Does Offshoring Pay? Firm-Level Evidence from Japan*

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Abstract

This paper explores the impact of offshoring, or contracting out of business activities to foreign providers, on firm productivity, using Japanese firm-level data for the period 1994-2000. We find that offshoring has generally a positive effect on productivity growth. This effect is robust to controlling for the possible endogeneity of offshoring with respect to unobserved productivity shocks. Our preferred specification suggests that a one percent increase in offshoring intensity raises productivity growth by 0.17 percent. For the average offshoring firm this implies a 1.8 percent increase in annual productivity growth. These results do not appear to depend much on either the level of technological sophistication of a firms' industry or a firms' international orientation. However, we find that the scope for productivity improvements from offshoring depends negatively on the initial level of productivity of the firm.

Keywords: offshoring, international insourcing, domestic sourcing, TFP

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1. Introduction

The rise in offshoring, or contracting out of business activities to foreign providers, has been an important factor behind the growth in world trade (Yeats, 1998; Yi, 2003). East Asia is not an exception to the rise in offshoring: The growing geographical specialization along the value-chain has given rise to the development of sophisticated production sharing arrangements within East Asia (Ng and Yeats, 1999; Fukao, Ishido and Ito, 2003). In particular, Japanese firms have increasingly taken advantage of the business opportunities provided through offshoring of production activities to other East Asian countries (Ando and Kimura, 2005).

Given the importance of these developments, understanding implications of offshoring should be of significant interest to academics and the policy-making community. However, most research so far has concentrated on the potentially adverse labor market aspects of offshoring in developed countries (Feenstra and Hanson, 1996, 1999; Head and Ries, 2002; Hijzen, Görg and Hine, 2005), and much less attention has been directed towards understanding the benefits of the offshoring phenomenon. Possible benefits of offshoring include increased firm profitability, reduced consumer prices and enhanced total factor productivity. In the present paper we focus on the impact of offshoring on total factor productivity. Offshoring may lead to the improvement of the productivity of primary factors of domestic production by allowing firms to specialize in activities they perform relatively well.[1] We focus explicitly on goods offshoring rather than services offshoring which has recently become the centre of the offshoring debate, but does not come close, as of yet, to the importance of goods offshoring (Amiti and Wei, 2006).

[1] Offshoring may also yield important benefits to the economy due to sizeable cost-savings that may translate in either higher firm profits and/or lower consumer prices. However, this aspect of offshoring cannot be examined in the analytical framework of the present paper, as we will later explain.

For our analysis of the impact of offshoring on productivity growth we make use of firm-level data for the Japanese manufacturing sector for the period 1994-2000. One great advantage of our dataset is that it comprises information on the value of subcontracting to foreign providers so that we can construct a direct measure of offshoring. This measure includes both subcontracting at arm's length, which corresponds to 'international outsourcing', and the purchases of intermediate inputs from a firm's foreign affiliates. We refer to this broad notion of offshoring as 'offshoring'. In addition, we have data on the amount of purchases from a firm's foreign subsidiaries, which provides us with a proxy for the extent of international subcontracting within the firm. Following Olsen (2006) we refer to this second measure as 'international insourcing'. By including both measures simultaneously we can infer to what extent the organisational model of offshoring, intra-firm or arm's length, matter. Finally, we also consider the effects of subcontracting to domestic providers, which we refer to as 'domestic sourcing'.

A number of previous studies have analyzed similar issues using industry-level data. For the measurement of offshoring, such studies typically rely on input-output data. Egger and Egger (2006) analyze how international outsourcing affects the productivity of low-skilled workers employed in the EU manufacturing sector. They find that the rise in international outsourcing accounted for 6 percent of the increase in value added per worker during the period 1992-1997. Amiti and Wei (2006) analyze the productivity effects of materials and services offshoring on the productivity of US firms. They find that both materials and services offshoring have a positive effect on firm productivity, but that the positive effect of services offshoring is considerably larger, accounting for about 11 percent of productivity growth during the sample period compared to 5 percent for materials offshoring.

Görg and Hanley (2005) and Görg, Hanley and Strobl (2005) were the first to analyze the impact of offshoring on productivity using firm-level data. The main advantage of using firm-level data is, no doubt, that it allows one to control for firm heterogeneity. Using data for Ireland, they find that both materials and services offshoring benefit firm productivity, but that the benefits only accrue to multinationals and exporters. Criscuolo and Leaver (2005) who focus exclusively on services offshoring also find a positive impact on productivity, using data for the United Kingdom.[2]

To the best of our knowledge, the link between offshoring and productivity has not been explicitly explored in the context of Japan. Kimura (2002) analyzes the relationship between subcontracting and productivity, but does not consider international subcontracting. Tomiura (2005) analyzes the determinants of offshoring decisions. He finds that firms that engage in offshoring tend to be larger and more productive than firms that do not offshore, suggesting that there may be sizable fixed costs associated with offshoring.

To preview our results, we find that offshoring and international insourcing have generally a positive effect on total factor productivity (TFP) growth at the firm level. This effect is robust to controlling for the possible endogeneity of offshoring and international insourcing with respect to unobserved productivity shocks by employing the system generalized method of moments (GMM) estimation developed by Blundell and Bond (1998). The results suggest that a one percent increase in offshoring intensity raises productivity growth by 0.17 percent. For the average offshoring firm this implies, ceteris paribus, an annual TFP growth rate that is 1.8 percent higher than that of non-offshoring firms. The positive effect appears to be associated with both international insourcing and international outsourcing. These results are further fairly general in the sense that the positive relationship between offshoring and productivity growth extends across firms with different levels of technological sophistication or international orientation. However, we find that the scope for productivity improvements from offshoring

[2] See Olsen (2006) for an excellent survey on the productivity impact of offshoring.

depends negatively on the initial level of productivity of the firm, which indicates that offshoring may be an effective channel in restoring the competitiveness of less productive firms.

The remainder of this paper is structured as follows. Section 2 discusses the empirical methodology, whereas Section 3 describes the data and provides some descriptive statistics on offshoring. In Section 4, we discuss the estimation results, and finally, Section 5 concludes.

2. Empirical Methodology

In line with recent production function studies such as Aghion, Blundell, Griffith, Howitt, and Prantl (2004), we adopt a two-step estimation procedure in which we first derive a TFP measure and then estimate the effect of offshoring on the growth of the TFP measure. Compared to a one-step procedure in which we would directly estimate the impact of offshoring on value added growth, the two-step procedure has the advantage that we do not need to use the growth of the capital stock or labor as regressors. Since the capital stock and labor are often highly persistent, the first-differenced log of capital stock and labor may be close to a white noise. Consequently, the estimated coefficients on $\Delta \ln K$ and $\Delta \ln L$ from regression of $\Delta \ln Y$ are often very different from commonly accepted values, 1/3 and 2/3, respectively.

