

Does Firm Boundary Matter?:

The Effect of Offshoring on Productivity of Japanese Firms

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Abstract

Recently, great interest has been aroused in the examination of the impact of offshore sourcing that has increased rapidly and expanded over various tasks. Theoretical studies have shown that offshore sourcing contributes to higher productivity. This paper aims to provide evidence of the effect of offshore sourcing on productivity, on the basis of original survey data of offshore sourcing of Japanese firms. The estimation results show that offshore in-sourcing within multinationals has a positive impact on productivity but there is a time-lag in the appearance of the impact. On the other hand, it is found that offshore outsourcing through arm's-length contracting out did not appear to affect productivity despite the expectation that the reallocation of resources to more advanced production processes contributes to productivity.

Keywords: Offshore sourcing, outsourcing, productivity

JEL codes: D24, F14, L14

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1. Introduction

Recently, great interest has been aroused in the examination of the impact of offshore sourcing to foreign countries that has increased rapidly and expanded over various tasks. It is remarkable that the offshore sourcing of not only production parts, intermediate goods, and final assemblies but also financial, legal, and customer support services increased. There is evidence of recent development of theoretical studies on offshore sourcing. Grossman and Rossi-Hansberg (2006) and Baldwin and Robert-Nicoud (2007) showed that offshore sourcing contributes to higher production efficiency. Antràs (2003) and Antràs and Helpman (2004) indicated that on the basis of productivity and sectoral characteristics, firms decide whether to produce intermediate inputs or outsource them. A number of empirical studies have focused on the effect of offshore sourcing on the labor market in source countries (e.g., Ekholm and Hakkala, 2006; Egger and Egger, 2006; Feenstra and Hanson, 1996, 1999; Geishecker and Görg, 2005; Head and Ries, 2002; Helg and Tajoli, 2005; Hijzen et al., 2005) while few studies at the firm-level have examined the economic impact of offshore sourcing. This paper aims to provide empirical evidence of the causal effect of offshore sourcing on growth of firm productivity using unique micro-data on Japanese manufacturing firms.

Previous empirical studies that have explored this issue using industry-level data suggest that offshore sourcing positively affects productivity (e.g., Amiti and Wei, 2006; Egger and Egger, 2006; Ito and Tanaka, 2009). As the first attempt using firm-level data, Görg and Hanley (2005) examined the effect of offshore outsourcing on labor productivity using Irish firm-level data in the electronics industry over the period 1990–1995. They found that the impact of offshore outsourcing on total factor productivity (TFP) to be positive, when estimating the effect of outsourcing of materials and services

combined; however, they discovered the effect of outsourcing of services to no longer have a significant impact when distinguishing between two tasks.¹ Their advantage is no doubt that the data on offshore outsourcing can be distinguished into materials and services inputs. However, the measurement of “offshore outsourcing” used in their study includes not only outsourcing but also in-sourcing, for it is defined as the ratio of total imported inputs to total inputs. Taking into account the firm’s boundaries, offshore outsourcing to local firms through arm’s-length transactions should be distinguished from the total offshore sourcing. Hijzen et al. (2006) also estimated the impact of offshore sourcing on firm productivity using Japanese firm-level data for the period 1994–2000. They found that offshore sourcing defined as the ratio of the expenditure on subcontracting to foreign suppliers has a positive and significant effect on TFP even after controlling offshore in-sourcing defined as all intermediate purchases from the firm’s own foreign subsidiaries. Although they suggested the positive impact of offshore sourcing regardless of the firm’s boundaries, the definition of their data doesn’t explicitly identify both offshore in-sourcing and outsourcing. Further, their definition of offshore sourcing is restricted to the manufacturing of goods and materials while firms’ offshoring activities have extended to a wide range of tasks including not only production parts, intermediate goods, and final assemblies but also financial, legal, and customer support services. Thus, there is a possibility of underestimating offshore sourcing due to the restriction of micro-data.

In this paper, we examine the impacts of both offshore outsourcing and in-sourcing on the productivity by using the firm-level data that directly identifies outsourcing firms and in-sourcing firms.

¹ Görg et al. (2008), which extended data coverage to 1990–1998 and all manufacturing industries and took into account the status of trade activity and ownership, report similar results on labor productivity.

This data covers the firms that conduct offshore sourcing not only production outsourcing but also outsourcing of service-related tasks such as R&D, information services, customer support, and professional services through contracting out. To identify the causal effect on firm productivity, we implement the propensity score matching with the difference-in-differences technique. The results show that offshore outsourcing has no impact on firm productivity though offshore in-sourcing has a positive impact on it with a time lag of several years.

This paper is organized as follows. The next section describes the construction of the data set and general features of offshoring firms. In Section 3, we present an analytical framework to examine the effect of offshoring on firm productivity and empirical strategy. Section 4 presents the empirical results of the effect of offshoring on productivity and discusses the results, and section 5, the conclusions.

2. Data and Statistical Descriptions

2.1 Data

To obtain basic information on the firm characteristics and performance, we used the *Basic Survey of Japanese Business Structure and Activities* (*Kigyo Katsudo Kihon Chosa*, in Japanese) for the period 1997–2005, conducted by Japan’s Ministry of Economy, Trade and Industry (henceforth METI survey). This annual national survey is mandatory for all firms with 50 or more employees and whose paid-up capital or investment fund is over 30 million yen in mining, manufacturing, wholesale, retail, and food and beverage industries. This firm-level data allows us to construct a panel data set. As for the data on offshore sourcing activity, we used the *Survey of Corporate Offshore Activities* (*Kigyo*

Kaigai Katsudo Chosa, in Japanese)², which is an academic survey conducted by the Research Institute of Economy, Trade and Industry (henceforth RIETI survey) on 14,062 manufacturing firms listed in the METI survey. The RIETI survey succeeded in collecting responses from 5,528 firms. Considering that other previously available firm-level data sets on offshoring include only a limited number of firms and are not designed to cover the entire manufacturing industry, this survey has a clear advantage in terms of its coverage. This survey has direct information on a binary choice of foreign outsourcing with contracting out, explicitly distinguished from domestic outsourcing and from arm's-length purchases at foreign markets. This survey covers not only outsourcing of production-related tasks including final assembly, production of intermediates, and production of jigs/dies but also outsourcing of service-related tasks, such as R&D, information services, customer support, and professional services. Although this survey is a one-shot survey, its data include the status of offshore sourcing of five years earlier, as a retrospective question. Hence, we matched the METI data and RIETI data in 2000 and 2005. As a result, we could draw on more than 3,000 observations for each 2000 and 2005 sample with accurate information on the variables of interest.

