The Effect of Offshoring on Productivity and Export Growth

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Abstract

This paper investigates the link between offshoring and growth in productivity and export intensity utilizing novel and detailed firm- and product level dataset for the Danish manufacturing sector during the period 1995-2006. By using the information on all domestic export and import transactions disaggregated by destination/origin and product code (8-digit CN), I am able to define whether a firm is an exporter or not and also separate the firms' intra-industry imports of intermediate inputs, i.e. narrow offshoring to high- or low-wage countries. The result, after controlling for potential endogeneity of the offshoring decision by using instrument variable and DiD matching approach, shows that offshoring firms experience higher growth in both productivity and export intensity as compared to firms with no offshoring activities. However, the result suggests that it is only firms that mainly offshore to high-wage countries that experience this positive effect. Firms that offshore to low-wage countries do not seem to have different effect on neither productivity nor export intensity as compared to their non-offshoring counterparts.

Keywords: Offshoring, Productivity, Export, DID Matching Estimator

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1. Introduction

The significant rise of imported intermediate inputs in the domestic production, often defined as offshoring, is one of the most important factors behind the recent increase in international trade (Yeats 1998; Yi 2003). Many countries, especially developed, have in the past decade experienced rapid growth in offshoring activities and, in most cases the public perceptions have been flawed with negative undertones towards this development. The anxiety is about the major treat for job losses that potentially might occur when domestic firms reallocate their production abroad. There is indeed some evidence for this adverse effect on the labor market, especially for low-skilled workers since their jobs are relatively more offshorable than jobs of high-skilled workers (Feenstra and Hanson, 1996; Blinder, 2006; Geishecker and Görg, 2008). However, as discussed by Grossman and Rossi-Hansberg (2006), Jabbour (2010) and Wagner (2011), the offshoring activities may generate substantial gains both at the micro level, the profitability, efficiency and productivity of the firms may rise, and at the macro level, the competitiveness of the domestic economy may improve.

For this reason there has been an increasing demand both from the academia and policy makers for more research to enrich our understanding about the causes and consequences associated with offshoring activities. The attempts so far to fulfill these requirements have ended up with the focus on the impacts of offshoring on the domestic labor market only (see, e.g., Feenstra and Hanson 1999; Head and Ries 2002; Hijzen et.al.,2005). However, the role of offshoring in shaping the domestic economies in other aspects such as productivity and export performance has received relatively less attention.

As to fulfill this gap, the aim of this paper is to investigate the link between firm´s offshoring activities, productivity growth and export performance. More precisely, the aim is to evaluate whether firms' intra-industry imports of intermediate inputs, defined as narrow offshoring, affects productivity and export intensity growth. The dataset used in this paper is detailed firm-level information from the Danish manufacturing sector during the period 1995-2006. The novelty of the dataset is that it provides information on all domestic export and import transactions disaggregated by destination/origin and product which is measured at the eight-digit Combined Nomenclature (HS8) level. The data then allow me to categorize whether the firms are exporter or not and whether they are engaged in offshoring activities or not. In using the information on country-of-origin import, firms' offshoring activities can be separated to be carried out either in high- or low-wage countries. For the estimation strategy, this paper will first use a difference-in-difference (DiD) model taking account of the potential endogeneity of the offshoring decision (i.e. the decision to offshore is positively correlated with firm performance, see for example Sethupathy, 2013 and Görg et. al., 2008) by implementing an instrumental variable approach. As an alternative strategy, I use an extended version of the matched DiD method suggested by Blundell and Costas Dias (2000) by first matching, on a yearly basis, offshoring and non-offshoring firms with similar propensity scores and in the next step estimate DiD on the matched sample.

The empirical analysis in this paper is motivated by several theoretical literature related to offshoring and firm performances. The first theoretical aspect concerns the relationship between imports of intermediate goods and productivity. The arguments discussed are either that it is productivity that affects importing positively, which is in line with the self-selection of more productive firms into import markets, or that it is importing that affects productivity positively, defined as learning-by-importing. The arguments for self-selection relates to the impending sunk cost that are associated with import such as for example searching for potential foreign suppliers, quality inspections etc. in which only inherently high productive firms are able to overcome. However, there are in some way stronger arguments in favor of learning-by-importing, outlined by the earlier work of Ethier (1982), Markusen (1989) and Grossman and Helpman (1991). These literatures evidenced that factors such as lower input prices, higher quality of inputs and access to new technologies embodied in the imported varieties, all have enhancing effect on productivity growth. Also, the learning effect is expected to be larger if the imports are from R&D intensive advanced economies (Lööf and Andersson, 2010 and Keller, 1998). Empirically, firms-level studies (i.e. Kasahara and Rodrigue, 2008 and Amiti and Konings, 2007) show positive relationship between importing and productivity, however research investigating the direction of the causality between import and productivity is still rare (Wagner, 2012). Furthermore, the discussion about the relationship between productivity and import can be extended to include export performance. If the direction of causality is pointing towards learning-by-importing, then import increases productivity which in turn, in line with the Melitz (2003) model, may lead to firms self-select themselves and successfully operates in the export market.

This paper contributes to the literature in several important aspects. Firstly, to my knowledge, this is the first study that analyses the impact of offshoring on productivity and export intensity growth for a small open economy such as Denmark. Secondly, as opposite to some of the earlier studies that uses industry- level proxy for offshoring activities, this paper uses firm-level information on offshoring. Thirdly, by implementing IV and DiD on matched sample, I take particular account of the potential endogeneity of the offshoring decision, in which many of the earlier papers neglect.