2.1 Measures of total factor productivity

In order to analyze the impact of offshoring on firm-level total factor productivity growth, we start off by defining two measures of total factor productivity (TFP). First, we employ the chained multilateral index of firm-level TFP based on the methodology in Caves, Christensen and Diewert (1982) and Good, Nadiri and Sickles (1996). This index is defined as:

$$\begin{aligned} \ln TFP_{it}^{IN} = {} & \left(\ln Y_{it} - \overline{\ln Y_t}\right) + \sum_{\tau=1}^{t}\left(\overline{\ln Y_\tau} - \overline{\ln Y_{\tau-1}}\right) \\ & - \frac{1}{2}\sum_{J=K,L}\left(s_{iJt} + \overline{s_{Jt}}\right)\left(\ln J_{it} - \overline{\ln J_t}\right) - \sum_{\tau=1}^{t}\frac{1}{2}\sum_{J=K,L}\left(\overline{s_{J\tau}} + \overline{s_{J,\tau-1}}\right)\left(\overline{\ln J_\tau} - \overline{\ln J_{\tau-1}}\right), \end{aligned} \qquad (1)$$

where subscripts i and t represent firm i and year t, respectively. Y refers to value added, K to capital, L to labor, and s_{iJt} is the cost share of factor J for firm i in year t. $\overline{\ln Y_t}$, $\overline{\ln J_t}$, and $\overline{s_{Jt}}$ are the arithmetic means of $\ln Y_{it}$, $\ln J_{it}$, and s_{iJt}, respectively, across all i in the same 2-digit industry in year t. Equation (1) implies that the multilateral TFP index, TFP_{it}^{IN}, measures firm i's TFP level in year t relative to the TFP level of the hypothetical firm in year 0 whose input shares are equal to the arithmetic mean of input shares and whose output and input quantities are equal to the geometric mean of output and input quantities, respectively.

Second, we derive a regression-based measure of firm-level TFP by estimating:

$$\ln TFP_{it}^{BT} = \ln Y_{it} - \hat{\beta}_K \ln K_{it} - \hat{\beta}_L \ln L_{it} \qquad (2)$$

where $\hat{\beta}_K$ and $\hat{\beta}_L$ represent estimated capital and labor elasticity, respectively. We estimate (2) whilst taking account of the potential correlation between factor inputs and the error term. This may be important when contemporaneous unobserved productivity shocks affect the choice of factor inputs. The standard method to account for this is by implementing the procedure proposed by Olley and Pakes (1996) or extensions of the Olley-Pakes procedure such as the one proposed by Levinsohn and Petrin (2003). As R&D activities are considered to be an important determinant of TFP growth in Japan we allow for this feature in our empirical model. Accordingly, we use the method developed by Buettner (2003) that extends the Olley and Pakes procedure to account for the potential correlation between R&D activities and unobserved productivity shocks. See Appendix A for more details on Buettner's (2003) method.

An advantage of the multilateral TFP index given by equation (1) is that we do not need to assume a specific functional form of the production function, while its drawback is that we have to assume perfect competition and constant returns to scale. In contrast, a major benefit of the regression-based TFP measure obtained from Buettner's (2003) method is that we do not need to assume constant returns to scale. Its main shortcoming lies in assuming a Cobb-Douglas production function. Therefore, these two measures of TFP can be viewed as complements, and we will employ both measures to check the robustness of our results with respect to the measurement of TFP.

2.2 Effect of offshoring on TFP growth

Offshoring may affect TFP mainly because it allows firms to benefit from static and dynamic gains from specialization. Consider a developed-country firm which has multiple stages of production process and is more efficient in skill-intensive production stages. Offshoring labor-intensive or less skill-intensive stages allows the firm to make a more efficient use of production factors that remain in employment and thus increase the firms' productivity. Moreover, the gain from specializing in skill-intensive stages of production process may be dynamic, rather than static. Young (1991), for example, suggests, that productivity in more advanced production stages may grow at a higher rate than productivity in less advanced stages, since the potential of improvements in the productivity through learning by doing are likely to be more pronounced in more sophisticated production activities than in more standardised activities which can be offshored. Thus, we would expect that specializing in skill-intensive production stages through offshoring generates higher *growth* in productivity due to larger learning-by-doing effects than in the case of no offshoring.

Based on this argument, we assume that the extent of offshoring has a positive effect on TFP growth of the firm. We assume the following estimable equation for firm-level TFP growth:

$$\Delta \ln A_{it} = \rho \Delta \ln A_{i,t-1} + \beta_O O_{i,t-1} + \beta_D D_{i,t-1} + \beta_R R_{i,t-1} + \delta_i + \alpha_t + \varepsilon_{it} , \qquad (3)$$

where A_{it} is one of the two measures of TFP discussed in the previous subsection, and $\Delta \ln A_{it} \equiv \ln A_{it} - \ln A_{i,t-1}$. The lagged dependent variable, $\Delta \ln A_{i,t-1}$, is included as a regressor to account for the persistence of TFP growth over time.[3] $O_{i,t\text{-}1}$ and $D_{i,t\text{-}1}$ represent the extent of offshoring and domestic sourcing, respectively, for firm i in year t - 1. $R_{i,t\text{-}1}$ is the R&D intensity for firm i, or the ratio of R&D expenditure to value added. In contrast to Görg and Hanley (2005), Görg, Hanley and Strobl (2005), and Amiti and Wei (2006), we explicitly control for the role of the R&D activities in TFP growth. Failing to do so may lead to omitted variable bias, when the decision to offshore and expenditure on R&D are correlated. δ_i and α_t are firm- and time-specific effects, respectively, and ε_{it} is the error term.

More specifically, the offshoring intensity, O, is represented by the ratio of the expenditure on subcontracting of products, parts and components to foreign providers to value added of the firm. We denote this as *Offshoring* that represents the intensity of offshoring in general, including international outsourcing and international insourcing. In addition, we employ a measure of the intensity of international insourcing, a particular type of offshoring, defined as the ratio of purchases from the firm's own foreign subsidiaries to value added. This variable, denoted by *International Insourcing*, is used to examine the effect of offshoring to the firm's own subsidiaries in particular, rather than offshoring in general. By including both measures simultaneously we can infer to what extent the organisational model of offshoring, intra-firm or arm's length, matter. The intensity of domestic sourcing, D, is represented by the ratio of the expenditure on subcontracting of products, parts and components to domestic providers to value added and denoted by *Domestic Sourcing*. The expenditure on international and domestic subcontracting and purchases from firms' own foreign subsidiaries are directly reported by each firm. Table 1 summarizes the definition of the key variables used in the present analysis.

[3] GMM estimation without the lagged TFP growth as a regressor and GMM estimation with the lagged TFP *level* lead to the rejection of the null hypothesis that instruments and the error term are orthogonal according to the Hansen J statistic.

