at the beginning of the period and declines to around 70 at the end of the period. For the latter plants, the corresponding figures are around 70 and almost 50 at the end of the period. These figures suggest then that plants of offshoring firms are initially larger and that the growth (negavitely) in employment is slower as compared to plants within non-offshoring firms. However, this seems only to be the case for plants within offshoring firms to high-wage countries. For plants within offshoring firms to medium- and low-wage countries the mean employment level is lower and the speed of the negative growth seems to be faster, at least for the latter type of plants, as compared to non-offshoring plants.

Table 3, presenting plant and firm specific characteristic of offshoring and non-offshoring firms, gives similar image for the level of employment as in *Figure 2*. While the level of employment in plants within firms mainly offshoring to high-wage countries is higher as compared to non-offshoring plants, the level of employment is less in both the other offshoring plants. Plants within offshoring firms to high-wage countries are also more productive, have higher capital stock and are more skill-intensive than plants within non-offshoring firms. Again, plant within offshoring firms to medium- and low-wage countries seems to have been outperformed in all these variables by non-offshoring plants.

In order to control for differences in plant and firms characteristics that may have an impact on the survival rates I now turn to the semi-parametric complementary log-log model in section 5.1 and to the DiD matching estimator for the employment growth analyze in section 5.2.

5. Result

5.1 Offshoring and plant survival

The results from estimating the hazard model described in equation (4) on a sample of Danish manufacturing plants in firms with 10 employees or more are presented in *Table 4*. All estimations are stratified by industry and year and the table report the hazard ratios (exponentiated coefficients) which means that a coefficient less than one implies that the respective independent variable increases the probability of survival while a coefficient greater than one implies negative effect on survival, ceteris paribus.

As to establish a benchmark to how the plant probability of survival is been affected, the result in column (1) only control for plant-level characteristics such as plant size, measured by plant employment, plant age, and plant skill-intensity, that is, the percentage of employees with post-secondary education, i.e. at least category 3 in ISCED. Consisting with the previous literature, i.e. Dunne and Hughes (1994) and Mata and Portugal (2002), I find that older, larger and skill-intensive plants have higher probability of surviving.

In column (2) I also include variables at the firm-level such as labor productivity, defined as value added per employee, capital intensity, defined as capital stock divided by turnover, a dummy variable indicating whether a firm is a multi- or single plant operation, and a dummy variable capturing whether another plant in the same firm has exited. Column (2) also control for employment growth at the industry level as a measure of sectoral growth. The result reveals that plants in firms with higher productivity and higher capital intensity are more likely to survive, while the plant´s survival probability is reduced if another plant in the same firm exited and finally the survival ratio seems to be unaffected whether the firm that the plants belongs to is multi- or single plant operation.

The offshoring dummy (according to the narrow definition) that equals to one if the firm is engaged in offshoring and zero if the firm is not engaged in offshoring is included in column (3). The result from this column suggests that, controlling for plant-, firm-, and industry characteristics, plants within offshoring firms have more than 30 percent higher chances to survive than plants of non-offshoring firms. In column (4) I separate the firms’ offshoring activities to different regions in order to evaluate whether there are differences in the survival ratio where the main offshoring activities are carried out. I Therefore divide the offshoring dummy into three dummies; *offshoring high-wage*, equals to one if the main offshoring activity (more than 50 percent of the total offshoring value) by the firm is carried out in high-wage countries, *offshoring medium-wage*, equals to one if the main offshoring activity is carried out in medium-wage countries, and *offshoring low-wage*, equals to one if the main offshoring activity is carried out in low-wage countries. This division seems to be of crucial importance since the effect of offshoring on plant survival differs as to where the main offshoring activity is carried out. While the survival prospect is higher in plants belonging to firms that mainly offshore to high-wage countries (as compared to plants of non-offshoring firms), the survival is not affected if the main offshoring is carried out in medium-wage countries and is negatively affected if the main offshoring is carried out in low-wage countries.

In column (3) and (4) the offshoring decision is assumed to be exogenous determined. However, there are strong reasons to believe that only “better” firms, in terms of productivity, size, human capital intensity etc., are engaged in offshoring activities (Görg et. al., 2008). In order to control for the potential endogeneity in the offshoring decision I estimate equation (4) on a matched sample that is generated using propensity score matching procedure. Details of the matching procedure are in the Appendix. The estimates based on a matched sample, presented in column (5) and (6), seem to not differ from those in the previous columns which underlines the robustness of the results.