With regard to the outsourcing partners, the survey distinguishes three types of firms: (a) own offshore subsidiaries which are defined by the majority ownership, (b) subsidiaries owned by other Japanese multinationals, and (c) foreign-owned firms including either local firms or subsidiaries of

² Firm-level data of this survey cannot be publicly disclosed. The authors are allowed to access this firm-level data set as a part of a RIETI research project. For details and aggregate statistics of the survey, Ito et al. (2007) provided a comprehensive description of this survey.

multinationals from third countries.³ In this survey, as for the respondent firms, because two or more answers are permitted, the overlapping answer across three choices is potentially included in the data. In order to estimate the impact of offshoring respectively of offshore in-sourcing and offshore outsourcing separately, we constructed two dummy variables. One is the offshore in-sourcing dummy variable that takes a value of 1 if the firm at least engages in contracts with its own offshore subsidiaries and 0 for non-offshoring firms. The other one is the offshore outsourcing dummy variable that takes a value of 1 if the firm engages in exclusively arm's-length contracts with local firms and 0 for non-offshoring firms. Thus, the former dummy potentially includes the firms positively responding to the choice of both or either (b) or (c). The latter dummy covers the firms exclusively engaging in both or either (b) or (c) while the firms engaging in offshore in-sourcing are excluded from the sample.

To measure firm performance, first, we calculated the value added as the total sales minus the sum of cost of goods sold and general and administrative costs minus wage, rental, depreciation, and tax costs. The total sales and part of the intermediate input are deflated by the output and input deflators, respectively. The deflators have been taken from the Japan Industrial Productivity (JIP) database of 2008, which has comprehensive Japanese industry-level data. The real capital stock is calculated by the perpetual inventory method, using the book value of fixed tangible assets and investment data from the METI surveys. The deflator of investment goods and the depreciation rate have also been sourced from the JIP database of 2008. The labor input indicates the number of total employees reported in the METI surveys. We estimate the TFP level for each firm using the above

³ Since the category (a) concentrates on the majority-owned subsidiaries, the categories (b) and (c) could include minority-owned affiliates of the outsourcing firm.

statistical data of sampled firms for the period 1997–2005. The direct calculation of TFP using the estimated coefficients of capital stock and labor in the Cobb-Douglas function form suffers from the endogeneity problem. As the benchmark of TFP, the estimated labor share and capital share are 0.76 and 0.23, respectively, when estimating production function by the Levinsohn and Petrin (2003) procedure.⁴

2.2 Differences of Productivity between Offshoring and Non-offshoring

Before analyzing the causal effect of offshoring, we examine the difference in TFP distribution between offshoring firms and non-offshoring firms by pooling the data of 2000 and 2005. Figures 1 and 2 present the kernel density estimate of productivity for the firms engaging in offshore in-sourcing and outsourcing compared to non-offshoring firms. Both results indicate that offshoring firms are likely to be more productive than non-offshoring firms. Further, we examined the difference in TFP distribution by applying t-tests for equality of differences in the means of the distributions and two-sample Kolmogorov-Smirnov tests for equality of distribution functions. The differences with offshoring firms were statistically significant in both of two tests. These results suggest the productivity distribution of offshoring firms dominates that of non-offshoring firms.

Figures 1 and 2 around here

⁴ In this procedure, the purchase of input is used as a proxy variable of productivity shock. We also applied an alternative method by using investment as the proxy, as proposed by Olley and Pakes (1996); however, the results were found to be almost the same. In consideration of omitted firms with zero investment, we relied on the estimator by the Levinsohn–Petrin procedure.

Next, we graphically compare the changes in the productivity level of both offshoring and non-offshoring firms over time by using the panel data. The basic information at the firm-level is retrieved from the METI survey as the source for Japanese manufacturing firms while the data on outsourcing is collected from the RIETI survey. Using the offshore in-sourcing dummy and outsourcing dummy mentioned in the previous section and the panel data for the periods 1997-2005, we distinguished firms into non-offshoring firms, offshore insourcing firms and offshore outsourcing firms in 2000 and repeated to do so thereafter, and non-offshoring firms are restricted to firms that did not engage in offshoring in either 2000 or 2005. Figure 3 depicts the difference in the average of the logarithm of the TFP level over time between the three types as of 2000. The trends in the productivity level of offshoring firms provide important information to show the dynamic change attributed to offshoring. The figure shows that even before 2000, the TFP of offshore in-sourcing firms and offshore outsourcing firms was already higher than that of non-offshoring firms. Further, it seems that the difference in TFP between offshoring firms and non-offshoring firms has expanded from year to year since around 2002. Although the different trend between the two would imply that offshoring activity yields high productivity, it cannot be identified as an influence by offshoring, and a further examination by econometric analysis would be required. More precisely, to compare the difference between offshoring firms and non-offshoring firms is not appropriate because the characteristics of both firms are potentially different and it may be due to other factors. In the next section, we present a procedure to estimate the causal effect of offshoring on productivity.

Figure 3 around here

3. The Effect of Offshoring on Productivity Growth

3.1 Analytical Framework

The production of goods is a multistage process. Each stage of production activity can be considered to be a bundled task in the process of transformation from an intermediate product to a final product. At every stage, capital, labor, and intermediate goods are input. Outsourcing of a task is defined as unbundling the task from the production process and replacing it with intermediate goods produced outside of the firm.⁵ If (1) the production activity of each stage is competitive, (2) prices of intermediate products are market dependent, and (3) primary factors such as capital and labor are available at a given price in the factor market, similar to the availability of labor at fixed wages in a labor market, a firm may be deficient in some stages of production because of the gap between the value of the marginal product of labor and the wage rate. In such a case, the firm will choose to (1) unbundle a task from the production process and offshore it to a foreign country where the wage rate is lower than the value of marginal product of labor, (2) re-import processed intermediate products, and (3) include them in the production process of the final product. In this manner, outsourcing enables a firm to work around the deficits in its own production process.

Such a shift in resources to more efficient stages of a production process raises the productivity growth. Previous studies have included characterized offshoring by productivity growth in the aggregate production function. Our paper investigates how a one-shot change in the production process affects the TFP as well as the previous work (e.g. Görg and Hanley, 2005; Hijzen et al., 2006).

⁵ See Feenstra and Hanson (1999), Antràs (2003), Grossman and Rossi-Hansburg (2006), and so on.

3.2 Empirical Strategy

On the basis of the framework of offshoring and productivity growth, we expect that offshoring positively affects a firm's TFP growth. The statistical analysis presented in the former section identifies the only average difference in the productivity between offshoring firms and non-offshoring firms but it can not clarify the causality. In order to capture the causal effect of offshoring on firm productivity, we implement the Propensity Score Matching (PSM) technique developed by Rosenbaum and Rubin (1983) with the difference-in-differences technique. First, we estimate the binary response model on the choice of offshoring and gain the propensity score for each firm. In the second step, we match the similar non-offshoring firms with offshoring firms in terms of various firm characteristics using the propensity score by matching algorithms. Finally, we examine the difference in productivity growth between treated and matched control observations.