2.3 Estimation method

An econometric concern that needs to be addressed when estimating equation (3) is the endogeneity of regressors. In other words, estimation will be biased if firms decide to engage in offshoring on the basis of any unobserved productivity differences across firms. The direction of the bias is not immediately clear. When there is a fixed cost of offshoring that induces a self-selection process so that only the most productive firms offshore, the coefficient on offshoring will be upward biased. If, on the contrary, low productivity firms engage in defensive offshore in order to boost their competitiveness, the coefficient on offshoring will be downward biased. The same applies to our domestic sourcing and R&D variables.

Therefore, we employ the system GMM estimation developed by Blundell and Bond (1998) to correct for the possible endogeneity of any of our right-hand side variables in equation (3) and to eliminate firm-specific fixed effects. We use as instruments the first and second lags of endogenous regressors for the first-differenced equation and their first first-differenced lags for the level equation. We employ one-step GMM, using robust standard errors.[4]

Before closing this section, we should note several limitations of our empirical framework. First, we only allow the offshoring intensity (as well as the domestic sourcing and the R&D intensity) to shift the iso-product curve, and we do not allow for an effect of offshoring that leads to the rotation of the iso-product curve. In other words, we only focus on Hicks neutral productivity effects and disregard the role of offshoring as channel for skill-biased technological changes as, for example, Feenstra and Hanson (1996) argue. The present empirical model may thus be considered as a short-run model in which factor shares are constant.[5] Second, our empirical specification only captures partial equilibrium effects and disregards general

[4] We also include the full set of industry-year dummies (note that this does not mean industry dummies and year dummies) in equation (3).

[5] This characterization is convenient for the present case as we are interested in the benefits of offshoring to the firm rather than the distributional issues which have preoccupied the lion's share of the existing literature.

equilibrium effects. In the long-run, however, general equilibrium effects are also likely to affect productivity, if, for example, individual offshoring decisions at the firm level are concentrated in certain sectors so as to induce sector-wide technological change.[6] Finally, gains from offshoring discussed here refer exclusively to the increase in the productivity growth of the factors that remain in employment. It should be emphasized that although firms often engage in offshoring to reduce costs through lower input prices, the present methodology employing TFP based on real inputs and output does not capture the cost-saving motive of offshoring.

3. Data Description and Summary Statistics

The data employed in this paper are drawn from *Kigyo Katsudo Kihon Chosa* (Basic Survey of Enterprise Activities), which is conducted annually by the Ministry of Economy, Trade and Industry (METI). This dataset covers all firms with more than 50 employees and 30 million yen of assets in manufacturing, mining and commerce industries. Participation in the survey for those firms is compulsory. The survey was first conducted in 1991, and then annually from 1994 onward. We restrict ourselves to manufacturing firms during the period 1994-2000, since for more recent years no information on domestic or international subcontracting is available.[7]

Figure 1 provides time trends in the measures of offshoring and domestic sourcing. During the period 1994-1999, the average of offshoring intensity (*Offshoring*) rises from 1.2% to 1.8% in terms of value added, whereas the international insourcing intensity (*International Insourcing*) rises from 3.4% to 5.3%. In contrast to the increasing trend in the offshoring and international insourcing intensity, the trend in the domestic sourcing intensity is negative.[8]

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[6] See Kohler (2004) and Hijzen (2006) for more details of such general equilibrium effects.

[7] Data for 2000 are only used to construct the growth rate of TFP, whereas data for the period 1994-1999 contain information on offshoring and domestic sourcing.

[8] However, given the short nature of our panel any inferences regarding the time trend should be taken with caution.

It is worth noting that *International Insourcing* in our dataset is greater on average than *Offshoring*. This may be surprising as in our definitions above international insourcing was represented as a subset of offshoring. The fact that this is not the case in practice reflects differences in the product coverage of both variables. *International Insourcing* includes all intermediate purchases from the firms' foreign subsidiaries, whereas *Offshoring* includes only the value of subcontracted production activities to foreign providers. The former may therefore include the imports of raw material and capital goods which are not excluded from the latter.

Figure 2 represents the offshoring intensity across different industries. It shows significant differences across industries. According to the offshoring measure, the apparel and leather industries appear to be the most active offshoring industries in Japan. Both industries are relatively intensive users of unskilled labor and well-known examples of import offshoring industries. The presence of large foreign-home wage differentials are likely to play an important role in explaining the offshoring decisions in these two industries. These two are followed by the electrical machinery and electronics industry and the medical, precision and optical instruments industry, which on average are high-technology industries but also contain less skill-intensive production processes.

Figure 2 also shows that industries with large offshoring intensity tend to exhibit large international insourcing intensity as well. There are, however, some exceptions. Most notably, the coke and petroleum products industry shows an extremely large *International Insourcing*, while showing an *Offshoring* close to zero. This can be explained by the wider product coverage of our *International Insourcing* measure as compared to our *Offshoring* measure.

We present summary statistics for the regressand and regressors in panel A of Table 2, whereas panel B of the same table distinguishes between firms that offshore and that do not offshore. We are particularly interested in the relationship between offshoring and productivity growth. The descriptive statistics indicate that firms that engage in offshoring or international insourcing exhibit faster productivity growth and larger domestic sourcing and R&D intensity than other firms. In our formal econometric analysis we will now examine whether offshoring in fact leads to faster productivity growth, controlling for other possible factors and unobserved productivity shocks or whether offshoring firms merely do so because they experience higher productivity growth.

4. Results

4.1 Baseline results

Table 3 presents the baseline results on the impact of offshoring on TFP growth. The results in Table 3A are based on estimations using the multilateral index of TFP, whereas results in Table 3B are based on estimations using Buettner's (2003) regression-based measure of TFP. Since the results are virtually identical for both measures of TFP, we will concentrate on the results based on the multilateral TFP index.[9]

Although our benchmark estimation method is the system GMM, as we previously explained, we first look at the results from ordinary least squares (OLS) reported in columns 1-3 of Table 3A for reference. The results in columns 1 and 2 show that offshoring and international insourcing have a positive and significant effect on TFP growth when included separately, but that the effect of offshoring becomes insignificant when the two variables are included together as regressors (column 3). The extent of domestic sourcing and R&D activities shows a significant and positive effect on TFP growth in all of the three specifications. However, these results may be biased when offshoring decisions are taken on the basis of unobserved productivity differences between firms captured by the error term.

[9] The correlation coefficient of the two measures of TFP growth is 0.99.

