

Employment effects of offshoring across sectors and occupations in Japan*

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Abstract

First moves towards a real understanding of offshoring date back to very recent times. In the case of Japan, the studies conducted so far focus alone on firm level data and delve into the productivity effects and the skill upgrading between skilled and unskilled workers. Here I carry out an empirical analysis of the employment effects of offshoring for Japanese industries on a broader classification of skills or occupations, while considering the three major sectors of the economy and taking account of both services and materials offshoring. My results suggest that different types of offshoring affect occupations differently. In particular, services offshoring tends to benefit highly skilled occupations more, while materials offshoring tends to benefit production workers instead.

JEL Classification: F16, J23.

Keywords: offshoring; employment; sectors; occupations.

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1 Introduction

It is now no secret that Japan has been lagging behind for the past twenty years, running into an uncertain post-bubble era that seems to stretch to unknown horizons. The lost decade, as it came to be known, has practically left in the shadows the increasingly important subject of offshoring, which can have practical consequences for the competitiveness of local firms and industries when they most need it.

The goal of this paper is to disentangle the employment effects of offshoring on Japanese industries and across sectors and occupations. Highly aggregated data not only will help reassure the previous results obtained for Japan at the firm level and for particular industries (Head and Ries, 2002; Hijzen *et al.*, 2006, 2010) but, due to their comprehensiveness, they will serve to extend the analysis to the whole economy. The Japan Industrial Productivity database (JIP) will provide the data for constructing two offshoring indices—in line with Feenstra and Hanson (1996)—representative of the intensities of services and materials (or production) offshoring.

But why are the economic implications of offshoring really important? Although it seems reasonable to think of adjustment costs in the short run for workers and firms, one would expect the sectorial composition (rather than the quantity) of the economy's workforce to change in the future. In the words of Blinder (2006), "the world as a whole cannot lose from increases in productivity" that are a natural result of trade and offshoring. Eventually, better paid and higher value-added jobs will probably show up in the 'relocating' economy due to economic scarcity and the exploitation of comparative advantages.

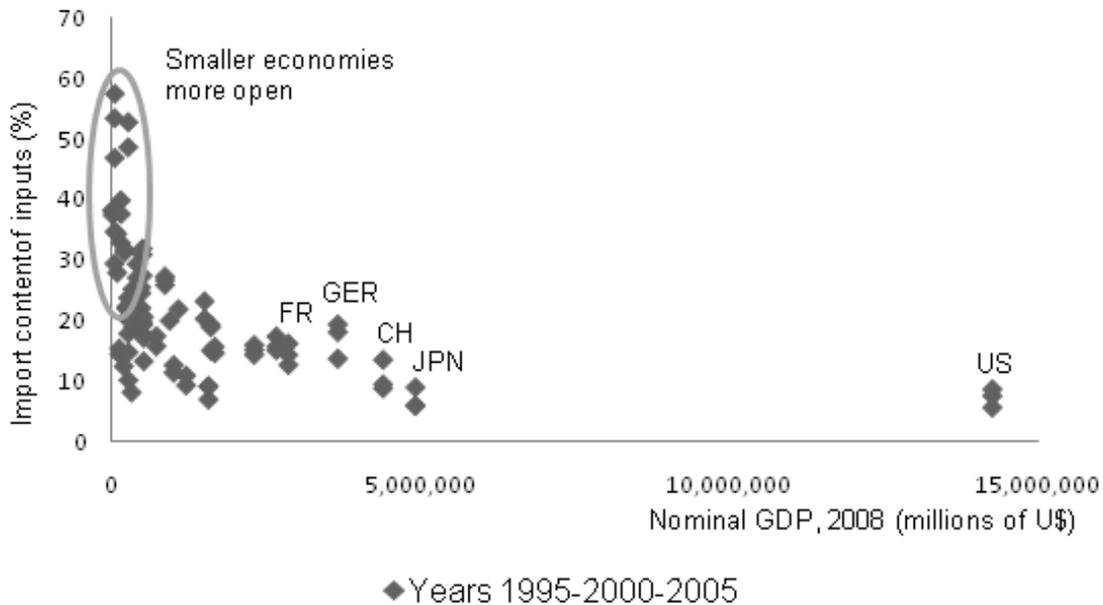
Simply put, widespread fears on the subject usually revolve around the millions of jobs soon to be relocated from developed economies into developing ones, with a significant welfare cost in the former due to 'employment destruction'. However, the media reports as well as the surveys conducted by consulting firms tend to overlook the brighter side of the story. Gains in terms of employment and productivity for local firms not only are possible, but most expected. For instance, productivity gains could translate into price discounts and a boost in domestic demand, thus affecting employment positively. In fact, at a time when Japan is wavering on the verge of multiple crises and prospects for a possible recovery look rather bleak, offshoring might as well be the answer.

Beyond the discussion about the effects—to which we will come back later—it could be misleading to fall for the story that it is just large developed economies which undertake all the offshoring business. Figure 1 shows how inaccurate it might be to conceive offshoring as a one-way road going from a few big economies to other less developed ones. As we shall see, one alternative to assess the extent of these particular business

practices lies in determining the import content of intermediate trade. As suggested by Feenstra and Hanson (1996), firms might respond to import competition from low-wage countries by moving non-skill-intensive activities to foreign locations from which they can later import back those parts previously produced at home.

Using data from the OECD I-O database (2009), I plot the shares of imported inputs in the total use of inputs across industries for a set of 40 countries, for years 1995, 2000 and 2005. As can be seen from Figure 1, smaller economies exhibit a larger dependence on international intermediate trade. This is naturally so because larger economies produce a greater absolute amount of inputs, thus curbing the extent to which they have to resort to international trade. Among the larger economies, Japan and the US appear notably below the others when it comes to offshoring ‘intensity’.

