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Does Material and Service Offshoring Improve Domestic Productivity? Evidence from Japanese manufacturing industries

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Abstract

An increasing number of manufacturers are shifting some stages of the production process offshore. This study investigates the effects of offshoring on productivity in Japanese manufacturing industries for the period 1988-2004. Material offshoring, as measured by an import share of intermediate material inputs, has steadily increased during the period, with a pronounced increase in offshoring to Asian countries. In a wide range of specifications, we find significantly positive correlations between material offshoring and productivity at the industry level. The estimates are particularly robust for offshoring to Asia. These results suggest that Japanese manufacturing firms have developed an extensive international division of labor in East Asia, which in turn may have enhanced domestic productivity. In contrast, service offshoring, as measured by an import ratio of service inputs, is not associated with industry-level productivity. We find a positive correlation between offshoring and productivity only for information services, suggesting that in this segment, offshoring offers potential benefits.

Key words: Offshoring, productivity, Japan, manufacturing, services.
JEL classification: F10, F14, F23

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1. Introduction

Relocating business activities abroad, or "offshoring," has become one of the most important issues in international economics in recent years.[1] Advances in technology have reduced transportation costs significantly, which has contributed to the international fragmentation of the value-added chain. The production of individual commodities within an industry is divided into ever smaller production processes, some of which are then relocated to low-wage foreign countries so as to minimize total production costs. Such international fragmentation has brought about a substantial increase in offshoring of intermediate inputs in many regions around the world. Moreover, the development of information technology (IT) means that many services that were traditionally non-tradable have become tradable. Particularly in the United States and other English-speaking developed countries, offshoring of services has become increasingly important.

Triggered by the rise in offshoring, there has been growing interest in many developed countries in its impact on factor demand and productivity at home. In the case of offshoring of intermediate material inputs (hereafter, "material offshoring"), production processes requiring low-skilled human capital tend to be relocated to low-wage foreign countries, which potentially affects the wages and employment levels of low-skilled workers at home. On the other hand, in the case of service offshoring, a growing range of activities is relocated abroad, including even tasks requiring high-skilled human capital. The potential negative impact of offshoring on wages and employment in jobs that are more likely to be offshored is probably the main reason why much of the research on offshoring has focused on labor market issues.[2]

However, offshoring may have long-term economic benefits for domestic industries through factor-cost reductions and productivity gains. If offshoring enables firms to lower costs by relocating abroad, production processes in which they are relatively inefficient, this allows them to specialize in processes where they have a comparative advantage, or to engage in new business activities. Moreover, the productivity-enhancing effect of offshoring may not be limited to incumbent firms. Offshoring may increase productivity at a more aggregate level if it leads to the exit of inefficient firms and the creation of new firms (Antràs et al., 2005). While these issues are critical to understand the impact of

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[1] Following Olsen (2006), we use the term "offshoring" to refer to the relocation of jobs and processes to a foreign country without distinguishing whether the provider is external or affiliated with the firm. Strictly speaking, the relocation of business activities to unaffiliated foreign firms is typically referred to as "international outsourcing," while that to affiliated foreign firms is called "international insourcing," but there is a growing number of studies that simply use the term "offshoring" to refer to both international outsourcing and international insourcing.

[2] There is a substantial body of empirical research that has explored the impact of offshoring on labor demand at home. Most of the research confirms that offshoring has a skill-upgrading effect: the relative demand for unskilled labor decreases and the relative demand for skilled labor increases when unskilled-labor intensive tasks are outsourced to unskilled-labor abundant countries. Such studies exist for the United States (Feenstra and Hanson 1999), the United Kingdom (Hijzen et al., 2005), France (Strauss-Kahn 2004), Sweden (Ekholm and Hakkala 2006), Japan (Head and Ries 2002, Ito and Fukao 2005, Ahn et al., 2008), and other countries.

offshoring activities, it is an empirical question of whether the offshoring activity can generate productivity gains for domestic industries.

Although there is a growing number of studies empirically examining the productivity effects of offshoring either at the firm or the industry level, the statistical evidence so far that offshoring indeed enhances productivity is still weak.[3] This is especially the case for service offshoring. Amiti and Wei (2006, 2009), estimating the effects of both service offshoring and material offshoring on productivity using industry-level data for the U.S. manufacturing sector, find that offshoring has a significant positive effect on productivity and that the magnitude is much larger for service offshoring than for material offshoring. In contrast, other empirical studies applying the Amiti and Wei-type industry-level analysis for Italy and Korea do not find any productivity-enhancing effects of service offshoring (Daveri and Jona-Lasinio 2008, Lin and Ma 2008). Moreover, there have been few firm- or plant-level studies finding evidence of a productivity-enhancing effect of service offshoring, with a notable exception being the study by Görg et al. (2008) for the case of Irish manufacturing.[4]

In this study, we investigate a relationship between offshoring and domestic productivity, employing industry-level panel data for Japanese manufacturing for the period 1988–2004. The Japanese manufacturing sector is an interesting case because Japanese firms have been playing an important role in the fragmentation of production in East Asia since the 1980s. The rapid expansion of international division of labor is expected to have some impact on domestic productivity. Furthermore, studying the case of Japan should help us understand the nature of service offshoring and its impact on productivity. It is sometimes claimed that business practices in Japanese firms are different from those in U.S. firms. Therefore, the productivity-enhancing effect of service offshoring confirmed by Amiti and Wei (2006, 2009) for U.S. manufacturing may not be found in the case of Japan because of the different business practice. In this respect, the case of Japanese manufacturing possibly provides an interesting implication for factors, which play a role in determining the productivity effects of offshoring.

This study also examines whether the effects of offshoring on productivity depend on the region, to which activities are outsourced and whether the effects depend on the type of service tasks offshored. By doing so, we try to provide clues to understanding determinants of the productivity effects of offshoring, which have not yet been sufficiently investigated in previous studies.

In order to make our analysis comparable to previous studies, we follow the empirical methodology of Amiti and Wei (2006, 2009). We find that Japan's material offshoring to Asia has been increasing drastically, which is consistent with the widely described fact that there has been a

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[3] See Olsen (2006) for a survey on the productivity impact of offshoring. Section 2 of this paper also provides an updated survey on this issue.

[4] Ito et al. (2008) also find that offshoring of tasks for production of intermediate goods and final assembly, as well as the offshoring of tasks for R&D and information services, positively affects firm-level productivity growth. However, their analysis is based on the information on whether or not the firm carries out offshoring, and the information on the amount of offshoring is not available.

significant increase in the fragmentation of production between Japan and East Asian countries in the last two decades or so. On the other hand, we find no clearly increasing trend in service offshoring in the Japanese manufacturing sector. These findings imply that Japanese firms have shifted a substantial part of the production processes for intermediate inputs to foreign countries, while they have been slow in relocating service tasks offshore.

Our statistical investigation finds that material offshoring tends to be positively associated with domestic productivity. In particular, material offshoring to Asia has a robust productivity-enhancing effect. On the other hand, there is little correlation between service offshoring and productivity, which is at odds with the result for U.S. manufacturing in Amiti and Wei (2006, 2009). While material offshoring mainly aims at cost savings through the relocation of relatively inefficient parts of the production process to another country, service offshoring is more likely to promote restructuring or improving the way activities are performed. The contrasting result between Japan and the U.S. may imply that Japanese firms are lagging behind in restructuring the way activities are performed, or that peculiar business practices in Japanese firms prevent them from streamlining their service activities across borders.

However, we find that service offshoring tends to be positively associated with productivity at home when we focus on offshoring of information services only. Information services such as data processing and computer programming are conducive to standardization of tasks, in the sense that the performance of these tasks involves less judgment skill compared with commercial services such as business, legal, and engineering consultancy activities. Our findings imply that in this segment, offshoring offers potential benefits.

The remainder of the paper is organized as follows. Section 2 presents a review of the literature on the relationship between offshoring and productivity at both the industry and the firm level and, moreover, provides a more thorough discussion of the potential productivity-enhancing effects of offshoring. Next, Section 3 explains our methodology for measuring offshoring, takes a look at offshoring trends in Japanese manufacturing, and outlines our empirical framework. Section 4 then presents our results with a discussion on the nature of offshoring in Japan. Section 5 concludes.

2. Literature Review

Empirical work to date has failed to produce clear evidence that offshoring helps to lift productivity. A likely explanation is that the productivity-enhancing effects of offshoring depend on a variety of country and/or firm characteristics as well as market or institutional factors. The purpose of this literature review is to summarize possible reasons why offshoring is expected to raise domestic productivity and to present previous empirical results on this issue. We also discuss factors which may prevent firms or industries from enjoying an improvement in domestic productivity through offshoring.

Although there is still little theoretical work on the relationship between offshoring and domestic productivity, it seems reasonable to assume that offshoring contributes to productivity increases in domestic manufacturing operations. The reason is that, first, by relocating inefficient tasks to low-cost countries, the unit cost of the firm's product falls, which can be interpreted as an improvement in productivity.[5] Second, offshoring allows firms to move abroad less productive stages of the production process and shift corporate resource to high-productivity activities, such as product development and process innovation. The remaining workers may become more efficient if offshoring enables firms to restructure in a way that shifts the production possibility frontier outward (Amiti and Wei 2006). Third, the use of new varieties of imported material or service inputs may enable firms to lower costs of intermediate inputs or streamline the production processes, which possibly increases domestic productivity. Taken together, there are reasonable channels through which offshoring improves domestic productivity.

Meanwhile, advances in IT have brought about a drastic reduction in the cost of offshoring. Technological innovations in information and communication processes, such as the Internet have dramatically reduced communication costs across borders and barriers to trade in service tasks (Freund and Weinhold 2002). In general, the provision of service inputs requires physical contact between suppliers and manufacturers, which in the past made the offshoring of service tasks impossible. However, the introduction of new information technologies in manufacturing production at home has enabled firms to coordinate production processes with foreign suppliers of service tasks at a low cost, resulting in an increase in service offshoring in developed countries. Technology has also played a key role in the global expansion of material offshoring, for example through the way that it has revolutionized logistic management techniques. These technological advances, combined with low labor costs abroad as well as the erosion of trade barriers, have created opportunities for manufacturers to reduce production costs by integrating foreign suppliers into their global supply chains.

The rapid increase in offshoring, boosted by such technological innovation, has attracted considerable attention in many countries around the world. In recent years, a growing number of empirical studies have analyzed the productivity effects of offshoring. Industry-level studies include Egger and Egger (2006), who, using industry-level data for the EU manufacturing sector, find that offshoring has a positive impact on real value added per low-skilled worker in the long run. Specifically, they find that the change in offshoring intensity accounts for about 6 percent of the increase in value added per low-skilled worker during the period 1992–1997. Amiti and Wei (2006, 2009) analyze the impact of offshoring on productivity, distinguishing between the effects of service and material offshoring for the U.S. manufacturing sector for the period 1992–2000. Their findings

[5] Grossman and Rossi-Hansberg (2008) show that a decline in the cost of trade in a particular task directly boosts the productivity of the factor whose tasks become easier to move offshore. However, they also show that whether both low-skilled and high-skilled workers can share in the gains from improved opportunities for offshoring depends on the changes in the relative price between low-skilled and high-skilled workers and on the changes in labor supply for each type of worker.

indicate that service offshoring has a significant positive effect on productivity, accounting for around 11 percent of productivity growth in U.S. manufacturing. Although material offshoring also has a positive effect on productivity, the magnitude is much smaller.

The findings by Amiti and Wei (2006, 2009) are consistent with results reported in Mann (2004) and McKinsey Global Institute (2003, 2005), which show that service offshoring has a positive effect on the U.S. economy. However, similar studies applying an Amiti and Wei-type framework to Italy and Korea do not find any positive effect of service offshoring: Daveri and Jona-Lasinio (2008) find that in the case of the Italian manufacturing sector, there is a positive relationship between productivity growth and material offshoring, but not service offshoring, while Lin and Ma (2008) find that service offshoring leads to a decline in productivity in the case of the Korean manufacturing sector. In addition, McKinsey Global Institute (2005) reports that in contrast with the positive impact of service offshoring on the U.S. economy, the impact on the French and German economies is negative, although it should be noted that the analytical framework is very different from that employed by Amiti and Wei (2006, 2009).[6] These empirical studies indicate that while material offshoring generally tends to improve productivity at home, this is not necessarily the case for service offshoring, as not every country has benefited from service offshoring.