The last two columns of Table 4 include only plants within offshoring firms and the empirical examination is to evaluate the effect of offshoring intensity on plant survival probabilities. The offshoring intensity is based on the total value of offshoring over sales. The result in column (8) reveals that a one percentage point increase in the offshoring intensity to high-wage countries increases the plants survival probabilities by 1.2 percentage points. However, a one percentage point increase in the offshoring intensity to medium- and low-wage countries reduces the plants survival probabilities by 2.2 and 2.5 percentage points, respectively.

5.2 Offshoring and employment growth

In order to evaluate the effect of offshoring on employment growth I use the DiD matching estimator as described in equation (6). In order to separate the effect of offshoring on different type of employment, I divide the employment into high skilled, that is employees with a tertiary education corresponding to categories 5 and 6 in ISCED, medium skilled, that is employees with upper secondary or post-secondary non-tertiary education, i.e. category 3 and 4 in ISCED, and low skilled, that is employees with Lower secondary or second stage of basic education as their highest education level corresponding to category 2 in ISCED.

The results, reported in *Table 5*, reveals that there is no significant effect of offshoring on either the growth rate of high skilled employment or on the growth rate of medium skilled employment and this no matter whether the offshoring is manly carried out in high-, medium or low-wage countries. However, the growth rate of less-skilled employment is negatively affected by offshoring. Depending on where the main offshoring activity is carried out the magnitude of this negative growth rate is between 2 and 6 percent.

6. Summary and conclusion

This paper has investigated the effects of firms’ offshoring activity on plants survival and employment growth prospects in the Danish manufacturing industries during the period 1995-2006. In line with Feenstra and Hanson (1999), I define narrow offshoring as purchases of inputs belonging to the same industry as that of producing firms. Narrow offshoring is then the sum of imports in the same HS2 category as goods sold by the firm either domestically or in exports. By using a unique dataset that not only links plant- and firm-level information but also provide information on country-of-origin import, I am able to separate the firms’ offshoring activities to different regions, high-, medium- and low-wage countries. In the paper I define developed countries to be high-wage countries, while developing countries as medium-wage countries and East-Asian countries as low-wage countries.

This division seems to be of crucial importance since the effect of offshoring on plant survival differs as to where the main offshoring activity is carried out. While the survival prospect is higher in plants belonging to firms that mainly offshore to high-wage countries (as compared to plants of non-offshoring firms), the survival is not affected if the main offshoring is carried out in medium-wage countries and is negatively affected if the main offshoring is carried out in low-wage countries.

Moreover, the result reveals that there is no significant effect of offshoring on either the growth rate of high skilled employment or on the growth rate of medium skilled employment and this no matter whether the offshoring is manly carried out in high-, medium- or low-wage countries. However, the growth rate of less-skilled employment is negatively affected by offshoring. Depending on where the main offshoring activity is carried out the magnitude of this negative growth rate is between 2 and 6 percent.

There are important implication of this finding for researchers and policy makers. First, in evaluating the effect of offshoring it is important to consider where the main offshoring activity is carried out. The effect of offshoring on plant survival and employment growth differs depending whether the offshoring is carried out in high-, medium-, or low-wage countries. Secondly, it is also important to separate the employment into different skills since not all types of employment are being affected equally from the offshoring activity.

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Table 1 Total number of firms and plant and the share of offshoring firms

Year	Total firm	Total plant	Multiplant firms[1)]	offshoring firms[1)]	offshoring_ high-wage[2)]	offshoring_ medium-wage[2)]	offshoring_ low-wage[2)]
1995	2,847	4,318	21.6	29.0	98.2	0.8	1.0
1996	2,833	4,395	22.0	30.4	97.4	1.4	1.2
1997	2,752	4,132	21.1	29.8	97.1	1.3	1.6
1998	2,798	4,193	20.9	29.1	96.8	1.5	1.7
1999	2,681	3,973	20.3	31.0	97.5	1.1	1.4
2000	2,562	3,808	20.8	33.2	97.0	1.1	1.9
2001	2,471	3,832	21.7	34.0	96.7	1.2	2.1
2002	2,375	3,729	22.6	34.9	96.1	1.3	2.6
2003	2,255	3,651	23.9	34.6	95.8	1.7	2.5
2004	2,217	3,663	23.6	33.3	95.0	1.6	3.4
2005	2,165	3,564	23.9	32.6	93.9	2.1	4.0
2006	2,139	3,506	23.4	32.4	93.3	2.6	4.1
1995-2006	30,095	46,764	22.2	32.0	96.2	1.5	2.3

Notes: 1) Share of total firms. 2) Share of offshoring firms.