In order to take account of the possible endogeneity problem associated with the OLS regressions, we re-estimate our model employing the system GMM and report the results in columns 4-6 of Table 3A. In all specifications, the Hansen *J* statistic and the Arrellano-Bond statistic presented in the last two rows suggest that the instruments are orthogonal to the error term and that there is no serial correlation in the error term. The system GMM estimations point at statistically significant effects of offshoring and international insourcing on total factor productivity in all specifications,. Moreover, these effects are larger than the results from the OLS estimations suggesting that the OLS results are downward biased due a positive contemporaneous correlation between offshoring and unobserved productivity shocks and accordingly a negative correlation between offshoring and first-differenced productivity shocks (ε in equation [3]).[10]

More specifically, the GMM results suggest that a 1-percentage point increase in the offshoring intensity raises TFP growth by 0.17 percentage points. Using the mean of the offshoring intensity in Table 2, this result suggests that for the average offshoring firm, which has a mean offshoring intensity of 0.104, average annual TFP growth is 1.8-percentage points higher[11] than had it not engaged in offshoring, everything else equal. Similarly, firms that engage in international insourcing experience, on average, a 1.5 percentage increase in TFP growth than firms that do not engage in international insourcing. Thus, we conclude that the effect of offshoring and international insourcing on TFP growth is quantitatively large and positive.

When we use both of the offshoring intensity and the international insourcing intensity as regressors, we find that both have a positive and significant effect (column 6 of Table 3A). The positive effect of the offshoring intensity even after controlling for the international insourcing

[10] Amiti and Wei (2006) also observe that the effect of offshoring increases once they control for the correlation between offshoring and unobserved productivity shocks.

[11] 0.104 * 0.17 = 0.01768.

intensity implies that international outsourcing, or contracting out of production activities to foreign firms that are not the firm's own foreign subsidiaries, also has a positive impact on TFP growth. In other words, offshoring production activities improves firms' TFP growth regardless of the organisational mode, intra-firm or arm's length, that is adopted.

In addition to the offshoring and international insourcing intensity, the domestic sourcing intensity has a positive and significant impact on TFP growth in all specifications. Since *Offshoring* and *Domestic Sourcing* represent the ratio to value added of purchases of intermediate inputs from foreign and domestic suppliers we can directly compare the effect of offshoring and domestic sourcing by looking at the coefficients of the two variables. Column 6 of Table 3A reports that the coefficient of *Offshoring* is 0.168 whereas the coefficient of *Domestic Sourcing* is 0.040. These results indicate that contracting out a particular production process to foreign suppliers leads to a fourfold improvement in TFP growth compared to the case when contracting out the same production process to domestic suppliers.[12]

4.2 Differences in the size of the effect of offshoring across firms

So far, we have estimated the effect of offshoring on TFP growth, ignoring the possible variation in its size across firms. However, the size of the effect of offshoring may be expected to differ for a number of reasons. First, the offshoring effect may vary across industries. Firms in high-technology industries that engage in offshoring may be able to specialize in highly sophisticated production stages that involve substantial learning-by-doing effects. However, for offshoring firms in low-technology industries the potential of such learning effects may be more limited since their specialized production stages are not as sophisticated as in high-technology

[12] However, since offshoring firms are likely to incur larger initial search costs to select providers than firms that source domestically, this evidence does not necessarily suggest a larger net benefit from offshoring than that from domestic sourcing. However, this evidence does suggest that the net benefit from offshoring may be larger than that from domestic sourcing for firms with low search costs of offshoring.

industries. If this is the case, we would expect to observe a larger offshoring effect on TFP growth in high-technology industries than in low-technology industries.

Second, Görg, Hanley and Strobl (2005) suggest that the benefits from offshoring may vary in the level of the search costs of selecting foreign suppliers. Görg, Hanley and Strobl (2005) therefore split the sample between multinationals and domestic firms, and exporters and non-exporters, based on the conjecture that experience in foreign markets may lower the search costs for foreign suppliers. The results by Görg, Hanley and Strobl (2005) confirm their predictions.

Third, the benefits from offshoring may depend on a firms' current productivity level. For firms that have already achieved a high productivity level, the benefits from offshoring may be smaller since the opportunity for further productivity growth is likely to be small.

To see whether the benefits from offshoring differ across different types of firm, we split the sample to two sub-samples in the following three ways and report the mean of key variables for those subsamples in Table 4: firms in high- and low-technology industries[13]; multinational and local firms; and exporting and non-exporting firms. In Table 4, we do not observe any major differences in terms of their offshoring or international insourcing intensity between high- and low-tech industries, or between exporters and non-exporters. However, we do observe, perhaps not surprisingly, that multinationals are more important offshorers than purely domestic firms. Multinationals, after all, have access to an international production work which may be destined, or at the very least, may be expected to facilitate offshoring arrangements.

To formally examine how the size of the effect of offshoring on productivity depends on industry- and firm-characteristics, we augment equation (3) with an interaction term between the offshoring measure and a dummy variable for certain industry- and firm-characteristics. First,

[13] High-technology industries are defined as the following 5 industries: chemicals, machinery and equipment, electrical machinery and electronics, transportation equipment, and precision instruments. Low-technology industries are all other industries.

we use a dummy variable which is one for firms in high-technology industries and zero otherwise. The GMM results reported in columns 1 and 2 of Table 5 indicate that the effect of either interaction term between the dummy variable and *Offshoring* or *International Insourcing* is not statistically significant at conventional levels.[14] These results are inconsistent with the conjecture put forward above. The effect of offshoring in low-technology industries is as large as the effect of offshoring in high-technology industries. This suggests that learning effects do not depend on the level of technological sophistication of one's industry.

Second, we estimate whether the effect of offshoring differs between multinational and domestic firms and between exporting and non-exporting firms using interaction dummies for multinational firms and for exporting firms. The GMM results presented in columns 3-6 of Table 5 show that the coefficients on the interaction terms are insignificant. At first sight, these results seem to inconsistent with the hypothesis and the empirical results presented by Görg et al. (2005) that multinationals and exporters benefit more from offshoring than other firms. However, we should note that Görg et al. (2005) find a larger effect of offshoring on the *level* of productivity for multinationals and exporters, while here we focus on the effect of offshoring on productivity *growth*. Thus, the disparity between the results of the present study and those by Görg et al. (2005) suggests that the advantage of multinationals and exporters due to lower search costs of selecting suitable foreign suppliers is static, rather than dynamic. In other words, lower search costs for multinationals and exporters benefit those firms only one time when they start offshoring, but the benefit vanishes in later years.

Finally, in order to examine how the firm's current productivity level affects the impact of offshoring, we interact the offshoring variables with the lagged TFP level and include the resulting interaction term as an additional regressor. The GMM results reported in columns 7-8

[14] The result in column 1 of Table 6 indicates that the effect of *Offshoring* is insignificant. This result is probably generated by multicollinearity between *Offshoring* and the interaction term between *Offshoring* and the dummy variable for high-tech industries. The correlation coefficient of the two variables is 0.77.

of Table 5 indicate that including the interaction terms does not greatly affect the estimates for the offshoring and international insourcing intensity. However, we find that the interaction term has a negative and significant effect in the two specifications. This evidence indicates that firms with a lower level of TFP benefit more from offshoring than firms with a higher TFP level probably due to latecomers' advantage, being consistent with our presumption above.[15] Thus, offshoring appears to provide an effective strategy for less productive firms to catch up with their competitors.