Turning to micro-level analyses, Görg and Hanley (2005) explore the impact of offshore outsourcing of materials and services on electronics firms in the Republic of Ireland over the period 1990–1995. They find a significantly positive effect on Total Factor Productivity (TFP) when looking at offshore outsourcing of materials and services combined. When distinguishing between offshoring of services and materials, however, the productivity impact of service offshoring is found to be insignificant while that of material offshoring is still significantly positive. Moreover, the positive productivity effect of material offshoring holds only for plants with low export intensities. Their interpretation of this result is that offshoring generates productivity increases for plants with low export intensity because offshoring enables these plants to benefit from greater flexibility in production techniques and to learn from international best practice. On the other hand, using Irish data again, but this time for the manufacturing sector overall, Görg et al. (2008) obtain robust evidence for a positive effect of service offshoring only for exporters. They argue that in the case of service offshoring, the search for partners to which to outsource activities involves costs, which makes exporting firms with sufficient knowledge and experiences in foreign markets advantageous in conducting such a search efficiently.

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[6] The McKinsey Global Institute (2003, 2005) reports estimate the potential economic value created from offshoring by assessing the cost savings for customers and investors, the direct benefits arising from any increase in export to the offshore location and repatriated profits from affiliated offshore providers, and the value of labor re-employed. According to McKinsey Global Institute (2005), every dollar of corporate spending on back-office and IT services offshored to India generates more than $1.14 of new wealth for the U.S. economy. However, Germany earns back only €0.74 for every euro of spending on corporate service jobs that are moved offshore. France falls between the two (€0.86).

Meanwhile, using Japanese firm-level data for the period 1994–2000, Hijzen et al. (2006) find that offshoring generally has a positive effect on productivity growth. Although they do not distinguish between service and material offshoring, they separately examine the effects of subcontracting at arm's length internationally (international outsourcing) and domestically (domestic outsourcing).[7] They find that the impact on TFP growth in the case of international outsourcing is four times greater than that in the case of domestic outsourcing. They also 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. Finally, for the case of Spanish manufacturing, Fariñas and Martín-Marcos (2008), using firm-level data for the period 1990–2002, find a positive relationship between the intensity of offshoring and productivity.

The industry-level and firm- or plant-level studies cited here, focusing on a variety of countries, generally support the hypothesis that material offshoring has a positive impact on domestic productivity. In contrast, the results on the effects of service offshoring are less clear. There are several potential explanations for the zero or negative correlation between service offshoring and productivity. Daveri and Jona-Lasinio (2008) argue that it may take time for the compositional or structural gains from service offshoring to offset the transitional adjustment costs. As pointed out by McKinsey Global Institute (2005), such adjustment costs may arise from low re-employment rates among workers losing their job to offshoring because of low labor market flexibility and job creation. Daveri and Jona-Lasinio (2008) also point out that, depending on a country's factor endowment, it may be the most productive service activities that are offshored in order to escape existing inefficiencies at home resulting from insufficient liberalization in the market for such services. On the other hand, Lin and Ma (2008), focusing on the case of Korea, conjecture that language barriers may be a main reason why service offshoring has a negative effect on productivity. In addition, McKinsey Global Institute (2005) points out that the size of cost savings varies across countries to which business activities are offshored, depending on the wage levels of destination countries. It also points out that the size of other direct costs or benefits from offshoring differs depending on the size and productivity of industries in the home country and the ownership structure of offshore providers, i.e., whether the offshore providers are affiliates of the home country firms or not. Such factors affect the magnitude of exports from the home country to the offshore location as well as the repatriated profits of affiliated offshore providers and hence the balance of the impact overall.

Turning to trends in Japan's manufacturing sector, there has been a substantial increase in the role of material offshoring, as indicated by the considerable growth in intra-regional outsourcing of intermediate inputs within East Asia (Ahn et al., 2008, Wakasugi et al., 2008). Since there are large factor price differences within the region, the division of labor through material offshoring may have

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[7] They also examine the effects of purchases of intermediate inputs from a firm's foreign affiliates (international insourcing).

contributed to cost savings of domestic operations, which potentially produces a significant impact on productivity in Japan. Although the firm-level study by Ito et al. (2008) finds that firms conducting offshoring show higher productivity growth than firms not conducting offshoring, such evidence is still scarce. Moreover, Ito et al.'s (2008) study does not take account of the impact of changes in magnitude of offshoring.

Thus, previous studies find mixed results for the relationship between offshoring and domestic productivity. Particularly, empirical evidence for the productivity-enhancing effect of service offshoring is scarce. Against such a background, it is important to accumulate empirical evidence from various countries with differing characteristics in terms of factor costs, technological level, business practice, institutional and market characteristics, etc., in order to evaluate the economic benefits of offshoring. Japan's case should be particularly interesting because Japanese firms play an important role in the fragmentation of production in East Asia and also because business practices in Japanese firms are pointed out to be very different from those in Western developed countries, which may result in different impacts of offshoring on domestic productivity. This study employs a similar analytical framework to the one in Amiti and Wei (2006, 2009) in order to evaluate our findings in comparison to their results for the United States. However, by investigating different impacts of offshoring by destination and by type of activities, we try to provide a clue to understanding the mechanism whereby offshoring enhances domestic productivity.

In the next section, we present the analytical framework for our examination of the impact of material and service offshoring on productivity in Japanese manufacturing.

3. Analytical Framework

3.1 Measurement of Offshoring

A number of recent studies, using a variety of data sources, have tried to analyze trends in the trade in intermediate inputs. One of the empirical issues in these studies has been how to measure the importance of trade in intermediate inputs or offshoring. There are two widely-used methodologies to measure offshoring. One of these is the methodology by Feenstra and Hanson (1999). In this methodology, offshoring is only indirectly measured utilizing the import propensity for each good. They estimate offshoring in industry i, for example, by assuming that the share of imported input purchases of good j in total input purchases of good j for industry i equals the import propensity for good *j for the entire economy* (i.e., the share of imports of good j in total domestic demand for good j).[8] The other methodology is to use direct information on the value of imported intermediate inputs for each industry from and within each sector. In the case of Japan, data on imported intermediate inputs can be obtained directly from the input-output tables and we therefore employ the second

8 Amiti and Wei (2006, 2009) and Lin and Ma (2008), for example, employ this methodology.

methodology.[9] Hence, our measure of offshoring is:

$$z_i = \frac{\sum_{j=1}^{N} m_{ij}}{Y_i} \qquad (1)$$

where m_{ij} is industry i's use of imported intermediate inputs from industry j and Y_i stands for the total non-energy intermediate inputs used by industry i. For the purposes of our analysis, we construct separate offshoring measures for material offshoring and service offshoring. Therefore, in the case of the material offshoring measure ($z = MO$), industry j denotes all manufacturing industries, while in the case of the service offshoring measure ($z = SO$), industry j denotes offshorable service industries. Following Amiti and Wei (2006), when considering imported service inputs in manufacturing, inputs from the following five sectors are considered: telecommunications, insurance, finance, business services, and information services.[10]

Comprehensive and detailed input-output tables are available in Japan for every five years. Utilizing the input-output tables for 1990, 1995, and 2000 as benchmark data, we construct a time series for our offshoring measures as follows:

Equation (1) can be rewritten as:

$$z_i = \sum_{j=1}^{N} \frac{m_{ij}}{IM_j} \frac{IM_j}{Y_i} \qquad (2)$$

where IM_j denotes imports in industry j. We observe industry i's use of imported intermediate inputs from industry j as a share of total imports in industry j, m_{ij}/IM_j, for 1990, 1995, and 2000. We also have information on the ratio of imports in industry j to total non-energy intermediate inputs used in industry i (IM_j/Y_i) every year. We use a linear interpolation of 1990, 1995, and 2000 values of m_{ij}/IM_j for the years 1991–1994 and 1996-1999. For 1988 and 1989, we use m_{ij}/M_j for the year 1990, and for 2001–2004, we use m_{ij}/IM_j for the year 2000. Thus, we assume that an industry's use of imported inputs from the same and other industries as a share of its total imports (m_{ij}/IM_j) changes at a certain growth rate for the estimated values. However, total imports in industry j (IM_j) and total non-energy intermediate inputs used in industry i (Y_i) are directly taken from the JIP (Japan Industry Productivity) Database 2009 for each year.[11]

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[9] Examples of studies employing this methodology include Hijzen et al. (2005), Ekholm and Hakkala (2006), and Daveri and Jona-Lasinio (2008).

[10] These services correspond to eleven JIP industries, as shown in Appendix Table 1. While Daveri and Jona-Lasinio (2008) include transportation services in their service offshoring measure, we exclude transportation sectors. The reason is that the amount of imported transportation services greatly depends on the volume of goods trade and does not purely consist of supporting services for manufacturing activities similar to back-office or IT services.

[11] The JIP Database 2009 is available at <http://www.rieti.go.jp/en/database/JIP2009/index.html>. Refer to Fukao and Miyagawa (2008) for details of the data construction and methodology. The primary objective of the JIP Database 2009 is to provide a consistent database for the industry-level analysis of structural change and economic growth in Japan from a long-term perspective. To this end, the JIP Database 2009 includes a wide variety of indicators on industry characteristics for 108 sectors from 1970 to 2006: capital service

3.2 Material and Service Offshoring by the Japanese Manufacturing Sector

Table 1 presents the trends in the intensity of material and service offshoring for the Japanese manufacturing sector during the period 1990–2004.[12] The table shows that the share of imported material inputs in 2004 was 8.9 percent, while the share of imported service inputs was only 0.2 percent. It also clearly shows that the share of material inputs has been increasing and that particularly material offshoring to Asia has grown rapidly during this period.[13] Remarkably, material offshoring to China increased by nearly six-fold. On the other hand, service offshoring has been very small and remained essentially unchanged during this period.[14] In fact, the degree of offshoring in 2004 was smaller than that in 1990. The regional distribution of service offshoring has also seen little change, although the share of North America, which accounted for the largest slice, has decreased slightly. On the other hand, China's share has increased somewhat (see the percentage increase during the period 1990–2004), although the overall amount is still very small and the change in terms of China's share is therefore not discernable in the table.

Comparing the figures in Table 1 with corresponding figures for other countries that have been the subject of previous empirical studies, certain characteristics of Japanese offshoring patterns stand out. In Amiti and Wei (2006), the intensity of material offshoring for the U.S. manufacturing sector is around 15 percent for the period 1992–2000, while the corresponding figures for Italy and Korea, calculated by Daveri and Jona-Lasinio (2008) and Lin and Ma (2008), respectively, are around 24 percent. The corresponding figure for Japan in Table 1 suggests that the extent of material offshoring in Japan is much smaller than that in the United States, Italy, and Korea, though our figures cannot be directly compared with corresponding figures in other studies because of definitional or methodological differences. The low degree of material offshoring for Japan that we find (6–9 percent) likely reflects the large size of the domestic manufacturing sector and the high technological capability

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input indices and capital costs, labor service input indices and labor costs, nominal and real values of inputs and outputs, and TFP. Additional datasets on trade, FDI, and market reforms are also provided.

[12] We also construct offshoring measures by region, assuming that the country distribution of imports in industry *i* is the same for intermediate inputs as for final products. Our regional classification is as follows: North America denotes Canada and the United States, not including Mexico; EU includes both Western and Eastern European countries; and Asia denotes East, Southeast, and South Asian countries, not including Middle Eastern countries.

[13] It should be noted that, as pointed out by Ekholm and Hakkala (2006), this outsourcing measure may underestimate the magnitude of the shift of intermediate goods production to low-income countries in Asia because outsourcing is measured based on the value of imports, which is affected by price changes and exchange rates. If lower production costs in low-income Asian countries lead to a shift of intermediate goods production to these countries, similar goods can be imported at lower prices from Asia than from higher-income countries. Therefore, the increase in outsourcing to Asia may be more pronounced on a volume basis.

[14] For imported services, we use the information from the regional balance of payment statistics provided by the Bank of Japan. Because the regional balance of payment statistics are available only for 1996 onward, we assume that the regional distribution of imports in service industry *i* for the years before 1996 is the same as the regional distribution in 1996.

and efficiency of intermediate input producers in Japan.

