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# ABSTRACT

## Japan and Her Dealings with Offshoring: An Empirical Analysis with Aggregate Data*

First moves towards a real understanding of offshoring date back to very recent times. In particular for Japan, the studies conducted so far focus alone on the productivity effects of offshoring at the firm level. Here I carry out the analysis of both the employment and productivity effects at the aggregate level of the industry, covering the years 1980-2005. Moreover, I consider all industries within the economy and take account of both services and materials offshoring. My results suggest that we should expect, on average, a positive effect of services and a negative effect of materials offshoring on employment. However, the effects are rather negligible and only amount to a 1.5 to 2 percent net loss of the change in employment. On the other hand, positive effects on the growth rate of productivity are found as a result of both types of offshoring, with larger effects from services. In particular, the average offshoring industry displays 1.4 to 1.98 additional percentage points for services and 0.48 to 0.64 for materials.

JEL Classification: F16, J23, O47

Keywords: offshoring, Japan, employment, productivity

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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. Indeed, the recent and heated discussions on economic policy which abound worldwide have to do with these peculiar business practices.

The goal of this paper is to disentangle the employment and productivity effects of offshoring at the aggregate level of the industry. Highly aggregated data not only will help reassure the previous results obtained for Japan at the firm level and for particular industries but, due to their comprehensiveness, will serve to extend the analysis to the whole economy. This is important since one of the objectives is to see whether offshoring can produce, empirically, a negative effect on total employment. In addition, as is our case, the Japan Industrial Productivity database (JIP) provides sufficient data for constructing two offshoring indices representative of the intensities of two distinguishable types of offshoring: services and materials (or production).

In this paper I will try to find an answer to the following questions. Is offshoring to be seen as a real threat to the economy's employment level? Are we to expect any improvement in the productivity of industries after offshoring takes place? But before these questions are properly addressed, we should come to terms with the measurement of offshoring. How are we to proxy this phenomenon empirically?

It has been lately suggested that intermediate trade data of goods and services can well provide with the answer (Feenstra and Hanson, 1996a, 1996b, 1997, 1999). Presumably, it is the import content of inputs what best proxies offshoring and gives us a clue to understanding its economic implications. We shall see that for our industry level analysis this works just fine. But why are these economic implications 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 open in the "relocating" economy due to economic scarcity.

This is not to deny the possible short-run layoffs or the implied dynamics the employers have to face when dealing with the decision to go abroad. But in the end these frictions should fade away as comparative advantages eventually turn out in increased social welfare, and the entrepreneurs finally succeed in making the most out of them. According to the classical tenets, we should be thinking about offshoring as causing as much harm to an economy's labor market as international trade might also bring about. As we shall see here, offshoring and intermediate trade can be seen interchangeably. Underlying the empirical research laid out below is the necessity of finding an empirical answer to such tenets.

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, in a time when Japan is wavering on the verge of multiple futures and doubts start assailing the population on prospects for a possible recovery, offshoring might as well be the answer.

I therefore undertake the study of the Japanese economy for the 1980-2005 period, using dynamic panel estimation for aggregate data. As we will see, the little evidence that has been collected for Japan refers alone to the disaggregate level. To carry out such endeavor I make use of the JIP database, which covers 108 industries or branches of activities. This is an exhaustive database with data on manufacturing industries, services industries, and other varied activities.

The empirical research presented here is divided in two, as in Amiti and Wei (2006). First, I take a look at the demand side of the labor market and focus on the effects of offshoring on total employment, rather than on the relative employment among workers of different skills or their relative wages (as in Feenstra and Hanson, 1996a, 1996b, and 1999, for instance). And second, I deal with the direct effects of offshoring on total factor productivity, while considering two possible ways of measuring the latter.

My results suggest: (1) that the total employment loss during 1980-2005 due to offshoring was negligible (around 1.5 to 2 percent in the total increase); and (2) that the average offshoring industry enjoys higher productivity growth rates, with larger effects when services activities and not goods (material inputs) are relocated (from 1.4 to 1.98 additional percentage points in the former case and from 0.48 to 0.64 in the latter).

An outline of the paper is the following. In Section 2 I briefly review the major works of the recent literature. Section 3 is devoted to the details of measuring offshoring properly, and to lay out the econometric methodologies underlying our subsequent analysis. Section 4 goes over the data, an introductory statistical analysis, and the results of the set of estimated equations regarding the employment and productivity effects of offshoring. Section 5 finally concludes the paper.

## 2. The story so far

Much has been said about offshoring in recent times, less indeed has been produced in terms of sound and unambiguous empirical evidence. However, this relatively scarce literature has taken a drastic step forward since the mid 1990s, hardly to go unnoticed. Table 1 below compiles some of the major works.

Contributions to the subject of offshoring and its interplay with labor markets split into studies undertaken at different levels of aggregation. Highly aggregated (e.g. industry) works came in first place, with the focus on the US economy and the trade and productivity-related literature.[1] Later on, with the labor market at the center of attention, several aggregate as well as disaggregate studies began to see the light. This implied some loss of homogeneity in the empirical definition of offshoring and the little tangible consensus in the econometric approaches. As for the results, even though some broad conclusions can be drawn, much is yet to be said about the real impact of offshoring on labor markets.