The data on offshoring used in this analysis is dichotomous data, and we constructed the dummy variable, O_{it} that takes a value of 1 if the firm i enters into contracts with foreign suppliers in year t and 0 for non-offshoring firms. The productivity of firm i in year $t+s$ ($s \geq 0$) and the firm characteristics in year $t-1$ is presented as $Y_{i,t+s}$ and $X_{i,t-1}$, respectively. We can define the causal effect of offshoring on productivity as the difference in the performance between the offshoring firm non-offshoring firms by introducing the conditional independence assumption. The average causal effect is written as;

$$\delta' = E\left(Y_{i,t+s}^1 \mid O_{it} = 1, X_{i,t-1} = x_{i,t-1}\right) - E\left(Y_{i,t+s}^0 \mid O_{it} = 0, X_{i,t-1} = x_{i,t-1}\right) \quad (1)$$

where $Y_{i,t+s}^1$ and $Y_{i,t+s}^0$ are potential outcome according to the status of offshoring, and δ' is the average effect of treatment on the treated (ATT). The counterfactual group is created by using a selected group of non-offshoring firms that have similar firm characteristics, $x_{i,t-1}$. Thus, we need to extract non-offshoring firms with similar firm characteristics from the sample. Rosenbaum and Rubin (1983) propose using the propensity score to find the counterfactual group from the control group. The concrete procedure of this method is, first, to estimate predicted probabilities on entry of offshoring $\Pr(O_{it} = 1 | X_{i,t-1} = x_{i,t-1})$ for each firm by probit or logit, secondly to select non-offshoring firms of which the probability is close to the probability of offshoring firms as the counterfactual group and finally, to estimate the difference of the productivity among both. The ATT estimates under the PSM procedure are shown by the following form.

$$\delta^{PSM} = \frac{1}{N} \sum_{i \in T} \left(Y_{i,t+s}^1 - \sum_{j \in C} W(\Pr(X_{i,t-1}), \Pr(X_{j,t-1})) Y_{j,t+s}^0 \right) \quad (2)$$

where N is the number of offshoring firm and T means the treatment group while C means the control group. $W(\Pr(X_{i,t-1}), \Pr(X_{j,t-1}))$ is a matching weight ($0 < W \leq 1$) which depends on the probabilities of both offshoring and non-offshoring firms.

The panel data enable us to control for unobserved time-invariant firm individual effects by taking difference and to gain more robust estimates. The PSM technique can be enhanced to the Difference-in-differences (DID) estimate to which time invariable, individual effects can be removed by taking the difference. The ATT estimates in this case can be written as follows.

$$\delta^{PSM-DID} = \frac{1}{N} \sum_{i \in T} \left(\Delta Y_{i,t+s}^1 - \sum_{j \in C} W(\Pr(X_{i,t-1}), \Pr(X_{j,t-1})) \Delta Y_{j,t+s}^0 \right) \quad (3)$$

We use two matching techniques, nearest-neighbor matching and kernel matching to match offshoring firms with non-offshoring firms. Nearest-neighbor matching is to search out similar firms to which the difference of the participation probability is minimized as shown in the next expression from the control group (non-offshoring firms).

$$|p_i - p_j| = \min_{k \in \{D=0\}} \{|p_i - p_k|\} \quad (4)$$

In the case of nearest-neighbor matching, three different matching methods are tested. One is one-to-one matching, which matches each observation in the treatment group to only one control observation that has the closest propensity score, the second is k-nearest-neighbor matching, which allows matching more than one observation in the control group, and the third is caliper matching, which each observation in the treatment group is matched with a observation in the control group that has the closest propensity score within the caliper that is set at 0.01 in this analysis.

Kernel matching is to apply the following matching weight in the equation (2) and (3).

$$W = \frac{K(\Pr(X_{j,t-1}) - \Pr(X_{i,t-1}))/b}{\sum_{k \in \{R=0\}} K(\Pr(X_{k,t-1}) - \Pr(X_{i,t-1}))/b} \quad (5)$$

where K is a kernel function and b is bandwidth.⁶

4. Empirical Results

4.1 Propensity Score and Balancing Test

It is necessary to estimate the participation probability whether to outsource to a foreign supplier with a contract as a procedure of the PSM technique. Following the empirical studies on determinants of offshoring (e.g. Girma and Görg, 2004; Kimura, 2002; Tomiura, 2005), we select the firm attributes expected to have an influence on the offshoring decision as explanatory variables, and gain the predicted probabilities by estimating the following logit model.

$$\ln\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \beta_1(R/Q)_{it-1} + \beta_2 \ln L_{it-1} + \beta_3(K/L)_{it-1} + \beta_4 W_{it-1} + \beta_5(R \& D/Q)_{it-1} + \beta_6(S/L)_{it-1} + \beta_7 AGE_{it-1} \quad (6)$$

where subscript it denotes the index of the firm in the period t . The dependent variable is the log-odds ratio in terms of the probability on the participation in offshoring. We use lagged explanatory variables to avoid the simultaneity problem. The profit to total sales R/Q is included as a measure of business performance to control possible self-selection. The labor cost saving strategies would be a major motivation to start offshoring in order to focus on core competencies. On the other hand, firms may need high technological capacity and skills to absorb output through offshoring activities. We add the capital-labor ratio K/L , wage per employees W , R&D expenditures over total sales $R\&D/Q$ and skill intensity defined as the number of employees in headquarters over total employees S/L . As other firm

⁶ The epanechnikov kernel function is applied, and bandwidth is set to be 0.06 in this analysis.

attributes, we employ the logarithm of the number of employees as a proxy for firm size $\ln L$ and the firm age AGE to control the firm's vintage effect. The variation among industries is controlled by two-digit industry dummy variables. Table 1 describes the summary of the statistics for each variable on the basis of the status of offshore in-sourcing and outsourcing.

Table 1 around here

Since we have the METI data collecting basic information at the firm-level for the period 1997–2005 and the RIETI data on offshore sourcing activity in 2000 and 2005, the logit model is estimated by cross-sectional data of 2000 and ATT-DID is estimated after 2000. Therefore the explanatory variables in year 1999 are included in the model. The estimation result is displayed in Table 2. In both cases of offshore in-sourcing and outsourcing, the coefficient of the lagged profit rate is not statistically significant though it was forecast that the firms with good performance would be selected. The results show that the firm size and skill intensity have a positive impact on the probability of participation in offshoring. The coefficient of the number of employees is significantly positive in both estimations. As the firm-level analyses on the determinants of internationalization have shown, the larger the firm size is, the more active offshoring is. The skill intensity measured by the ratio of employees in headquarters has a positive sign, suggesting that offshoring activities require firms to strengthen skill capabilities. As for capital-labor ratio, a negative coefficient is expected if labor cost saving as a motivation of offshoring is supported. The coefficient of capital-labor ratio is not statistically significant in the case of in-sourcing, while being negative and significant in the case

of outsourcing. Both coefficients of wage per employee and R&D intensity are not significant at all while the firm age is positively correlated with offshore in-sourcing. The older firms are more inclined to engage in offshoring than the younger firms.⁷

Table 2 around here

It is necessary to match similar non-offshoring firms in terms of firm attributes with offshoring firms to obtain the ATT estimate by the PSM technique with high accuracy. The sample is restricted by imposing the common support condition which means non-offshoring firms whose probability is higher than offshoring firms with the maximum probability and offshoring firms whose probability is lower than non-offshoring firms with the minimum probability are excluded from the sample.⁸ After the match, we carry out the balancing test to judge whether the difference of the mean value in terms of firm attributes used in the estimation for the participation probability between both groups is statistically different from 0. It can be judged that non-offshoring firms with firm attributes similar to offshoring firms are correctly matched if a significant difference is not statistically found for each variable between the two. As in all matching techniques, the null hypothesis that the difference of the

⁷ As for the ATT estimate value by the PSM technique, the result was influenced by selecting the explanatory variable used for estimating participation probability (Heckman et al., 1998). However, a substantial change was not seen in the following ATT estimate, even though the combination of explanatory variables changed as the variables were added or dropped, one by one, and the ATT estimate was tested. We also omit the variables that have no explanatory power and estimate ATT, however, the change in the results was negligible.