To preview the results, firms offshoring activities seem to have positive effect on productivity growth but only if the main offshoring is carried out in high-wage countries. Firms using intra-industry import of intermediate inputs, so-called narrow offshoring, from high-wage countries have 2-4 percent higher productivity growth as compared to non-offshoring firms. Similar results are obtained analyzing the scope of offshoring on export performance. Firms that mainly offshore to high-wage countries have higher growth in export intensity than their non-offshoring counterparts.

The structure of the paper is as follows; section 2 describes the construction of the dataset and presents some trends in offshoring activities from different regions in the Danish manufacturing sectors during the period 1995-2006. Section 3 outlines the methodological framework and the econometric specifications. Section 4 reports the empirical findings. Section 5 summarizes and concludes.

2. Data description

The dataset used in this paper are form two sources, Firm Statistics Register (FirmStat) and Danish Foreign Trade Register (TradeStat), which both have been assembled annually over the period 1995-2006 by Statistic Denmark. The dataset cover the entire manufacturing firms with at least 20 employees or more[1]. The information from FirmStat consist of general firm accounting data such as total wages and employment divided into different educational level, value added, output (measured in terms of sales), capital stock, a dummy variable showing whether a firm is a single- or multi-operating firm and industry code. Using the information from FirmStat we can calculate the labor productivity, defined as value added per employee, capital intensity, defined as capital stock over output, and skill intensity, defined as the share of employees with a post-secondary education.

[1] Firms with less than 20 employees are excluded from the analysis due to information inconsistency

Moreover, using the information from FirmStat we can estimate the total factor productivity (TFP) by implementing the Levinsohn and Petrin (2003) methodology.

The data from TradeStat include information on both export and import that are disaggregated by destination/origin and products. For each trade flows, measured at the eight-digit Combined Nomenclature (HS8), the value, in Danish Kroner (DKK), and weight, in kilos, are reported for. The imported products are further classified as being raw materials, semi-manufactured products and intermediary products. This classification ensures us that import is not covering final good imports but only intermediate input imports.

The information on firms' import of intermediate inputs captures both international outsourcing, that is inputs purchased from foreign suppliers instead of produced in-house, and offshoring, that is relocation of processes previously undertaken in-house to foreign affiliates. In this paper, I follow the previous literature (i.e. Olsen, 2006; Grossman and Rossi-Hansberg, 2006 and Crinó, 2009) in defining 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.

Moreover, following Feenstra and Hanson (1999), offshoring can be separated as being narrow offshoring, that is intra-industry offshoring, or as broad offshoring, that is inter-industry offshoring. Narrow offshoring is then 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. Given that the narrow measure is widely used and is in line with the World Trade Organization (WTO) mode 1 definition of international fragmentation[2], the regression analyses below will be based on narrow offshoring calculated as the sum of imports in the same HS2 category as goods sold by the firm either domestically or in exports[3].

[2] Bhagwati et al. (2004) provide a detail description of the WTO:s different mode definitions of international fragmentation.
[3] Narrow offshoring based on HS4 category yields similar regression results.

The data from TradeStat allow me then to *i*) define whether a firm is an exporter or not, simple by assigning a dummy variable that equals to one for firms that have positive export value[4], and, *ii*) separate the firms' offshoring activities to high- and low-wage countries by using the information on country-of-origin import. Similar to Bernard et al. (2006) and Mion and Zhu (2013), countries with per capita GDP lower than 5 percent of the U.S. per capita GDP in 1992 are defined as low-wage countries and OECD countries as high-wage countries.

Table 1 provides summary statistics on the number of firms per year as well as the share of the firms that are engaged in export and/or offshoring activities. There are a total of 33,554 observations in the dataset with an average of 2,796 firms over the period 1995-2006. The share of firms with export activity steadily increased by 6 percent and is around 78 percent over the period. *Table 1* also shows that at the same time period the share of firms engaged in offshoring activity increased by almost 12 percent. Even if the majority of offshoring firms mainly allocated their activities (more than 50 percent of the total offshoring value) to high-wage countries, it seems that the choice of destination has changed over the years. While the share of offshoring firms that mainly allocated their activities to high-wage countries dropped by 5 percent in the period 1995-2006, the share of firms that mainly offshored to low-wage countries increased by almost fourfold. From the last column we also can see that in the year 1995, around 35 percent of the exporting firms were engaged in offshoring activities while in the year 2006, the share of offshoring firms among exporter increased to more than 38 percent, an increase by almost 8 percent.

Table 1 here

The same pattern seems to appear if we look at the development of the average export and offshoring values over the time period 1995 and 2006, as displayed in *Figure 1*. At the year 1995, the average export and offshoring values were around 50 and 15 million Danish Krona, and at the year 2006, these values increased to around 130 and 35 million Danish Krona, respectively.

Figure 1 here

[4] As robustness check in the regression analysis below, I also re-defined exporting firms that have maximum export value of up to 1 percent of their total sales as non-exporter. This however, does not change the main results obtained in section 4.