Figure 1: Offshoring ‘intensity’ worldwide



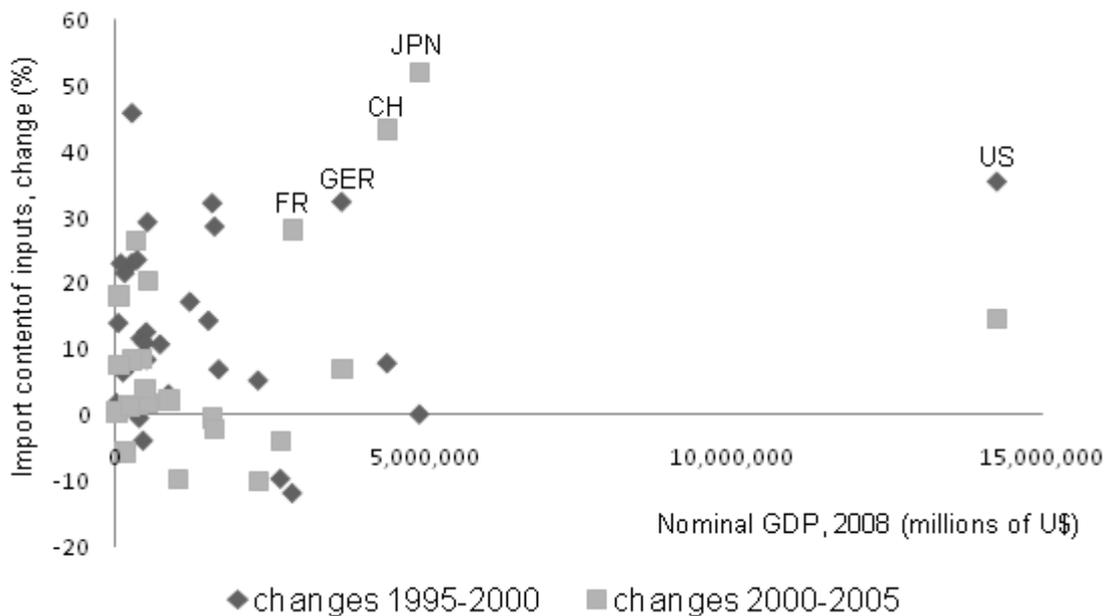
Source: own calculations based on OECD I-O database (2009), 40 countries.

Nevertheless, when we take a look at the percentage change in Figure 2, which took place from 1995 to 2005, we get another story. Larger economies now show themselves as having undergone a significant expansion of offshoring activities, especially during the more recent period of 2000-2005, and most notably in countries like Japan and neighboring China—in which, incidentally, Japan has significantly increased its presence in recent years (see Belderbos and Zou, 2006).

In sum, accepting that offshoring can be proxied by an intermediate trade index, what we see from these figures is that: (i) smaller countries are, by their own nature, more open and, seemingly, more prone to offshoring; but (ii) the growth of intermediate

trade in recent years has been more pronounced in larger countries, while offshoring is a relatively recent phenomenon—according to OECD input data, Japan shows the largest increase among these countries during the period 2000-2005. This is why the study of Japan and offshoring deserves further attention, and this is what I set out to do in the next few sections. There, however, I will be using a measure of offshoring which will permit us to distinguish between services and materials offshoring; a categorization that will come handy when assessing the diverging economic effects.

Figure 2: Offshoring ‘intensity’ worldwide, growth



Source: own calculations based on OECD I-O database (2009), 40 countries.

Japan’s offshoring little tale remains so far in the shadows. The evidence consists only of firm-level studies displaying the expected qualitative conclusions that abound elsewhere in the literature. Namely, that a factor-biased technological change might occur favoring high-skilled workers domestically (Head and Ries, 2002), and that productivity gains are to be expected as a result of offshoring (Hijzen *et al.*, 2006, 2010). Other survey-type studies are however skeptical about the importance of offshoring among Japanese firms (see Ito *et al.*, 2007; Takeuchi, 1991; and Tomiura, 2005). Let us briefly discuss the main results in the next paragraph.

In the work by Head and Ries (2002), the results in a set of different specifications and samples show that changes in overseas employment shares can explain a 0.9 percentage point increase of the roughly 10 percentage point increase in the share of nonproduction workers. In the paper by Hijzen *et al.* (2006), a one percent increase in offshoring intensity would raise productivity growth by 0.17 percent. For the average

offshoring firm, they find that this would imply a 1.8 percent increase in annual productivity growth. Hijzen *et al.* (2010) update and extend their previous results and find that the median firm engaging in ‘intrafirm’ offshoring (as opposed to third-party arrangements) experiences an annual total factor productivity (TFP) growth rate that is 0.6 percentage points higher than that of nonoffshoring firms.

The present paper complements the above-cited studies for Japan in that: (i) the study is carried out at the industry level; (ii) in addition to materials–or ‘production-related’–offshoring, the offshoring of services activities is accounted for; and (iii) the whole economy is considered and not just one sector. On the latter, in particular, the paper contributes to the general literature by studying the diverse effects of offshoring on the three major sectors of the economy–manufacturing, services, and primary plus energy–for a group of different skill-level occupations.

After defining the offshoring measures and discussing the analytical framework, I will undertake the study of the Japanese economy for the 1980-2005 period relying on panel estimation for aggregate industry data. To carry out such an endeavor I will make use of the JIP database, which covers 108 industries or branches of activities. This is an exhaustive database with industry-level data from the three sectors defined before (see Appendix A for more details). My results suggest that different types of offshoring affect occupations differently. In particular, the effect is usually positive when there are potential complementarities between the type of offshoring and these occupations (e.g. services offshoring and skill-intensive occupations).

The outline of the paper goes as follows. Section 2 is devoted to the details of measuring offshoring properly, and shows the evolution of two types of offshoring indices for Japan. Section 3 lays out the analytical framework underlying our subsequent econometric analysis. Section 4 goes over the results for a set of estimated equations regarding the employment effects of offshoring. Section 5 concludes.

2 Measurement

2.1 Indirect indicators

Feenstra and Hanson (1996) define offshoring as the share of imported intermediate inputs in the total purchase of nonenergy inputs. More formally, this can be written as follows:

$$OS_{it} = \sum_j \left(\frac{I_{jt}}{Q_t} \right)^i \left(\frac{\Pi_{jt}}{D_{jt}} \right) \quad (1)$$

where I_j is purchases of inputs j by industry i , Q is total inputs (excluding energy) used

by i , Π_j is total imports of goods j , and D_j their domestic demands. Consequently, for a given industry i at time t , multiplying the shares of input purchases from each supplier industry times the ratio of imports to total consumption in the supplier industry, and then adding over, gives the offshoring intensity measure.

This formula estimates the import content of intermediate trade of industries which, in turn, proxies their offshoring intensities. Specifically, the first term in (1) generally stems from the census data or Input-Output tables, while the second term, which is an economy-wide import share, is obtained from trade data. Conveniently, this expression serves as a measure for both the traditional offshoring of materials (or production-related offshoring) and the more up-to-date offshoring of services (see Amiti and Wei, 2005, 2009).¹

One common drawback to all measures relying on import shares is that offshoring does not necessarily imply an increase of imports, and vice versa. Another disadvantage is that the second term in (1)—the import penetration of inputs—is usually taken as fixed for every industry due to limited data availability. With these drawbacks in mind, the rationale for using an index of this kind should still be clear: importing trade stands for an important amount of intra and inter firm trade nowadays, from which offshoring can be proxied.

2.2 Materials and services offshoring in Japan

To estimate the offshoring index for Japan I employ the definition in (1), resorting exclusively to the JIP database. This is a positive feature since the Feenstra and Hanson index necessarily takes data from intermediate inputs and trade, which usually stem from different sources.