### *2.1. First steps and breakthrough*

The first works included offshoring as a source to the changes in the skill composition of the employed workforce or the underlying relative wages. Such economic events as the shift from nonskilled toward skilled labor or the wage inequality among workers of different skills, were thus explained by

[1] See the references cited in the next paragraphs.

this "new" phenomenon. However, these studies found no decisive evidence of offshoring being a major driver of these relative changes. Berman *et al.* (1994), Krugman (1995), Lawrence and Slaughter (1993), Leamer (1994), Siegel and Griliches (1992), and Slaughter (1995, 2000), present research efforts on similar lines.

In the late 1990s Feenstra and Hanson (1996a, 1996b, 1997, 1999) produced evidence for the first time in favor of a shift towards skill-intensive activities within domestic industries due to offshoring. Their rationale was: if firms respond to import competition from low-wage countries by moving nonskilled-intensive activities abroad, then trade has to shift employment toward skilled workers in the domestic economy. Therefore, it is the composition of trade and the share of intermediate inputs in particular what matters in the end for employment and wages.

These efforts described offshoring as a factor-biased technological change. In this sense, high-skilled employment results favored after offshoring takes place precisely because low-skill activities are more prone to go offshore due to potential labor cost gains. Under this perspective, offshoring might just bring about an increase in the skill-intensity of production that comes with an increase in the wage rate for high-skilled relative to low-skilled labor. Feenstra and Hanson argue that if certain activities at the lower end in terms of skill intensity in the US are offshored to Mexico, where they can be said to be in the upper end of the scale, then skill intensity goes up in both countries. Consequently, an increased demand for high-skill workers in both countries is accompanied by a rise in their relative wages, and offshoring becomes a factor-biased technological change.

Feenstra and Hanson also contend that the previous calculations found in earlier efforts might have underestimated the real extent of offshoring. In their 1996b paper, for example, the estimations suggest that offshoring can explain up to 31 percent of the increase in the nonproduction wage share during the 1980s for 450 US manufacturing industries. The 1999 paper produced smaller numbers; there, offshoring accounted for 13 to 23 percent of the shift toward nonproduction labor, which is still a significant proportion. More recent efforts within the field, however, are now testing the significance of the direct effects on employment (see, among others, Amiti and Wei, 2005 and 2006, and Cadarso *et al.*, 2008, in table 1).

## Table 1: Empirical evidence (selected works)

| Work (year) | Country | Sample | Sector[a] | Period | F-H index[b] | Analytical framework[c] | Dependent variable | Effect | OSS[d] |
|---|---|---|---|---|---|---|---|---|---|
| Siegel and Griliches (1992) | US | 392 industries | M | 1959-1986 | ✓ | Correlation analysis | - | 0 | 0 |
| Berman *et al.* (1994) | US | 450 industries | M | 1959-1987 | 0 | Translog cost, share eq. | Relative employment | 0 | 0 |
| Slaughter (1995, 2000) | US | 32 industries | M | 1977-1989 | 0 | Translog cost, share eq. | Relative employment | 0 | 0 |
| Feenstra and Hanson (1996a) | US | 450 industries | M | 1959-1987 | ✓ | Translog cost, share eq. | Relative employment | ✓ | 0 |
| Feenstra and Hanson (1996b) | US | 450 industries | M | 1972-1990 | ✓ | Translog cost, share eq. | Relative employment | ✓ | 0 |
| Feenstra and Hanson (1999) | US | 447 industries | M | 1979-1990 | ✓ | Translog cost, share eq. | Relative employment | ✓ | 0 |
| Amiti and Wei (2006) | US | 450 industries | M & S | 1992-2000 | ✓ | Cobb-Douglas PF, LD | Prducty. & Emplmnt. | ✓, 0 | ✓ |
| Canals (2006) | US | 27 industries | M & S | 1980-1999 | ✓ | Translog cost, share eq. | Relative wages | ✓ | 0 |
| Crinò (2010) | US | 58 occupations | M & S | 1997-2006 | ✓ | Logit, Probit | Transition probabilities | ✓ | ✓ |
| | | | | | | | | | |
| Girma and Görg (2004) | UK | 19,000 est. | M | 1980-1992 | 0 | Reduced form/PF | Offshoring/Productivity | ✓ | ✓ |
| Amiti and Wei (2005) | UK | 78 industries | M & S | 1995-2001 | ✓ | LD | Employment | 0 | ✓ |
| Criscuolo and Leaver (2005) | UK | 35,000 plants | M & S | 2000-2003 | ✓ | PF | Productivity | ✓ | ✓ |
| Hijzen *et al.* (2005) | UK | 50 industries | M | 1982-1996 | ✓ | Translog cost, share eq. | Relative employment | ✓ | 0 |
| | | | | | | | | | |
| Egger *et al.* (2003) | Austria | 38,000 workers | M | 1988-2001 | ✓ | Multinomial logit | Transition probabilities | ✓ | 0 |
| Egger and Egger (2003, 2005) | Austria | 21 industries | M | 1990-1998 | ✓ | General equilibrium | Relative employment | ✓ | 0 |
| Strauss-Kahn (2004) | France | 50 industries | M | 1977-1993 | ✓ | Translog cost, share eq. | Relative employment | ✓ | 0 |
| Geishecker and Görg (2005) | Germany | 1,612 workers | M | 1991-2000 | ✓ | Wage equation | Relative wages | ✓ | 0 |
| Görg and Hanley (2005) | Germany | 80 plants | Elec. | 1990-1995 | ✓ | LD | Employment | ✓ | ✓ |
| Cadarso *et al.* (2008) | Spain | 93 industries | M | 1993-2003 | ✓ | LD | Employment | ✓, 0 | 0 |
| Ekholm and Hakkala (2006) | Sweden | 20 industries | M & S | 1995-2000 | ✓ | Translog cost, share eq. | Relative employment | ✓, 0 | 0 |
| Hakkala *et al.* (2007) | Sweden | 15,000 firms | M & S | 1990-2002 | 0 | LD | Employment | 0 | 0 |
| | | | | | | | | | |
| Head and Ries (2002) | Japan | 1,070 firms | M | 1971-1989 | 0 | Translog cost, share eq. | Relative employment | ✓ | 0 |
| Tomiura (2005) | Japan | 118,300 firms | M | 1998 | 0 | Survey/Reduced form | Offshoring intensity | - | 0 |
| Hijzen *et al.* (2006) | Japan | 12,564 firms | M | 1994-2000 | 0 | PF | Productivity | ✓ | 0 |
| Ito *et al.* (2007) | Japan | 5,500 firms | M | 2006 | 0 | Survey | - | - | ✓ |