Figure 1 Import over time from different regions, 1995-2006

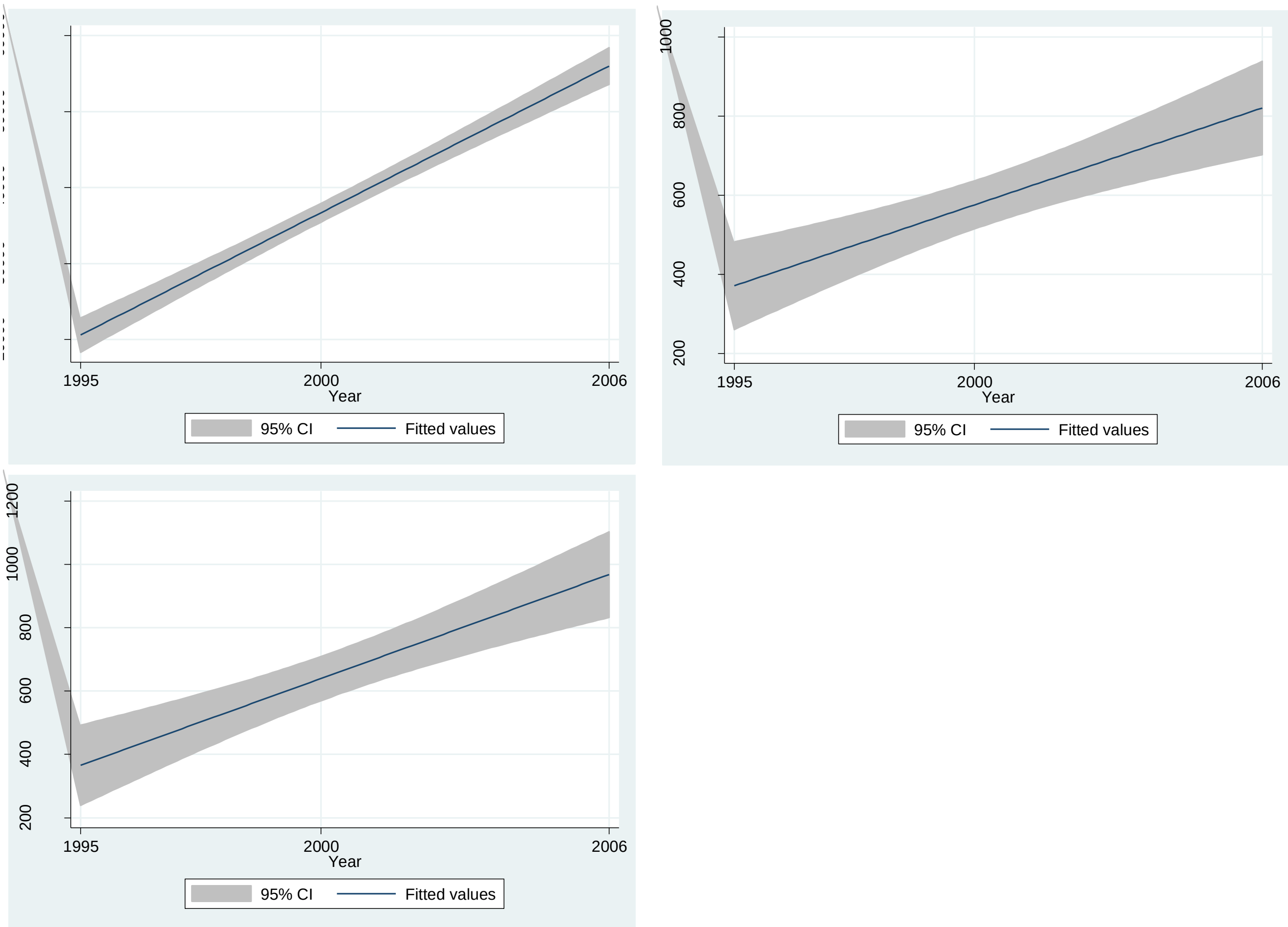
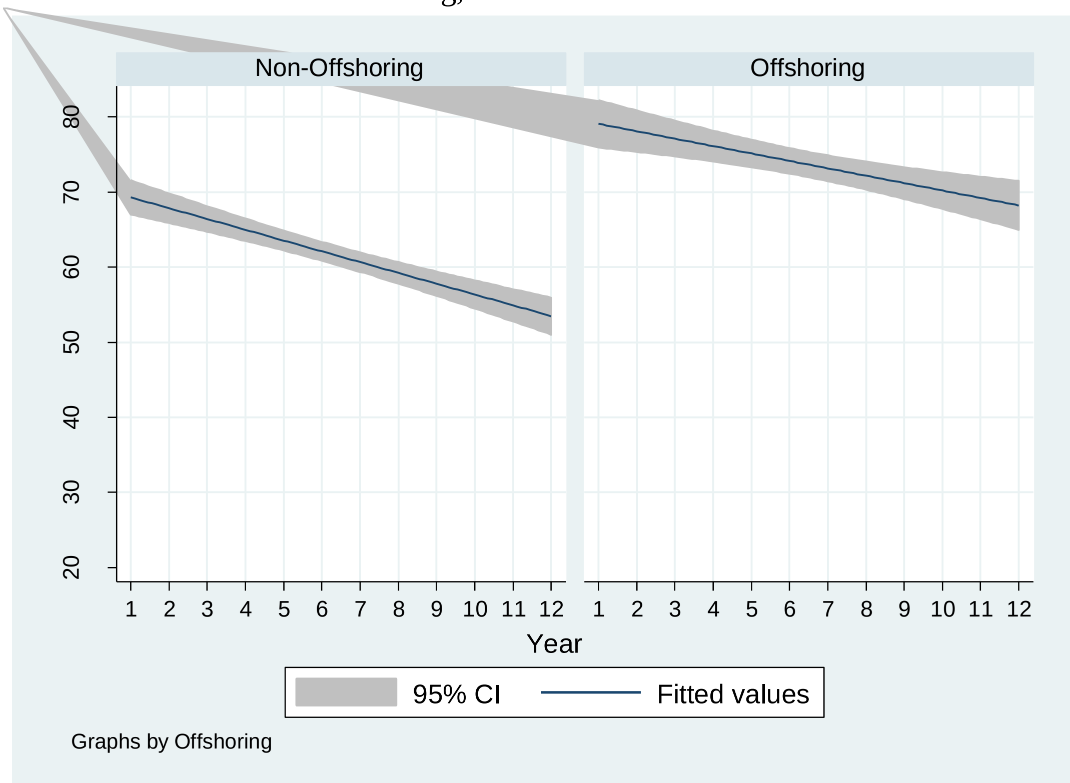