On the other hand, as for the degree of service offshoring, our figure for Japan is comparable to that for the United States in Amiti and Wei (2006), although the corresponding figures for Italy and Korea in Daveri and Jona-Lasinio (2008) and Lin and Ma (2008), respectively, are much larger.[15] Again, the size of the domestic sector, in this case services, may be responsible, with the domestic service sectors in Japan and the United States being much larger than those in Italy and Korea. However, there is an important difference between Japan and the United States in that the intensity of service offshoring has grown rapidly in the latter, while it has stagnated in the former. In the United States, the intensity of service offshoring increased from 0.18 percent in 1992 to 0.29 percent in 2000 (Amiti and Wei 2006: Table 1). In contrast, in the case of Japan, the corresponding intensity was steady around 0.2 percent for the period 1990-2004.

INSERT Table 1

Table 2 presents a breakdown of the material and service offshoring intensity for each industry.[16] This shows that while the levels of material and service offshoring intensity vary substantially across industries, many industries – in line with the manufacturing sector overall – have seen an increase in the intensity of material offshoring. This is particularly the case for machinery industries. On the other hand, when it comes to service offshoring, none of the industries shows any clear trend, mirroring the finding for the manufacturing sector as a whole.

INSERT Table 2

In fact, balance of payment statistics show that the growth rate of Japan's service trade in the last decade has been much smaller than that of other developed countries, suggesting that service offshoring by Japanese firms has not increased at a similarly rapid pace as that by firms in the United States and other developed countries.[17] Moreover, several pieces of anecdotal evidence lend further support to the conclusion that the service offshoring in Japan did not increase during the period 1990-2004. First, from around 2000, international service outsourcing to developing countries such as India and its impact on domestic white-collar jobs received much attention both from the media and

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[15] In Amiti and Wei (2006), the measure of service offshoring is estimated in the range of 0.18 – 0.29 percent for the U.S., while corresponding figures for Italy in Daveri and Jona-Lasinio (2008) and for Korea in Lin and Ma (2008) are estimated to be more than 1 percent.

[16] Although we calculated the offshoring intensity for each JIP industry (52 manufacturing industries), we present the intensities at a more aggregated industry level in Table 2. For a list of the JIP industries, see Appendix Table 1.

[17] According to the OECD statistics, for example, the average annual growth rate of Japan's imports of services (in terms of nominal U.S. dollar) was 3.3 percent for the period 2000-2005, while the corresponding rates for the U.S. and for the EU15 were 8.1 percent and 13.3 percent, respectively.

from political circles in the United States, the United Kingdom, and Australia (Amiti and Wei 2005, Mankiw and Swagel 2006). In contrast, in Japan, service offshoring has never been a major issue of public discussion or the cause for fear of job losses, although some supporting services, such as software development, customer services, and professional services, have been moved to China and other Asian countries. The likely reason is that the scale of the relocation of such supporting services abroad was not very large. Second, it can be pointed out that service offshoring is not easy for Japanese firms because of language problems and different business practices. For instance, Japanese firms tend to maintain long-term relationships with supporting service providers and to purchase various custom-made services from these providers. As a result, large manufacturing firms tend to possess service affiliates. Even in the case of outsourcing, they are likely to require frequent face-to-face consultations for the development of custom-made services.

Thus, service offshoring by Japanese firms so far has not expanded dramatically. However, the IPA survey (IPA 2009) indicates that IT service offshoring, particularly to China, India, and Vietnam, is projected to steadily increase in the future. Moreover, it has often been argued that an increase in the degree of international openness may improve the productivity of the Japanese service sector which has stagnated in recent years (Jones and Yoon 2008). Against this background, and despite the fact that the degree of service offshoring in Japan is still at a low level, whether or not the offshoring of services has some impact on productivity in the manufacturing sector is becoming an important issue which deserves to be scrutinized.

3.3 Estimation Model

This section describes our empirical specification for the analysis of the link between offshoring activities and manufacturing productivity in Japan. In order to render our empirical results comparable to previous findings for other countries, we adopt the standard production function approach as employed by Amiti and Wei (2009). The production function for industry i at time t is defined as follows:

$$Q_{i,t} = T\left(SO_{i,t}, MO_{i,t}\right)F\left(S_{i,t}, M_{i,t}, L_{i,t}, K_{i,t}\right) \qquad (3)$$

where Q is the level of output in industry i as a function of service inputs, S, material inputs, M, labor, L, and capital, K. The technological level of the production function is expressed as T, which depends on our key variables of sectoral offshoring activities: service offshoring, SO, and material offshoring, MO. In equation (3), it is assumed that the offshoring of service and material input purchases contributes to Hicks-neutral technological change in the production function for industry i. In this approach, global sourcing activities change the technology level without affecting the balance between factor inputs such as labor and capital. Therefore, we assume that offshoring leads to a shift of the industry's production function because domestic production processes are reorganized to take advantage of sourcing material and service inputs from foreign providers.

For the regression analysis, we assume a general Cobb-Douglas production function for equation (3).[18] Taking the natural logarithm of the Cobb-Douglas function, the equation can be expressed as follows:

$$LnQ_{i,t} = \alpha_0 + \alpha_1 SO_{i,t} + \alpha_2 MO_{i,t} + \beta_1 LnS_{i,t} + \beta_2 LnM_{i,t} + \beta_3 LnL_{i,t} + \beta_4 LnK_{i,t} + \gamma_i + \gamma_t + e_{i,t} \tag{4}$$

where γ_i *and* γ_t are industry- and time-specific effects, respectively, and $e_{i,t}$ is the error term. By estimating the coefficients of *SO* and *MO*, α_1 and α_2, we examine whether an increase in the offshoring intensity (*SO* or *MO*) leads to higher output, holding all factors of production constant (total service input, total manufacturing input, labor input, and capital stock). That is, the coefficients α_1 and α_2 denote the effect of offshoring on TFP. To control for the unobserved industry-specific fixed effects (γ_i), we take the first difference of equation (4). Denoting the first-differenced variables by Δ, our central regression equation is as follows:[19]

$$\begin{aligned}\Delta LnQ_{i,t} = {} & \alpha_0 + \alpha_1 \Delta SO_{i,t} + \alpha_2 \Delta MO_{i,t} + \beta_1 \Delta LnS_{i,t} + \beta_2 \Delta LnM_{i,t} + \beta_3 \Delta LnL_{i,t} + \beta_4 \Delta LnK_{i,t} \\ & + \pi_i \delta_i' + \pi_t \delta_t' + \varepsilon_{i,t}\end{aligned} \tag{5}$$

Although the time-constant industry-specific fixed effects on the productivity level are removed by taking the first difference of equation (4), we still include industry dummies (δ_i') in equation (5) in order to take account of the possibility that the growth rate of industry productivity can be influenced by time-constant industry characteristics. For instance, some industries may exhibit substantially higher productivity growth rates than other industries due to technological innovation during our period of interest. On the other hand, some industries may show considerably lower productivity growth rates, perhaps because their products have reached a mature stage in the product cycle, and production efficiency is already high, leaving little room for productivity improvements. Thus, it is possible that low-growth industries are more likely to exploit global sourcing strategies for efficiency reasons than high-growth industries. Alternatively, high-growth industries may be more likely to take advantage of foreign sourcing because of the global production networks that have been established.

[18] Egger and Egger (2006) estimate a CES production function to study the effect of foreign outsourcing on labor productivity of low-skilled workers in 12 EU countries during the period 1992–1997.

[19] Some may argue that changes in the material and service offshoring measures include both changes in imported intermediate input and in composition of material inputs and service inputs. That is, in our offshoring measures expressed in equation (1), the denominator is the total non-energy intermediate inputs used by each manufacturing industry. Therefore, the material and service offshoring would likely be affected by changes in the composition of material intermediate inputs and service intermediate inputs, not only by changes in import ratio of material or service inputs. In our central regression equation (5), we include material inputs (*M*) and service inputs (*S*) separately as input factors of the production function. By doing so, we control for the changes in composition of material and service intermediate inputs. Moreover, we also checked trends of material offshoring and service offshoring by calculating the measures using only material intermediate inputs as the denominator for the former and only service intermediate inputs as the denominator for the latter. The trends of the alternative material and service offshoring measures were consistent with the trends of our original offshoring measures, suggesting that the impact of changes in the composition of material and service inputs would not be crucial.

Such tendencies could give rise to a spurious relationship between offshoring activities and productivity growth, and it is for this reason that we include industry dummies in the time-differenced equation. The year dummies ($\delta_t^{'}$) in equation (5) address the concern that aggregate time effects on industry productivity growth can vary across years. For the regression analysis, we also include one-period lags of the offshoring variables to take account of the possibility that productivity effects may not be instantaneous.

3.4 Econometric Issues

The main hypothesis in this study is that manufacturing firms that engage in offshoring of service and material inputs are likely to experience a higher growth rate of manufacturing productivity through the adoption of more efficient technology such as a more efficient supply chain system. A standard regression framework allows us to disentangle the effects of offshoring from those of other important determinants of productivity growth in an industry. However, we are faced with a potential problem of endogeneity between offshoring and productivity growth, which would yield biased coefficients on the offshoring variables in the production function estimation.

Specifically, the question is whether firms' decisions whether to purchase intermediate inputs domestically or from abroad can plausibly be isolated from cross-industry patterns of productivity growth. For example, Tomiura (2005) finds that in 1998, fewer than 3 percent of firms in Japan engaged in foreign outsourcing, and that in particular high-productivity firms that produce labor-intensive products are more likely to rely on foreign outsourcing. His findings raise the reasonable concern that the offshoring variables could be positively correlated with productivity at the industry level, if more productive firms are concentrated in high-growth industries.

Because of this concern, we remove the industry-specific fixed effects by taking the first difference of equation (4) to control for industry heterogeneity such as the distribution of firm productivity. This ensures that any positive correlation between offshoring and productivity growth would not merely be due to the concentration of offshoring firms in high-growth industries. Moreover, the inclusion of industry dummies in our regression equation (5) alleviates the potential endogeneity problem that high-growth industries over time may tend to exhibit an increase of offshoring activities.[20]

Another concern is that firms simultaneously determine the composition of material and service inputs from domestic and foreign suppliers for production, which can give rise to biases in a standard

[20] The inclusion of industry fixed effects in the first-difference equation (5) allows us to estimate the short-run effect of offshoring on productivity, which illustrates the *ex post* productivity gain of industries that engage in offshoring activities. However, the fixed effects specification can produce a downward bias in the estimates in the presence of measurement errors. Since the measurement of offshore sourcing is obviously a difficult task, it is possible that the short-run effect of offshoring on productivity is underestimated in our analysis.

linear regression. To address the endogeneity of input choices, we also estimate the effect of offshoring activities on labor productivity, measured as value added per worker, at the industry level.

3.5 Description of Industry-level Data

The data used for our empirical analysis are taken mainly from the JIP Database 2009. The dependent variable, *Q*, is the real volume of aggregate output at constant prices in industry *i.* For service and material inputs, we use the real value of intermediate inputs taken from the input-output tables of the JIP Database 2009. Material and service inputs, *M* and *S*, are defined as intermediate inputs purchased from JIP industries 1–59 and 60–107, respectively. Labor input, *L*, is the total number of employees in an industry. Data on the share of workers by occupation are taken from the supplementary tables of the JIP Database 2009. Data on capital stocks are created by aggregating IT and non-IT capital stocks, which are also taken from the JIP Database 2009. In the JIP Database, the IT capital stock is estimated by the perpetual inventory method using the aggregate value of software and hardware investment for each industry. These data are also used to calculate the share of IT capital stock in total capital stock for each industry. Data on the degree of import penetration are constructed by dividing the value of imports by domestic demand, i.e., imports/(domestic production + imports – exports). The offshoring variables, *SO* and *MO*, are constructed following the methodology explained in Section 3.1.

4. Estimation Results

In this section, we present the estimation results of our central regression model (equation (5)) for a panel dataset covering the Japanese manufacturing sector for the period 1988 through 2004. Regression results are reported with standard errors corrected for cluster correlation within industries. All independent variables except for the offshoring variables are the first difference of the natural logarithm of the variables. We begin with our main results of the effects of offshoring on productivity, and then explore the relationship between industries' productivity and offshoring disaggregated by region and type.

4.1 Total Factor Productivity and Labor Productivity

Table 3 shows the OLS estimation results for the production function (equation (5)). Columns (1) to (4) show the results for the first-differenced specification with year fixed effects only, while columns (5) to (8) include industry dummies. To begin with, we estimate the coefficients of the contemporaneous variables for service and material offshoring, presented in column (1). The coefficient for current service offshoring is negative, but not statistically significant, while that for material offshoring is positive and significant. Next, since offshoring activities may affect domestic operations in subsequent periods, in column (2) we used offshoring variables lagged by one period.