5. Concluding Remarks

In the present paper, we explore the impact of offshoring on firm productivity growth, using firm-level data for the Japanese manufacturing industries during the period 1994-2000. We find that offshoring has generally a positive effect on productivity growth. This effect is robust to controlling for the possible endogeneity of offshoring with respect to unobserved productivity shocks. We further find that the size of the effect of offshoring does not vary between firms in high- and low-technology industries, between multinationals and domestic firms, or between exporting and non-exporting firms. This evidence suggests that offshoring has a positive impact on productivity growth for a wide range of firms. Finally, the impact of offshoring is found to depend negatively on the productivity level of the firm, indicating that offshoring provides an effective channel to restore competitiveness for less productive firms.

Although our findings shed some light on the offshoring literature, we should note that our results need to be interpreted with care. First, the cost-saving effect cannot be examined in the framework of our analysis using TFP based on real output and inputs. Second, our analysis is based on a production function and thus disregards general-equilibrium effects. Therefore, the

[15] The interaction term between the lagged TFP level and the domestic sourcing intensity has also a negative and significant effect, indicating that latecomers' advantage can be applied to domestic sourcing.

results of the present paper should be interpreted at the level of the individual firm and cannot be straightforwardly be used to make inferences about the total effect of offshoring on the Japanese economy.

Appendix A: Buettner's (2003) Method for Productivity Measurement

Buettner (2003) incorporates R&D investment into the method of Olley and Pakes (1996) for productivity measurement and presents several alternative methods. In what follows, we explain a particular type of those methods that assumes no exit of firms (type "k" in his notation), which is adopted in this paper.

We begin with the following Cobb-Douglas production function for firm i at time t:

$$y_{it} = \beta_0 + \beta_K k_{it} + \beta_L l_{it} + \omega_{it} + \eta_{it}, \tag{A1}$$

where $x \equiv \ln X$ for any variable X, Y_{it}, K_{it}, and L_{it} are value added, capital stocks, and labor of firm i at time t, respectively. ω_{it} represents the productivity level, and η_{it} a productivity shock. It is assumed that the distribution of ω_{it} is governed by a single parameter, ψ_{it}. At the beginning of time t + 1, firm i observes k_{it} and ω_{it} and chooses $k_{i,t+1}$ and $\psi_{i,t+1}$. This choice requires R&D expenditure of $REX_{i,t+1} = REX(\psi_{i,t+1}, \omega_{it})$, where $\partial REX / \partial \psi > 0$ and $\partial REX / \partial \omega < 0$. In other words, the distribution of the productivity in the next period is a function of the current productivity level and the current R&D investment.[16]

Given these assumptions, firm i's optimal choice of investment at time t, I_{it}, depends on the current productivity level ω_{it} and the current capital stock k_{it}: $i_{it} = i_t(\omega_{it}, k_{it})$. We invert this equation to obtain ω_{it} as a function of i_{it} and k_{it}. Then, the production function (A1) can be rewritten as

$$y_{it} = \beta_L l_{it} + \phi_{it}(i_{it}, k_{it}) + \eta_{it}$$

where $\phi_{it} = \beta_0 + \beta_K k_{it} + \omega_{it}$. Semi-parametric estimation of this equation by OLS assuming that ϕ_{it} is a polynomial series expansion of the arguments leads to a consistent estimation of β_L.

To estimate β_K in the second stage, we first rearrange equation (A1) as

[16] In the Olley-Pakes method, $\psi_{i,t+1}$ equals ω_{it} and does not depend on R&D investment.

$$y_{it} - \beta_L l_{it} = \beta_0 + \beta_K k_{it} + \omega_{it} + \eta_{it} \,. \tag{A2}$$

We assume a Markov process in ω: $\omega_{it} = E[\omega_{it} | \psi_{it}] + \xi_{it} + \eta_{it}$, where ξ_{it} is productivity innovation and unrelated with k_{it}. Thus, equation (A2) can be rewritten as

$$y_{it} - \beta_L l_{it} = \beta_0 + \beta_K k_{it} + E[\omega_{it} | \psi_{it}] + \xi_{it} + \eta_{it} \,. \tag{A3}$$

The optimal choice of the distribution parameter $\psi_{i,t+1}$ can be written as a function of ω_{it} and $k_{i,t+1}$:

$$\psi_{i,t+1} = \overline{\psi}(\omega_{it}, k_{i,t+1}) \,. \tag{A4}$$

Combining equations (A3) and (A4), we obtain

$$y_{it} - \beta_L l_{it} = \beta_0 + \beta_K k_{it} + g(\overline{\psi}_{it}(\omega_{i,t-1}, k_{it})) + \xi_{it} + \eta_{it} \,. \tag{A5}$$

Since we have $\omega_{i,t-1} = \phi_{i,t-1} - \beta_0 - \beta_K k_{i,t-1}$, we further rewrite the first three terms of the right-hand side of equation (A5) as a nonlinear function of $\phi_{i,t-1} - \beta_K k_{i,t-1}$ and k_{it}:

$$y_{it} - \beta_L l_{it} = f(\phi_{i,t-1} - \beta_K k_{i,t-1}, k_{it}) + \xi_{it} + \eta_{it} \,. \tag{A5}$$

We estimate equation (A5) by nonlinear least squares, approximating function f by a polynomial series expansion, to obtain a consistent estimate of β_K.

Given the consistent estimates of β_K and β_L, we measure the log of the TFP level of firm i at time t as $y_{it} - \beta_L l_{it} - \beta_K k_{it}$.

Appendix B: Construction of Variables

This appendix provides supplementary information on the construction of our dataset.[17] To construct data employed in the present analysis, we use firm-level data from *Kigyo Katsudo Kihon Chosa* (KKKC, Basic Survey of Enterprise Activities) and industry-level data from the Japan Industry Productivity (JIP) Database 2006. The JIP Database 2006 is constructed by the Firm- and Industry-Level Productivity Research Group organized in the Research Institute of Economy, Trade and Industry (RIETI) of Japan and headed by Kyoji Fukao and Tsutomu Miyagawa. The JIP Database 2006 includes various data during the period 1970-2002 at the 3-digit industry level, including price deflators of output, intermediate inputs, and capital goods and input-output matrices. The complete database is available at the web site of RIETI (http://www.rieti.go.jp).

Real sales is defined as nominal total sales reported in KKKC deflated by the output deflator at the 3-digit level taken from the JIP Database. The nominal value of intermediate inputs is defined as the sum of costs of goods sold and general and administrative expense minus labor costs and the value of depreciation. The nominal value of intermediate inputs is deflated by the intermediate-goods deflator also taken from the JIP Database to obtain the real value of intermediate inputs. Real value added is defined as real sales less the real value of intermediate inputs.