Table 2 Kaplan-Meier estimates of the survivor function for offshoring and non-offshoring firm

Time	Non-offshoring	Offshoring_ high-wage	Offshoring_ medium-wage	Offshoring_ low-wage
1	96.6 (0.002)	96.9 (0.004)	96.3 (0.042)	95.9 (0.029)
2	91.0 (0.004)	94.9 (0.005)	93.2 (0.031)	89.2 (0.036)
3	88.4 (0.004)	92.3 (0.006)	91.3 (0.036)	87.5 (0.025)
4	82.9 (0.005)	89.0 (0.007)	85.8 (0.036)	81.6 (0.047)
5	79.6 (0.005)	86.3 (0.007)	81.4 (0.051)	79.3 (0.051)
6	76.7 (0.006)	83.8 (0.008)	79.0 (0.065)	76.1 (0.054)
7	74.3 (0.006)	79.8 (0.009)	76.0 (0.065)	70.6 (0.062)
8	70.8 (0.006)	76.2 (0.009)	73.5 (0.081)	68.6 (0.063)
9	66.8 (0.006)	72.6 (0.010)	69.9 (0.093)	65.5 (0.066)
10	63.2 (0.007)	68.2 (0.010)	66.9 (0.093)	61.1 (0.057)
11	60.0 (0.007)	64.8 (0.010)	62.9 (0.093)	55.3 (0.068)
12	60.0 (0.007)	64.8 (0.010)	62.9 (0.093)	55.3 (0.068)

Notes: Standard error is within parentheses.