⁸ The loss of the number of observations by common support condition was very few.

means of the variable between offshoring firms and matched non-offshoring firms is zero is not rejected for all variables after the match, though the hypothesis is rejected in many cases before the match. This result indicates that the matched non-offshoring firms resemble the offshoring firms in terms of the firm attributes. The results of balancing tests for each variable used in the logit estimation are displayed in Appendix 1 and 2.

4.2 Estimate of offshoring effect on productivity

Using the propensity score on participation in offshoring gained from the logit estimation, we estimate the ATT with DID in terms of the logarithm of TFP in the matched sample. The effect of offshore in-sourcing and outsourcing on productivity may be different in magnitude. We estimate the effect of offshoring on TFP with respect to both offshore in-sourcing and outsourcing, distinguishing offshoring firms into firms engaging in both in-sourcing to a firm's foreign subsidiaries and outsourcing to local firms through arm's-length transactions and firms engaging in exclusively offshore outsourcing. In both cases, the control group is non-offshoring firms.

Table 3 presents the results of ATT with DID estimate in the case of offshore in-sourcing. Since the effects of offshoring might have a time lag to appear, the ATT estimate is calculated from the time of t to five years later, namely from 2000 to 2005 that data is available. The difference in $\ln TFP$ is defined as $\ln TFP$ in each year minus that in year 2000. Hence, the estimates indicate TFP growth rate due to offshoring. The first and second columns present the mean value of each status of offshoring, the third column displays ATT with DID estimates, and the results for testing the null of equivalence between groups are indicated in the right side of each panel. The difference after four or

five years is positive and statistically significant at the significance level of 5% while those before 2003 are not significant. The results indicate that offshoring through intra-firm in-sourcing has a positive impact on productivity growth after controlling unobserved firm individual effects, but the effects appear with a time lag of four or five years. The estimated ATT with DID of Table 3, for instance, implies that offshore in-sourcing leads to a 9-11% increase in TFP four or five years after offshoring.

Table 3 around here

We also examine the effect of offshore outsourcing to local firms in foreign countries on TFP growth. The ATT with DID estimates of offshore outsourcing are presented in Table 4. The estimates show the positive sign in most cases, but they are not statistically significant in any of the matching techniques. This result indicates that there is no difference in average productivity growth between non-offshoring firms matched to the treated and the firms conducting offshore outsourcing, and it is suggested that offshore outsourcing to local suppliers does not contribute to productivity growth.⁹

Table 4 around here

⁹ We obtained the comparable result of the ATT estimate without the difference-in-differences. See Appendix 3 and 4.

4.3 Discussion

The estimated results show that offshore in-sourcing increases productivity growth with a time lag of several years. On the other hand, the results of estimation for offshore outsourcing indicate that outsourcing through arm's-length contracts has no impact on productivity growth. It would be an interesting issue to discuss why the effect of offshore in-sourcing has a time-lag and why the results are different according to firm boundaries.

One possible explanation for our finding that the effect of in-sourcing has a time-lag is that the reallocation of resources to other production processes within the firm takes a time-lag to affect productivity. Offshoring activities enable firms to specialize in production processes with core competencies. However, resources shifted to other production processes, which are supposed to be more skill intensive than the processes that can be outsourced, would improve productivity through learning by doing. Therefore, it is expected that time is required until the reallocation of the resources can indeed contribute to productivity growth. The time-lag until the appearance of the effect of offshore in-sourcing in our result may reflect the interpretation.

Regarding the second question, the result might reflect that the outsourced task is different according to firm boundaries. The survey on offshoring used in this study also contains disaggregated information on the types of tasks outsourced offshore at the firm-level. The survey distinguishes three production-related tasks (production of intermediates, final assembly, and production of jigs/dies), four service-related tasks (R&D, information services, customer support, professional (legal, accounting, or financial) services, and the other tasks. We found that two tasks (the production of intermediates and the final assembly) are most frequently offshore sourced and whose share to total offshore sourcing is

35%, respectively. Moreover, the data shows that final assembly tends to be relatively often in-sourced to firms' own foreign subsidiaries, while the production of intermediates concentrates on the case of outsourcing through arm's-length contracting.¹⁰ Therefore, our results might be associated with the difference of tasks between in-sourcing and outsourcing. Firms engaging in in-sourcing the more labor-intensive production processes, such as final assembly, might possibly be able to concentrate on more advanced production processes compared with firms that choose to outsource the production of intermediates. The gain from specializing in more advanced production processes is expected to be larger than in other production processes which can be outsourced beyond the firm's boundaries. As a result, the rise of productivity is observed by the in-sourcing firm that has succeeded in subcontracting the final assembly stage in which productivity is expected to be low to outside the firm.¹¹

5. Conclusions

In recent years, great interest has been aroused in the examination of the impact of offshore sourcing that has increased rapidly and expanded over various tasks. This paper examines the causal effect of offshore sourcing on TFP growth by shedding light on the organizational form in terms of the ownership of suppliers and on the time-lag in appearance of the effects, using Japanese firm-level data in manufacturing industries over the period 2000–2005. The advantage of this study, over previous

¹⁰ According to our survey as reported in Ito et al. (2007), Table 6, in around half of the cases, the final assembly and the production of intermediates are in-sourced within the boundary of multinationals and outsourced to foreign unrelated suppliers, respectively.

¹¹ Although it is likely to be able to examine whether this interpretation is correct by disaggregating data according to the task further, we have not tested because the number of observations decreased sharply.

studies, is a distinctive investigation of offshore sourcing between offshore in-sourcing and outsourcing based on firm-level data. The effect of offshore sourcing is examined separately with respect to offshore in-sourcing and outsourcing by distinguishing offshore sourcing firms into firms engaging in both in-sourcing to firm's foreign subsidiaries and outsourcing to local firms through arm's-length transactions and firms engaging in exclusively offshore outsourcing.

The results are summarized as follows. First, the impact of offshore in-sourcing within multinationals on productivity measured as TFP is found to be positive. One interesting finding is that there was a time-lag in the appearance of the impacts. This result implies that the effect is dynamic through learning by doing in more skill intensive processes. Second, it is found that offshore outsourcing through arm's-length contracting out did not affect productivity. These contrastive results between offshore in-sourcing and outsourcing may indicate that the productivity gain is associated with the difference in offshoring tasks between the two types of sourcing.