Firms' real capital stock represents the real value of the stock of tangible fixed assets *excluding* land, since the book value of land may not reflect the true value of the land, in particular if the land was purchased long time ago. However, the value of land owned by each firm is available only in the KKKC data for 1995 and 1996, although information on the total

[17] When importing raw datasets, we heavily relied on Stata programs written by Toshiyuki Matsuura for Matsuura (2004).

value of tangible fixed assets *including* land is available for all years. Therefore, we estimate the nominal value of tangible fixed assets excluding land of firm i in industry j in year t, $NomK_{ijt}$, by multiplying the firm's total tangible assets including land by one minus industry j's average share of the land value in the total tangible fixed assets in 1995 and 1996. Then, we derive the real capital stock of firm i in industry j in year t, K_{ijt}, from $NomK_{ijt}$, using the industry total of nominal tangible fixed assets excluding land, $NomK_{jt} = \sum_{i \in j} NomK_{ijt}$, and the estimated real value of the corresponding variable, K_{jt}, taken from the JIP Database: $K_{ijt} = NomK_{ijt} \times K_{jt} / NomK_{jt}$. K_{jt}, is obtained by the perpetual inventory method, using industry-level data on fixed capital formation during the period 1975-2000 and industry-level data on fixed assets in 1975.

Labor inputs are measured in the man-hour base. Since information on working hours for each firm is not available in KKKC, we use the industry average of working hours taken from the JIP Database. R&D expenditure of each parent firm is deflated by the industry price deflator of intermediate inputs.

We limit our sample to firms whose TFP level, R&D expenditure, the measure of offshoring, and the measure of domestic sourcing are available for at least five consecutive years during the seven-year period 1994-2000. Then, to alleviate biases due to outliners, we drop firms whose R&D, offshoring, or domestic sourcing intensity is among the top 1 percent.

References

Aghion, P., R. Blundell, R. Griffith, P. Howitt, and S. Prantl (2004), "Entry and Productivity Growth: Evidence from Microlevel Panel Data," *Journal of European Economic Association*, Vol. 2, Iss. 2-3, 265–376.

Amiti, M. and S. Wei (2006), "Services Offshoring and Productivity: Evidence from the United States," NBER Working Paper, No. 11926.

Blundell, R., and S. Bond (1998), "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models," *Journal of Econometrics*, Vol. 87, Iss. 1, pp. 115–143.

Branstetter, L. (2001), "Are knowledge spillovers international or intranational in scope? Microeconometric evidence from the U.S. and Japan," *Journal of International Economics* Vol. 53, pp. 53–79.

Buettner, T. (2003), "R&D and the Dynamics of Productivity," unpublished, London School of Economics.

Caves, D. W., L. R. Christensen, and E. W. Diewert (1982), "Multilateral Comparisons of Output, Input, and Productivity Using Superlative Index Numbers," *Economic Journal*, Vol. 92, Iss. 365, pp. 73–86.

Criscuolo, C. and M. Leaver (2005), "Offshore Outsourcing and Productivity," presented at OECD Conference on Globalisation of Production, 14-15 November 2005.

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

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

Feenstra, R. C. and G. H. Hanson (1999), "The Impact of Outsourcing and High-Technology Capital on Wages: Estimates for the United States, 1979-1990," *Quarterly Journal of Economics*, Vol. 114, Iss. 3, pp. 907-941.

Fukao, K., H. Ishido, and K. Ito (2003), "Vertical Intra-Industry Trade and Foreign Direct Investment in East Asia," *Journal of the Japanese and International Economies*, Vol. 17, Iss. 4, pp. 468-506.

Good, D. H., M. I. Nadiri, and R. C. Sickles (1996), "Index Number and Factor Demand Approaches to the Estimation of Productivity," NBER Working Paper, No. 5790.

Görg, H. and A. Hanley (2005),"International Outsourcing and Productivity: Evidence from the Irish electronics Industry," *North American Journal of Economics and Finance*, Vol. 16, Iss. 2, pp. 255-269.

Görg, H., A. Hanley and E. Strobl (2005),"Productivity effects of international outsourcing: Evidence from plant level data", mimeo, University of Nottingham.

Head, K. and J. Ries (2002), "Offshore Production and Skill Upgrading by Japanese Manufacturing Firms," *Journal of International Economics*, Vol. 58, No. 1, pp. 81-105.

Hijzen, A. (2006), "International Outsourcing, Technological Change and Wage Inequality," *Review of International Economics*, forthcoming.

Hijzen, A., H. Görg, and R. C. Hine (2005), "International outsourcing and the skill structure of labor demand in the United Kingdom," *Economic Journal*, Vol. 115, pp. 860-878.

Jaffe, A. B., M. Trajtenberg, and R. Henderson (1993), Geographic localization of knowledge spillovers as evidenced by patent citations, *Quarterly Journal of Economics*, Vol. 108, Iss. 3, pp. 577–598.

Kimura, F. (2002), "Subcontracting and the Performance of Small and Medium Firms in Japan," *Small Business Economics*, Vol. 18, Iss. 1-3, pp. 163-175.

Kimura, F. and M. Ando (2005), "Two-Dimensional Fragmentation in East Asia: Conceptual Framework and Empirics," *International Review of Economics and Finance*, Vol. 14, Iss. 3, pp. 317-348.

Kohler, W. (2004), "International Outsourcing and Factor Prices with Multistage Production," *Economic Journal*, forthcoming.

Levinsohn, J. and A. Petrin (2003), "Estimating Production Functions Using Inputs to Control for Unobservables," *Review of Economic Studies*, Vol. 70, Iss. 2, pp. 317-341.

Matsuura, Toshiyuki, 2004, Estimation of economic activity of Japanese multinationals, *Keizai Toukei Kenkyu*, Vol. 32, pp. 1–16.

Ng, F. and A. Yeats (1999), "Production Sharing in East Asia: Who Does What for Whom and Why?," World Bank Working Paper, No. 2197.

Olley, S. G. and A. Pakes (1996), "The Dynamics of Productivity in the Telecommunications Equipment Industry," *Econometrica*, Vol. 64. Iss. 6, pp. 1263-1297.

Olsen, K. B. (2006), "Productivity Impacts of Offshoring and Outsourcing: A Review," OECD Science, Technology and Industry Working Papers, 2006/1.