The estimated coefficients for the offshoring variables, however, are not statistically significant. In column (3), we then estimate a specification that includes both the contemporaneous and lagged values of the offshoring variables. We find that only the current variable for material offshoring has a significant positive coefficient. All of these results imply that TFP growth in Japan's manufacturing sector was positively related with contemporaneous increases in material offshoring, but not service offshoring.

It is often argued that international sourcing of intermediate inputs can play a role in the skill upgrading of domestic workers. The positive impact of material offshoring on manufacturing TFP may therefore reflect a change in the skill composition of workers at domestic plants across industries rather than a shift in the production function. To examine this issue in more detail, we disaggregate the number of workers employed into production and nonproduction workers for each industry. Column (4) indicates that the contemporaneous variable for material offshoring is still positive and significant, meaning that the result in column (3) is robust to a change in the skill composition of workers. However, the coefficient for contemporaneous material offshoring in column (4) is smaller than in column (3), suggesting that the effect of material offshoring on production may in part reflect the positive effect of the resulting skill upgrading on production.

Next, we estimate time-differenced specifications with industry dummies to address the concern that certain high-growth industries may be more likely to rely on offshoring than other industries. The results are shown in columns (5) through (8). In contrast with the results in columns (1) to (4), however, the coefficients for both service and material offshoring are not statistically significant in all specifications. The coefficient on the contemporaneous material offshoring variable is still positive, but much smaller. As the estimations in columns (5) to (8) contain industry dummies controlling for cross-industry variations in TFP growth and offshoring intensity, these results are driven primarily by the time-series variation in offshoring and TFP. The implication is that the TFP growth rate is higher in industries with greater reliance on global sourcing, but industries that increase their offshoring intensity do not necessarily experience *ex post* a higher growth rate of TFP in subsequent periods.

Column (9) shows the result using observations only for years 1990, 1995, and 2000. As explained in Section 3.1, the measures of offshoring are constructed partly by linear interpolation. Although there is no better way to construct the annual measures under data constraints, this methodology may induce some spurious time-series correlations between the offshoring measures and productivity. In order to check sensitivity of the results, we drop the years for which the offshoring measures are estimated. The estimated coefficient of the material offshoring variable in column (9) is not statistically significant. This result suggests that the significantly positive impact of material offshoring in columns (1) to (4) may be partly due to the estimation method of offshoring variables.

INSERT Table 3

A possible problem in the foregoing results is that input choices with regard to material and service inputs are endogenously determined by firms' output choices, which may produce a bias in the OLS estimates for the offshoring variables. A conventional solution to such an endogeneity problem is to employ an instrumental variable for offshoring that is significantly correlated with a change in offshoring intensity but sufficiently uncorrelated with unobserved determinants of industry output. As such an instrument is not readily available, we take an alternative approach and estimate the effect of offshoring on labor productivity, where labor productivity is measured as the total output minus material and service inputs, divided by the number of workers.

Table 4 presents the estimation results of the labor-productivity specification. All models are first differenced, with specifications (1) to (5) including year dummies only, while (6) to (10) also include industry dummies. As in Table 3, column (11) shows the result using observations only for years 1990, 1995, and 2000 as a robustness check. We find that in specifications (1) to (3), the coefficient for service offshoring is not significant, but that for material offshoring is positive and significant. In order to check whether these results are driven by omitted variables, we include the IT capital share and the import penetration ratio as additional control variables. If an increase in the IT capital share and/or the import penetration ratio improved productivity, and this was associated with an increase in offshoring, then omitting these variables may cause the coefficients on the offshoring variables to be inflated. The estimation results including these additional variables are shown in columns (4) and (5). We find that the coefficient for material offshoring remains positive and significant. These results lead us to conclude that material offshoring has a significant positive impact on the growth rate of labor productivity, consistent with the results from Table 3.[21]

Next, we look at the results for the specification including the industry dummies (columns (6) to (10)). While the estimated coefficients for the offshoring variables are not statistically significant in columns (6) and (7), the coefficient for material offshoring is significantly positive in columns (8) to (10). The results in columns (8) to (10) suggest that the growth rate of labor productivity significantly increased in those industries where the share of material offshoring expanded, while the estimation results of the TFP specification in Table 3 suggest that the TFP growth rate did not necessarily increase in industries where the share of material offshoring expanded. However, the insignificant coefficient for the material offshoring variable in column (11) indicates that our estimation results may not be robust enough to conclude that global sourcing of material inputs enhances the domestic productivity.

INSERT Table 4

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[21] The results are qualitatively similar when we estimate the model by robust regression estimation using an iterative process which gives less weight to outlier observations. Moreover, simply excluding outlier observations from the estimation also produces similar results.

4.2 Material Offshoring by Region

The regression models up to this point have assumed that TFP and labor productivity are related to aggregate international sourcing of service and material inputs. However, it is possible that the effects of offshoring on manufacturing productivity depend on the region to which activities are outsourced. As mentioned earlier, our analysis is based on the notion that firms engage in offshoring in the search for cheaper inputs to lower costs, and that lower costs can be interpreted as a shift in the production function. Yet, the extent to which offshoring indeed lowers costs is likely to vary by partner country or region to which activities are offshored. For instance, unskilled-labor intensive intermediate inputs can be imported from unskilled labor-abundant developing countries at low cost, which would have a strong cost-saving effect on domestic production. If unskilled labor-intensive inputs are more easily offshored than skilled labor-intensive inputs, we would expect that offshoring to developing countries has a larger positive impact on manufacturing productivity at home than offshoring to developed countries.

To examine whether there are any regional differences in the effect of offshoring on productivity growth, we disaggregate material offshoring by region: offshoring to Asia, Europe, and North America. As is well known, Asian countries play a prominent role in the international production networks of Japanese firms. The estimation results for material offshoring to Asia are shown in Table 5.[22] Column (1) shows that a change in material offshoring to Asia has a significant positive impact on TFP, while column (2) shows a positive correlation between TFP and the lagged variable for material offshoring. Including both the contemporaneous and the lagged variables (column (3)) yields significant positive coefficients for both variables.

Moreover, as shown in column (4), the coefficients for the material offshoring variables are still significant even controlling for the skill composition of workers, indicating that our results are not driven by a change in the skill composition. In columns (5) to (8), we include industry dummies to rule out that our results reflect industry-specific dynamics, such as an increase in offshoring by only a few fast-growing industries. Columns (9) and (10) show the GMM estimation results and column (11) shows the results using observations only for years 1990, 1995, and 2000 as robustness checks. These results show that the coefficient for material offshoring to Asia is significantly positive. Our results in Table 5 thus demonstrate that material offshoring to Asia brings a significant productivity gain in domestic manufacturing operations while the results in Tables 3 and 4 suggest that the productivity-enhancing effect of material offshoring as a whole is less robust.

INSERT Table 5

[22] To refine our analysis, we further distinguish offshoring to China, the ASEAN4, and the NIEs4 countries. The estimation results for these three regions are shown in Appendix Tables 4, 5, and 6, respectively.

In contrast to that for offshoring to Asia, the coefficients for material offshoring to Europe and North America are not significant.[23] The implication is that whether offshoring activities improve domestic TFP depends on the foreign country, from which domestic firms import material inputs. The likely reason for our result is that factor price differences between Japan and Asia are greater on average than those with Europe and North America. The geographic proximity of Asia to Japan also results in lower transportation costs. In addition, by distinguishing material offshoring to China, ASEAN4, and NIEs4, we find that material offshoring to ASEAN4 tends to be positively associated with productivity with a time lag while the contemporaneous material offshoring variable tends to be positively associated with productivity in the case of offshoring to NIEs4.[24] In the case of offshoring to China, neither contemporaneous nor lagged offshoring variables have a significant coefficient, suggesting that material offshoring to China is not associated with domestic productivity. Although material offshoring from a low-cost country appears to matter for domestic productivity, the quality or technology level of the offshored material should be crucial to have a productivity-enhancing effect.

Previous studies such as Amiti and Wei (2006, 2009) and Görg and Hanley (2005) have estimated the impact of aggregate offshoring activities on productivity without breaking these down into regions. In contrast, we empirically demonstrate that the effects of offshoring of material inputs on domestic productivity depend on the region from which domestic firms import materials. Our results suggest that material offshoring to a low-cost region is likely to bring greater productivity gains for domestic manufacturing sectors.

4.3 Service Offshoring by Type

One of the topics widely discussed in the literature, with the aim of trying to understand the impact of offshoring on domestic service employment, is what type of service jobs are likely to be transferred offshore (see, e.g., Jensen and Kletzer 2006). Service activities such as R&D and corporate management require close contact between service workers to facilitate the flow of tacit knowledge, so outsourcing these activities offshore involves large fixed costs. On the other hand, activities such as data input, computer programming, and customer services are relatively standardized in the sense that the performance of these tasks involves less judgment skill. Consequently, the costs of offshoring such information-related tasks are relatively small. Despite the fact that there has been great interest in the matter, there has been little empirical work on the issue that the existence and magnitude of productivity-enhancing effects of service offshoring are likely to depend on the nature of offshored service tasks. Thus, we also investigate the impact of offshoring for different types of service tasks offshored. To do so, we construct separate offshoring measures for information services and for business services. Specifically, information services include the use of computers, information

[23] These results are provided in Appendix Tables 2 and 3.
[24] These results are provided in Appendix Tables 4, 5, and 6.

processing, and the provision of information, while business services comprise business, legal, and engineering consultancy activities.

For the estimation, service offshoring disaggregated by type of activity is entered in the first-differenced specification. The results for information services offshoring are shown in Table 6. The estimations shown in columns (1) to (4) include year dummies, while those in columns (5) to (8) include both year and industry dummies. Column (9) shows the result using observations only for years 1990, 1995, and 2000 as a robustness check. While the contemporaneous variable for information services offshoring is not significant in any of the specifications where it is included except column (3), the lagged variable is positive and significant in all specifications where it is included. A possible explanation is that productivity gains from information service offshoring do not show up instantaneously, but would take time to materialize.

INSERT Table 6

In contrast to offshoring of information services, the estimated coefficient of business service offshoring is not statistically significant in most cases, suggesting that business services offshoring does not play a significant role in improving domestic productivity in manufacturing.[25] In the case of offshoring of business services, there still seem to be various tasks that are difficult to define in a standardized manner such as business and legal consultancy. These business services involve a substantial amount of judgment and communication between clients and professionals engaged in the production of such services. Moreover, congruence of language and business culture is likely to play a large role in whether domestic firms can exploit and benefit from business services offshoring. In the case of Japan, peculiarities of the Japanese language and culture seem to be a barrier to international transactions in such business service tasks. Therefore, it would still be costly to offshore these tasks, and Japanese manufacturing firms seem not yet to be able to take advantage of doing so.

On the other hand, in the case of information service offshoring, recent innovations in information and communication technology have dramatically improved the ability to transmit information across borders at low cost. Our finding that information service offshoring is positively associated with domestic productivity indicates that Japanese manufacturing firms benefit from innovations in information and communication technology. However, we should note that we do not see a clear and rapid increase in information service offshoring in the case of Japanese manufacturing. Although it is beyond the scope of this paper to explore a barrier to service offshoring, it is important to pin down possible reasons why Japanese firms have not been able to fully take advantage of overseas IT suppliers.

According to a survey conducted by the Information-Technology Promotion Agency (IPA) of

[25] The results are provided in Appendix Table 7.

Japan in 2008, the biggest concern about IT service offshoring is language and communication problems, followed by difficulties concerning quality control and differences in cultural and business practices (IPA 2009). In fact, Japanese firms tend to use custom-made IT systems and software rather than ready-made IT systems or packaged software, which makes it difficult for them to outsource such IT services to foreign companies. Even in Japan, large firms tend to have affiliated firms, from which they insource such services, rather than outsourcing them to independent firms. This reflects part of a general pattern in Japan, where outsourcing to completely unrelated firms is not very common. Moreover, because of firms' reliance on custom-made IT systems and software, outsourcing in many cases would be unlikely to reduce the costs of IT services, particularly when the development of such systems and software requires long-term and frequent face-to-face communication.

Furthermore, a survey conducted by the Research Institute of Economy, Trade and Industry (RIETI) in 2007 shows that the Chief Information Officers (CIOs) in Japanese firms tend to be in charge of duties other than IT systems while the CIOs in U.S. firms tend to be full-time CIOs being in charge of IT systems exclusively (RIETI 2007). Analyzing the survey results, Motohashi (2007) argues that U.S. firms place greater importance on using IT as a tool to accomplish corporate strategy than Japanese firms. In addition, U.S. firms maintain a relationship with outsourcing firms as partners for consulting on technology trends, whereas a large number of Japanese firms perceive them as a means of cost reduction.