3. Methodology

To investigate the direction of causality between offshoring and productivity and export intensity, I first begin to estimate the following growth rate model:

$$\Delta lny_{iT} = lny_{it+s} - lny_{it-1} = \beta_0 + \beta_1 lny_{it} + \beta_2 OFF_{it} + \theta_1 \Delta Firm_{iT} + \gamma_1 Industry + \gamma_2 Year_t + \varepsilon_{it}, \quad s\epsilon\{1,3\} \tag{1}$$

where Δlny_{iT} is growth in productivity or export intensity in firm *i* between time period *t-1* and *t+s*; $s \in \{1,3\}$. OFF_{it} is a dummy variable that equals to one if firm *i* started to offshore in period *t*. $\Delta Firm_{iT}$ is a vector of growth rate of firm-specific characteristics, such as capital-labor ratio, $\Delta ln(K/L)$, turnover, $\Delta ln(T)$, and size, $\Delta ln(employment)$. The model also control for industry and year dummies. The omitted groups in equation (1) are firms not engaged in offshoring activity in time period *t*. Hence, β_2 captures the differences in productivity and export intensity between firms that started to offshore and firms not using offshoring.

As discussed more formally in Sethupathy (2013) and Görg et al. (2008), offshoring at the firm level is considered to be correlated with estimation errors due to endogeneity problems, i.e. firms that relocate parts of their activities abroad are "better" than their counterparts in terms of productivity, size and human capital intensity. There is in fact, according Bandick (2015), some evidence for this self-selection process also among the Danish manufacturing firms. This is, however, not reflected in equation (1) since the underlying assumption on coefficient β_1 for the offshoring dummy is that, conditional on 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 two approaches where the first is an instrumental variable estimation and the second is a selection of a control group based on propensity score matching technique. For the former approach, I construct an instrumental variable calculated as the predicted value of the dependent variable from a probit regression for the probability for a firm to engage in offshoring[5]. The probit model is:

$$P(OFF_{it} = 1) = F(X_{it-1}, I_j, T_t) \qquad (2)$$

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. In section 4, I will discuss more in detail the set of instruments and also report the results from this probit model.

As an alternative setup to evaluate the causal effect and also to control for the self-selection bias, I use a DiD estimation technique on a matched sample of firms that is generated by using the propensity score-matching approach (PSM). The DiD estimator compares the differences in the growth rate of the outcome variable (in our case productivity and export intensity) between treated (those that started to offshore) and control (non-offshoring) firms. The parameter to be estimated is then $\theta_{t+s} = (y^A_{t+s} - y^A_{t-1}) - (y^C_{t+s} - y^C_{t-1})$, and can be obtained by regressing data pooled across treated (A) and control (C) firms:

$$y_{it-1,t+s} = \beta_0 + \beta_1 OFF_i + \beta_2 After_{t+s} + \beta_3 OFF_i \, x \, After_{t+s} + \varepsilon, \quad s \geq 0 \qquad (3)$$

where $y_{it-1,t+s}$ is the outcome variable, productivity or export intensity, in period *t-1* to *t+s*. OFF_{it} is again a dummy variable that equals to one for firms that started to offshore (treated), A, and 0 for non-offshoring (control) firms, C. The coefficient β_1 captures the differences in productivity/export intensity between the two types of firms in the period prior the offshoring episode. The dummy variable $After_{t+s}$ is defined as post-offshoring period, which means it equals to one in the years after the offshoring, *t+s*, and 0 in the one year before, *t-1*. This dummy variable captures aggregate period effects that are common between the two groups A and C. Finally, the term $OFF_i \, x \, After_{t+s}$

[5] This approach has been used by McGuckin and Nguyen (2001) and Bandick and Görg (2010) analyzing the effect of acquisitions on plant exit in the US and Sweden, respectively and by Hujer, Maurer, and Wellner (1999) in a non-linear hazard model for the analysis of the effect of training on unemployment duration in Germany. Conyon et al. (2002) also use this approach in modelling the wage effects of foreign acquisitions. Note that, in order to get accurate standard errors for the estimators using generated IV, I compute bootstrapped standard errors.

is an interaction term between OFF_{it} and $After_{t+s}$. The coefficient β_3 then represents the DiD estimator of the effect of offshoring on the treated firms A, i.e. $\beta_3 = y_{t+s}$. The advantage of the DiD estimator is that it eliminates unobserved time-invariant differences in the outcome variable between treated and control firms. *Table 2* summarizes the interpretation of the coefficients in the regression in equation (3).

Table 2 here

The DiD is, however, not a valid estimator if the differences between treated and control firms are very high in the years before the offshoring episode, i.e. β_1 statistically differ from zero. As discussed above, this is unfortunately not unlikely to be the case; firms engaged in offshoring activities have better firm characteristics. It is then difficult to distinguish whether the performances in terms of productivity and export intensity in the years following the offshoring are affected by this activity or by the firm's better characteristics in the pre-offshoring periods. To get a more accurate estimator, I use a sample where offshoring firms are matched together with similar firms that did not fragmented their production process to foreign countries. Here the matched control firms approximate for the non-observed counterfactual event, i.e. what would on average have happened to the productivity and export intensity in offshoring firms had they kept the production process in-house.

The matched sample is constructed as pairing, on a yearly basis, 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 by using the same probit model as in equation (2).

Once the propensity scores are calculated, the nearest control firms in which the propensity score falls within a pre-specified radius can be selected as a match for a firm that started to engage in offshoring.[6] Moreover, the balancing condition, i.e. each independent variable does not differ significantly between offshoring and non-offshoring firms, and the so-called common support

[6] This is done using the "caliper" matching method. The procedure we 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.

condition[7], i.e. firms with the same X values have a positive probability of being both offshoring and non-offshoring firms, need to be verified. The constructed matched sample is then used to estimate equation (3), similar to Bandick and Karpaty (2011) and Bandick (2011). Furthermore, since the purpose is to study post-offshoring dynamics in productivity and export intensity, I only include firms that remain at least five years in the panel.