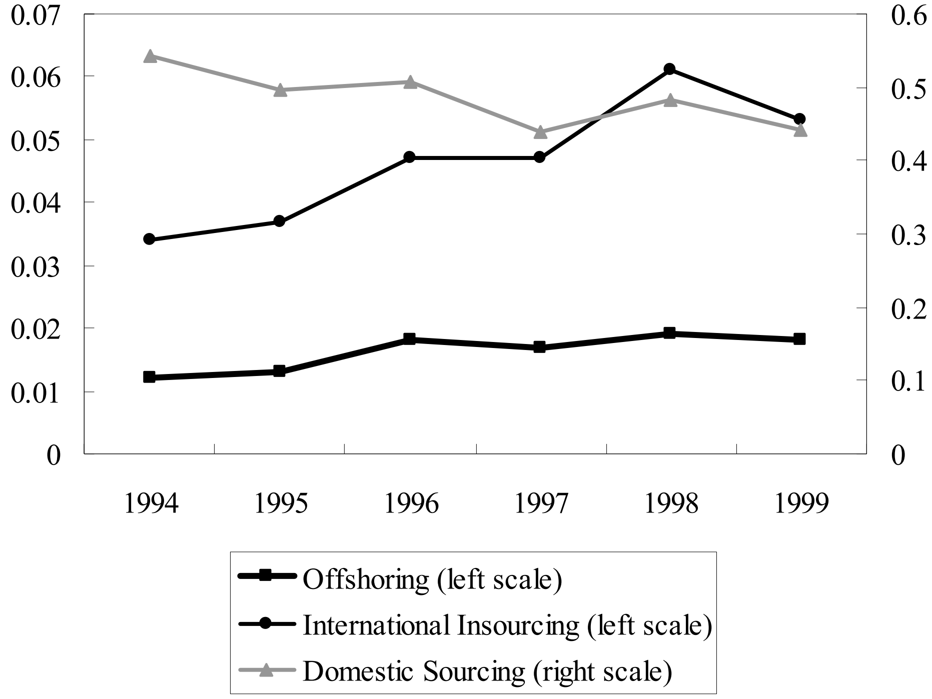
Tomiura, E. (2005), "Foreign Outsourcing and Firm-Level Characteristics: Evidence from Japanese Manufacturers," *Journal of the Japanese and International Economies*, Vol. 19, Iss. 2, pp. 255-271.

Yeats, A. J. (1998), "Just How Big Is Global Production Sharing?," Policy Research Working Paper, No. 1871, World Bank.

Yi, K.-M. (2003), "Can Vertical Specialization Explain the Growth of World Trade?" *Journal of Political Economy*, Vol. 111, Iss. 1, pp. 52-102.

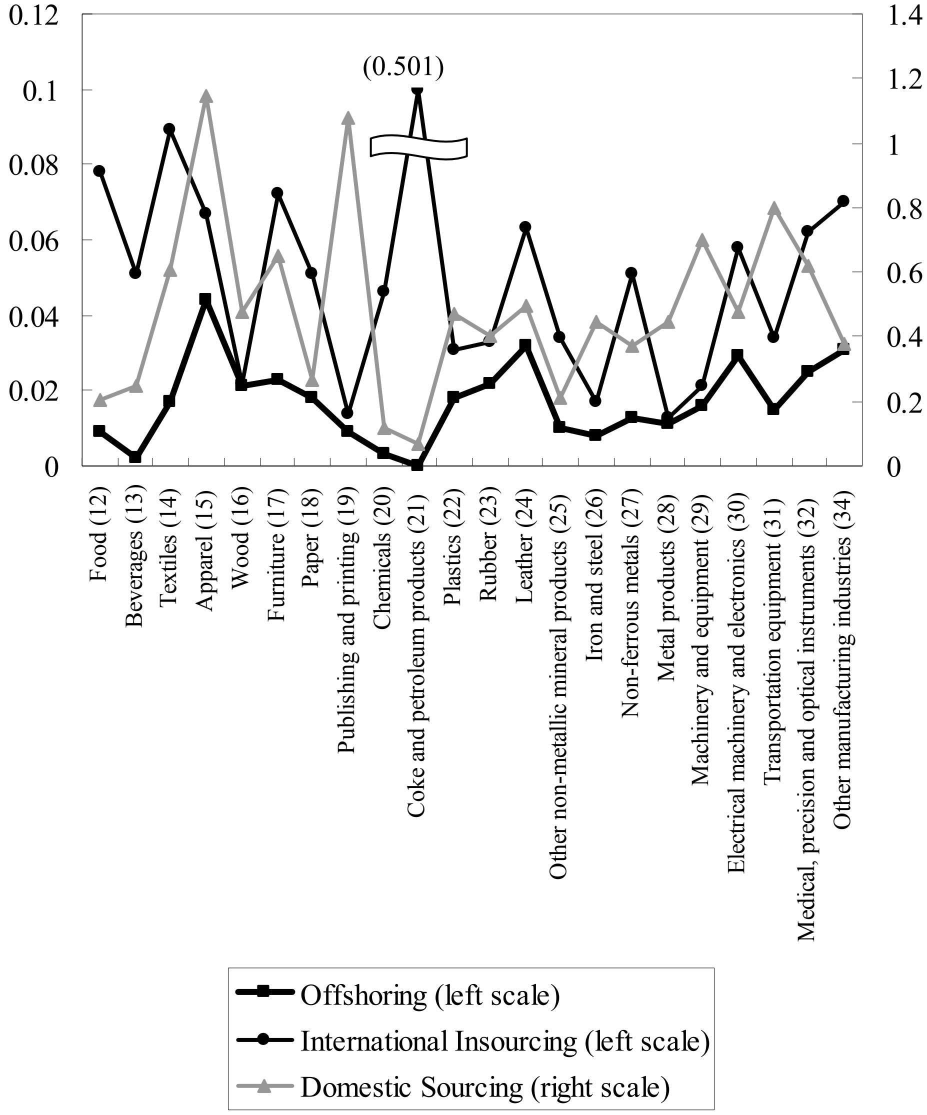
Young, A. (1991), "Learning by Doing and the Dynamic Effects of International Trade," *Quarterly Journal of Economics*, Vol. 106, Iss. 2, pp. 369-405.

Figure 1. Extent of International and Domestic sourcing by Year



Notes: This figure presents the average of the key variables in our sample by year. See Table 1 for the definition of these variables.

Figure 2. Extent of International and Domestic sourcing by Industry



Notes: This figure presents the average of the key variables in our sample by industry. Numbers in parentheses on the horizontal axis indicate 2-digit industry classifications. See Table 1 for the definition of these variables.

Table 1. List of Key Variables

Variable name	Definition
Offshoring	Ratio of the value of subcontracting to foreign providers to value added
International Insourcing	Ratio of purchases from the firm's own foreign subsidiaries to value added
Domestic Sourcing	Ratio of the value of subcontracting to domestic providers to value added
R&D	Ratio of R&D expenditure to value added

Table 2. Summary Statistics

A: Whole Sample

Variable	Mean	Standard deviation	Minimum	Maximum
$\Delta\ln TFP^{IN}$	0.014	0.325	-4.705	3.034
$\Delta\ln TFP^{BT}$	0.011	0.324	-4.705	3.028
Offshoring	0.017	0.070	0.000	0.844
International Insourcing	0.049	0.235	0.000	11.974
Domestic Sourcing	0.473	0.665	0.000	5.218
R&D	0.075	0.093	0.000	0.631

B: Offshoring versus Non-Offshoring Firms

Subsamples	*Offshoring* > 0	*Offshoring* = 0	*International Insourcing* > 0	*International Insourcing* = 0
No. of observations	2052	10512	3590	8974
$\Delta\ln TFP^{IN}$	0.021	0.013	0.024	0.010
$\Delta\ln TFP^{BT}$	0.018	0.011	0.022	0.007
Offshoring	0.104	0.000	0.033	0.011
International Insourcing	0.068	0.045	0.171	0.000
Domestic Sourcing	0.937	0.382	0.552	0.441
R&D	0.089	0.072	0.094	0.067

Notes: See Table 1 for the definition of the variables used.