The results of these surveys and analyses suggest that peculiarities of the Japanese language and business culture as well as a lack of strategic IT management prevent Japanese firms from increasing service offshoring and from enjoying productivity gains from doing so.

5. Conclusion

This study analyzed the effect of offshoring of services and material inputs on domestic productivity using industry-level data for Japanese manufacturing. We found that material offshoring tends to be positively associated with domestic productivity, while service offshoring does not appear to have any significant relationship. Therefore, our results suggest that service offshoring does not contribute to productivity in the manufacturing sector, which is in line with findings for Italy and Korea obtained by Daveri and Jona-Lasinio (2008) and Lin and Ma (2008). However, our results for service offshoring are at odds with results by Amiti and Wei (2006, 2009) for the U.S. manufacturing sector, where service offshoring has a large positive effect on productivity.

One notable finding is that material offshoring to Asia has a significant positive effect on productivity growth, while material offshoring to Europe and North America does not have any significant effects. This implies that whether offshoring activities improve domestic productivity depends on the foreign country, from which domestic firms import material inputs. In the case of Japan, the large differences between factor prices at home and in Asian countries, coupled with geographic proximity, appears to have yielded a significant productivity-enhancing effect of material offshoring. In fact, material offshoring to Asia has increased dramatically in the 1990s through the early 2000s. As a result, offshoring to Asia could contribute to productivity growth in Japanese manufacturing.

In the case of service offshoring, we find that offshoring is positively associated with productivity in the subsequent period when we focus on offshoring of information services though the statistical robustness is somewhat weak. The statistical weakness would be partly laid on the stagnancy of service offshoring in Japan. However, our results suggest that even though the level of offshoring is still low, offshoring of services, at least in the segment of information services, is likely to produce productivity gains with a time lag. What, then, hinders Japanese firms from increasing offshoring of such services? It has often been indicated that the corporate organization of Japanese firms is not well suited to IT systems, which are designed to use standardized software. In addition, it has also been pointed out that the decision-making processes in Japanese firms, requiring substantial interdivisional communication, are obstacles to the effective use of state-of-the-art IT systems (see, e.g., Motohashi 2008). These factors would make it difficult for Japanese firms to utilize foreign service providers. As the U.S. evidence implies potentially large productivity gains from exploiting service offshoring, it is worth further scrutinizing the determinants of service offshoring in Japanese manufacturing industries. In this respect, our findings shed light on the importance of IT management in determining whether firms import IT services and realize productivity gains from offshoring of information services.

As a final note, we discuss some of the issues that are not sufficiently addressed in this study. First, we found no significant effect of offshoring of business services on productivity. We conjecture that the nature of business services, which involve a substantial amount of communication between clients and professionals, as well as peculiarities of the Japanese language and culture hinder Japanese firms from effectively using offshored business services. However, if it is the peculiarities of the Japanese language and culture that are the biggest obstacles to the international outsourcing of business services, outsourcing of such services to domestic suppliers may nevertheless have a positive productivity effect. Thus, it would be interesting to examine whether domestic service outsourcing has a productivity-enhancing effect, and also which has the stronger productivity effect, international or domestic outsourcing.

Second, this study does not address the effects of offshoring on each type of worker, i.e., low-skilled workers and high-skilled workers. From a theoretical perspective, task-level analysis has attracted much attention in the literature (e.g., Grossman and Rossi-Hansberg 2008). Particularly in the context of service offshoring, high-skilled tasks have been increasingly moved overseas due to advances in IT. Investigating the productivity effect of offshoring separately on low-skilled workers (or tasks) and on high-skilled workers (or tasks) is another possible item for a future research agenda.

Finally, we did not explore the productivity effect of service offshoring by region in this study because sufficient data on the regional distribution of service offshoring were not available. Thus far, the magnitude of service offshoring in Japanese manufacturing has remained low and has not shown as conspicuous an increasing trend as in the case of material offshoring. However, it will become important to analyze the effect of service offshoring by region if the volume of service offshoring increases in the future. If services offshored to developed countries embody greater knowledge or know-how while services offshored to developing countries are less knowledge-intensive but cheaper, the productivity-enhancing effect of service offshoring may differ by region/country to which activities are outsourced. Regional differences in the effect of service offshoring on productivity are another issue that it would be useful to further scrutinize in the future. Exploring these issues will help to shed light on the mechanism whereby offshoring can increase productivity.

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Table 1. Material and Service Offshoring in Japanese Manufacturing

	1990 (%)	1995 (%)	2000 (%)	2004 (%)	Change 1990–2004 (% points)	(%)
Imported inputs as a percentage share of total inputs						
Materials	**5.95**	**6.29**	**7.69**	**8.89**	**2.95**	**49.57**
of which:						
from North America	2.16	2.08	2.29	1.96	-0.21	-9.63
from EU	1.21	1.14	1.32	1.56	0.35	28.81
from Asia	1.60	2.24	3.23	4.40	2.80	175.56
from China	0.29	0.60	0.98	1.73	1.44	505.10
from ASEAN4	0.48	0.61	0.96	1.16	0.68	140.19
from NIEs4	0.76	0.96	1.20	1.39	0.63	82.70
Services	**0.21**	**0.20**	**0.23**	**0.19**	**-0.02**	**-11.50**
of which:						
from North America	0.09	0.09	0.11	0.08	-0.003	-3.72
from EU	0.06	0.04	0.05	0.06	-0.008	-11.72
from Asia	0.04	0.05	0.05	0.04	-0.008	-18.78
from China	0.01	0.01	0.01	0.01	0.003	47.09
from ASEAN4	0.01	0.01	0.01	0.01	-0.002	-20.16
from NIEs4	0.03	0.03	0.03	0.02	-0.008	-30.65

Note: The shares for 1990 and 1995 are calculated using the regional distribution in 1996 as weights. Data on the regional distribution of services trade are only available from 1996 onwards.

Table 2. Material and Service Offshoring by Industry

(a) Imported material inputs as a percentage of total inputs (%)

	1990	1995	2000	2004
Food & beverages	10.73	10.06	11.01	11.40
Textiles	10.47	9.13	10.65	15.07
Wood products	24.89	20.11	19.81	21.05
Pulp & paper	8.49	8.98	8.93	9.42
Printing	2.19	2.77	1.82	2.26
Leather	24.11	19.55	21.68	26.43
Rubber & Plastics	4.47	4.89	6.45	8.07
Chemicals	6.71	7.08	7.35	8.47
Non-metallic minerals	1.36	1.03	1.93	2.59
Basic metals	3.47	3.41	2.38	3.12
Fabricated metal products	11.64	9.63	10.68	13.99
Machinery & equipment	2.43	3.19	5.84	6.30
Electrical machinery	5.07	8.30	12.13	16.55
Transport equipment	2.01	1.67	3.16	3.70
Precision machinery	4.89	9.10	12.10	14.63
Mfg.n.e.c.	5.77	6.45	6.99	8.59

(b) Imported service inputs as a percentage of total inputs (%)

	1990	1995	2000	2004
Food & beverages	0.21	0.22	0.26	0.23
Textiles	0.19	0.21	0.19	0.19
Wood products	0.10	0.04	0.07	0.06
Pulp & paper	0.14	0.16	0.16	0.14
Printing	0.23	0.29	0.33	0.26
Leather	0.16	0.14	0.17	0.18
Rubber & Plastics	0.15	0.16	0.17	0.13
Chemicals	0.44	0.40	0.43	0.37
Non-metallic minerals	0.19	0.16	0.20	0.17
Basic metals	0.09	0.07	0.07	0.04
Fabricated metal products	0.15	0.16	0.17	0.13
Machinery & equipment	0.24	0.19	0.21	0.16
Electrical machinery	0.30	0.24	0.27	0.24
Transport equipment	0.16	0.14	0.19	0.14
Precision machinery	0.30	0.25	0.26	0.22
Mfg.n.e.c.	0.21	0.22	0.29	0.29

Table 3. OLS Estimates of the Effect of Offshoring on TFP

Dependent variable: Δln (Real Output)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δ Service Offshoring	-0.58		-0.588	-0.588	-0.613		-0.635	-0.658	-5.028
	(1.627)		(1.511)	(1.497)	(1.716)		(1.603)	(1.604)	(2.554)
Δ Service Offshoring, $_{t-1}$		0.374	0.374	0.31		0.249	0.136	0.095	
		(1.048)	(0.706)	(0.753)		(1.044)	(0.674)	(0.691)	
Δ Material Offshoring	0.408**		0.445**	0.380**	0.151		0.19	0.175	0.822
	(0.198)		(0.183)	(0.152)	(0.132)		(0.130)	(0.129)	(0.423)
Δ Material Offshoring, $_{t-1}$		0.229	0.258	0.207		0.062	0.101	0.092	
		(0.257)	(0.230)	(0.191)		(0.179)	(0.171)	(0.163)	
Δ ln(Material Input)	0.542***	0.533***	0.544***	0.542***	0.479***	0.478***	0.484***	0.486***	0.754***
	(0.048)	(0.047)	(0.050)	(0.050)	(0.049)	(0.048)	(0.052)	(0.052)	(0.106)
Δ ln(Service Input)	0.07*	0.071**	0.071**	0.075**	0.062*	0.062*	0.062*	0.063*	0.167*
	(0.036)	(0.032)	(0.035)	(0.035)	(0.032)	(0.031)	(0.033)	(0.033)	(0.063)
Δ ln(Number of Workers)	0.084	0.062	0.074		0.104*	0.088	0.09		0.286**
	(0.057)	(0.066)	(0.065)		(0.057)	(0.069)	(0.068)		(0.094)
Δ ln(Number of Nonproduction Workers)				0.159				0.103	
				(0.130)				(0.136)	
Δ ln(Number of Production Workers)				-0.079				-0.012	
				(0.131)				(0.133)	
Δ ln(Capital Stock)	0.262**	0.280**	0.267**	0.267**	0.124**	0.155***	0.152***	0.149**	0.114
	(0.105)	(0.109)	(0.109)	(0.109)	(0.055)	(0.057)	(0.056)	(0.057)	(0.090)
Year Dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes
Industry Dummies	no	no	no	no	yes	yes	yes	yes	no
Observations	800	750	750	750	800	750	750	750	100
R-squared	0.641	0.629	0.635	0.637	0.700	0.692	0.693	0.693	0.803

Notes: Clustered standard errors at the industry level are shown in parentheses, with ***, **, and * indicating significance at the 1, 5, and 10 percent levels, respectively. The constant term is not reported.

Table 4. OLS Estimates of the Effect of Offshoring on Labor Productivity

Dependent variable: Δln (Real value added per worker)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Δ Service Offshoring	0.858		0.534	1.430	0.818	1.215		1.217	2.210	1.478	-43.350
	(5.404)		(5.399)	(4.976)	(5.575)	(5.237)		(5.188)	(4.821)	(5.181)	(24.520)
Δ Service Offshoring, $_{t-1}$		0.855	1.790	2.048	1.776		0.921	1.841	2.245	2.091	
		(3.417)	(2.152)	(2.273)	(2.137)		(3.554)	(2.386)	(2.722)	(2.429)	
Δ Material Offshoring	2.101**		1.970***	2.200***	2.384**	0.430		1.373***	1.406***	2.124***	3.548
	(0.936)		(0.717)	(0.693)	(0.904)	(0.715)		(0.370)	(0.384)	(0.486)	(2.407)
Δ Material Offshoring, $_{t-1}$		1.769*	1.888**	2.089*	1.715**		1.084	1.359	1.367	1.533	
		(0.997)	(0.905)	(1.082)	(0.785)		(1.098)	(1.088)	(1.087)	(1.269)	
Δ ln(Capital Stock)	0.854	0.933	0.920	0.952	0.950	0.397	0.533	0.532	0.638	0.545	1.645
	(0.691)	(0.725)	(0.731)	(0.725)	(0.755)	(0.503)	(0.525)	(0.524)	(0.588)	(0.494)	(1.050)
Δ IT Capital Stock Share				-0.731					-0.654		
				(1.818)					(1.149)		
Δ IT Capital Stock Share, $_{t-1}$				-3.547					-2.974		
				(3.140)					(2.138)		
Δ Import Share					-1.254					-2.484***	
					(0.776)					(0.630)	
Δ Import Share, $_{t-1}$					0.422					-0.858	
					(0.363)					(0.678)	
Year Dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Sector Dummies	no	no	no	no	no	yes	yes	yes	yes	yes	no
Observations	795	747	747	747	747	795	747	747	747	747	99
R-squared	0.049	0.049	0.059	0.070	0.069	0.184	0.171	0.175	0.181	0.205	0.093

Notes: Clustered standard errors at the industry level are shown in parentheses, with ***, **, and * indicating significance at the 1, 5, and 10 percent levels, respectively. The constant term is not reported.