From (1) we have that:

Definition 1 *the materials offshoring index is the import content in materials inputs.*

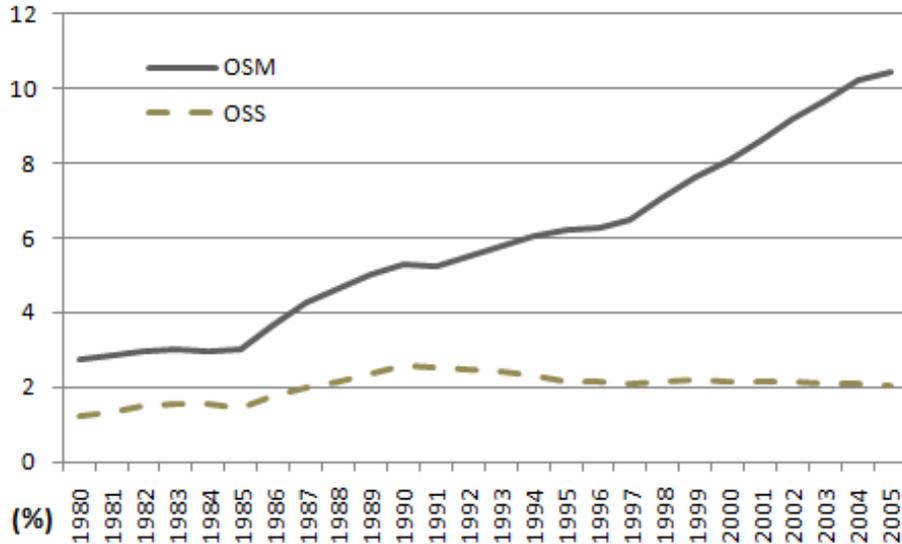
Definition 2 *the services offshoring index is the import content in services inputs.*

For example, for the materials offshoring index, the first term in (1) corresponds to input purchases of material j by industry i at time t , as a share of that industry's total use of materials inputs. The second term is a global measure of the import penetration of the referred input j which, even though is time-varying, it remains fixed across industries or branches of activities. This implies the assumption that all industries

¹It can also be useful to split offshoring into its narrow and broad measures (as done for the firm in Hijzen *et al.*, 2010). Empirically, the narrow measure would be restricted to the imported intermediate inputs from the same-digit industry, whereas the broad measure would include all other industries as well. In particular, when $i = j$, we have that the equation in (1) becomes the narrow measure.

carry out the importing of these materials with the same intensity. The same reasoning applies to the construction of the services offshoring index. Figure 3 and Table 1 show the evolution of both indices, weighted by industry value added.^{2,3}

Figure 3: Materials and services offshoring (%)



Note: offshoring indices (OSS , OSM) according to formula (1); broad measures weighted by industry value-added (own calculation, JIP database).

Let it be warned, though, that our OSS and OSM indices imply different denominators, so they cannot be added together. This should not be problematic, for services and materials offshoring are intrinsically very different phenomena. As a result, our offshoring intensity indices tend to be somewhat larger than those found elsewhere in the literature (see Appendix B for an analysis on the suitability of the indices).

Three things are worth commenting for the particular case of Japan. First, materials offshoring is expectedly more predominant, as its development dates back to much earlier times.⁴ Second, the annual rate of growth of services offshoring is, on average, surprisingly smaller than that of materials in the whole sample period, and more predominantly during the lost decade. And third, it is to stress the slowdown in both indices' growth rates, but especially in services offshoring, during the lost decade and up until recent times. The average annual growth rate for services offshoring was

²In order to come up with the offshoring indices I used the Input-Output tables in section 1.4 of JIP, and the final demand tables in section 1.7, both at constant prices (2000). Some of the import figures were missing, so they had to be linearly interpolated.

³The average annual growth rates in Table 1 are calculated using a compound annual growth rate index (CAGR).

⁴This is true for the whole economy and when separating between sectors. This breakdown is however not shown for reasons of space.

in fact negative during that period. A possible explanation, which adds to that of the domestic crisis, is the loss of appeal for services offshoring to be hosted in neighboring Asian countries. This might be due to the relative loss of competitiveness that comes with the catch-up process experienced in those fast-growing economies.

Table 1: Offshoring intensity, whole economy

<i>Year</i>	<i>OSM (%)</i>	<i>annual g.r. (%)</i>	<i>OSS (%)</i>	<i>annual g.r. (%)</i>
1980	2.72	-	1.22	-
1981	2.84	4.54	1.33	8.70
1982	2.97	4.34	1.47	10.95
1983	2.99	0.92	1.54	4.73
1984	2.98	-0.28	1.56	1.18
1985	3.03	1.70	1.46	-6.71
1986	3.68	21.41	1.75	20.33
1987	4.28	16.16	1.97	12.27
1988	4.62	7.92	2.15	9.18
1989	5.03	8.89	2.35	9.46
1990	5.26	4.60	2.61	10.80
1991	5.24	-0.34	2.52	-3.33
1992	5.50	4.87	2.44	-2.96
1993	5.75	4.63	2.41	-1.59
1994	6.03	4.76	2.31	-3.80
1995	6.21	3.08	2.17	-6.21
1996	6.29	1.21	2.13	-1.99
1997	6.50	3.43	2.12	-0.52
1998	7.08	8.88	2.14	0.99
1999	7.63	7.73	2.18	1.93
2000	8.04	5.37	2.13	-2.16
2001	8.60	6.94	2.14	0.29
2002	9.20	7.08	2.14	-0.02
2003	9.68	5.19	2.10	-1.93
2004	10.22	5.55	2.08	-0.58
2005	10.45	2.23	2.04	-2.30
avg. annual g.r. (%)		5.31		1.98
up until 1989		6.35		6.77
1990 to 2005		4.38		-1.53

3 Analytical framework

To understand the employment effects of offshoring on Japanese industries I follow the strand of literature which proposes offshoring as a possible source of skill upgrading (see Berman *et al.*, 1994; and Feenstra and Hanson, 1996, most representatively). For this, I implicitly assume a translog cost function—as is typically done—, implying that the share of a certain variable factor (e.g. labor) in the total variable costs can be represented as a linear function of input prices and quasi-fixed factors (e.g. capital).

While constant returns to scale imply the condition of linear homogeneity in factor prices, Shephard’s lemma guarantees that minimizing total costs yields the factor demand functions. For a certain factor X we would have:

$$S_x = \frac{w_x X}{C} = \phi_o + \sum_i \phi_i \ln w_i + \phi_Y \ln Y + \phi_K \ln \frac{K}{Y} \quad (2)$$

where the cost share S_x is equal to the factor expenditures $w_x X$ in the total variable costs C , and can be expressed as a function of all input prices w_i , value added Y , and capital intensity $\frac{K}{Y}$.