Figure 2 Plant-level mean employment within offshoring and non-offshoring firms in the Danish manufacturing, 1995-2006



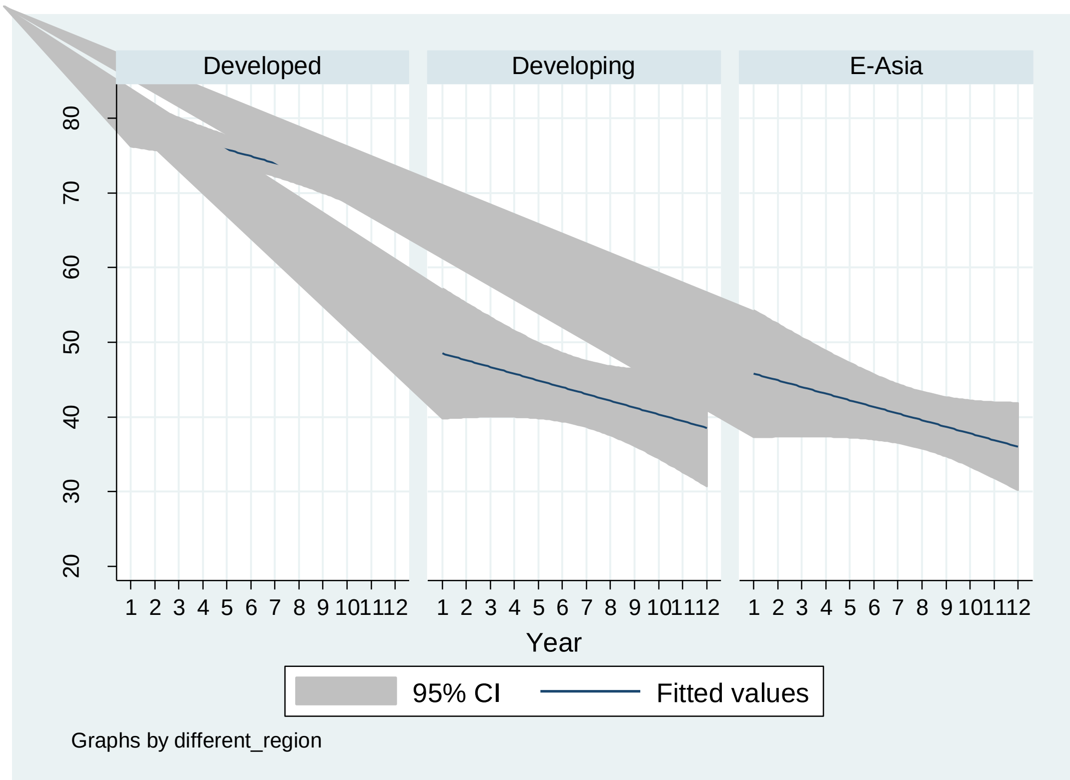


Table 3 Plant and firm characteristics of offshoring and non-offshoring firm, 1995-2006

Plant variables	Non-offshoring	Offshoring_ high-wage	Offshoring_ medium-wage	Offshoring_ low-wage
Age	12.7	13.0	13.0	13.3
Employment	62	75	43	39
Skill share	15.3	15.8	12.2	13.6
Firm variables				
Employment	87	113	42	50
Labor productivity	430	470	393	402
Capital stock	31	43	10	13
Average plant number	1.6	1.6	1.1	1.4

Notes: Capital stock is in millions DKK and labor productivity, value added per employee, are in thousand DKK. skill share is the share of employees with post-secondary education at the plant level.