Table 5. Estimate of the Effect of Material Offshoring to Asia on TFP

Dependent variable: Δln (Real Output)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	GMM	GMM	OLS
Δ Service Offshoring	-0.638		-0.481	-0.489	-0.637		-0.565	-0.575	-5.852	-5.562	-3.718
	(1.649)		(1.528)	(1.523)	(1.720)		(1.613)	(1.615)	(6.171)	(5.029)	(2.926)
Δ Service Offshoring, $_{t-1}$		0.304	0.034	0.031		0.232	-0.027	-0.037	-1.443	-0.329	
		(1.033)	(0.674)	(0.691)		(1.048)	(0.652)	(0.652)	(6.016)	(5.134)	
Δ Material Offshoring to Asia	1.037***		1.015***	0.966***	0.466**		0.622**	0.606**	2.460	2.112*	2.027**
	(0.303)		(0.220)	(0.288)	(0.225)		(0.234)	(0.287)	(1.473)	(1.106)	(0.802)
Δ Material Offshoring to Asia, $_{t-1}$		1.242**	0.963***	0.915***		0.728*	0.690**	0.675**	0.834**	0.964**	
		(0.547)	(0.356)	(0.310)		(0.425)	(0.337)	(0.320)	(0.401)	(0.417)	
Δ ln(Material Input)	0.536***	0.509***	0.530***	0.530***	0.480***	0.465***	0.484***	0.484***	0.550***	0.445***	0.714***
	(0.045)	(0.044)	(0.046)	(0.046)	(0.047)	(0.045)	(0.049)	(0.048)	(0.132)	(0.106)	(0.112)
Δ ln(Service Input)	0.071**	0.074***	0.077**	0.078**	0.063*	0.064**	0.066**	0.067**	0.062	0.046	0.179***
	(0.035)	(0.027)	(0.032)	(0.032)	(0.032)	(0.028)	(0.031)	(0.031)	(0.064)	(0.068)	(0.064)
Δ ln(Number of Workers)	0.091	0.091*	0.094		0.105*	0.116**	0.098				0.327***
	(0.061)	(0.051)	(0.067)		(0.060)	(0.053)	(0.069)				(0.091)
Δ ln(Number of Nonproduction Workers)				0.083				0.067	0.104		
				(0.120)				(0.130)	(0.272)		
Δ ln(Number of Production Workers)				0.012				0.031	0.222		
				(0.124)				(0.130)	(0.265)		
Δ ln(Number of Technical and Managerial Workers)										0.077	
										(0.130)	
Δ ln(Number of Non-technical and Managerial Workers)										0.326	
										(0.304)	
Δ ln(Capital Stock)	0.258**	0.268**	0.260**	0.261**	0.127**	0.141***	0.156***	0.154***	0.056	0.024	0.094
	(0.104)	(0.102)	(0.105)	(0.105)	(0.055)	(0.049)	(0.056)	(0.055)	(0.077)	(0.077)	(0.095)
Δ ln(Real Output), $_{t-1}$									0.206	0.232**	
									(0.140)	(0.115)	
Year Dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Industry Dummies	no	no	no	no	yes	yes	yes	yes	no	no	no
Observations	800	800	750	750	800	800	750	750	750	750	100
R-squared	0.646	0.631	0.646	0.646	0.701	0.691	0.697	0.697			0.809
p-value of Hansen Statistic									0.178	0.208	
p-value of AR Test Statistic									0.056	0.033	
Number of Included Industries									50	50	

Notes: Clustered standard errors at the industry level are shown in parentheses, with ***, **, and * indicating significance at the 1, 5, and 10 percent levels, respectively. The constant term is not reported. For the GMM estimations (models 9 and 10), we use as instruments the first, second, and third lags of each variable except for year dummies.

Table 6. OLS Estimates of the Effect of Information Services Offshoring on TFP

Dependent variable: Δln (Real Output)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δ Information Services Offshoring	10.753		48.847*	43.996	-0.341		65.724	65.404	-8.684
	(21.485)		(27.719)	(32.420)	(24.464)		(43.043)	(47.453)	(83.960)
Δ Information Services Offshoring, $_{t-1}$		82.621***	116.420***	108.504***		84.851***	146.501***	145.918**	
		(24.364)	(33.407)	(37.795)		(25.024)	(49.006)	(55.442)	
Δ Material Offshoring	0.409**		0.377**	0.343**	0.152		0.130	0.129	0.821*
	(0.197)		(0.164)	(0.144)	(0.132)		(0.124)	(0.126)	(0.435)
Δ Material Offshoring, $_{t-1}$		0.347	0.204	0.178		0.148	0.056	0.055	
		(0.285)	(0.213)	(0.184)		(0.186)	(0.160)	(0.155)	
Δ ln(Material Input)	0.542***	0.517***	0.542***	0.541***	0.480***	0.465***	0.482***	0.482***	0.756***
	(0.049)	(0.044)	(0.050)	(0.050)	(0.049)	(0.045)	(0.052)	(0.052)	(0.106)
Δ ln(Service Input)	0.071*	0.068**	0.074**	0.076**	0.063*	0.061**	0.066*	0.066*	0.169**
	(0.036)	(0.030)	(0.036)	(0.036)	(0.032)	(0.030)	(0.034)	(0.034)	(0.064)
Δ ln(Number of Workers)	0.084	0.070	0.071		0.105*	0.105*	0.082		0.288***
	(0.057)	(0.057)	(0.068)		(0.057)	(0.057)	(0.072)		(0.096)
Δ ln(Number of Nonproduction Workers)				0.105				0.042	
				(0.144)				(0.141)	
Δ ln(Number of Production Workers)				-0.031				0.040	
				(0.145)				(0.137)	
Δ ln(Capital Stock)	0.261**	0.272**	0.258**	0.259**	0.124**	0.130**	0.135**	0.135**	0.105
	(0.105)	(0.107)	(0.112)	(0.111)	(0.055)	(0.052)	(0.062)	(0.061)	(0.088)
Year Dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes
Industry Dummies	no	no	no	no	yes	yes	yes	yes	no
Observations	800	800	750	750	800	800	750	750	100
R-squared	0.641	0.626	0.643	0.643	0.700	0.693	0.703	0.703	0.803

Notes: Clustered standard errors at the industry level are shown in parentheses, with ***, **, and * indicating significance at the 1, 5, and 10 percent levels, respectively. The constant term is not reported.

Appendix Table 1. List of Industries

Sector	Industry	JIP industry classification	
Primary	-	1	Rice, wheat production
Primary	-	2	Miscellaneous crop farming
Primary	-	3	Livestock and sericulture farming
Primary	-	4	Agricultural services
Primary	-	5	Forestry
Primary	-	6	Fisheries
Energy-related	-	7	Mining
Manufacturing	Food & beverages	8	Livestock products
Manufacturing	Food & beverages	9	Seafood products
Manufacturing	Food & beverages	10	Flour and grain mill products
Manufacturing	Food & beverages	11	Miscellaneous foods and related products
Manufacturing	Food & beverages	12	Prepared animal foods and organic fertilizers
Manufacturing	Food & beverages	13	Beverages
Manufacturing	Food & beverages	14	Tobacco
Manufacturing	Textiles	15	Textile products
Manufacturing	Wood products	16	Lumber and wood products
Manufacturing	Mfg. n.e.c.	17	Furniture and fixtures
Manufacturing	Pulp & paper	18	Pulp, paper, and coated and glazed paper
Manufacturing	Pulp & paper	19	Paper products
Manufacturing	Printing	20	Printing, plate making for printing and bookbinding
Manufacturing	Leather	21	Leather and leather products
Manufacturing	Rubber & Plastics	22	Rubber products
Manufacturing	Chemicals	23	Chemical fertilizers
Manufacturing	Chemicals	24	Basic inorganic chemicals
Manufacturing	Chemicals	25	Basic organic chemicals
Manufacturing	Chemicals	26	Organic chemicals
Manufacturing	Chemicals	27	Chemical fibers
Manufacturing	Chemicals	28	Miscellaneous chemical products
Manufacturing	Chemicals	29	Pharmaceutical products
Energy-related	-	30	Petroleum products
Energy-related	-	31	Coal products
Manufacturing	Non-metallic minerals	32	Glass and its products
Manufacturing	Non-metallic minerals	33	Cement and its products
Manufacturing	Non-metallic minerals	34	Pottery
Manufacturing	Non-metallic minerals	35	Miscellaneous ceramic, stone and clay products
Manufacturing	Basic metals	36	Pig iron and crude steel
Manufacturing	Basic metals	37	Miscellaneous iron and steel
Manufacturing	Basic metals	38	Smelting and refining of non-ferrous metals
Manufacturing	Fabricated metal products	39	Non-ferrous metal products
Manufacturing	Fabricated metal products	40	Fabricated constructional and architectural metal products
Manufacturing	Fabricated metal products	41	Miscellaneous fabricated metal products
Manufacturing	Machinery & equipment	42	General industry machinery
Manufacturing	Machinery & equipment	43	Special industry machinery
Manufacturing	Machinery & equipment	44	Miscellaneous machinery
Manufacturing	Machinery & equipment	45	Office and service industry machines
Manufacturing	Electrical machinery	46	Electrical generating, transmission, distribution and industrial apparatus
Manufacturing	Electrical machinery	47	Household electric appliances
Manufacturing	Electrical machinery	48	Electronic data processing machines, digital and analog computer equipment and accessories
Manufacturing	Electrical machinery	49	Communication equipment
Manufacturing	Electrical machinery	50	Electronic equipment and electric measuring instruments
Manufacturing	Electrical machinery	51	Semiconductor devices and integrated circuits
Manufacturing	Electrical machinery	52	Electronic parts
Manufacturing	Electrical machinery	53	Miscellaneous electrical machinery equipment
Manufacturing	Transport equipment	54	Motor vehicles
Manufacturing	Transport equipment	55	Motor vehicle parts and accessories
Manufacturing	Transport equipment	56	Other transportation equipment
Manufacturing	Precision machinery	57	Precision machinery & equipment
Manufacturing	Rubber & Plastics	58	Plastic products
Manufacturing	Mfg. n.e.c.	59	Miscellaneous manufacturing industries

(continued)

-	-	60	Construction
-	-	61	Civil engineering
Energy-related	-	62	Electricity
Energy-related	-	63	Gas, heat supply
Energy-related	-	64	Waterworks
Energy-related	-	65	Water supply for industrial use
Services	-	66	Waste disposal
Services	-	67	Wholesale
Services	-	68	Retail
Services	Finance	69	Finance
Services	Insurance	70	Insurance
Services	-	71	Real estate
Services	-	72	Housing
Services	Transportation	73	Railway
Services	Transportation	74	Road transportation
Services	Transportation	75	Water transportation
Services	Transportation	76	Air transportation
Services	Transportation	77	Other transportation and packing
Services	Telecommunication	78	Telegraph and telephone
Services	-	79	Mail
Services	-	80	Education (private and non-profit)
Services	-	81	Research (private)
Services	-	82	Medical (private)
Services	-	83	Hygiene (private and non-profit)
Services	-	84	Other public services
Services	Business Services	85	Advertising
Services	Business Services	86	Rental of office equipment and goods
Services	Business Services	87	Automobile maintenance services
Services	Business Services	88	Other services for businesses
Services	-	89	Entertainment
Services	Information Services	90	Broadcasting
Services	Information Services	91	Information services and internet-based services
Services	Information Services	92	Publishing
Services	Information Services	93	Video picture, sound information, character information production and distribution
Services	-	94	Eating and drinking places
Services	-	95	Accommodation
Services	-	96	Laundry, beauty and bath services
Services	-	97	Other services for individuals
Services	-	98	Education (public)
Services	-	99	Research (public)
Services	-	100	Medical (public)
Services	-	101	Hygiene (public)
Services	-	102	Social insurance and social welfare (public)
Services	-	103	Public administration
Services	-	104	Medical (non-profit)
Services	-	105	Social insurance and social welfare (non-profit)
Services	-	106	Research (non-profit)
Services	-	107	Other (non-profit)
-	-	108	Activities not elsewhere classified