4. Empirical results

Before turning to the main results in this paper, I need first to discuss and outline the relevant firm-specific characteristics in year *t-1* that may affect the firms' probability to engage in offshoring in year *t*, i.e. the variables to be included in the covariate X_{it-1} of equation (2). According to Abraham and Taylor (1996), the decision for a firm to contract out activities is influenced by three general motives, *i*) to save labor costs, i.e. if the wages are lower in the foreign country due to abundance of labor, *ii*) to reduce workload volatility, i.e. allocating some of the workload to suppliers during peak periods and perform the entire workload in-house during slow periods, and *iii*) to gain from economies of scale, i.e. to get access of specialized skills that are scare, especially for small or medium sized enterprises and that are being offered by the external suppliers. For this reason, the probit model will include the following firm-level variables; log average skilled and unskilled wage costs to account for labor costs, growth (in terms of sales) as compared to the industry to account for workload volatility, and firm size and skill intensity to control for the economies of scale effect.[8] As a proxy for firm size I will use log level of employment, log capital stock and a dummy variable indicating whether the firm is a multi- or single plant operation. The probit model will also include a dummy variable showing whether the firm is an exporter or not. As discussed in Görg, Hanley and Strobl (2008), exporters are expected to be more inclined in offshoring activities since, due to

[7] 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. Moreover, In determining the common support region I use two methods where the first is to compare the minima and maxima of the propensity score in both offshoring and non-offshoring firms and the second is to estimate the density distribution in both groups. For a detailed review of these two methods, see Caliendo and Kopeinig (2008).

[8] However, there is no consensus about how firm size might affect the offshoring decision. The literature have postulated arguments for a negative relation (see e.g. Abraham and Taylor 1996), for a positive relation (see, e.g., Kimura 2002) and for inversed-U relation (see, e.g. Merino and Rodriguez Rodriguez ,2007) between firm size and offshoring decision.

their international experience they might face lower search cost for international sourcing as compared to non-exporters. The result from the probit model is shown in *Table 3*.

The findings in column (1) are in line with the predictions outlined by Abraham and Taylor (1996) that labor cost (as it seems only skilled wage cost), growth in sales as relative to the industry as proxy for workload volatility, and firm size (only level of employment) and skill intensity as proxy for economies of scale, are all positively related to firms offshoring decision. Moreover, as predicted by Görg, Hanley and Strobl (2008) and shown by Debaere et al. (2013), firms that are engaged in the export markets are, as compared to non-exporters, more inclined in offshoring activities. Hence, from the result in column (1) we can once again draw the conclusion that offshoring firms, at some extent, do have better ex-ante characteristics than non-offshoring firms, i.e. the result provides support for the self-selection hypothesis. Furthermore, in order to investigate the role of productivity for the offshoring decision, I include in column (2) the level of log productivity measured by value added per employee.[9] The result seems to indicate that ex-ante productivity also is significant determinant for the offshoring decision. This means that, in the empirical analysis it is highly important to control for this self-selection, otherwise the estimate of the causal effect of offshoring could potentially be biased as is discussed in section 3.

Table 3 here

One way to deal with this problem is, as discussed above, to construct an instrumental variable by using the two different models of *Table 3* to calculate the predicted probability for a firm to engage in offshoring. The two alternative IV:s are then separately included in equation (1) to, along with other firm-specific characteristics, determine the growth rate of productivity or export intensity. As an alternative approach we can create a valid counterfactual of non-offshoring firms with similar characteristics as those of the offshoring firms. This can be created by using the same set of variables as presented in *Table 3*, column (1) and (2) to estimate the propensity scores and select the nearest control firms as a match for the offshoring firms. After establishing that the propensity score

[9] Using TFP instead of labor productivity does not significantly change the result obtained in *Table 3*, column (2). Moreover, the model presented in column (2) is also used as a robustness check for the validity of the propensity score matching. As suggested by Dehejia (2005), one should check the sensitivity of the matching estimates to minor changes in the propensity score model. If the results are not sensitive to such minor changes, the propensity score specification can be deemed robust and reliable. In the regression analysis below, all the matching estimates are based on the first propensity score estimation in column (1). However, the model in column (2) produces very similar results, which indicate that the matching procedure is reliable. These results are available upon request.

matching procedure is reliable and robust by using a number of balancing tests, more details of these tests are found in Appendix, we can use this matched sample to estimate the DiD model given by equation (3)

4.1 Results for the growth rate model

The results from estimating the growth rate model described in equation (1) are presented in *Table 4* and *5*. The outcome variable in the first specification of *Table 4* is the difference in log productivity between the period *t+1* and *t-1*, whereas in the second specification the growth rate is defined between the period *t+3* and *t-1*. I use two productivity measures, labor productivity (measured as value added per employee) in the first two columns, and total factor productivity (estimated by Levinsohn and Petrin, 2003 method) in the following two columns. To correct for the possible endogenetiy of the offshoring decision, the estimations in Model (1) and (2) are based on the two alternative ways of generating the instrument for the offshoring dummy. Model (1) uses the instrument generated from the probit regression described in *Table 3*; column (1) while Model (2) uses the instrument generated by *Table 3*; column (2). In all estimates, I control for other firm-specific characteristics such as described in equation (1).[10]

The results in the first model of *Table 4*, Specification (1), seem to indicate that, as compared to their counterparts, firms that started to reallocate some of their production process abroad experienced, one year following this activity, on average between 3-4 percent higher productivity growth. Moreover, as shown in Specification (2), the differences in growth rates between the two types of firms seem to have been persistent up to three years after the offshoring episode started.