Assuming several variable factors, such as different types of labor (e.g. different skill levels), would result in a cost function yielding several factor functions. These functions or "skill shares" can be estimated to analyze the "first-order" or direct effects of offshoring across different skill-level occupations, by simply augmenting specification (2) with the offshoring indices. In a nutshell, we want to assess the employment effects of offshoring on different occupations or skills. This is what I do in the next section for a set of various occupations (other than the usual skill to unskilled, or nonproduction to production classification).⁵

The JIP database provides the employment share of seven skill groups by industry from the manufacturing, services, and primary sectors; sorted out in a decreasing skill order these are: (1) professionals and technical workers, (2) managers and officials, (3) clerical and related workers, (4) sales workers, (5) service workers, and (6) production process workers and laborers. A seventh "residual" category comprises all workers not classified in the previous categories.⁶ Notice that these data are expressed as shares of employment, not wages, so the interpretation in terms of skill upgrading is not completely straightforward.⁷

If we consider the seven different types of labor as the only variable factors in our implicit cost function then, for our convenience, the wages w_i in (2) can be omitted as regressors in our forthcoming estimation. This can be done under the hypothesis of no exogenous variation in wages across industries (see Berman *et al.*, 1994; and Head and Ries, 2002). Unfortunately, the classification of wages according to skill levels was not available in our dataset. The system of seven share equations can be so represented:

⁵See, for example, Thangavelu and Chongvilaivan (2011), who, in addition to the first order effects, go on to study the "second order" or substitution effects of offshoring in Thailand. There, a translog cost function is explicitly specified as to include materials and both high and low skill labor as variable factors, with the further objective of assessing the impact of offshoring on the substitution among these three variable factors.

⁶These include "protective service workers", "agricultural, forestry and fisheries workers", "workers in transport and communications occupations", and "workers not classifiable by occupation". This category will be dropped from the estimation below.

⁷Skill upgrading can be understood as a change in relative wages reflecting a change in productivity levels. Our dependent variable, however, is relative employment and, in addition to that, we have several skill levels which make it even more difficult to discern how the groups benefit (or not) at the expense of others. I will henceforth avoid this terminology just to focus on whether offshoring is beneficial for each particular occupation, all other things the same.

$$\begin{aligned}
S_{1it} &= \frac{w_1 X}{C} = \alpha_1 + \beta_1 OSS_{it} + \gamma_1 OSM_{it} + \delta_1 \ln Y_{it} + \zeta_1 \ln \frac{K_{it}}{Y_{it}} + \mu_t + \nu_i + \epsilon_{1it} \\
&\vdots \\
&\vdots \\
S_{7it} &= \frac{w_7 X}{C} = \alpha_7 + \beta_7 OSS_{it} + \gamma_7 OSM_{it} + \delta_7 \ln Y_{it} + \zeta_7 \ln \frac{K_{it}}{Y_{it}} + \mu_t + \nu_i + \epsilon_{7it}
\end{aligned} \tag{3}$$

where the employment share of each skill level (1 to 7) for industry i at time t is dependent on the offshoring measures, OSS and OSM , value added Y , and capital intensity $\frac{K}{Y}$. Additionally, time and industry dummies μ_t and ν_i capture persistent differences over time and across industries,⁸ and errors ϵ are normally distributed and with constant variance.

We can arbitrarily drop one of the share equations since they must necessarily add up to one—this is the seventh category as defined above. Given that the independent variables are identical for all equations, and given the lack of cross-equation constraints in (3), single-equation and system estimations yield equivalent outcomes. Accordingly, I will estimate six share equations separately, and not jointly.

In order to disentangle the effects of both services and materials offshoring on employment, it is also interesting to look at the estimations by economic sector and interpret the results in this light. For us, this will mean the manufacturing, services, and primary sectors broadly defined (see Appendix A). As a final note, the estimation of the share equations in (3) entails potential endogeneity problems mainly due to the offshoring variables.

4 Empirical analysis

4.1 Data

I now proceed to gauge the employment effects of offshoring relying on panel data analysis, but first, a short comment on the data is in order. The database was filtered as to be left only with those industries where their labor shares delivered a sensible outcome (e.g. they were less than 1). As a result, I am left with 83 industries out of a total of 108. Table 2 below provides the summary statistics of the main variables by economic sector.

From there it can be clearly seen that production workers (S_6) form a vast majority

⁸In particular, the time effects are meant to capture year-to-year changes in the wages faced by industries. Head and Ries (2002) suggest this interpretation for firm level data in Japan, assuming too that there is no exogenous variation in wages across industries.

in the manufacturing sector (66% on average for the industry), whereas professional plus technical (S_1) and clerical (S_3) stand out in the services sector (at around 25% each). Given the miscellaneous nature of the primary sector, the two most important categories there are clerical and production (both above 20%). Besides, manufacturing industries, when compared to services industries: (i) have a larger propensity to offshore materials and a smaller propensity to offshore services; (ii) display a much higher dispersion in the intensity of materials offshoring and a far smaller dispersion of services; (iii) are traditionally more productive; and (iv) exhibit smaller average wages.

Before getting down to discussing the results, some general remarks on the estimation methodology need be made. In a panel estimation framework, heterogeneity bias usually implies the inclusion of either fixed or random effects which can capture the differences among cross-sections better than a pooled estimation. Moreover, in our case it also becomes important to address the potential endogeneity of offshoring, since it might not be random which industries engage more in this practice. If the same industries engage in offshoring all over the sample, then industry fixed effects can do the job. But in reality this is hardly the case and, on top of that, the endogeneity of offshoring can be further magnified by the presence of measurement errors. To solve for this I instrument services and materials offshoring by the investment in information technology used to produce software and hardware, respectively.⁹

4.2 Employment effects

Our variables of interest are OSS and OSM in (3), and since these are not transformed into logarithms they ought to be read as semi-elasticities. Remember too that they should not necessarily be interpreted as a source of skill upgrading due to the structure of our data. Instead, we will only be able to identify which occupations benefit from (or are harmed by) offshoring and in what sector.

Tables 3 and 4 below show the share equations estimated by panel least squares and panel two-stage least squares for the six occupations listed above. Keep in mind that the potential endogeneity of the offshoring variables should make us lean more towards the 2SLS results in Table 4. To check for the validity of the instruments sets and of the overidentifying restrictions I rely on the conventional Sargan test. Under the null hypothesis that the overidentifying restrictions are valid, the Sargan statistic is distributed as a $\chi^2_{(k-p)}$ where k is the number of instruments and p the number of estimated coefficients. Not rejecting the test is indicative of the exogeneity of the instruments used, something we can confirm for all the share equations in Table 4 (the p-value is, in all cases, greater than 0.10).