[a]: M is manufacturing, S services, and Elec. electronics.; [b]: Feenstra-Hanson index or similar; [c]: PF is production function and LD labor demand; [d]: offshoring of services.
Note: the column labeled "effect" refers to the effect of the offshoring variable on the dependent variable (✓ stands for significance and 0 for non-significance).

### *2.2. Recent evidence*

Let us here summarize the results of the additional evidence presented in table 1. There, it is possible to make out those works undertaken at the aggregate level of the industry from those conducted at a more disaggregate instance. Let us start from the former.

At this level of aggregation we can draw the following general conclusions. For continental Europe there is evidence on both offshoring being a source of (biased) technological change (Egger and Egger, 2003 and 2005; Strauss-Kahn, 2004; Ekholm and Hakkala 2006) and a source of employment loss (Cadarso *et al.*, 2008). However, the latter is dependent on the technology level of the industries involved domestically and the destination countries. For the UK and US there is evidence in favor of offshoring as a factor biased change (see Hijzen *et al.*, 2005, and Canals, 2006, respectively) yet not as a significant source of employment loss (Amiti and Wei, 2005 and 2006). Moreover, positive productivity effects of offshoring are also found for the US (Amiti and Wei, 2006). It must be observed too, that with the exception of both works by Amiti and Wei, the case for services offshoring is not covered.

We can see that also at the disaggregate level the evidence provides with proof for the effects of offshoring on the labor markets. For continental Europe it is again possible to dig up both the relative effects (Geishecker and Görg, 2005) and the direct effects (Görg and Hanley, 2005) upon employment. Others, however, do not find a significant direct effect on employment (Hakkala *et al.*, 2007). Further, evidence about the effects on labor turnover has also been produced (Egger *et al.*, 2003). On the UK and the US, positive effects of offshoring on productivity are obtained for the former (Girma and Görg, 2004; Criscuolo and Leaver, 2005), whereas some evidence on labor turnover due to offshoring is found for latter US (Crinò, 2010). Apparently, services offshoring is here more present than in aggregate studies, but it is still far from receiving the deserved attention.

### *2.3. What's with Japan?*

Japan's offshoring little tale remains in the shadows, as it is the case for much of the subject so far and much of Japan's puzzling performance in the 1990s. We can see from table 1 that the evidence consists of firm-level studies displaying the expected qualitative conclusions that abound elsewhere in the literature. Namely, that a factor biased technological change might occur when offshoring takes place, favoring high-skilled workers domestically

(Head and Ries, 2002), and that productivity gains are surely to be expected as a result of offshoring (Hijzen *et al.*, 2006).

In the work by Head and Ries (2002), 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.

Tomiura's work (2005), however, raises important questions around the subject and its significance for the Japanese economy. Nearly 98 percent of the firms of the sample did not offshore their production overseas. The extensive nature of the sample employed in this study bears some limitations though, as made explicit by the author. First, offshoring of services is not covered, and second, only manufacturing firms are considered. Finally, the survey by Ito *et al.* (2007) indicates that offshoring is more present now than five years ago: sampled firms engaged in offshoring went from 15 percent in 2001 to 20 percent in 2006. Moreover, production-related tasks take most of the offshoring pie, while services offshoring is still of a rather narrow scope. Also according to these authors, offshoring for Japanese firms is mainly restricted to own affiliates within East Asia.

The present paper thus fills in the holes left by the past literature in that: (i) the study is carried out at the industry level; (ii) the whole economy is considered and not just one sector; (iii) offshoring of services is accounted for; and (iv) the direct effects of offshoring on employment are estimated.

## 3. Measurement and analytical frameworks

Offshoring can be measured either directly or indirectly. Nevertheless, the lack of reliable direct data should make us consider indirect measures to a greater extent (see Kirkegaard, 2007). The intermediate trade index I discuss below has so far proved to be a reliable proxy.