In Specification (3) and (4), the firms' offshoring activities are separated to different regions to check whether there are differences in the casual effect on productivity where the main offshoring activities are located. In order to do this, I divide the offshoring dummy into two dummies; *offshoring high-wage*, equals to one if firm *i* started to offshore mainly (more than 50 percent of the total offshoring value) to high-wage countries and *offshoring low-wage,* equals to one if firm *i* started to offshore mainly to low-wage countries. I once again use column (1) and (2) of *Table 3* to

[10] To get a rough indicator of whether or not the assumption of exogeneity holds, I use a standard Hausman test. These tests, not reported in the table but available upon request, provide evidence that, in all cases, we can reject the assumption of exogeneity of the offshoring dummy.

generate an instrument for these two dummies. The division of the offshoring activities to different regions appears to be of crucial importance since the entire positive effect obtained in the previous specifications is for firms that started to offshore mainly to high-wage countries. Firms that started to offshore mainly to low-wage countries, however, do not seem to have different effect on productivity as compared to non-offshoring firms.

The results from *Table 4* provide, at some extent, support for the learning-by-importing arguments, discussed by e.g. Ethier (1982), Markusen (1989) and Grossman and Helpman (1991), that imports of intermediate goods (which is defined as offshoring in this paper) have enhancing effect on the productivity growth. Moreover, the results are in line with the prediction drawn by Lööf and Andersson (2010) that imports from R&D intensive advanced economies (high-wage countries) have stronger effect on productivity than other imports. In fact, the results in *Table 4* indicate that the productivity effect is only positive if the main offshoring activity is located in high-wage countries while the productivity is not affect by offshoring activities that mainly are located in low wage countries.

Table 4 here

Having established that productivity is positively affected by offshoring, the question now is what is the impact of offshoring on export intensity? We know from Meltiz (2003) that firm´s productivity determines the export intensity, thus implicitly having the above results in mind, this mechanism might be reinforced through which offshoring, via productivity, is affecting the export intensity. The prediction would then be that offshoring has an enhancing effect on export intensity and, furthermore, giving that it is only firms that started to offshore mainly to high-wage countries that experienced higher productivity, the effect on export intensity is expected to be more pronounced for these firms.

The results analyzing the effect of offshoring on export intensity are presented in *Table 5* Here, the outcome variable in the first specification is the log difference in export intensity, defined as the ratio of export value over turnover, between *t+1* and *t-1* and in Specification (2) between the period *t+3* and *t-1*. Again, as in *Table 4*, I first start with analyzing the effect of offshoring as a whole, i.e. not separating for different offshoring destination. The result seems to indicate also here of positive post-offshoring effect. Firms that started to offshore seem to have had between 5-8 percent higher growth of export intensity as compared to non-offshoring firms.

One explanation to this result is that, by starting to offshore, firms might source for cheap foreign intermediate inputs to improve their competitiveness in the export market, which as a result, can be translated to higher export intensity. Another explanation is that offshoring give possible access to new technologies and higher quality inputs not available in the home economy which might entail the firms to increase their sales varieties in their current export market and/or to enter new export markets. Whereas the first explanation put forward implies that the offshoring activities needs to be located in low-wage countries (that provide cheap intermediate inputs), the second explanation obviously implies that the offshoring needs to be located in high-wage countries (that provide high quality intermediate inputs). Hence, to evaluate whether the export intensity is being affected differently from different sourcing destinations, the offshoring dummy is divided, as in *Table 4*, into two dummies showing whether the firms started to offshore mainly to high- or low-wage countries.

The results are shown in Specification (3) and (4) of *Table 5*. As the above results for the productivity effect, the export intensity is positively affected only in firms that started to offshore to high-wage countries. Starting to offshore to low-wage countries however, has no effect on the growth rate of export intensity. The results from *Table 4* and *Table 5* indicate that the firms are sourcing for quality, rather than for low price intermediate inputs and in which, as it seems, they have benefited from in terms of higher productivity and export intensity.

Table 5 here

4.2 Difference-in-Difference Matching Results

For a further robustness check, I first implement a propensity score-matching procedure to generate a sample of offshoring and non-offshoring firms as a valid counterfactual. I then estimate equation (3) on this matched sample, similar to Greenaway and Kneller (2007), Bandick and Karpaty (2011) and Bandick (2011). Once again I extend the basic model of equation (3) to allow for different offshoring impact depending on where this activity is located, high- or low-wage countries. Moreover, to investigate the dynamic pattern of the post-offshoring effects on productivity and export intensity growth, I replace the interaction variables for the whole post-offshoring period with year-by-year interaction variables. However, to save place I only report the first and third post-offshoring period. Furthermore, since the matching procedure did not reduce all the differences between offshoring and non-offshoring (matched) firms, as shown in *Table A1* and *Table A2*, I estimate the modified equation (3) with a firm fixed effect model and control for a vector of firm characteristics such as firms size (in terms of total employment and capital), skill-intensity, and wages. *Table 6* reports the results. The matched sample used to estimate the modified equation (3) is generated by the probit model described in *Table 3*, column (1).