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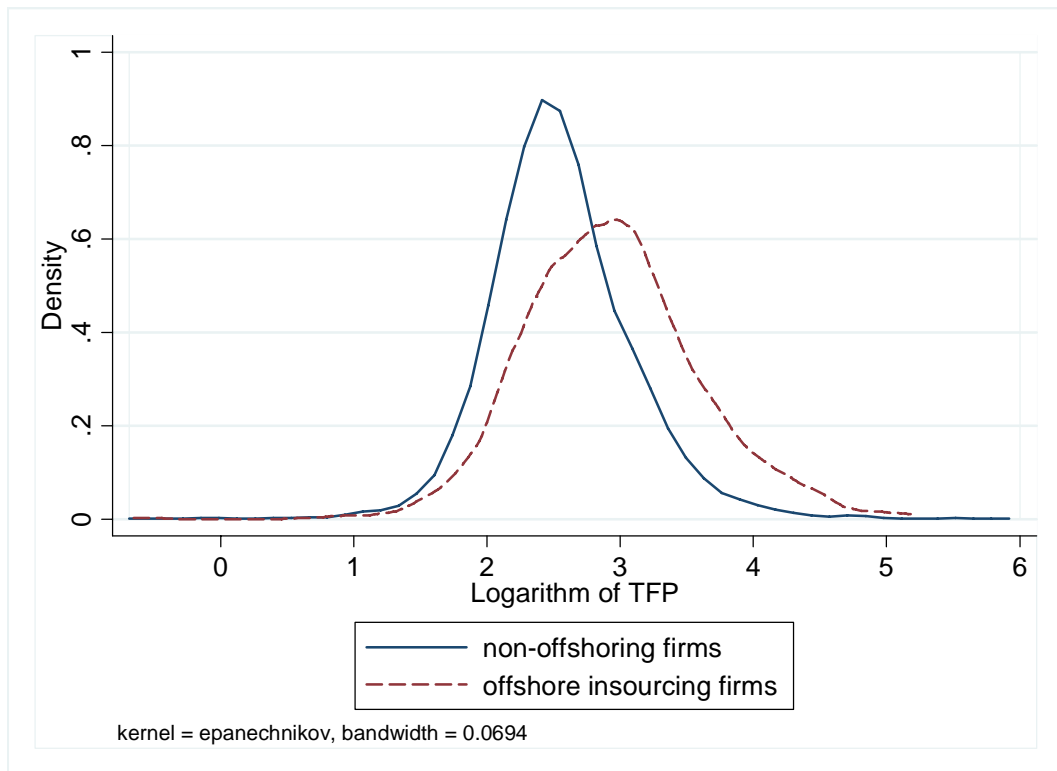


Figure 1. Differences in TFP: offshore in-sourcing vs non-offshoring
 Note: Kernel density estimate is applied to the pooled data of 2000 and 2005.

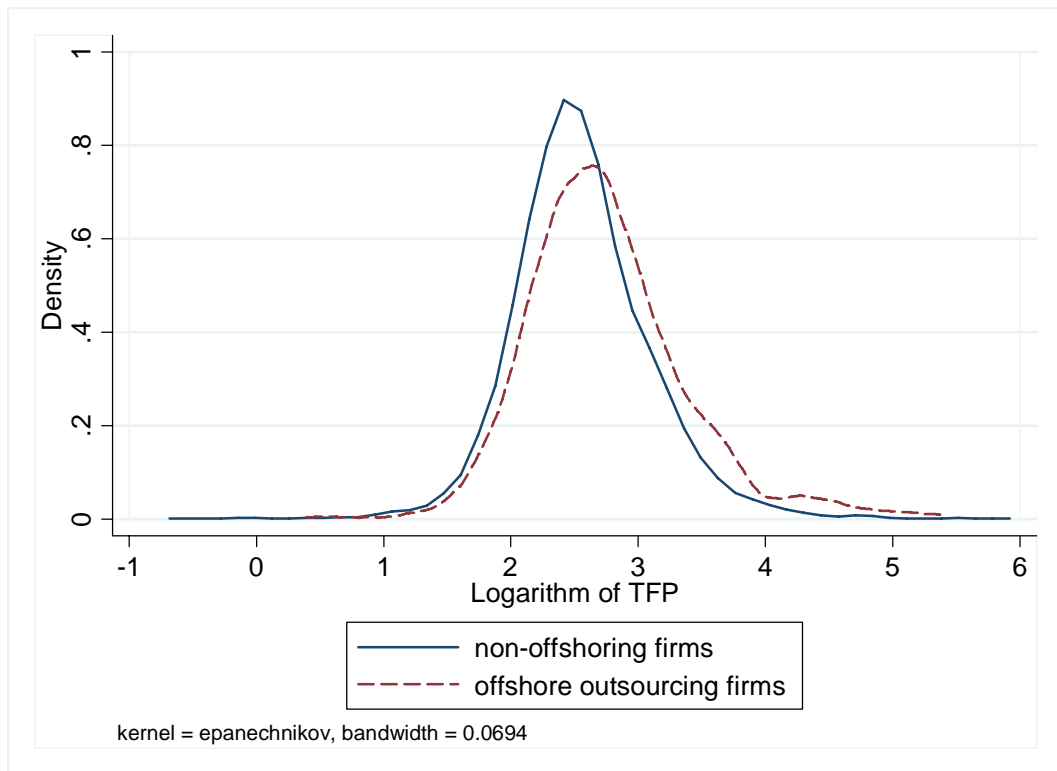


Figure 2. Differences in TFP: offshore outsourcing vs non-offshoring
 Note: Kernel density estimate is applied to the pooled data of 2000 and 2005.

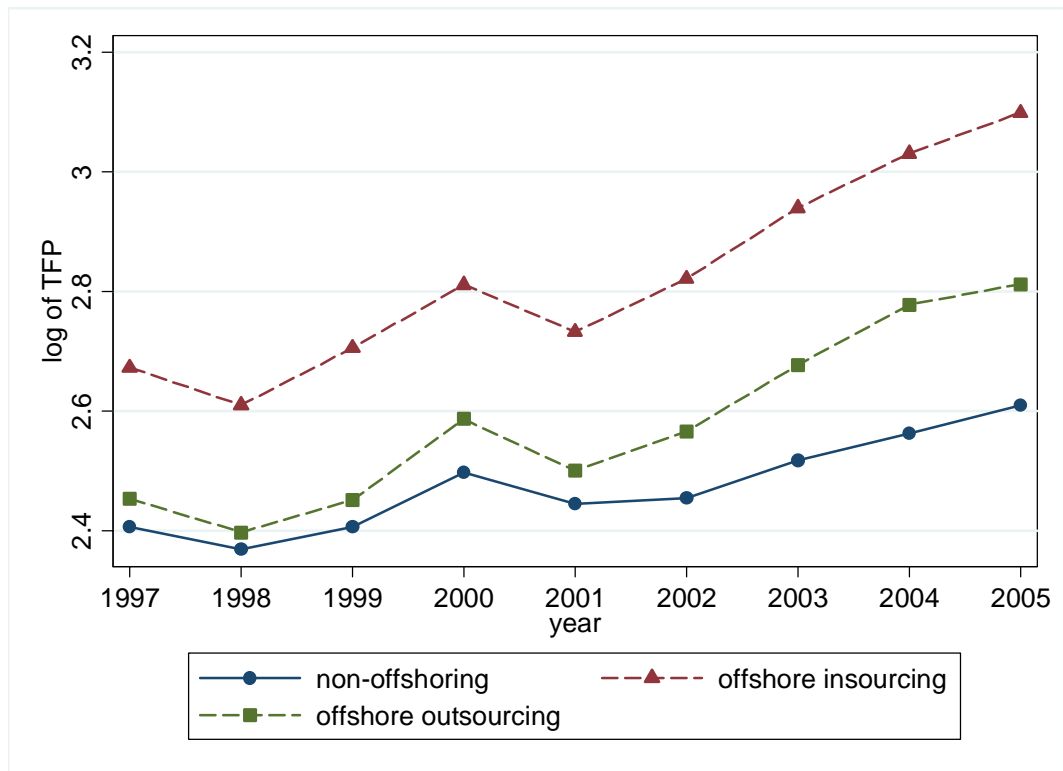


Figure 3. Differences in TFP over time

Note: Each mean value over time is calculated in terms of the firms that engage in offshore in-sourcing, outsourcing and non-offshoring firms in 2000.