Table 3. Baseline Results

A: Using the multilateral TFP index (TFP^{IN})

	Dependent variable: Δln*TFP*					
	(1)	(2)	(3)	(4)	(5)	(6)
Estimation method	OLS	OLS	OLS	GMM	GMM	GMM
Offshoring	0.070		0.050	0.173		0.168
	(0.032)*		(0.032)	(0.090)$^{+}$		(0.091)+
International Insourcing		0.053	0.051		0.090	0.087
		(0.009)**	(0.010)**		(0.019)**	(0.019)**
Domestic Sourcing	0.008	0.009	0.008	0.041	0.042	0.040
	(0.004)*	(0.004)*	(0.004)*	(0.016)*	(0.016)**	(0.016)*
R&D	0.156	0.154	0.154	0.158	0.156	0.165
	(0.026)**	(0.026)**	(0.026)**	(0.094)$^{+}$	(0.093)$^{+}$	(0.094)+
Lagged Δln*TFP*	-0.226	-0.224	-0.224	-0.135	-0.134	-0.133
	(0.009)**	(0.009)**	(0.009)**	(0.020)**	(0.020)**	(0.020)**
No. of obs.	12564	12564	12564	12564	12564	12564
R^2	0.47	0.48	0.48			
Hansen *J* statistic				0.98	1.00	1.00
Arrellano-Bond statistic				0.25	0.24	0.27

B: Using Buettner's (2003) TFP measure (TFP^{BT})

	Dependent variable: Δln*TFP*					
	(1)	(2)	(3)	(4)	(5)	(6)
Estimation method	OLS	OLS	OLS	GMM	GMM	GMM
Offshoring	0.073		0.054	0.173		0.168
	(0.032)*		(0.032)+	(0.089)+		(0.090)+
International Insourcing		0.052	0.051		0.087	0.084
		(0.009)**	(0.009)**		(0.019)**	(0.019)**
Domestic Sourcing	0.009	0.010	0.009	0.041	0.042	0.040
	(0.004)*	(0.004)**	(0.004)*	(0.016)**	(0.016)**	(0.016)*
R&D	0.146	0.145	0.144	0.140	0.137	0.146
	(0.026)**	(0.026)**	(0.026)**	(0.094)	(0.094)	(0.094)
Lagged Δln*TFP*	-0.222	-0.220	-0.220	-0.134	-0.133	-0.132
	(0.009)**	(0.009)**	(0.009)**	(0.019)**	(0.019)**	(0.019)**
No. of obs.	12564	12564	12564	12564	12564	12564
R^2	0.48	0.48	0.48			
Hansen *J* statistic				1.00	1.00	1.00
Arrellano-Bond statistic				0.22	0.21	0.24

Notes: See Table 1 for the definition of the variables used. Standard errors are in parentheses. +, *, and ** denote statistical significance at the 10, 5, and 1 percent levels, respectively. All specifications include industry-year dummies. *P* values are reported for Hansen *J* statistics and the Arellano-Bond statistics for second-order serial correlation.

Table 4. Means of Variables for Various Subsamples

Subsamples	Hi-tech industries	Low-tech industries	Multinational firms	Local firms	Exporters	Non-exporters
No. of observations	7671	4893	5495	7069	9915	2649
$\Delta\ln TFP^{IN}$	0.021	0.003	0.020	0.010	0.016	0.008
$\Delta\ln TFP^{BT}$	0.017	0.001	0.018	0.006	0.013	0.006
Offshoring	0.018	0.016	0.025	0.011	0.017	0.016
International Insourcing	0.044	0.056	0.075	0.028	0.046	0.059
Domestic Sourcing	0.509	0.415	0.559	0.405	0.485	0.425
R&D	0.095	0.044	0.094	0.060	0.082	0.047

Notes: See Table 1 for the description of the variables used. High-technology industries are defined as the following five industries: chemicals, machinery and equipment, electrical machinery and electronics, transportation equipment, and precision instruments. Low-technology industries are all other industries. Multinational firms are defined as firms with any positive balance in foreign investment.

Table 5. Effect of Interaction Terms between Offshoring Measures and Variables Representing Industry- and Firm-Characteristics

	Dependent variable: $\Delta \ln TFP^{IN}$							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Estimation method	GMM	GMM	GMM	GMM	GMM	GMM	GMM	GMM
X (interacted variable)	Dummy for firms in high-tech industries		Dummy for multinational firms		Dummy for exporting firms		lagged ln*TFP*	
Offshoring	0.137		0.264		0.157		0.220	
	(0.140)		(0.127)*		(0.156)		(0.069)**	
*Offshoring * X*	0.067		-0.177		0.004		-0.316	
	(0.187)		(0.159)		(0.171)		(0.143)**	
International Insourcing		0.085		0.087		0.088		0.114
		(0.019)**		(0.019)**		(0.019)**		(0.018)**
*International Insourcing * X*		0.186		0.041		0.149		0.037
		(0.125)		(0.115)		(0.099)		(0.027)
Domestic Sourcing	0.040	0.040	0.041	0.041	0.041	0.041	0.033	0.033
	(0.016)*	(0.016)*	(0.016)*	(0.016)*	(0.016)*	(0.016)*	(0.011)**	(0.011)**
*Domestic Sourcing * X*							-0.128	-0.132
							(0.016)**	(0.016)**
R&D	0.153	0.158	0.149	0.152	0.157	0.158	0.148	0.192
	(0.094)	(0.094)+	(0.095)	(0.094)	(0.094)+	(0.094)+	(0.094)	(0.092)*
Lagged $\Delta \ln TFP$	-0.135	-0.134	-0.135	-0.134	-0.135	-0.134	-0.129	-0.099
	(0.020)**	(0.020)**	(0.020)**	(0.020)**	(0.020)**	(0.020)**	(0.020)**	(0.019)**
No. of observations	12564	12564	12564	12564	12564	12564	12564	12564
Hansen *J* statistic	0.96	1.00	1.00	1.00	0.98	1.00	0.99	1.00
Arrellano-Bond statistic	0.26	0.26	0.26	0.25	0.25	0.26	0.09	0.14

Notes: See Table 1 for the definition of the variables used. Standard errors are in parentheses. $^{+}$, *, and ** denote statistical significance at the 10, 5, and 1 percent levels, respectively. All specifications include the interacted variable *X* and industry-year dummies. *P* values are reported for Hansen *J* statistics and the Arellano-Bond statistics for second-order serial correlation.