The DiD estimators indicate that one year after starting with offshoring, firms seems to not experience any different effects on the growth rate of neither productivity nor export intensity as compared to non-offshoring firms. However, three years after starting with offshoring, firms have had higher growth in both productivity and export intensity but only if they reallocated their offshoring activities to high-wage countries. Three years after starting with offshoring to high-wage countries, the productivity and export intensity seems to have grown by about 2-4 and 7 percent more when compared with non-offshoring firms. There is, however, no significant impact on neither the growth of productivity or export intensity from offshoring activities located in low-wage countries.

Table 6 here

5. Conclusions

In recent years, offshoring has become to be the most important factor behind the growth in world trade. As to provide an answer to the causes and consequences of this activity, the academia has so far focused on its impact on the labor market only. The role of offshoring on other aspects, such as productivity and export performance, has however been neglected.

To fulfill this gap, this paper investigates the link between offshoring, productivity growth and export performance by utilizing novel and detailed firm- and product level dataset for the Danish manufacturing sector during the period 1995-2006. The novelty of the dataset is that, besides offering information of general firm accounting data, it also provides information on all domestic export and import transactions disaggregated by destination/origin and product code (8-digit CN). This dataset then, allow me to define whether a firm is an exporter or not, and to separate the firms' intra-industry imports of intermediate inputs, i.e. narrow offshoring to high- or low-wage countries.

The result, after controlling for potential endogeneity of the offshoring decision by using instrument variable and DiD matching approach, shows that offshoring firms experience higher growth in both productivity and export intensity as compared to firms with no offshoring activities. However, the result suggests that it is only firms that mainly offshore to high-wage countries that experience this positive effect. Firms that offshore to low-wage countries do not seem to have different effect on neither productivity nor export intensity as compared to their non-offshoring counterparts. These results is then consistent with the hypothesis provided by Lööf and Anderson (2008) and Keller (1998) that imports from R&D intensive advanced economies (high-wage countries) are more conducive for productivity and export performance than imports from less-R&D intensive economies (low-wage countries).

There are important implications of the above findings for both researchers and policy makers. Firstly, it is important to consider in which region the main offshoring activity is carried out when evaluating its impact on firm performance since this may differ depending whether the activity is carried out in high- or low-wage countries. Secondly, since both productivity and export performance are positively affected by offshoring activities, there is no need for fears and therefore no need for policy makers to start thinking about limiting these activities.

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Table 1 The Share of Exporting and Offshoring Firms in the Danish Manufacturing Industries, 1995-2006

Year	**Total number of firms**	**% exporting firms**	**% offshoring firms**	**% offshoring_ high-wage**[2)]	**% offshoring_ low-wage**[2)]	**% offshoring firms among exporter**
1995	2,994	75.5	29.0	98.2	1.8	35.6
1996	2,949	76.9	30.4	97.4	2.6	36.6
1997	2,922	76.1	29.8	97.1	2.9	36.6
1998	2,965	75.6	29.1	96.8	3.2	36.1
1999	2,861	76.7	31.0	97.5	2.5	38.3
2000	2,943	76.5	33.2	97.0	3.0	39.4
2001	2,847	77.9	34.0	96.7	3.3	40.4
2002	2,769	80.3	34.9	96.1	3.9	40.4
2003	2,659	79.8	34.6	95.8	4.2	39.9
2004	2,590	80.4	33.3	95.0	5.0	38.7
2005	2,526	78.9	32.6	93.9	6.1	38.2
2006	2,529	80.2	32.4	93.3	6.7	38.3
Average 1995-2006	2,796	77.9	32.0	96.2	3.8	38.2
% change 1995-2006	-15.5	6.2	11.7	-5.0	372	7.6