⁹In addition, the current and past values of the value added variable perform as additional instruments of the quasi-fixed capital (another potentially endogenous variable) and the offshoring indices.

Table 2: Summary statistics, 1980-2005

	<i>Variable</i>	<i>Observations</i>	<i>Mean</i>	<i>Max.</i>	<i>Min.</i>	<i>Std. dv.</i>
<i>Manufacturing: 48 industries</i>						
<i>Skill</i>	S_1 : professional & tech.	1,248	0.06	0.21	0.00	0.04
<i>shares</i>	S_2 : managers	1,248	0.04	0.08	0.02	0.01
	S_3 : clerical	1,248	0.16	0.27	0.08	0.04
	S_4 : sales	1,248	0.05	0.15	0.01	0.03
	S_5 : services	1,248	0.00	0.01	0.00	0.00
	S_6 : production	1,248	0.66	0.81	0.39	0.08
	<i>Offshoring indices</i>	<i>OSS (%)</i>	1,248	2.08	4.28	0.88
<i>OSM (%)</i>		1,248	9.85	114.13	0.78	16.15
<i>Productivity g.r.</i>	τ (%)*	1,248	0.74	34.42	-25.35	4.89
<i>Inputs and Output</i>	L (workers)	1,248	254,429	1,051,690	3,974	212,068
	K (real, million yen)	1,248	3,501,545	22,128,066	239,404	3,200,528
	Y (real, million yen)†	1,248	1,632,974	8,285,190	34,134	1,221,315
<i>Wages</i>	w (avg., real, million yen)	1,248	4.89	34.84	0.33	3.13
<i>Services: 27 industries</i>						
<i>Skill</i>	S_1 : professional & tech.	702	0.25	0.74	0.00	0.27
<i>shares</i>	S_2 : managers	702	0.04	0.14	0.00	0.03
	S_3 : clerical	702	0.26	0.66	0.03	0.14
	S_4 : sales	702	0.13	0.66	0.00	0.17
	S_5 : services	702	0.13	0.87	0.00	0.22
	S_6 : production	702	0.12	0.76	0.00	0.15
	<i>Offshoring indices</i>	<i>OSS (%)</i>	702	2.32	25.12	0.54
<i>OSM (%)</i>		702	5.38	18.44	0.63	2.79
<i>Productivity g.r.</i>	τ (%)*	702	-0.01	29.33	-36.42	5.85
<i>Inputs and Output</i>	L (workers)	702	1,197,027	7,285,919	35,755	1,505,973
	K (real, million yen)	702	15,287,871	123,000,000	60,968	22,809,850
	Y (real, million yen)†	702	7,097,333	38,767,333	229,638	7,541,274
<i>Wages</i>	w (avg., real, million yen)	702	5.63	21.28	0.54	3.86
<i>Primary sector plus energy: 8 industries</i>						
<i>Skill</i>	S_1 : professional & tech.	208	0.07	0.18	0.00	0.07
<i>shares</i>	S_2 : managers	208	0.03	0.08	0.00	0.02
	S_3 : clerical	208	0.26	0.45	0.00	0.18
	S_4 : sales	208	0.02	0.18	0.00	0.04
	S_5 : services	208	0.00	0.01	0.00	0.00
	S_6 : production	208	0.24	0.55	0.00	0.18
	<i>Offshoring indices</i>	<i>OSS (%)</i>	208	1.91	3.38	0.70
<i>OSM (%)</i>		208	6.15	15.35	1.44	2.65
<i>Productivity g.r.</i>	τ (%)*	208	0.00	0.17	-0.16	0.05
<i>Inputs and Output</i>	L (workers)	208	186,660	1,061,700	1,767	204,673
	K (real, million yen)	208	14,923,080	87,059,609	1,624,774	21,390,066
	Y (real, million yen)†	208	1,588,984	7,769,604	91,981	1,817,250
<i>Wages</i>	w (avg., real, million yen)	208	5.05	14.93	0.63	3.00

*: TFP as calculated by Fukao *et al.* (2007) using the JIP database (2006).

†: gross value-added (factor prices). Note: K , Y and w were deflated using the GDP deflator.

Table 3: Employment effects across sectors and occupations, panel least squares (1980-2005)

	S_1	S_2	S_3	S_4	S_5	S_6
<i>Manufacturing sector</i>						
OSS	0.6614 (0.1411)***	-0.2587 (0.0554)***	-0.2186 (0.1370)	0.3409 (0.1057)***	-0.0009 (0.0076)	-0.3608 (0.3070)
OSM	0.0171 (0.0085)**	-0.0001 (0.0033)	0.0004 (0.0082)	0.0180 (0.0064)***	0.0002 (0.0005)	-0.0228 (0.0185)
ln Y	0.0134 (0.0019)***	-0.0012 (0.0007)	0.0055 (0.0018)***	0.0040 (0.0014)***	0.0007 (0.0001)***	-0.0233 (0.0041)***
ln K/Y	0.0021 (0.0022)	0.0004 (0.0009)	0.0062 (0.0021)***	0.0054 (0.0016)***	0.0010 (0.0001)***	-0.0177 (0.0047)***
No. obs.	1,248	1,248	1,248	1,248	1,248	1,248
R ²	0.9166	0.8742	0.8992	0.8638	0.8409	0.8956
<i>Services sector</i>						
OSS	0.3018 (0.2697)	0.0264 (0.0359)	-0.1927 (0.1540)	0.3313 (0.1869)*	-0.1384 (0.1695)	-0.2636 (0.2234)
OSM	-0.8285 (0.2238)***	-0.0046 (0.0298)	0.3713 (0.1278)***	-0.1624 (0.1551)	0.6057 (0.1407)***	0.2723 (0.1854)
ln Y	-0.0022 (0.0114)	-0.0051 (0.0015)***	-0.0355 (0.0065)***	0.0429 (0.0079)***	0.0207 (0.0072)***	-0.0107 (0.0095)
ln K/Y	-0.0180 (0.0090)**	-0.0061 (0.0012)***	-0.0184 (0.0051)***	0.0236 (0.0062)***	0.0232 (0.0057)***	-0.0131 (0.0075)*
No. obs.	702	702	702	702	702	702
R ²	0.9647	0.9480	0.9574	0.9593	0.9795	0.9240
<i>Primary plus energy</i>						
OSS	1.4037 (0.3913)***	-0.1742 (0.0816)**	0.8639 (0.2110)***	-0.9615 (0.4591)**	-0.0464 (0.0196)**	0.4986 (1.1869)
OSM	-0.0204 (0.1477)	-0.1582 (0.0308)***	-0.0757 (0.0797)	-0.2205 (0.1733)	-0.0030 (0.0074)	1.0004 (0.4481)**
ln Y	0.0190 (0.0112)*	-0.0193 (0.0023)***	-0.0220 (0.0060)***	0.0721 (0.0131)***	0.0004 (0.0006)	-0.1238 (0.0340)***
ln K/Y	0.0431 (0.0159)***	-0.0199 (0.0033)***	0.0066 (0.0086)	0.0422 (0.0187)**	-0.0014 (0.0008)*	-0.0160 (0.0483)
No. obs.	208	208	208	208	208	208
R ²	0.9487	0.9777	0.9980	0.8126	0.8815	0.9377

Notes: Standard errors in parentheses and ***, **, * the usual levels of significance: 1%, 5%, and 10%. All specifications include industry and period effects.