Appendix Table 2. TFP and Material Offshoring to Europe

Dependent variable: Δln (Real Output)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	GMM	GMM	OLS
Δ Service Offshoring	-0.785		-0.819	-0.786	-0.677	-0.727		-0.822	-0.846	-0.817	-2.053	1.868	-5.192*
	(1.627)		(1.481)	(1.460)	(1.435)	(1.690)		(1.560)	(1.556)	(1.553)	(6.621)	(9.413)	(2.590)
Δ Service Offshoring, $_{t-1}$		0.299	0.103	0.072	0.152		0.211	-0.034	-0.073	-0.044	-0.227	2.968	
		(1.058)	(0.675)	(0.748)	(0.723)		(1.079)	(0.679)	(0.698)	(0.686)	(3.562)	(6.243)	
Δ Material Offshoring to Europe	0.440		0.476	0.431	0.439	0.362		0.425	0.425	0.428	1.412	0.574	1.916
	(0.454)		(0.464)	(0.453)	(0.457)	(0.480)		(0.491)	(0.487)	(0.489)	(2.505)	(2.296)	(1.372)
Δ Material Offshoring to Europe, $_{t-1}$		0.129	0.250	0.198	0.153		0.150	0.335	0.334	0.327	0.789	0.394	
		(0.378)	(0.346)	(0.359)	(0.357)		(0.392)	(0.373)	(0.377)	(0.381)	(0.812)	(0.978)	
Δ ln(Material Input)	0.534***	0.521***	0.538***	0.537***	0.533***	0.476***	0.467***	0.480***	0.483***	0.481***	0.600***	0.557***	0.790***
	(0.045)	(0.047)	(0.049)	(0.048)	(0.048)	(0.046)	(0.046)	(0.049)	(0.049)	(0.049)	(0.182)	(0.131)	(0.101)
Δ ln(Service Input)	0.071**	0.065**	0.071**	0.076**	0.076**	0.063**	0.060*	0.062*	0.064**	0.063*	0.132	0.106	0.177***
	(0.033)	(0.032)	(0.034)	(0.033)	(0.032)	(0.031)	(0.030)	(0.032)	(0.032)	(0.032)	(0.087)	(0.104)	(0.066)
Δ ln(Number of Workers)	0.075	0.063	0.059			0.103*	0.108*	0.089					0.253**
	(0.058)	(0.055)	(0.063)			(0.057)	(0.055)	(0.068)					(0.104)
Δ ln(Number of Nonproduction Workers)				0.204					0.113		0.216		
				(0.151)					(0.139)		(0.412)		
Δ ln(Number of Production Workers)				-0.132					-0.024		-0.078		
				(0.152)					(0.137)		(0.224)		
Δ ln(Number of Technical and Managerial Workers)					0.196					0.047		0.168	
					(0.131)					(0.116)		(0.263)	
Δ ln(Number of Non-technical and Managerial Workers)					-0.120					0.042		0.010	
					(0.143)					(0.125)		(0.283)	
Δ ln(Capital Stock)	0.272**	0.284***	0.283**	0.278**	0.271**	0.126**	0.144***	0.155***	0.151**	0.155**	0.119	0.091	0.093
	(0.106)	(0.105)	(0.109)	(0.109)	(0.107)	(0.055)	(0.050)	(0.058)	(0.058)	(0.058)	(0.103)	(0.103)	(0.093)
Δ ln(Real Output), $_{t-1}$											0.277**	0.271*	
											(0.138)	(0.162)	
Year Dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Industry Dummies	no	no	no	no	no	yes	yes	yes	yes	yes	no	no	no
Observations	800	800	750	750	750	800	800	750	750	750	750	750	100
R-squared	0.637	0.617	0.629	0.633	0.633	0.700	0.687	0.693	0.693	0.693			0.797
p-value of Hansen Statistic											0.049	0.056	
p-value of AR Test Statistic											0.160	0.100	
Number of Included Industries											50	50	

Notes: Clustered standard errors at the industry level are shown in parentheses, with ***, **, and * indicating significance at the 1, 5, and 10 percent levels, respectively. The constant term is not reported. For the GMM estimations (models 11 and 12), we use as instruments the first, second, and third lags of each variable except for year dummies.

Appendix Table 3. TFP and Material Offshoring to North America

Dependent variable: Δln (Real Output)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	GMM	GMM	OLS
Δ Service Offshoring	-0.695		-0.676	-0.664	-0.563	-0.651		-0.674	-0.699	-0.671	-2.757	-1.206	-5.396**
	(1.685)		(1.542)	(1.513)	(1.480)	(1.725)		(1.602)	(1.601)	(1.594)	(8.005)	(13.304)	(2.252)
Δ Service Offshoring, $_{t-1}$		0.324	0.158	0.106	0.170		0.243	0.023	-0.019	0.008	-0.887	0.807	
		(1.027)	(0.655)	(0.730)	(0.708)		(1.047)	(0.644)	(0.665)	(0.650)	(5.822)	(9.118)	
Δ Material Offshoring to North America	0.070		0.137	0.078	0.054	-0.107		-0.080	-0.085	-0.086	-0.085	-0.372	0.244
	(0.309)		(0.336)	(0.330)	(0.336)	(0.272)		(0.301)	(0.306)	(0.307)	(1.079)	(1.384)	(1.127)
Δ Material Offshoring to North America, $_{t-1}$		0.123	0.121	0.101	0.085		0.077	0.042	0.045	0.039	0.390	0.273	
		(0.234)	(0.257)	(0.262)	(0.259)		(0.249)	(0.272)	(0.281)	(0.276)	(0.495)	(0.534)	
Δ ln(Material Input)	0.533***	0.521***	0.537***	0.535***	0.531***	0.473***	0.467***	0.477***	0.479***	0.477***	0.556***	0.529***	0.776***
	(0.046)	(0.047)	(0.050)	(0.049)	(0.049)	(0.047)	(0.046)	(0.050)	(0.050)	(0.050)	(0.131)	(0.111)	(0.107)
Δ ln(Service Input)	0.070**	0.065**	0.070**	0.075**	0.075**	0.063**	0.060*	0.061*	0.064**	0.062*	0.115	0.110	0.180**
	(0.033)	(0.032)	(0.034)	(0.033)	(0.032)	(0.031)	(0.030)	(0.031)	(0.031)	(0.032)	(0.079)	(0.082)	(0.068)
Δ ln(Number of Workers)	0.073	0.064	0.057			0.100*	0.108*	0.086					0.276**
	(0.059)	(0.055)	(0.064)			(0.058)	(0.054)	(0.068)					(0.105)
Δ ln(Number of Nonproduction Workers)				0.205					0.113		0.184		
				(0.151)					(0.140)		(0.410)		
Δ ln(Number of Production Workers)				-0.134					-0.026		-0.153		
				(0.151)					(0.138)		(0.170)		
Δ ln(Number of Technical and Managerial Workers)					0.197					0.049		0.226	
					(0.131)					(0.117)		(0.261)	
Δ ln(Number of Non-technical and Managerial Workers)					-0.123					0.038		-0.092	
					(0.141)					(0.124)		(0.253)	
Δ ln(Capital Stock)	0.271**	0.283***	0.282**	0.277**	0.270**	0.127**	0.143***	0.156***	0.152**	0.155***	0.081	0.071	0.094
	(0.107)	(0.105)	(0.110)	(0.110)	(0.108)	(0.056)	(0.049)	(0.057)	(0.057)	(0.057)	(0.082)	(0.091)	(0.084)
Δ ln(Real Output), $_{t-1}$											0.312*	0.283*	
											(0.167)	(0.158)	
Year Dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Industry Dummies	no	no	no	no	no	yes	yes	yes	yes	yes	no	no	no
Observations	800	800	750	750	750	800	800	750	750	750	750	750	100
R-squared	0.637	0.617	0.628	0.633	0.633	0.700	0.687	0.692	0.692	0.692			0.793
p-value of Hansen Statistic											0.079	0.079	
p-value of AR Test Statistic											0.093	0.065	
Number of Included Industries											50	50	

Notes: Clustered standard errors at the industry level are shown in parentheses, with ***, **, and * indicating significance at the 1, 5, and 10 percent levels, respectively.
The constant term is not reported. For the GMM estimations (models 11 and 12), we use as instruments the first, second, and third lags of each variable except for year dummies.

Appendix Table 4. TFP and Material Offshoring to China

Dependent variable: Δln (Real Output)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	GMM	GMM	OLS
Δ Service Offshoring	-0.666		-0.600	-0.621	-0.520	-0.641		-0.632	-0.657	-0.632	-11.228	-4.216	-5.584**
	(1.676)		(1.521)	(1.507)	(1.477)	(1.735)		(1.612)	(1.613)	(1.607)	(18.032)	(9.780)	(2.574)
Δ Service Offshoring, $_{t-1}$		0.372	0.156	0.124	0.182		0.270	0.044	0.017	0.034	-6.091	0.047	
		(1.042)	(0.703)	(0.755)	(0.743)		(1.052)	(0.671)	(0.684)	(0.676)	(14.218)	(4.091)	
Δ Material Offshoring to China	0.372		0.480	0.189	0.245	0.181		0.293	0.215	0.276	-2.239	-0.763	-0.672
	(0.718)		(0.743)	(0.639)	(0.674)	(0.638)		(0.663)	(0.634)	(0.660)	(3.648)	(4.773)	(0.999)
Δ Material Offshoring to China t-1		0.922	0.797	0.556	0.588		0.660	0.676	0.612	0.659	0.376	0.698	
		(0.758)	(0.766)	(0.695)	(0.693)		(0.607)	(0.685)	(0.692)	(0.689)	(0.958)	(0.859)	
Δ ln(Material Input)	0.532***	0.518***	0.533***	0.533***	0.529***	0.474***	0.465***	0.476***	0.478***	0.476***	0.538***	0.543***	0.775***
	(0.045)	(0.045)	(0.047)	(0.047)	(0.047)	(0.046)	(0.045)	(0.047)	(0.047)	(0.047)	(0.138)	(0.119)	(0.105)
Δ ln(Service Input)	0.069*	0.072**	0.075**	0.079**	0.079**	0.062*	0.065**	0.066*	0.067**	0.066*	0.104	0.094	0.182**
	(0.034)	(0.031)	(0.035)	(0.035)	(0.034)	(0.032)	(0.030)	(0.033)	(0.033)	(0.033)	(0.092)	(0.093)	(0.069)
Δ ln(Number of Workers)	0.077	0.068	0.066			0.102*	0.109*	0.089					0.266**
	(0.058)	(0.055)	(0.065)			(0.058)	(0.055)	(0.069)					(0.100)
Δ ln(Number of Nonproduction Workers)				0.191					0.099		0.194		
				(0.146)					(0.140)		(0.288)		
Δ ln(Number of Production Workers)				-0.117					-0.009		-0.229		
				(0.148)					(0.137)		(0.257)		
Δ ln(Number of Technical and Managerial Workers)					0.183					0.033		0.176	
					(0.124)					(0.114)		(0.256)	
Δ ln(Number of Non-technical and Managerial Workers)					-0.105					0.056		-0.122	
					(0.135)					(0.122)		(0.482)	
Δ ln(Capital Stock)	0.271**	0.286***	0.285**	0.281**	0.274**	0.125**	0.145***	0.157***	0.154**	0.157***	0.110	0.099	0.088
	(0.106)	(0.105)	(0.109)	(0.108)	(0.106)	(0.056)	(0.050)	(0.058)	(0.058)	(0.058)	(0.096)	(0.140)	(0.095)
Δ ln(Real Output), $_{t-1}$											0.295**	0.269*	
											(0.136)	(0.153)	
Year Dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Industry Dummies	no	no	no	no	no	yes	yes	yes	yes	yes	no	no	no
Observations	800	800	750	750	750	800	800	750	750	750	750	750	100
R-squared	0.637	0.619	0.630	0.633	0.634	0.700	0.688	0.693	0.693	0.693			0.794
p-value of Hansen Statistic											0.033	0.023	
p-value of AR Test Statistic											0.117	0.264	
Number of Included Industries											50	50	

Notes: Clustered standard errors at the industry level are shown in parentheses, with ***, **, and * indicating significance at the 1, 5, and 10 percent levels, respectively.
The constant term is not reported. For the GMM estimations (models 11 and 12), we use as instruments the first, second, and third lags of each variable except for year dummies.