Figure 1 The development of offshoring and export in the period 1995-2006

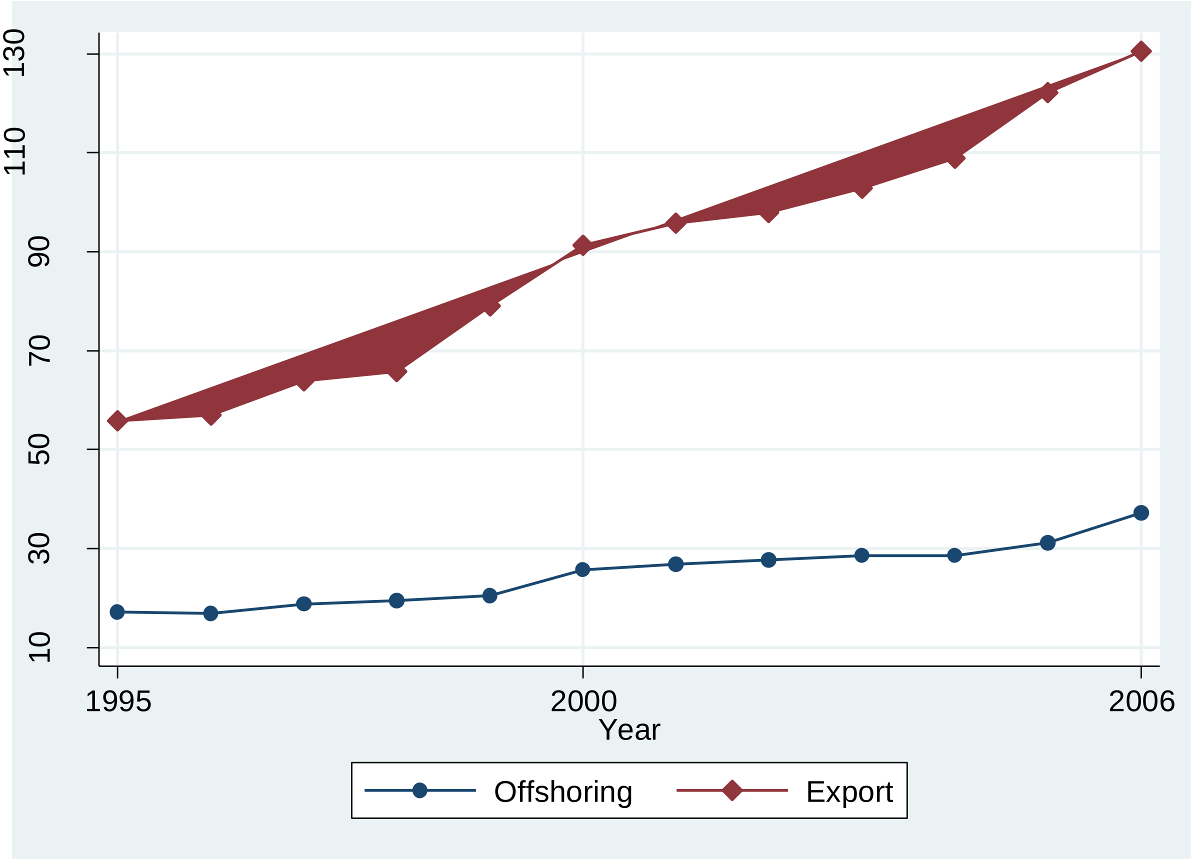

Table 2 Difference-in-Difference (DiD) Estimator

Variables	Before Offshoring	After Offshoring	Difference
Offshoring firms	$\beta_0 + \beta_1$	$\beta_0 + \beta_1 + \beta_2 + \beta_3$	$\beta_2 + \beta_3$
Non-offshoring firms	β_0	$\beta_0 + \beta_2$	β_2
Difference between offshoring and non-offshoring firms	β_1	$\beta_1 + \beta_3$	β_3

Table 3 Firms Probability to Engage in Offshoring, The Probit Model

Variables	Model (1)	Model (2)
Level of employment	0.061 (0.016)***	0.091 (0.016)***
Skill intensity	0.314 (0.093)***	0.361 (0.093)***
Capital stock	-0.002 (0.010)	0.018 (0.010)*
Multi-plant	0.014 (0.033)	0.036 (0.033)
Growth relative to industry	0.002 (0.001)**	0.002 (0.001)*
Average skilled wage	0.001 (0.000)**	0.001 (0.000)***
Average unskilled wage	-0.001 (0.002)	0.001 (0.001)
Exporter	0.795 (0.034)***	
Labor productivity		0.076 (0.031)**
Pseudo R^2	0.140	0.114
LR chi2	2,976	2,431
Observations	16,128	16,128

Notes: The dependent variable OFF_{it} is a dummy variable that equals to one if firm *i* started to offshore (according to the narrow definition). in period *t*. Std.Err. is within parentheses. All the explanatory variables are lagged one year. Labor productivity is value added per employee and skill intensity is the share of employees with post-secondary education at the firm level. Year and industry dummies are controlled for. Industries are defined at the two-digit level (21 industries). ***, ** and * indicate significance at 1, 5 and 10 percent levels, respectively. Only firms with 20 employees or more are included and the period of study is 1995-2006.

Table 4 Post-Offshoring Effect on Productivity, Instrumental Variable Approach

Specification (1)	Labor Productivity$_{t+1}$		TFP_{t+1}	
	Model (1)	Model (2)	Model (1)	Model (2)
$Offshoring$	0.042 (4.82)***	0.030 (3.32)***	0.043 (3.46)***	0.026 (2.13)**
Observations	19,765	19,765	13,467	13,467
Specification (2)	**Labor Productivity$_{t+3}$**		**TFP_{t+3}**	
$Offshoring$	0.046 (3.28)***	0.018 (2.09)**	0.045 (2.83)***	0.017 (2.01)**
Observations	12,228	12,228	8,114	8,114
Specification (3)	**Labor Productivity$_{t+1}$**		**TFP_{t+1}**	
$Offshoring_{High\_wage}$	0.040 (4.45)***	0.027 (2.08)**	0.031 (2.53)**	0.024 (2.12)**
$Offshoring_{Low\_wage}$	0.015 (1.39)	0.012 (1.15)	0.008 (1.05)	0.010 (1.28)
Observations	19,765	19,765	13,467	13,467
Specification (4)	**Labor Productivity$_{t+3}$**		**TFP_{t+3}**	
$Offshoring_{High\_wage}$	0.042 (2.57)**	0.016 (2.56)**	0.039 (2.21)**	0.015 (2.37)**
$Offshoring_{Low\_wage}$	0.003 (0.56)	0.006 (0.48)	0.004 (0.77)	0.007 (0.95)
Observations	12,228	12,228	8,114	8,114

Notes: The Hausman tests, not reported but are available upon request, reject the assumption of exogeneity of the offshoring dummy.

Table 5 Post-Offshoring Effect on Export Intensity, Instrumental Variable Approach

Specification (1)	Export intensity$_{t+1}$	
	Model (1)	Model (2)
$Offshoring$	0.077 (14.47)***	0.054 (4.23)***
Observations	18,974	18,974
Specification (2)	**Export intensity$_{t+3}$**	
$Offshoring$	0.100 (19.73)***	0.051 (1.88)*
Observations	11,569	11,569
Specification (3)	**Export intensity$_{t+1}$**	
$Offshoring_{High\_wage}$	0.113 (18.50)***	0.089 (5.21)***
$Offshoring_{Low\_wage}$	0.022 (0.50)	0.014 (1.64)
Observations	18,974	18,974
Specification (4)	**Export intensity$_{t+3}$**	
$Offshoring_{High\_wage}$	0.133 (12.47)***	0.083 (2.26)**
$Offshoring_{Low\_wage}$	0.034 (1.03)	0.022 (0.78)
Observations	11,569	11,569

Notes: See *Table 4*.