Table 1. Descriptive Statistics

Variable	non-offshoring firms (2,840 obs.)		offshore in-sourcing firms (273 obs.)		Total	
	Mean	S.D	Mean	S.D	Mean	S.D
R/Q	0.027	0.056	0.032	0.054	0.027	0.056
lnL	5.041	0.845	6.167	1.398	5.138	0.959
K/L	13.395	19.844	15.096	14.127	13.541	19.423
W	4.764	1.52	5.418	1.615	4.82	1.539
R&D/Q	0.008	0.019	0.022	0.028	0.01	0.021
S/L	0.15	0.117	0.18	0.124	0.152	0.118
AGE	37.977	15.383	44.748	16.771	38.558	15.62
Variable	non-offshoring firms (2,840 obs.)		offshore outsourcing firms (265 obs.)		Total	
	Mean	S.D	Mean	S.D	Mean	S.D
R/Q	0.027	0.056	0.026	0.052	0.027	0.056
lnL	5.041	0.845	5.342	0.954	5.066	0.858
K/L	13.395	19.844	11.879	13.869	13.266	19.412
W	4.764	1.52	4.955	1.585	4.78	1.526
R&D/Q	0.008	0.019	0.015	0.025	0.009	0.02
S/L	0.15	0.117	0.18	0.124	0.152	0.118
AGE	37.977	15.383	39.799	15.753	38.131	15.421

Table 2. Estimation Results of Logit

	In-sourcing	Outsourcing
R/Q	1.771 [1.332]	0.436 [1.194]
lnL	0.934 [0.075]**	0.379 [0.078]**
K/L	-0.01 [0.005]	-0.012 [0.006]*
W	-0.042 [0.059]	0.023 [0.054]
R&D/Q	3.374 [3.057]	2.2 [3.039]
S/L	2.143 [0.611]**	1.907 [0.564]**
AGE	0.012 [0.005]*	0.005 [0.005]
Industry dummies	Yes	Yes
Constant	-7.733 [0.448]**	-4.504 [0.456]**
Observations	3113	3105
Log likelihood	-725.63	-833.31
Pseudo R2	0.216	0.08

Notes: Standard errors in parenthesis; *, ** indicate significance at the 5, and 1 percent levels, respectively.

Table 3. ATT with DID Results on Offshore In-sourcing

Variable	one-to-one matching					k-nearest neighbour matching				
	Offshoring		ATT with DID	t-test for mean equivalence		Offshoring		ATT with DID	t-test for mean equivalence	
	Yes	No		t-value	p> t	Yes	No		t-value	p> t
$\Delta \ln TFP_{2001}$	-0.062	-0.046	-0.016	-0.710	0.481	-0.062	-0.057	-0.005	-0.220	0.829
$\Delta \ln TFP_{2002}$	-0.003	-0.007	0.003	0.120	0.907	-0.003	0.008	-0.012	-0.410	0.683
$\Delta \ln TFP_{2003}$	0.133	0.087	0.045	1.310	0.190	0.133	0.092	0.040	1.150	0.252
$\Delta \ln TFP_{2004}$	0.218	0.132	0.086	2.130	0.033	0.218	0.112	0.106	2.540	0.011
$\Delta \ln TFP_{2005}$	0.284	0.187	0.097	2.120	0.034	0.284	0.168	0.116	2.600	0.010
Variable	caliper matching					kernel matching				
	Offshoring		ATT with DID	t-test for mean equivalence		Offshoring		ATT with DID	t-test for mean equivalence	
	Yes	No		t-value	p> t	Yes	No		t-value	p> t
$\Delta \ln TFP_{2001}$	-0.061	-0.058	-0.003	-0.130	0.896	-0.062	-0.062	0.000	0.000	0.999
$\Delta \ln TFP_{2002}$	-0.002	-0.003	0.001	0.030	0.977	-0.003	-0.005	0.001	0.040	0.965
$\Delta \ln TFP_{2003}$	0.134	0.083	0.051	1.430	0.153	0.133	0.080	0.053	1.470	0.142
$\Delta \ln TFP_{2004}$	0.224	0.121	0.103	2.500	0.013	0.218	0.121	0.097	2.320	0.021
$\Delta \ln TFP_{2005}$	0.288	0.176	0.112	2.460	0.014	0.284	0.176	0.108	2.370	0.018

Table 4. ATT with DID Results on Offshore Outsourcing

Variable	one-to-one matching					k-nearest neighbour matching				
	Offshoring		ATT with DID	t-test for mean equivalence		Offshoring		ATT with DID	t-test for mean equivalence	
	Yes	No		t-value	p> t	Yes	No		t-value	p> t
$\Delta \ln TFP_{2001}$	-0.072	-0.073	0.000	0.020	0.986	-0.072	-0.079	0.007	0.280	0.782
$\Delta \ln TFP_{2002}$	-0.024	-0.045	0.021	0.570	0.571	-0.024	-0.059	0.035	1.010	0.314
$\Delta \ln TFP_{2003}$	0.087	0.098	-0.011	-0.270	0.784	0.087	0.054	0.033	0.820	0.415
$\Delta \ln TFP_{2004}$	0.181	0.162	0.019	0.430	0.669	0.181	0.118	0.063	1.530	0.128
$\Delta \ln TFP_{2005}$	0.218	0.209	0.009	0.170	0.865	0.218	0.165	0.052	1.070	0.286
Variable	caliper matching					kernel matching				
	Offshoring		ATT with DID	t-test for mean equivalence		Offshoring		ATT with DID	t-test for mean equivalence	
	Yes	No		t-value	p> t	Yes	No		t-value	p> t
$\Delta \ln TFP_{2001}$	-0.072	-0.080	0.008	0.290	0.772	-0.072	-0.068	-0.004	-0.170	0.865
$\Delta \ln TFP_{2002}$	-0.024	-0.060	0.036	1.030	0.306	-0.024	-0.044	0.019	0.610	0.543
$\Delta \ln TFP_{2003}$	0.087	0.053	0.033	0.840	0.402	0.087	0.047	0.040	0.990	0.321
$\Delta \ln TFP_{2004}$	0.181	0.117	0.064	1.550	0.121	0.181	0.107	0.074	1.770	0.077
$\Delta \ln TFP_{2005}$	0.218	0.164	0.053	1.090	0.276	0.218	0.151	0.067	1.390	0.166