Table 4: Employment effects across sectors and occupations, panel two-stage least squares (1980-2005)

	S_1	S_2	S_3	S_4	S_5	S_6
<i>Manufacturing sector</i>						
OSS	3.0820 (0.8262)***	1.0676 (0.3331)***	-1.8449 (0.6055)***	1.1753 (0.4537)***	-0.1805 (0.0431)***	-4.0538 (1.6875)**
OSM	-0.1461 (0.0636)**	-0.0566 (0.0256)**	-0.0540 (0.0466)	0.0364 (0.0349)	0.0058 (0.0033)*	0.3146 (0.1298)**
ln Y	0.0088 (0.0040)**	-0.0063 (0.0016)***	0.0105 (0.0029)***	0.0006 (0.0022)	0.0012 (0.0002)***	-0.0064 (0.0081)
ln K/Y	0.0077 (0.0055)	-0.0011 (0.0022)	0.0082 (0.0040)**	0.0043 (0.0030)	0.0007 (0.0003)***	-0.0132 (0.0112)
No. obs.	1,236	1,236	1,236	1,236	1,236	1,236
R ²	0.8624	0.7773	0.9040	0.8778	0.7348	0.8476
Sargan test	0.17	0.89	0.32	0.48	0.46	0.88
<i>Services sector</i>						
OSS	-0.5875 (1.6218)	0.0792 (0.1830)	-0.6078 (0.8069)	-0.0511 (1.2934)	-0.5804 (0.8777)	1.1682 (1.9421)
OSM	-4.4776 (0.9731)***	-0.0764 (0.1098)	-0.0938 (0.4841)	-3.7653 (0.7761)***	0.6178 (0.5266)	7.0759 (1.1653)***
ln Y	0.1119 (0.0321)***	-0.0064 (0.0036)*	-0.0477 (0.0160)***	0.1553 (0.0256)***	-0.0137 (0.0174)	-0.1765 (0.0385)***
ln K/Y	0.0388 (0.0203)*	-0.0120 (0.0023)***	-0.0449 (0.0101)***	0.0768 (0.0162)***	-0.0247 (0.0110)**	-0.0492 (0.0243)**
No. obs.	666	666	666	666	666	666
R ²	0.9492	0.9461	0.9502	0.9251	0.9636	0.7797
Sargan test	0.42	0.99	0.99	0.36	0.13	0.94
<i>Primary plus energy</i>						
OSS	2.5225 (1.2569)**	-0.1247 (0.2241)	1.1778 (0.4496)***	-2.9950 (1.2428)**	-0.1255 (0.0495)**	1.0271 (3.7214)
OSM	-2.2026 (1.1127)**	0.1441 (0.1984)	0.2030 (0.3980)	1.5319 (1.1002)	-0.0553 (0.0438)	6.6331 (3.2944)**
ln Y	-0.0087 (0.0368)	-0.0278 (0.0066)***	-0.0469 (0.0132)***	0.0836 (0.0364)**	0.0060 (0.0014)***	-0.2958 (0.1090)***
ln K/Y	0.0192 (0.0568)	-0.0351 (0.0101)***	-0.0297 (0.0203)	0.0371 (0.0562)	0.0070 (0.0022)***	-0.3118 (0.1683)*
No. obs.	194	194	194	194	194	194
R ²	0.8623	0.9526	0.9975	0.6628	0.7929	0.8332
Sargan test	0.39	0.99	0.99	0.41	0.72	0.44

Notes: Standard errors in parentheses and ***, **, * the usual levels of significance: 1%, 5%, and 10%. All specifications include industry and period effects. The Sargan test of overidentifying restrictions is distributed as a $\chi^2_{(k-p)}$ under the null of valid and exogenous instruments (p-values shown in table).

Due to the heterogeneity of the results and in order to facilitate the comparison between the two estimation methods, I compile the information of Tables 3 and 4 in a supplementary table. Table 5 below only displays the signs of the offshoring coefficients that are drawn from the previous two tables.

Table 5: Employment effects of offshoring

	S_1		S_2		S_3		S_4		S_5		S_6	
	LS	2SLS										
<i>Manufacturing sector</i>												
<i>OSS</i>	+	+	-	+	0	-	+	+	0	-	0	-
<i>OSM</i>	+	-	0	-	0	0	+	0	0	+	0	+
<i>Services sector</i>												
<i>OSS</i>	0	0	0	0	0	0	+	0	0	0	0	0
<i>OSM</i>	-	-	0	0	+	0	0	-	+	0	0	+
<i>Primary plus energy</i>												
<i>OSS</i>	+	+	-	0	+	+	-	-	-	-	0	0
<i>OSM</i>	0	-	-	0	0	0	0	0	0	0	+	+

Note: "+", "-", and "0" stand for positive, negative, and non-significant effects.

Such heterogeneity in the estimations should not be surprising since both types of offshoring are intrinsically very different and entail different processes among the sectors of the economy. The dissimilarities can go from radically different managerial strategies to diverse business relations with providers or local partners, as well as a rather disparate perception on the degree of customer satisfaction. Moreover, it should be stressed that services offshoring very often concerns more dynamic activities involving more highly trained workers. It is then to expect that all these factors should have different employment effects across the different sectors.

Positive and significant effects from services offshoring are seemingly more common in those employment shares corresponding to highly skilled workers. For instance, for S_1 , S_2 (only for 2SLS), and S_4 in the manufacturing sector; for S_4 (only LS) in the services sector; and S_1 and S_3 in the primary sector. Especially large are the S_1 coefficients for the 2SLS estimation. On the other hand, and with some exceptions (S_2 and S_4 in some specifications), negative and significant effects from services offshoring are more present at the lower end of the skill spectrum— S_5 and S_6 ; especially important is the coefficient of the latter under 2SLS. Materials offshoring, contrariwise, seems to be more friendly towards low skill workers. Positive and significant coefficients are mostly found for categories S_5 and S_6 in all sectors.