### *3.1. Indirect indicators*

Feenstra and Hanson (1996a, 1996b, 1997, 1999) define offshoring as the share of imported intermediate inputs in the total purchase of nonenergy inputs.[2] They combine US import data from the four-digit SIC (Standard Industrial Classification) with data on material purchases from the *Census of Manufactures*. The census data crisscross the trade between industries of the same level and provides the base for estimating the share of intermediate inputs in every industry. 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. More formally, this can be written as follows:

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

where $I_j$ is purchases of inputs $j$ by industry $i$, $Q$ is total inputs (excluding energy) used by $i$, $\Pi_j$ is total imports of goods $j$, and $D_j$ their domestic demands. This formula provides an index of the offshoring intensity at the industry level. It estimates the import content of intermediate trade of industries which, in turn, proxies their offshoring intensities. Specifically, the first term in (1) stems from the census data (or Input-Output tables), while the second term, which is an economy-wide import share, is obtained from the 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, 2006).[3]

However, a common drawback to all measures relying on import shares is that offshoring does not necessarily imply an increase of imports, and vice versa. If a local exporting firm decides to move part of its production abroad and continues exporting it from a foreign country, this would not translate into a drop in the imports to the parent firm. Rather, it would represent a fall of its exports. Likewise, a rise in a country's imports due to more favorable terms of trade should not be linked to an expansion of offshoring

[2] Other indices used frequently in the literature are: imported inputs in total output (see for instance Egger and Egger, 2003), or the "vertical specialization" index, which accounts for the share of imported inputs in exports (Campa and Goldberg, 1997, and Hummels *et al.*, 2001).

[3] It can also be useful to split offshoring into its narrow and broad measures. 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.

from local firms. Another disadvantage of this index is that the second term in (1), the import penetration of inputs, is usually taken as equal for every industry (this is due to data availability). In spite of these drawbacks, the rationale for using an index of this kind should by now be clear: importing trade stands for an important amount of intra and inter firm trade nowadays, from which offshoring could be proxied.

*3.2. Analytical framework: Employment*

To study the direct effects of offshoring on employment I depart from a Cobb-Douglas technology for the industry (Amiti and Wei, 2006). Thus, omitting subscripts, we have:

$$Y = A(t)K^{\alpha}L^{\beta} \tag{2}$$

with $K$ and $L$ being equal to capital and labor services respectively, $Y$ the value added, and $A$ the time-dependent technology shifter. Also accepting that the industries can be represented as a single cost-minimizing firm (that is, min $rK + wL$), from our knowledge of the production function we can derive the cost function; hypothetically:

$$C(w, r, Y) = \phi r^{\frac{\alpha}{\alpha+\beta}} w^{\frac{\beta}{\alpha+\beta}} Y^{\frac{1}{\alpha+\beta}} \tag{3}$$

$\phi$ being a constant, $r$ and $w$ the factor prices (the interest rate and wages, for instance), and $Y$ output. As we can see, the cost function and the production function are both sides of the same coin. With exogenous input prices, the production function and the cost function contain virtually the same information.

It must be remembered at this point that, particularly in former efforts, it was most appealing to specify a translog cost function allowing for more substitution possibilities among inputs. This provided with a more flexible framework as regards cross elasticities that led to the estimation of a factor-share equation. We should keep in mind though, that the original debate was all about explaining the wage gap (e.g. the wage skill premium) or the shifts in relative employment of both nonskilled and skilled labor, due essentially to some form of technological change (see Berman *et al.*, 1994, and Feenstra and Hanson, 1996b, most representatively). Some of the current efforts, however, try to disentangle a more direct incidence of offshoring on total employment as in, for example, Amiti and Wei (2005, 2006) or Cadarso *et al.* (2008), who implicitly assume a Cobb-Douglas technology. In this way we have that cost minimization, which entails the optimal demand for inputs given a certain level of output, is characterized by the conditional demand for labor augmented by other factor prices.

Following Hamermesh (1993), minimizing total costs in (3) using Shephard's lemma (Hicks, 1939; Samuelson, 1947; Shephard, 1953) yields the factor demand functions for $K$ and $L$. For the labor factor we have, in general form:

$$L = \Gamma(w, p, Y) \tag{4}$$

where the demand for labor depends on wages $w$, other factor prices $p$, and an output measure $Y$. Among input prices other than $r$, we can identify, following Amiti and Wei (2005, 2006), the price of foreign labor services. These pose as a substitute for domestic labor and enter the labor equation:

$$L = \Gamma(w, p', p^{os}, Y) \tag{5}$$

where $p'$ is a vector of factor prices other than those of foreign services ($p^{os}$). Since data on $p^{os}$ are often hard to get, these authors propose the offshoring intensity indices as an *inverse proxy* of the price of the imported intermediate inputs.

$$L = \Gamma(w, p', Y, OSS, OSM) \mid A(OSS, OSM) \tag{6}$$

where $OSS$ and $OSM$ are the services and materials offshoring indices, and $A$ is the technology shifter dependent on offshoring. Here Amiti and Wei (2005, 2006) identify three channels through which offshoring comes to affect the labor demand. First, a possible substitution effect between labor and prices of imported inputs (services or materials); a drop in the latter or, equivalently, an increase in the offshoring indices, would lead to a fall in the demand for labor. Second, a possible short-run productivity effect of offshoring to impact negatively on employment. And third, the scale effect (or long-run productivity effect) which might affect labor positively, provided firms are more efficient and competitive in the longer run due to previous productivity gains.