Appendix Table 5. TFP and Material Offshoring to ASEAN4

Dependent variable: Δln (Real Output)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	GMM	GMM	OLS
Δ Service Offshoring	-0.700		-0.656	-0.652	-0.556	-0.684		-0.706	-0.731	-0.704	-7.255	-4.894	-4.397*
	(1.683)		(1.531)	(1.512)	(1.484)	(1.768)		(1.635)	(1.633)	(1.627)	(12.008)	(12.120)	(2.541)
Δ Service Offshoring, $_{t-1}$		0.385	0.198	0.148	0.210		0.271	0.026	-0.013	0.013	-3.024	-0.343	
		(1.074)	(0.702)	(0.772)	(0.754)		(1.071)	(0.698)	(0.719)	(0.705)	(7.851)	(9.068)	
Δ Material Offshoring to ASEAN	-0.119		0.141	-0.009	-0.025	-1.026**		-0.926*	-0.920*	-0.919*	0.772	-0.474	2.587*
	(0.529)		(0.548)	(0.478)	(0.498)	(0.458)		(0.506)	(0.513)	(0.509)	(3.808)	(3.120)	(1.432)
Δ Material Offshoring to ASEAN, $_{t-1}$		1.443**	1.216**	1.069**	1.068**		0.677	0.325	0.325	0.329	1.558	1.307	
		(0.575)	(0.582)	(0.467)	(0.498)		(0.406)	(0.501)	(0.499)	(0.505)	(1.216)	(1.028)	
Δ ln(Material Input)	0.532***	0.524***	0.536***	0.535***	0.531***	0.472***	0.470***	0.477***	0.479***	0.478***	0.593***	0.576***	0.746***
	(0.045)	(0.045)	(0.047)	(0.046)	(0.046)	(0.045)	(0.045)	(0.047)	(0.047)	(0.047)	(0.165)	(0.137)	(0.105)
Δ ln(Service Input)	0.069**	0.063**	0.067**	0.072**	0.072**	0.059**	0.058**	0.057*	0.059**	0.058*	0.064	0.057	0.180***
	(0.032)	(0.030)	(0.031)	(0.031)	(0.030)	(0.028)	(0.029)	(0.029)	(0.029)	(0.029)	(0.097)	(0.100)	(0.066)
Δ ln(Number of Workers)	0.073	0.066	0.057			0.108*	0.106*	0.092					0.297***
	(0.058)	(0.056)	(0.065)			(0.056)	(0.055)	(0.066)					(0.097)
Δ ln(Number of Nonproduction Workers)				0.193					0.114		0.067		
				(0.142)					(0.139)		(0.424)		
Δ ln(Number of Production Workers)				-0.123					-0.022		-0.201		
				(0.144)					(0.137)		(0.175)		
Δ ln(Number of Technical and Managerial Workers)					0.187					0.047		0.152	
					(0.123)					(0.115)		(0.230)	
Δ ln(Number of Non-technical and Managerial Workers)					-0.113					0.045		-0.190	
					(0.135)					(0.123)		(0.251)	
Δ ln(Capital Stock)	0.272**	0.273**	0.275**	0.272**	0.265**	0.126**	0.141***	0.153***	0.149**	0.153***	0.130	0.112	0.081
	(0.106)	(0.104)	(0.108)	(0.108)	(0.107)	(0.056)	(0.049)	(0.057)	(0.057)	(0.057)	(0.087)	(0.091)	(0.091)
Δ ln(Real Output), $_{t-1}$											0.316**	0.303*	
											(0.156)	(0.152)	
Year Dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Industry Dummies	no	no	no	no	no	yes	yes	yes	yes	yes	no	no	no
Observations	800	800	750	750	750	800	800	750	750	750	750	750	100
R-squared	0.637	0.622	0.631	0.635	0.635	0.702	0.688	0.694	0.695	0.694			0.802
p-value of Hansen Statistic											0.0121	0.0125	
p-value of AR Test Statistic											0.131	0.106	
Number of Included Industries											50	50	

Notes: Clustered standard errors at the industry level are shown in parentheses, with ***, **, and * indicating significance at the 1, 5, and 10 percent levels, respectively.
The constant term is not reported. For the GMM estimations (models 11 and 12), we use as instruments the first, second, and third lags of each variable except for year dummies.

Appendix Table 6. TFP and Material Offshoring to NIEs4

Dependent variable: Δln (Real Output)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	GMM	GMM	OLS
Δ Service Offshoring	-0.424		-0.41	-0.422	-0.372	-0.537		-0.535	-0.555	-0.535	-7.153	-7.188	-5.346**
	(1.659)		(1.510)	(1.505)	(1.484)	(1.725)		(1.594)	(1.597)	(1.590)	(9.852)	(7.839)	(2.570)
Δ Service Offshoring, $_{t-1}$		0.502	0.203	0.184	0.203		0.322	0.078	0.055	0.067	-2.2	-1.218	
		(1.034)	(0.696)	(0.715)	(0.724)		(1.051)	(0.671)	(0.674)	(0.674)	(8.776)	(7.821)	
Δ Material Offshoring to NIEs4	3.049***		2.489**	2.346	2.332**	1.324		1.342	1.279	1.337	6.208	5.707	2.753**
	(0.778)		(1.059)	(1.203)	(1.112)	(0.856)		(1.040)	(1.176)	(1.081)	(4.964)	(4.900)	(1.361)
Δ Material Offshoring to NIEs4, $_{t-1}$		2.933**	1.384	1.275	1.238		1.187	0.64	0.598	0.633	-0.689	-0.143	
		(1.190)	(1.080)	(0.988)	(1.021)		(1.405)	(1.200)	(1.142)	(1.173)	(1.780)	(2.031)	
Δ ln(Material Input)	0.523***	0.502***	0.518***	0.519***	0.517***	0.477***	0.464***	0.479***	0.481***	0.479***	0.453**	0.388**	0.719***
	(0.044)	(0.047)	(0.048)	(0.047)	(0.048)	(0.046)	(0.047)	(0.049)	(0.049)	(0.049)	(0.188)	(0.159)	(0.119)
Δ ln(Service Input)	0.078**	0.065**	0.076**	0.078**	0.078**	0.066**	0.059*	0.065*	0.066*	0.065*	0.128	0.117	0.176**
	(0.034)	(0.031)	(0.034)	(0.034)	(0.034)	(0.032)	(0.030)	(0.033)	(0.033)	(0.033)	(0.082)	(0.080)	(0.068)
Δ ln(Number of Workers)	0.098*	0.082	0.086			0.109	0.110**	0.095					0.291***
	(0.057)	(0.050)	(0.061)			(0.057)	(0.053)	(0.067)					(0.093)
Δ ln(Number of Nonproduction Workers)				0.099					0.081		0.155		
				(0.125)					(0.137)		(0.307)		
Δ ln(Number of Production Workers)				-0.01					0.015		-0.029		
				(0.127)					(0.137)		(0.179)		
Δ ln(Number of Technical and Managerial Workers)					0.102					0.026		0.083	
					(0.103)					(0.108)		(0.144)	
Δ ln(Number of Non-technical and Managerial Workers)					-0.009					0.069		0.037	
					(0.114)					(0.117)		(0.276)	
Δ ln(Capital Stock)	0.249**	0.265**	0.254**	0.255**	0.250**	0.128**	0.144***	0.157***	0.155***	0.157***	0.02	0.004	0.096
	(0.104)	(0.101)	(0.106)	(0.106)	(0.105)	(0.055)	(0.049)	(0.056)	(0.056)	(0.056)	(0.119)	(0.118)	(0.097)
Δ ln(Real Output), $_{t-1}$											0.267*	0.300**	
											(0.138)	(0.130)	
Year Dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Industry Dummies	no	no	no	no	no	yes	yes	yes	yes	yes	no	no	no
Observations	800	800	750	750	750	800	800	750	750	750	750	750	100
R-squared	0.651	0.631	0.645	0.645	0.646	0.702	0.689	0.694	0.695	0.694			0.802
p-value of Hansen Statistic											0.000	0.000	
p-value of AR Test Statistic											0.032	0.022	
Number of Included Industries											50	50	

Notes: Clustered standard errors at the industry level are shown in parentheses, with ***, **, and * indicating significance at the 1, 5, and 10 percent levels, respectively.
The constant term is not reported. For the GMM estimations (models 11 and 12), we use as instruments the first, second, and third lags of each variable except for year dummies.

Appendix Table 7. TFP and Business Services Offshoring

Dependent variable: Δln (Real Output)

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(7) OLS	(8) OLS	(9) OLS	(10) OLS	(11) GMM	(12) GMM
Δ Business Services Offshoring	-0.800		2.275	1.069	1.541	-3.480		0.627	0.209	0.550	-1.701	-15.846
	(4.370)		(5.861)	(6.207)	(5.921)	(4.426)		(6.038)	(6.460)	(6.169)	(64.808)	(61.483)
Δ Business Services Offshoring, $_{t-1}$		10.379**	10.020*	8.825	9.415		10.703**	11.130*	10.602	11.014	8.504	5.297
		(4.862)	(5.752)	(6.100)	(5.873)		(5.134)	(6.449)	(6.893)	(6.602)	(24.233)	(20.376)
Δ Material Offshoring	0.410**		0.432**	0.373**	0.371**	0.153		0.175	0.164	0.172	2.053	1.355
	(0.198)		(0.179)	(0.150)	(0.159)	(0.132)		(0.127)	(0.127)	(0.128)	(1.388)	(1.101)
Δ Material Offshoring, $_{t-1}$		0.338	0.246	0.199	0.188		0.128	0.087	0.079	0.083	0.505	0.473
		(0.291)	(0.227)	(0.189)	(0.196)		(0.191)	(0.170)	(0.164)	(0.164)	(0.376)	(0.338)
Δ ln(Material Input)	0.541***	0.518***	0.545***	0.543***	0.540***	0.477***	0.466***	0.483***	0.484***	0.484***	0.600***	0.478***
	(0.049)	(0.045)	(0.051)	(0.051)	(0.051)	(0.050)	(0.045)	(0.053)	(0.053)	(0.053)	(0.195)	(0.146)
Δ ln(Service Input)	0.070*	0.069**	0.073**	0.076**	0.076**	0.062*	0.062**	0.063*	0.064*	0.064*	0.055	0.070
	(0.036)	(0.029)	(0.035)	(0.035)	(0.034)	(0.032)	(0.029)	(0.032)	(0.032)	(0.032)	(0.072)	(0.071)
Δ ln(Number of Workers)	0.084	0.073	0.078			0.105*	0.110*	0.095				
	(0.057)	(0.055)	(0.065)			(0.057)	(0.055)	(0.069)				
Δ ln(Number of Nonproduction Workers)				0.153					0.092		-0.003	
				(0.133)					(0.140)		(0.362)	
Δ ln(Number of Production Workers)				-0.070					0.004		0.166	
				(0.134)					(0.136)		(0.312)	
Δ ln(Number of Technical and Managerial Workers)					0.147					0.030		0.041
					(0.110)					(0.111)		(0.212)
Δ ln(Number of Non-technical and Managerial Workers)					-0.060					0.065		0.114
					(0.124)					(0.120)		(0.426)
Δ ln(Capital Stock)	0.262**	0.280**	0.268**	0.267**	0.261**	0.124**	0.144***	0.152***	0.149**	0.152***	0.091	0.080
	(0.105)	(0.105)	(0.109)	(0.109)	(0.107)	(0.055)	(0.049)	(0.056)	(0.056)	(0.056)	(0.085)	(0.094)
Δ ln(Real Output), $_{t-1}$											0.243**	0.298**
											(0.109)	(0.126)
Year Dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Industry Dummies	no	no	no	no	no	yes	yes	yes	yes	yes	no	no
Observations	800	800	750	750	750	800	800	750	750	750	750	750
R-squared	0.641	0.622	0.636	0.638	0.638	0.700	0.689	0.694	0.695	0.694		
p-value of Hansen Statistic											0.109	0.069
p-value of AR Test Statistic											0.218	0.142
Number of Included Industries											50	50

Notes: Clustered standard errors at the industry level are shown in parentheses, with ***, **, and * indicating significance at the 1, 5, and 10 percent levels, respectively. The constant term is not reported. For the GMM estimations (models 11 and 12), we use as instruments the first, second, and third lags of each variable except for year dummies.