But what is the argument behind an increase of the employment share of certain skill group once offshoring has taken place? It could be argued that relocating activities

abroad might turn into positive employment effects domestically by way of complementing and expanding other activities already undertaken at home. In particular for Japan, Ando and Kimura (2007) suggest that, as a result of offshoring, domestic employment can be expanded since these operations are usually ‘complementary to the rest of the value added chain’. Not surprisingly, the positive effects are usually associated with those occupations more closely related to the type of offshoring involved (e.g. services with S_1 , or materials with S_6).

A skill-biased interpretation of the employment effects of offshoring would conceive the offshoring of services as creating more opportunities among those high-skill occupations which can more easily adapt to the new technologies. Similarly, it would visualize materials offshoring as being more prone to increasing the opportunities of those occupations traditionally involved with production. In effect, what lies at the bottom from this perspective is none other than the exploitation of comparative advantages and the ensuing increase of productivity levels. For Japan, this has been studied by Hijzen *et al.* (2006, 2010).¹⁰

Related to the productivity story we can also identify a sector-biased exposition which becomes clear from a glance at Table 5. Seemingly, the services sector (also, the less productive among the three in the past years) is the less affected by services offshoring practices in terms of changes in the employment shares across occupations. This is important since services offshoring is called to be the next generation offshoring, mainly revolving around the Internet and the new technologies. The manufacturing sector, on the contrary (being the more productive for much of the past three decades), displays several effects in both directions.¹¹

We should finally comment on the employment effects of value added and capital intensity, as summarized in Table 6. According to Head and Ries (2002), "a negative scale effect is consistent with the knowledge capital hypothesis that firms need not increase skill-intensive knowledge capital as output increases". It should be noted that these authors stick to the usual skilled (nonproduction) to unskilled (production) labor ratio and employ firm level data. Given our breakdown by occupations, the knowledge capital hypothesis seems to hold for S_2 in all three sectors and S_3 in the services and primary sectors.¹² On the other hand, greater value added output clearly contributes to

¹⁰We should point out that our setting does not allow for spillover effects between industries or sectors. For an analysis from a general equilibrium perspective see Egger and Egger (2005), who explicitly account for spillovers, and Mitra and Ranjan (2007), who develop a theoretical model to study the impact of offshoring on sectoral and economywide rates of unemployment.

¹¹Productivity and offshoring are certainly related but not the subject of the present paper. However, I could not avoid commenting on the fact that, at least for Japan, there is a strong relationship sector wise.

¹²Notice that this makes a lot of sense for manager workers (S_2), clearly identified with highly skilled labor, as their number need not increase as output increases. Also notice the negative scale effect for S_6 in some specifications (especially in the primary sector) which cannot be understood as siding with

the increase of the S_1 , S_4 , and S_5 shares in the three sectors. On this, Slaughter (2000) finds a positive scale effect on skilled (nonproduction) labor for US manufacturing industry data.

Table 6: Employment effects of scale and capital intensity

	S_1		S_2		S_3		S_4		S_5		S_6	
	<i>LS</i>	<i>2SLS</i>										
<i>Manufacturing sector</i>												
<i>Y</i>	+	+	0	-	+	+	+	0	+	+	-	0
<i>K/Y</i>	0	0	0	0	+	+	+	0	+	+	-	0
<i>Services sector</i>												
<i>Y</i>	0	+	-	-	-	-	+	+	+	0	0	-
<i>K/Y</i>	-	+	-	-	-	-	+	+	+	-	-	-
<i>Primary plus energy</i>												
<i>Y</i>	+	0	-	-	-	-	+	+	0	+	-	-
<i>K/Y</i>	+	0	-	-	0	0	+	0	-	+	0	-

Note: "+", "-", and "0" stand for positive, negative, and non-significant effects.

Our estimates also suggest that capital intensity favors some occupations in the manufacturing sector. Greater capital investment contributes to the increase of the S_3 , S_4 , and S_5 shares. Slaughter (2000) also discovers complementary effects for skilled labor in the US manufacturing sector. In the services sector, in turn, it usually performs as a substitute for most occupations (not for S_4) while yielding ambivalent evidence in the primary sector.

The main message of Tables 3–6 can be thus summarized:

- Services offshoring tends to benefit highly skilled occupations more, especially those taking place within the traditionally high productivity manufacturing sector.
- Materials offshoring tends to benefit production workers and laborers in all three sectors.
- The knowledge capital hypothesis (negative scale effect) seems to hold for managers (S_2) and clerical (S_3) workers (the latter not for manufacturing).
- Capital is clearly complementary to clerical (S_3), sales (S_4), and services (S_5) workers in the manufacturing sector, while substitute for most occupations in the services sector.

the knowledge capital hypothesis because of the low-skill nature of the labor involved. Instead, we hypothesize that this has more to do with some form of skill upgrading taking place as industries increase production.

5 Conclusions

Usual fears around offshoring entail, above all, the loss of domestic jobs that are now being imported in greater numbers. It is true that as even more services become tradable (especially with the exponential growth of communications and the Internet), more jobs will be at risk of being moved abroad. But this argument loses sight of the other side of the story, namely, that new jobs might be created locally due to a complementary effect with the relocated activities. This synergy, it might be argued, can eventually improve the productivity levels of domestic industries.

The results of the econometric analysis presented here suggest a positive employment effect of services offshoring on the occupational share of highly skilled workers, especially within the manufacturing and primary sectors. Particularly large is the effect of the share of professional and technical workers (S_1). On the other end of the skill scale, positive and large effects from materials offshoring are observed on production workers and laborers (S_6). These results point into the direction of complementarities among the activities involved which lead to productivity increases due to the exploitation of particular labor skill comparative advantages.

One might still wonder why services offshoring has remained barely unchanged for most of the sample period in spite of its potential regarding skill upgrading. One possible explanation lies in the fact that the manufacturing sector, with its primary focus on materials offshoring and production workers, has been traditionally more productive and has been naturally exposed to innovations more frequently. As seen for the past two decades in Japan, it is the manufacturing sector which has been taking the burden of the crisis on its shoulders. Maybe it is about time for Japanese entrepreneurs to shift the focus and exploit the benefits of services offshoring more optimistically. We have seen in this paper how offshoring might be employment-friendly for some occupations and sectors and how this innovative practice might hold the key as regards productivity improvement, something Japan is certainly in need of.

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A The JIP database

The JIP database (2006, 2008) provides a comprehensive source for a wide set of variables through a relatively long time period and for the whole Japanese economy. It comprises annual data for the period 1970-2005 and for a total of 108 activities from both the manufacturing and services sectors (see Table A). Strictly speaking, this classification does not correspond exactly to the industry classification usually found elsewhere (e.g. ISIC, rev. 3, or the EU KLEMS project), yet stands as a faithful approximation (see Fukao *et al.*, 2007). The database includes 54 manufacturing activities, 42 services activities, and 12 activities from the primary sector plus energy.