Log-linearizing and adding the subscripts to the previous formulation, I obtain a widely used equation in the recent literature:

$$
\begin{aligned}
\ln L_{it} &= \beta_o + \beta_1 \ln L_{it-1} + \beta_2 OSS_{it} + \beta_3 OSM_{it} + \beta_4 \ln w_{it} + \beta_5 \ln p'_{it} \\
&\quad + \beta_6 \ln Y_{it} + \delta_i d_i + \delta_t d_t \qquad (7)
\end{aligned}
$$

Labor is regressed on its lagged value and a set of other explanatory variables, where the subscript $i$ stands for industry and $t$ for time. The introduction of the lagged dependent variable on the right-hand side is justified since we can reasonably suppose that labor does not adjust automatically to changes in the other variables. Or, what is the same, that the level of employment might deviate from its steady state when the adjustment takes place (see Cadarso *et al.*, 2008, and Görg and Hanley, 2005). Explanatory variables include, respectively: the services and materials offshoring intensity indices, $OSS$ and $OSM$, the real average wages $w$, other factor prices $p'$ (such as $r$), and an output measure $Y$. Here we can use the output (either volume or value), the capital stock, or some measure of R&D investment. Industry and year fixed effects also enter the equation through the dummy variables, $d_i$ and $d_t$. For the benefit of clarity, error terms are omitted here and in the following section.

Introducing lags of both $OSS$ and $OSM$ into equation (7) would allow us to account for the long run scale effects of offshoring. The signs of the coefficients would eventually tell the final effect on employment. The simple methodology undertaken here is only concerned with the direct effects of offshoring within industries, while no industrial spillovers are taken account of.[4] Therefore, the expected signs of the coefficients $\beta_2$ and $\beta_3$ are inconclusive, since it is not clear whether the scale effect is large enough to outweigh the substitution and productivity effects *within the same industry.* As stated before, the output may be increased (and employment with it) in response to offshoring-related productivity gains. Moreover, I expect that $\beta_4 < 0$ (a downward-sloping labor demand), and $\beta_5 > 0$ (if inputs are gross substitutes). Notice too that no restrictions are imposed on the coefficients as to comply with the constant returns to scale (CRS) hypothesis, since this is not found to hold on several specifications of the production function.

A couple of remarks by Amiti and Wei (2006) need be recapped. First, re-

[4]For this see Egger and Egger (2005), who claim that the final effect of offshoring could be strongly underrepresented if spillover effects are not being considered.

lying on the assumption of perfect mobility of labor across industries, we have that wages are exogenously determined. If that is not the case though, then wages are endogenous. Provided that these potential rents are unchanged over time, we can assume that they would be absorbed by the industry fixed effects ($\delta_i$), so the results would still be unbiased. Second, the price of other inputs (such as imported inputs and the rental on capital) are considered as a function of time, so they are captured by the time fixed effects ($\delta_t$). And lastly, these authors prefer the use of the output variable as a control, which supposes a strong endogeneity problem. Even though this is conventional in most empirical work, the estimated equation remains of doubtful interpretation as the coefficient on the real wage variable represents a partial and not a total elasticity (Webster, 2003).[5] For this reason, the exogenously determined capital stock variable is made explicit in our final estimating equation with no output variables:

$$\ln L_{it} = \theta_o + \theta_1 \ln L_{it-1} + \theta_2 OSS_{it} + \theta_3 OSM_{it} + \theta_4 \ln w_{it} + \theta_5 \ln K_{it} + \delta_i^* d_i + \delta_t^* d_t \tag{8}$$

Notwithstanding the previous assumptions in the last few paragraphs, the estimation of the panel in equation (8) still entails potential endogeneity problems due to the offshoring variables. A potential bias in the OLS estimates is expected and should make us consider the implementation of instrumental variables techniques.

*3.3. Analytical framework: Productivity*

Productivity can be measured in multiple ways. Fundamentally, it can be either measured as the ratio of a volume measure of output to a volume measure of input, or as a measure depending on all types of inputs. In this way it is possible to distinguish between labor and capital productivity on the one hand (a single-factor measure), and total factor productivity (TFP) on the other (that is, a multi-factor measure). Different measures of outputs and inputs and, thus, of productivity, reflect different representations of the same

[5] Webster (2003) carries on: "A total elasticity includes the full effects on employment, once the effects on intermediate variables such as output have been worked through. Partial elasticities are the effects if one or more of these intermediate variables are artificially held constant. Partial elasticities are artificial 'thought experiments', as in real life it is not possible to control most variables." (p. 135, footnote 5).

production process in a particular industry (Zheng, 2005). I am interested in calculating two of these widely used measures of the TFP for Japan and then estimate the direct effects of offshoring. This is the usual two-stage estimation methodology.[6]

First we have a generalization of the gross value added (or net output) representation of the production function. Gross value added is obtained by deducting intermediate consumption from gross output; at factor costs it includes: wages, consumption of fixed capital, and pre-tax profits. Supposing a Cobb-Douglas technology and omitting subscripts, such an output measure can be represented by:

$$Y_V = F(K, L, t) = A^{'}(t)\ K^{\alpha} L^{\beta} \tag{9}$$

where gross real value added $Y_V$ depends on labor $L$, capital $K$, and the Hicks-neutral and time-dependent technological parameter $A^{'}(t)$.