Appendix 1. Balancing Tests on Offshore In-sourcing

(a) one-to-one matching

Variable	Sample	Offshoring		%bias (Yes- No)/No×100	% reduction of bias	t-test for mean equivalence	
		Yes	No			t-value	p> t
R/Q t-1	Unmatched	0.035	0.028	12.5		1.90	0.057
	Matched	0.034	0.028	10.9	12.9	1.35	0.178
lnL t-1	Unmatched	6.261	5.083	102.0		20.53	0.000
	Matched	6.103	6.040	5.5	94.6	0.59	0.555
K/L t-1	Unmatched	15.250	13.559	9.9		1.35	0.177
	Matched	15.011	12.873	12.6	-26.4	1.85	0.064
W t-1	Unmatched	5.463	4.795	43.5		7.00	0.000
	Matched	5.369	5.268	6.6	85.0	0.72	0.469
RD/Q t-1	Unmatched	0.024	0.009	59.7		11.08	0.000
	Matched	0.022	0.020	8.8	85.3	0.86	0.389
S/L t-1	Unmatched	0.180	0.150	25.9		4.17	0.000
	Matched	0.180	0.179	1.2	95.2	0.13	0.893
AGE t-1	Unmatched	45.828	38.417	47.3		7.55	0.000
	Matched	45.115	44.096	6.5	86.2	0.70	0.483

(b) k-nearest neighbour matching

Variable	Sample	Offshoring		%bias (Yes- No)/No×100	% reduction of bias	t-test for mean equivalence	
		Yes	No			t-value	p> t
R/Q t-1	Unmatched	0.035	0.028	12.5		1.90	0.057
	Matched	0.034	0.033	1.5	87.6	0.19	0.852
lnL t-1	Unmatched	6.261	5.083	102.0		20.53	0.000
	Matched	6.103	6.094	0.8	99.2	0.08	0.934
K/L t-1	Unmatched	15.250	13.559	9.9		1.35	0.177
	Matched	15.011	14.617	2.3	76.7	0.28	0.776
W t-1	Unmatched	5.463	4.795	43.5		7.00	0.000
	Matched	5.369	5.387	-1.2	97.3	-0.13	0.897
RD/Q t-1	Unmatched	0.024	0.009	59.7		11.08	0.000
	Matched	0.022	0.023	-2.2	96.4	-0.21	0.834
S/L t-1	Unmatched	0.180	0.150	25.9		4.17	0.000
	Matched	0.180	0.181	-0.8	97.0	-0.09	0.932
AGE t-1	Unmatched	45.828	38.417	47.3		7.55	0.000
	Matched	45.115	45.032	0.5	98.9	0.06	0.954

(c) caliper matching

Variable	Sample	Offshoring		%bias (Yes- No)/No×100	% reduction of bias	t-test for mean equivalence	
		Yes	No			t-value	p> t
R/Q t-1	Unmatched	0.035	0.028	12.5		1.90	0.057
	Matched	0.033	0.033	0.7	94.7	0.08	0.938
lnL t-1	Unmatched	6.261	5.083	102.0		20.53	0.000
	Matched	6.017	6.007	0.8	99.2	0.09	0.928
K/L t-1	Unmatched	15.250	13.559	9.9		1.35	0.177
	Matched	14.614	14.280	2.0	80.2	0.24	0.812
W t-1	Unmatched	5.463	4.795	43.5		7.00	0.000
	Matched	5.333	5.354	-1.4	96.8	-0.15	0.880
RD/Q t-1	Unmatched	0.024	0.009	59.7		11.08	0.000
	Matched	0.021	0.022	-1.6	97.4	-0.15	0.880
S/L t-1	Unmatched	0.180	0.150	25.9		4.17	0.000
	Matched	0.182	0.181	1.2	95.3	0.13	0.899
AGE t-1	Unmatched	45.828	38.417	47.3		7.55	0.000
	Matched	44.749	45.341	-3.8	92.0	-0.40	0.690

(d) kernel matching

Variable	Sample	Offshoring		%bias (Yes- No)/No×100	% reduction of bias	t-test for mean equivalence	
		Yes	No			t-value	p> t
R/Q t-1	Unmatched	0.035	0.028	12.5		1.90	0.057
	Matched	0.034	0.033	1.7	86.4	0.20	0.841
lnL t-1	Unmatched	6.261	5.083	102.0		20.53	0.000
	Matched	6.103	6.052	4.4	95.7	0.46	0.644
K/L t-1	Unmatched	15.250	13.559	9.9		1.35	0.177
	Matched	15.011	14.508	3.0	70.3	0.38	0.704
W t-1	Unmatched	5.463	4.795	43.5		7.00	0.000
	Matched	5.369	5.299	4.6	89.5	0.51	0.607
RD/Q t-1	Unmatched	0.024	0.009	59.7		11.08	0.000
	Matched	0.022	0.022	0.9	98.6	0.08	0.934
S/L t-1	Unmatched	0.180	0.150	25.9		4.17	0.000
	Matched	0.180	0.176	3.7	85.6	0.40	0.689
AGE t-1	Unmatched	45.828	38.417	47.3		7.55	0.000
	Matched	45.115	44.156	6.1	87.1	0.66	0.508

Appendix 2. Balancing Tests on Offshore Outsourcing

(a) one-to-one matching

Variable	Sample	Offshoring		%bias (Yes- No)/No×100	% reduction of bias	t-test for mean equivalence	
		Yes	No			t-value	p> t
R/Q t-1	Unmatched	0.028	0.028	-0.4		-0.05	0.958
	Matched	0.028	0.030	-3.9	-1026.0	-0.46	0.643
lnL t-1	Unmatched	5.360	5.083	31.6		5.09	0.000
	Matched	5.356	5.263	10.6	66.6	1.14	0.255
K/L t-1	Unmatched	11.197	13.559	-14.1		-1.86	0.062
	Matched	11.231	9.672	9.3	34.0	1.62	0.105
W t-1	Unmatched	4.956	4.795	10.5		1.66	0.096
	Matched	4.965	4.806	10.3	1.7	1.22	0.223
RD/Q t-1	Unmatched	0.014	0.009	23.9		4.08	0.000
	Matched	0.014	0.016	-7.4	69.1	-0.70	0.486
S/L t-1	Unmatched	0.176	0.150	22.4		3.58	0.000
	Matched	0.177	0.176	0.5	97.8	0.05	0.958
AGE t-1	Unmatched	39.796	38.417	9.0		1.39	0.164
	Matched	39.663	39.682	-0.1	98.6	-0.01	0.988

(b) k-nearest neighbour matching

Variable	Sample	Offshoring		%bias (Yes- No)/No×100	% reduction of bias	t-test for mean equivalence	
		Yes	No			t-value	p> t
R/Q t-1	Unmatched	0.028	0.028	-0.4		-0.05	0.958
	Matched	0.028	0.027	2.1	-512.0	0.24	0.808
lnL t-1	Unmatched	5.360	5.083	31.6		5.09	0.000
	Matched	5.356	5.320	4.0	87.2	0.43	0.666
K/L t-1	Unmatched	11.197	13.559	-14.1		-1.86	0.062
	Matched	11.231	10.824	2.4	82.8	0.39	0.695
W t-1	Unmatched	4.956	4.795	10.5		1.66	0.096
	Matched	4.965	4.954	0.7	93.2	0.08	0.933
RD/Q t-1	Unmatched	0.014	0.009	23.9		4.08	0.000
	Matched	0.014	0.015	-4.3	82.1	-0.42	0.673
S/L t-1	Unmatched	0.176	0.150	22.4		3.58	0.000
	Matched	0.177	0.180	-2.6	88.4	-0.28	0.780
AGE t-1	Unmatched	39.796	38.417	9.0		1.39	0.164
	Matched	39.663	40.401	-4.8	46.5	-0.56	0.574