Table 4 Offshoring and plant survival in Danish manufacturing firms. Complementary log-log model

Variables	Offshoring as dummy						Offshoring as intensity	
	Whole sample				Matched sample		Whole sample	
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
Plant controls								
Age	0.210 (50.67)[a]	0.214 (48.87)[a]	0.215 (48.48)[a]	0.214 (48.36)[a]	0.159 (32.08)[a]	0.160 (32.13)[a]	0.176 (41.10)[a]	0.179 (40.04)[a]
Size	0.773 (15.84)[a]	0.775 (14.34)[a]	0.775 (14.28)[a]	0.776 (14.21)[a]	0.752 (12.38)[a]	0.750 (12.92)[a]	0.756 (10.51)[a]	0.747 (10.86)[a]
Skill share	0.850 (1.91)[c]	0.801 (2.59)[b]	0.800 (2.65)[a]	0.798 (2.62)[b]	0.746 (2.55)[b]	0.787 (2.10)[b]	0.750 (2.33)[b]	0.743 (2.40)[b]
Firm controls								
Labor productivity		0.643 (4.38)[a]	0.590 (5.24)[a]	0.574 (5.41)[a]	0.690 (2.76)[b]	0.514 (4.97)[a]	0.611 (3.12)[a]	0.644 (2.78)[a]
Failed other plant		1.356 (3.25)[a]	1.360 (3.27)[a]	1.364 (3.30)[a]	1.273 (2.36)[b]	1.280 (2.42)[b]	1.460 (2.97)[a]	1.466 (3.01)[a]
Capital intensity		0.530 (4.55)[a]	0.504 (4.90)[a]	0.501 (4.96)[a]	0.527 (3.71)[a]	0.578 (3.25)[a]	0.450 (4.02)[a]	0.447 (4.07)[a]
Multi-plant		1.079 (1.24)	1.074 (1.19)	1.074 (1.18)	1.022 (0.29)	0.984 (0.21)	0.920 (0.97)	0.894 (1.29)
Offshoring			0.687 (7.68)[a]		0.627 (9.28)[a]		0.996 (0.83)	
Offshoring_ high-wage				0.667 (8.16)[a]		0.664 (6.51)[a]		0.988 (2.72)[a]
Offshoring_ medium-wage				0.963 (0.09)		0.974 (0.06)		1.022 (3.77)[a]
Offshoring_ low-wage				2.376 (3.81)[a]		2.275 (3.14)[a]		1.025 (4.23)[a]
Industry control								
Employment growth		0.996 (1.90)[c]	0.996 (2.23)[b]	0.995 (2.22)[b]	0.992 (3.18)[a]	0.992 (3.12)[a]	0.990 (3.69)[a]	0.990 (3.81)[a]
Observations	43,255	43,255	43,255	43,255	30,648	30,648	27,783	27,783
Wald Chi Square	5,965[a]	6,110[a]	6,144[a]	6,122[a]	3,443[a]	3,451[a]	3,994	3,960[a]

Notes: Estimations are stratified by industry and year. Industries are defined at the SNI92 two-digit level (21 industries). Z-statistics in parentheses. **a**, **b**, **c** indicate significance at the 1, 5, and 10 percent levels, respectively. In all columns only plants in firms with 20 employees or more are included and the period of study is 1995-2006. In the last two columns only plans within offshoring firms are included.

Table 5 Offshoring and employment effects, DiD Matching estimator

	ΔTotal employment			
	DiD	Std.Err.	Observation	
			Treated	Control
Offshoring	-0.004	(0.004)	16,772	16,772
Offshoring_high-wage	-0.005	(0.004)	17,328	17,328
Offshoring_medium-wage	-0.007	(0.018)	779	35,721
Offshoring_low-wage	-0.004	(0.013)	1,036	34,470
	ΔHigh-skilled employment			
Offshoring	-0.002	(0.004)	16,772	16,772
Offshoring_high-wage	-0.003	(0.004)	17,328	17,328
Offshoring_medium-wage	0.010	(0.017)	779	35,721
Offshoring_low-wage	-0.018	(0.012)	1,036	34,470
	ΔMedium-skilled employment			
Offshoring	0.002	(0.005)	16,772	16,772
Offshoring_high-wage	-0.001	(0.005)	17,328	17,328
Offshoring_medium-wage	0.007	(0.031)	779	35,721
Offshoring_low-wage	-0.001	(0.017)	1,036	34,470
	ΔLess-skilled employment			
Offshoring	-0.023	(0.006)[a]	16,772	16,772
Offshoring_high-wage	-0.019	(0.006)[a]	17,328	17,328
Offshoring_medium-wage	-0.062	(0.032)[b]	779	35,721
Offshoring_low-wage	-0.041	(0.018)[b]	1,036	34,470