Additionally, we can consider the gross output-based measure, which is a representation of the production function augmented by the consumption of materials and services inputs:

$$Y_O = G(K, L, M, S, t) = A^{''}(t)\ K^{\gamma} L^{\delta} M^{\lambda} S^{\mu} \tag{10}$$

where gross real output $Y_O$ depends on labor $L$, capital $K$, materials inputs $M$, services inputs $S$, and the neutral technological shifter $A^{''}(t)$.

Taking logarithms and differentiating both expressions with respect to time we get, through Euler's theorem, the contributions of the growth in inputs to the growth in output:

$$\dot{Y}_V = \zeta_K \dot{K} + \zeta_L \dot{L} + \dot{\tau}_V \tag{11}$$

$$\dot{Y}_O = \eta_K \dot{K} + \eta_L \dot{L} + \eta_M \dot{M} + \eta_S \dot{S} + \dot{\tau}_O \tag{12}$$

where $\dot{X} = \frac{\partial \ln X}{dt}$ is the growth rate for any variable in (11) and (12), $\zeta_h = \frac{\partial F}{\partial Z_h}\frac{Z_h}{F}$ and $\eta_h = \frac{\partial G}{\partial Z_h}\frac{Z_h}{G}$ are the elasticities of output to the different inputs ($Z_h$), and $\dot{\tau}_V = \frac{\partial \ln F}{\partial t} = \dot{A}^{'}$ and $\dot{\tau}_O = \frac{\partial \ln G}{\partial t} = \dot{A}^{''}$ are the changes in

[6] Hijzen *et al.* (2006) also adopt this two-step estimation procedure for Japan, yet their study is conducted at the firm level.

the Hicks-neutral residuals (e.g. technical progress). Under the simplifying assumptions of CRS and perfect competition in the market of both output and inputs, these equations can deliver the growth in the TFP:

$$\dot{\tau}_V = \dot{Y}_V - s_K \dot{K} - s_L \dot{L} \tag{13}$$

$$\dot{\tau}_O = \dot{Y}_O - s'_K \dot{K} - s'_L \dot{L} - s'_M \dot{M} - s'_S \dot{S} \tag{14}$$

Because of the competitive equilibrium assumption in particular, equations (13) and (14) also imply the equivalence between factor income shares and output elasticities. That is, $s_h \equiv \frac{p_h Z_h}{p_V Y_V} = \zeta_h$ and $s'_h \equiv \frac{p_h Z_h}{p_O Y_O} = \eta_h$, with $p_h$ the price or return to inputs, and $p_V$ and $p_O$ the prices of real value-added and real gross output respectively. Each input is thus paid its marginal product.[7]

In order to keep consistency with the previous section, the CRS hypothesis is here relaxed. To account for non-constant returns (non-CRS) I follow Liu and Li (2008) decomposition approach,[8] which would imply modifying the output growth equations (11) and (12) as to adjust for the economies of scale effect. As seen in both these equations, when CRS apply, output growth can be decomposed into the weighted sum of input growth and technical progress. However, in the presence of non-CRS, Euler's equations can now be rewritten in general terms as:[9]

$$\dot{Y} = \xi \, \Sigma_h \frac{\xi_h}{\xi} \dot{Z}_h + \dot{A} \tag{15}$$

where $\xi_h$ is the output elasticity to input $Z_h$, $\xi$ is the sum of these elasticities ($\Sigma_h \, \xi_h$), and $\dot{A}$ is the technical progress. When production is CRS, $\xi = 1$,

[7]Generally speaking, for a production function with a single input $Z$ a simple productivity measure is given by $\frac{Y}{Z}$. When considering multiple inputs, the TFP can be defined as $TFP = \frac{Y}{\Psi}$. If we take logarithms and differentiate with respect to time we get: $T\dot{F}P = \dot{Y} - \dot{\Psi}$. We have that $\dot{\Psi}$ is the Divisia index (Jorgenson and Griliches, 1967), and also that $\dot{\Psi} = \Sigma \frac{p_h Z_h}{pY} \dot{Z}$, which corresponds to the subtracting terms in the right-hand side of (13) and (14), namely: $\Sigma_h \, s_h \dot{Z}_h$ and $\Sigma_h \, s'_h \dot{Z}_h$.

[8]Other references of interest are the work by Kee (2004) and the methodological review by Van Beveren (2007), which go over the different alternatives when classical hypotheses do not hold.