(c) caliper matching

Variable	Sample	Offshoring		%bias (Yes- No)/No×100	% reduction of bias	t-test for mean equivalence	
		Yes	No			t-value	p> t
R/Q t-1	Unmatched	0.028	0.028	-0.4		-0.05	0.958
	Matched	0.028	0.027	2.1	-487.1	0.23	0.815
lnL t-1	Unmatched	5.360	5.083	31.6		5.09	0.000
	Matched	5.356	5.317	4.4	85.9	0.48	0.632
K/L t-1	Unmatched	11.197	13.559	-14.1		-1.86	0.062
	Matched	11.231	10.811	2.5	82.2	0.40	0.686
W t-1	Unmatched	4.956	4.795	10.5		1.66	0.096
	Matched	4.965	4.950	0.9	91.2	0.11	0.914
RD/Q t-1	Unmatched	0.014	0.009	23.9		4.08	0.000
	Matched	0.014	0.015	-3.8	84.3	-0.37	0.711
S/L t-1	Unmatched	0.176	0.150	22.4		3.58	0.000
	Matched	0.177	0.179	-2.3	89.7	-0.25	0.804
AGE t-1	Unmatched	39.796	38.417	9.0		1.39	0.164
	Matched	39.663	40.448	-5.1	43.1	-0.60	0.550

(d) kernel matching

Variable	Sample	Offshoring		%bias (Yes- No)/No×100	% reduction of bias	t-test for mean equivalence	
		Yes	No			t-value	p> t
R/Q t-1	Unmatched	0.028	0.028	-0.4		-0.05	0.958
	Matched	0.028	0.028	-0.1	68.6	-0.01	0.990
lnL t-1	Unmatched	5.360	5.083	31.6		5.09	0.000
	Matched	5.356	5.305	5.8	81.7	0.62	0.537
K/L t-1	Unmatched	11.197	13.559	-14.1		-1.86	0.062
	Matched	11.231	11.592	-2.2	84.7	-0.31	0.758
W t-1	Unmatched	4.956	4.795	10.5		1.66	0.096
	Matched	4.965	4.931	2.2	79.2	0.25	0.802
RD/Q t-1	Unmatched	0.014	0.009	23.9		4.08	0.000
	Matched	0.014	0.014	3.5	85.3	0.36	0.719
S/L t-1	Unmatched	0.176	0.150	22.4		3.58	0.000
	Matched	0.177	0.172	3.6	83.7	0.39	0.698
AGE t-1	Unmatched	39.796	38.417	9.0		1.39	0.164
	Matched	39.663	39.599	0.4	95.4	0.05	0.962

Appendix 3. ATT Estimates on Offshore In-sourcing

Variable	one-to-one matching					k-nearest neighbour matching				
	Offshoring		ATT	t-test for mean equivalence		Offshoring		ATT	t-test for mean equivalence	
	Yes	No		t-value	p> t	Yes	No		t-value	p> t
lnTFP2000	2.786	2.741	0.044	0.980	0.330	2.786	2.777	0.009	0.190	0.848
lnTFP2001	2.721	2.692	0.029	0.600	0.547	2.721	2.719	0.002	0.030	0.973
lnTFP2002	2.791	2.741	0.051	0.980	0.328	2.791	2.796	-0.004	-0.080	0.935
lnTFP2003	2.924	2.836	0.088	1.600	0.110	2.924	2.874	0.050	0.910	0.364
lnTFP2004	3.005	2.865	0.140	2.450	0.015	3.005	2.888	0.117	2.070	0.039
lnTFP2005	3.070	2.929	0.141	2.380	0.018	3.070	2.945	0.125	2.160	0.031
Variable	caliper matching					kernel matching				
	Offshoring		ATT	t-test for mean equivalence		Offshoring		ATT	t-test for mean equivalence	
	Yes	No		t-value	p> t	Yes	No		t-value	p> t
lnTFP2000	2.757	2.758	-0.001	-0.010	0.990	2.786	2.762	0.024	0.540	0.589
lnTFP2001	2.695	2.702	-0.006	-0.130	0.895	2.721	2.700	0.022	0.450	0.651
lnTFP2002	2.766	2.764	0.001	0.020	0.982	2.791	2.763	0.028	0.530	0.597
lnTFP2003	2.895	2.844	0.051	0.920	0.356	2.924	2.847	0.077	1.390	0.165
lnTFP2004	2.981	2.875	0.106	1.870	0.062	3.005	2.882	0.123	2.150	0.032
lnTFP2005	3.045	2.934	0.111	1.900	0.058	3.070	2.937	0.133	2.250	0.025

Appendix 4. ATT Estimates on Offshore Outsourcing

Variable	one-to-one matching					k-nearest neighbour matching				
	Offshoring		ATT	t-test for mean equivalence		Offshoring		ATT	t-test for mean equivalence	
	Yes	No		t-value	p> t	Yes	No		t-value	p> t
lnTFP2000	2.575	2.577	-0.002	-0.060	0.951	2.575	2.590	-0.015	-0.390	0.698
lnTFP2001	2.499	2.511	-0.012	-0.300	0.767	2.499	2.513	-0.014	-0.330	0.741
lnTFP2002	2.552	2.532	0.020	0.430	0.666	2.552	2.533	0.018	0.390	0.699
lnTFP2003	2.675	2.673	0.002	0.040	0.968	2.675	2.643	0.032	0.610	0.542
lnTFP2004	2.759	2.740	0.018	0.340	0.733	2.759	2.707	0.052	0.960	0.337
lnTFP2005	2.793	2.786	0.006	0.110	0.915	2.793	2.756	0.037	0.620	0.535
Variable	caliper matching					kernel matching				
	Offshoring		ATT	t-test for mean equivalence		Offshoring		ATT	t-test for mean equivalence	
	Yes	No		t-value	p> t	Yes	No		t-value	p> t
lnTFP2000	2.575	2.589	-0.014	-0.360	0.722	2.575	2.568	0.007	0.170	0.862
lnTFP2001	2.499	2.511	-0.012	-0.290	0.770	2.499	2.502	-0.003	-0.070	0.943
lnTFP2002	2.552	2.532	0.020	0.430	0.669	2.552	2.528	0.024	0.520	0.601
lnTFP2003	2.675	2.641	0.034	0.650	0.513	2.675	2.616	0.060	1.130	0.258
lnTFP2004	2.759	2.704	0.054	1.010	0.315	2.759	2.674	0.084	1.540	0.124
lnTFP2005	2.793	2.753	0.039	0.660	0.509	2.793	2.719	0.074	1.250	0.213