Table A: The JIP database, economic branches of activity

<i>JIP code</i>	<i>Manufacturing</i>	<i>JIP code</i>	<i>Services</i>	<i>JIP code</i>	<i>Other</i>
008	Livestock products	067	Wholesale	001	Rice, wheat production*
009	Seafood products	068	Retail	002	Miscellaneous crop farming*
010	Flour and grain mill products	069	Finance	003	Livestock and sericulture farming
011	Miscellaneous foods	070	Insurance	004	Agricultural services*
012	Animal foods & fertilizers*	071	Real estate	005	Forestry
013	Beverages	072	Housing*	006	Fisheries
014	Tobacco	073	Railway*	007	Mining
015	Textile products*	074	Road transportation	062	Electricity
016	Lumber and wood products	075	Water transportation*	063	Gas, heat supply
017	Furniture and fixtures	076	Air transportation	064	Waterworks
018	Pulp, paper, and other paper	077	Other transportation*	065	Water supply for industrial use
019	Paper products	078	Telegraph and telephone	066	Waste disposal*
020	Printing, and plate making	079	Mail*		
021	Leather and leather products*	080	Education (private and non-p)		
022	Rubber products	081	Research (private)*		
023	Chemical fertilizers	082	Medical (private)		
024	Basic inorganic chemicals	083	Hygiene (private and non-p)*		
025	Basic organic chemicals	084	Other public services*		
026	Organic chemicals	085	Advertising		
027	Chemical fibers	086	Rental of office equipment		
028	Miscellaneous chemical pdts.	087	Automobile maintenance		
029	Pharmaceutical products	088	Other services for businesses		
030	Petroleum products	089	Entertainment		
031	Coal products	090	Broadcasting		
032	Glass and its products	091	Information and Internet ss.		
033	Cement and its products	092	Publishing		
034	Pottery	093	Video and sound*		
035	Miscellaneous ceramic	094	Eating and drinking places		
036	Pig iron and crude steel	095	Accommodation*		
037	Miscellaneous iron and steel	096	Laundry, beauty services		
038	Smelting non-ferrous metals	097	Other services for individuals*		
039	Non-ferrous metal products	098	Education (public)*		
040	Metal products	099	Research (public)		
041	Miscellaneous metal products	100	Medical (public)*		
042	General industry machinery	101	Hygiene (public)		
043	Special industry machinery	102	Ss. ins. & ss. welfare (public)		
044	Miscellaneous machinery	103	Public administration		
045	Office and industry machines	104	Medical (non-profit)		
046	Electrical and ind. apparatus	105	Ss. Ins. & ss. welfare (non-p)		
047	Household electric appliances	106	Research (non-profit)*		
048	Electronics, computer eqpmnt.*	107	Other (non-profit)		
049	Communication equipment	108	Activities not classified*		
050	Measuring instruments				
051	Semiconductor and circuits				
052	Electronic parts				
053	Miscellaneous machinery				
054	Motor vehicles				
055	Motor vehicle parts				
056	Other transportation eqpmnt.				
057	Precision machinery eqpmnt.				
058	Plastic products				
059	Miscellaneous industries				
060	Construction*				
061	Civil engineering*				

*: Industries not included in the estimations.

Source: JIP database (2006, 2008). RIETI, Hitotsubashi University, and ESRI, Japan.

B How good are the offshoring measures?

To answer this question I carry out a decomposition analysis over time (1980-2005) in a rather conventional way. The analysis involves following the ‘within’ and ‘between’ exercise to account for variations of, respectively, the industries’ offshoring intensity and their shares in total production (see Hummels *et al.*, 2001; and Strauss-Kahn, 2004). Decomposing the variance turns out helpful in isolating the changes in the offshoring intensities within industries from the changes in the production shares between them. Thus, it is easy to see what proportion of the change in the index is due to either a change in real offshoring or a change in the industries’ relative weights. The index might as well be picking up structural influences that have nothing to do with offshoring.

Therefore, to see to what extent the index describes the phenomenon accurately, I move on to extract the sources of growth using the following expression:

$$\Delta\Phi^{80-05} = \Delta \sum_i^n \theta_i \delta_i = \sum_i^n \bar{\theta}_i \Delta\delta_i + \sum_i^n \bar{\delta}_i \Delta\theta_i \quad ; \quad \Phi = OSS, OSM$$

where the change in the offshoring index at the country level (Φ) is decomposed, throughout industries (i), into the change in the offshoring intensity (the within term) and the change in the share of total production (the between term). The former fixes the structural component of industries, also the share of industry output to total output (θ), to focus on the change in the offshoring intensity (δ). The latter, contrariwise, fixes the offshoring component, thus capturing the contribution of the structural component to the change in the index. A bar over the variables defines the mean for the period under study.

Table B breaks down the sources of growth for the index during the whole sample and in two subsamples (1980-1990 and 1990-2005).

Table B: Sources of growth of the offshoring index

	<i>Within</i>	<i>Between</i>	<i>Total (w+b)</i>	<i>Within/Total</i>
OSS				
1980-1990	1.37	0.01	1.38	99.0%
1990-2005	-0.51	-0.06	<u>-0.57</u>	90.2%
1980-2005	0.84	-0.03	0.81	103.5%
OSM				
1980-1990	2.53	0.01	2.54	99.5%
1990-2005	5.25	-0.07	<u>5.19</u>	101.3%
1980-2005	7.79	-0.07	7.73	100.9%

Note: numbers were rounded.

With the exception of the last column, all numbers are the increases and drops in the indices, in percentage points, that could be derived from Table 1. The column labeled ‘within’ captures the change in the index that is due to changes in the offshoring intensities of industries alone, while the column labeled ‘between’ seizes the change in the index that corresponds to a change in the production shares. The contributions of each component are summed up under ‘total’, and refer to the total change, in percentage points, in the indices shown before. For instance, during 1980-1990, the increase in the *OSS* index for the whole economy was 1.38 percentage points (see Table 1), *of which*

1.37 correspond to a change in the offshoring intensity and 0.01 to a change in the structural component. Lastly, the ‘within/total’ column focuses on the proportion of the change in the index that is exclusively explained by a change in offshoring intensity.

In general, we can see that the changes in the offshoring intensity across all branches of activities account for most of the growth in overall offshoring, as shown in Table 1. The structural components have hardly any incidence on the indices, especially prior to the ‘lost decade’. After 1990 the ratios in the last column behave less consistently and deviate a bit from the 100 percent benchmark. Naturally, we should expect the economic turmoil in the 1990s to produce some changes in the sector composition of the Japanese economy. Coincidentally, it is argued that the three-sector hypothesis has taken longer to manifest in Japan (see Balassa and Noland, 1988). Whereas for other developed economies the shift from the secondary (manufacturing) to the tertiary (services) sector has long taken place, for Japan it seemingly started out during the 1990s.