[9]See Liu and Li (2008) for the formal derivation.

and equation (15) reduces to $\dot{Y} = \Sigma_h \, \xi_h \dot{Z}_h + \dot{A}$, which is a generalization of (11) and (12). By subtracting and adding $\Sigma_h \frac{\xi_h}{\xi} Z_h$ and rearranging terms, equation (15) then becomes:

$$\dot{Y} = (\xi - 1)\Sigma_h \frac{\xi_h}{\xi} \dot{Z}_h + \Sigma_h \frac{\xi_h}{\xi} \dot{Z}_h + \dot{A} \tag{16}$$

Equation (16) shows that output growth can now be decomposed into three components: the adjusted economies of scale effect, the weighted sum of input growth, and technical progress. This decomposition can be applied to the decomposition of productivity growth as well. As before, subtracting the growth in inputs to the growth in output yields the unobservable residual term:

$$T\dot{F}P = (\xi - 1)\Sigma_h \frac{\xi_h}{\xi} \dot{Z}_h + \dot{A} \tag{17}$$

which is the sum of the first and last terms in equation (16). Hence, the TFP growth has two components: the adjusted economies of scale effect and technical progress. Notice that when CRS are present $T\dot{F}P = \dot{A}$, as in Solow (1957). Therefore, as argued by Liu and Li, "as long as the parameters of the production function can be estimated", equation (16) "can be used for the empirical estimation of the sources of output growth" and, by extension, equation (17) can be used to extract the sources of productivity growth. Estimating expressions (11) and (12) and then using (16) and (17) to account for non-CRS, delivers both adjusted measures of productivity growth ($T\dot{F}P$), that is, $\dot{\tau}'_V$and $\dot{\tau}'_O$. These are two common measures of productivity growth widely used in the literature.[10]

Once the series $\dot{\tau}'_V$ and $\dot{\tau}'_O$ are constructed I am able to estimate the

[10] See Griliches (1996) and Hulten (2001) for a bibliographical survey and Zheng (2005) for a review of the main indices (which are not considered here) that can be derived from the production function using a nonparametric approach. According to this author, these indices can account for the technological change of a more general nature (e.g. non-neutral Hicks). For instance, in a production function like $Y = H(AK, L)$, the residual affects capital but not labor; in $Y = H(K, AL)$ it affects labor but not capital. These two cases can be described as Hicks-biased, and would account for a rotation of the isoquant curves (instead of a shift, which is our case). For our purposes here, the derivation of our productivity measures in equation (17) through the parametric estimation of (11) and (12) will suffice.

effects of offshoring directly. We should remember, though, that since the TFP growth measures are estimated relying on the real values of inputs and output, the cost-saving motive usually attached to offshoring is therefore left out of the analysis. Adding subscripts, the second stage reduced-form estimating equation is simply:

$$\dot{TFP}_{it} = \varphi_1 \dot{TFP}_{it-1} + \varphi_2 OSS_{it} + \varphi_3 OSM_{it} + \lambda_i d_i + \lambda_t d_t \tag{18}$$

where $\dot{TFP}$ is one of the three measures of TFP growth discussed so far: $\dot{\tau}'_V$, $\dot{\tau}'_O$, or $\dot{\tau}_{JIP}$. Additionally, we have the lagged dependent variable which would account for the persistence of TFP growth over time, our offshoring indices ($OSS$ and $OSM$), and industry and year fixed effects ($d_i$ and $d_t$). I expect the coefficients associated to both $OSS$ and $OSM$ to be positive independently of the TFP measure considered. According to Amiti and Wei (2006) offshoring can increase productivity either due to compositional or structural changes. First, relocating inefficient parts of the production process to another country could increase the productivity of the remaining workers. And second, due to the access to new inputs, productivity increases are also likely, yet with larger effects arising from services offshoring.

As with employment, potential endogeneity of offshoring is also present in equation (18). Either more productive industries self select into offshoring or, conversely, industries that expect a fall in productivity growth increase their levels of offshoring in the hope of increasing their productivity (Amiti and Wei, 2006). Here again, instrumental variables should be considered.

## 4. Empirical analysis

### *4.1. Descriptive statistics*

#### *4.1.1. Data*

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 2). 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 2: The JIP database, economic branches of activity

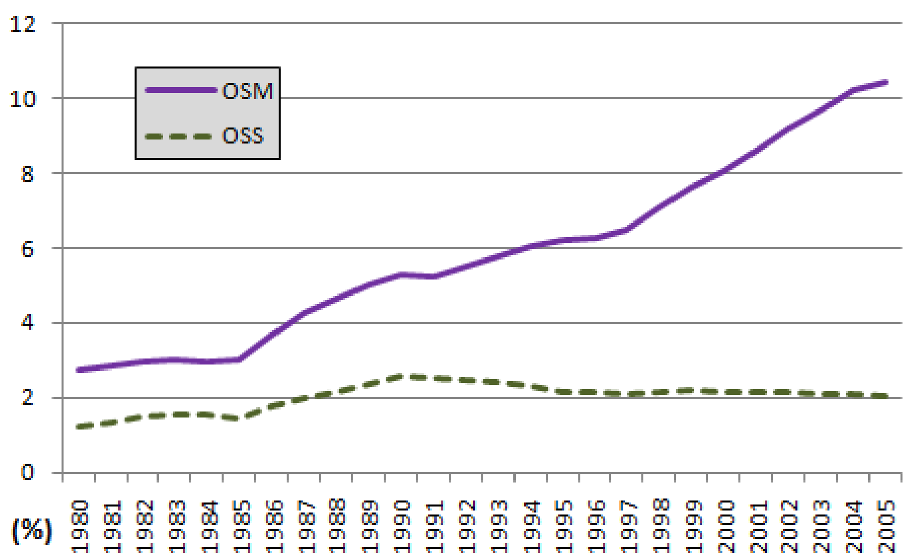
| *JIP code* | *Manufacturing* | *JIP code* | *Services* | *JIP code* | *Other* |
|---|---|---|---|---|---|
| 008 | Livestock products | 067 | Wholesale | 001 | Rice, wheat production |
| 009 | Seafood products | 068 | Retail | 002 | Miscellaneous crop farming |
| 010 | Flour and grain mill products | 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 | | | | |