Table 6 Post-Offshoring Effect on Productivity and Export Intensity, DiD on Matched Sample with Firm Fixed Effect.

	Labor $Productivity_{t+1}$	TFP_{t+1}	Export $intensity_{t+1}$
	(i)	(ii)	(iii)
$Offshoring_{High\_wage}\ x\ After_{t+1}$	0.021	0.007	0.023
	(1.81)*	(0.57)	(0.52)
$Offshoring_{High\_wage}\ x\ After_{t+3}$	0.036	0.018	0.073
	(1.97)**	(1.85)*	(2.09)**
$Offshoring_{Low\_wage}\ x\ After_{t+1}$	-0.003	-0.012	0.004
	(0.50)	(1.20)	(0.03)
$Offshoring_{Low\_wage}\ x\ After_{t+3}$	0.013	0.006	0.025
	(0.15)	(0.89)	(0.84)
Firm controls	Yes	Yes	Yes
R^2 within	0.086	0.053	0.029
R^2 between	0.186	0.259	0.235
R^2 overall	0.136	0.196	0.183
Observations	17,022	17,022	17,022

Appendix

Balancing tests for the matching procedure

I perform a number of balancing tests suggested in the recent literature (e.g., Smith and Todd, 2005) to check the reliability and robustness of the propensity score matching procedure. The first test is to examine the standardized difference (or bias), that is, mean difference between offshoring and control firm scaled by the average variance, for all the variables in the vector X in equation (2). This test is reported in *Table A.1 and A.2* for the two set of propensity score models. We should note that the lower the standardized bias the more balanced or similar the offshoring and control firms are in terms of the variables included in the vector X of equation (2). Although there is no formal criterion, but a value of 20 of the standardized bias is considered to be serious. As seen in *Table A.1* and *A.2* the standardized bias between the firms included in the matching sample is heavily reduced as compared to the unmatched sample and are all less than 4 %. As a second test I report, in the last column of *A.1* and *A.2*, a formal paired t-test for the differences in the variables between offshoring and control firms. While these differences seem all to be significant in the unmatched sample (not average skilled wage), they are all insignificant in the matching sample which means that the matching procedure has created a sample of firms with no significant difference in terms of the variables under consideration.

Table A.1 Balancing test for the matching sample

Model (1)							
Variable	Sample	Mean		Standardized bias	Bias reduction	*t*-test	
		Treated	Control			*t*	p>|*t*|
Level of employment	Unmatched	4.108	4.066	4.8		2.95	0.003
	Matched	4.108	4.115	-0.8	83.8	-0.43	0.669
Skill intensity	Unmatched	0.181	0.166	11.4		7.04	0.000
	Matched	0.181	0.179	1.5	86.8	0.84	0.403
Capital stock	Unmatched	16.713	16.613	6.2		3.78	0.000
	Matched	16.713	16.667	2.8	54.1	1.54	0.124
Multi-plant	Unmatched	0.151	0.138	3.7		2.29	0.022
	Matched	0.151	0.144	2.0	44.7	1.13	0.257
Growth relative to industry	Unmatched	-1.902	-1.462	-3.7		-2.41	0.016
	Matched	-1.902	-1.706	-1.7	55.4	-0.91	0.362
Average skilled wage	Unmatched	189.26	188.08	2.6		1.58	0.113
	Matched	189.26	189.5	-0.5	80.2	-0.29	0.773
Average unskilled wage	Unmatched	133.29	131.46	5.0	43.4	3.06	0.002
	Matched	133.29	132.26	2.8		1.61	0.108
Exporter	Unmatched	0.947	0.815	41.8		24.45	0.000
	Matched	0.947	0.935	3.8	90.9	1.12	0.268

Table A.2 Balancing test for the matching sample

Model (2)								
Variable	Sample	Mean		Standardized bias	Bias reduction	*t*-test	
		Treated	Control			*t*	p>|*t*|
Level of employment	Unmatched	4.108	4.066	4.8		2.95	0.003
	Matched	4.108	4.127	-2.1	56.7	-1.14	0.255
Skill intensity	Unmatched	0.181	0.166	11.4		7.04	0.000
	Matched	0.181	0.180	0.6	95.0	0.32	0.750
Capital stock	Unmatched	16.713	16.613	6.2		3.78	0.000
	Matched	16.713	16.657	3.4	44.2	1.83	0.067
Multi-plant	Unmatched	0.151	0.138	3.7		2.29	0.022
	Matched	0.151	0.145	1.6	55.8	0.91	0.365
Growth relative to industry	Unmatched	-1.902	-1.462	-3.7		2.41	0.016
	Matched	-1.902	-1.765	-1.2	69.0	0.63	0.526
Average skilled wage	Unmatched	189.26	188.08	2.6		1.58	0.113
	Matched	189.26	189.25	0.0	99.1	0.01	0.989
Average unskilled wage	Unmatched	133.29	131.46	5.0		3.06	0.002
	Matched	133.29	132.31	2.7	46.2	1.52	0.129
Labor productivity	Unmatched	13.004	12.972	8.0		4.98	0.000
	Matched	13.004	12,991	3.2	60.1	1.60	0.101