Appendix

Details on the matched sample

The idea of the propensity score matching approach is to find for every offshoring firm, a similar firm that is not engaged in offshoring activity and from which I can approximate the non-observed counterfactual event. Thus, the matching technique enables me to construct a sample of offshoring and non-offshoring firms with similar characteristics *X*, e.g. productivity, wages, size etc. Conditional on these characteristics I estimate the probability (or propensity score) of a firm being engaged in offshoring activity using the probit model described in equation (5). The result of the probit model, shown in *Table A1*, indicates that the more productive, skill- and capital intensive, the more likely the firms are engaged in offshoring.

Once the propensity scores are calculated, I can (using the "caliper" matching method) select the nearest control firms in which the propensity score falls within a pre-specified radius as a match for an offshoring firm.[6] Moreover, I check whether the balancing condition is verified, that is each independent variable do not differ significantly between offshoring and non-offshoring firms. Another condition that must be fulfilled in the matching procedure is the so-called common support condition. This criterion implies that at each point in time, a newly firm engaged in offshoring is matched with non-offshoring firms with propensity scores only slightly larger or smaller than the former firm[7]. The constructed matched sample is then used to estimate equation (4), similar to Greenaway and Kneller (2007) and Bandick and Görg (2010)

[6] The procedure I utilize to match offshoring and non-offshoring firms is the PSMATCH2 routine in Stata version 10 described in Leuven and Sianesi (2003). In our analysis, the pre-specified radius is set to 0.001.

[7] Note that some offshoring firms may be matched with more than one non-offshoring firm, while offshoring firms not matched with a non-offshoring firm are excluded.

Table A1 Firms probability to engage in offshoring

Variables	Probit model
Labor productivity	0.067
	(0.019)[a]
Skill intensity	0.420
	(0.042)[a]
Age	-0.194
	(0.159)
$(Age)^2$	0.111
	(0.038)[a]
Capital intensity	0.079
	(0.005)[a]
Multi-plant	-0.020
	(0.016)
Employment	-0.004
growth	(0.001)[a]
Industry dummies	Yes
Year dummies	Yes
Pseudo R^2	0.112
LR chi2	5,820
Observations	38,000

Notes: The dependent variable $OF_{it} = 1$ if firm *i* is engaged in offshoring (according to the narrow definition). Std.Err. is within parentheses. The explanatory variables are, apart from age age^2, firm specific characteristics in year $t-1$. Labor productivity is value added per employee and skill intensity is the share of employees with post-secondary education at the firm level. Industries are defined at the SNI92 two-digit level (21 industries). a, b and c indicate significance at 1, 5 and 10 percent levels, respectively. Only plants in firms with 20 employees or more are included and the period of study is 1995-2006.

Table A2 Balancing test for the matching sample

Variable	Sample	Mean		Standardized bias	Bias reduction	*t*-test	
		Treated	Control			*t*	p>|*t*|
Labor productivity	Unmatched	488	467	9.2		9.19	0.000
	Matched	488	492	-1.9	79.3	-1.50	0.133
Skill intensity	Unmatched	0.162	0.158	2.1		1.82	0.069
	Matched	0.162	0.161	1.1	94.6	1.06	0.291
Age	Unmatched	12.7	12.4	7.4		7.31	0.000
	Matched	12.7	12.8	-1.1	85.6	-0.98	0.328
$(Age)^2$	Unmatched	161.3	153.8	7.2		7.07	0.000
	Matched	161.3	163.8	-1.4	81.0	-1.24	0.214
Capital intensity	Unmatched	0.346	0.306	8.8		8.76	0.000
	Matched	0.346	0.331	1.3	51.0	1.14	0.255
Multi-plant	Unmatched	0.537	0.520	3.3		3.33	0.001
	Matched	0.537	0.539	-0.4	87.6	-0.36	0.720
Employment	Unmatched	-2.490	-1.302	-10.8		-11.37	0.000
growth	Matched	-2.490	-2.570	0.7	93.2	0.62	0.534