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

*4.1.2. Materials and services offshoring*

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

**Figure 1: Materials and services offshoring (%)**




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

From (1) we have that the index on materials offshoring is the import content in all materials inputs. Hence, the first term is the 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 carry out the importing of these materials with the same intensity. The same reasoning applies to the construction of the services offshoring index. Figure 1 and table 3 show the evolution of materials and services offshoring according to formula (1), weighted by industry value added.[11,12]

**Table 3: Offshoring intensity, whole economy**

| *Year* | *OSM (%)* | *annual g.r. (%)* | *OSS (%)* | *annual g.r. (%)* |
|---|---|---|---|---|
| 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 |

[11] In 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). The import figures had to be linearly interpolated; only years 1980, 1985, 1990, 1995, and 2000 were available. As a result, the econometric analysis below starts in 1980. Due to a possible aggregation bias (which underlies the whole empirical analysis), the measurement errors of the offshoring index, and the potential endogeneity of this variable in the econometric analysis below, it is important to note that any conclusions should be interpreted with caution.

[12] The average annual growth rates in table 3 are calculated using a compound annual growth rate index (CAGR). This can be expressed as follows: $CAGR = \left(\frac{ending\ value}{beginning\ value}\right)^{\left(\frac{1}{\#\ of\ years}\right)} - 1$

Let it be warned that the $OSS$ and $OSM$ indices are not directly comparable because the denominators are not the same. Recall that what we have is the import content of inputs (either services or materials) in terms of the total use of these same inputs (foreign and domestic). Other studies propose to set this share in terms of the total use of all inputs (services plus materials, both foreign and domestic), just to be able to derive an index of "total offshoring" later. As we happened to define offshoring this is not possible here, yet I believe that our indices stand closer to measuring the real extent of offshoring because services and materials offshoring are intrinsically very different phenomena.

Three things are worth commenting at this point. First, materials offshoring is expectedly more predominant, as its development dates back to much earlier times.[13] Second, the annual rate of growth of services offshoring is, on average, surprisingly smaller than that of materials in the whole sample period. Due to an ever-increasing globalized world where technologies abound and change fast for the better, one should have expected the opposite to be true. Yet this only happened in the period before the bubble crisis and the lost decade, when the rates of growth were approximately equal. 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 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.[14]

*4.1.3. A lost decade of growth*

Using data from 1970 to 2005 I estimate the output elasticities in (11) and (12). Then I combine this information with equations (16) and (17) and get both TFP growth rates adjusted by the economies of scale effect. Equations (11) and (12) were estimated through a panel considering fixed effects and cross-section weights. The database was filtered as to be left only with those

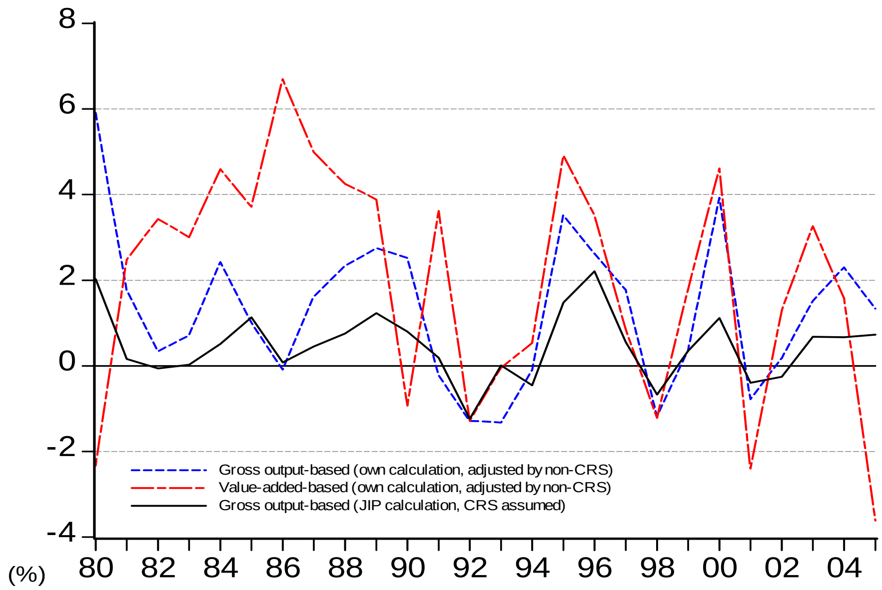
[13] This is true for the whole economy and when separating between manufacturing and services industries. This breakdown is however not presented for reasons of space.

[14] Ito *et al.* (2007) highlight the preference for large-sized Japanese firms to have their relocation processes being channeled into the region.

industries where their labor shares delivered a sensible result (e.g. they were less than 1). As a result, I am left with 83 industries out of a total of 108.

Figure 2 displays, for the 1980-2005 period, our value-added-based and gross output-based productivity measures as well as the one calculated by the JIP (Fukao *et al.*, 2004, 2007), which is also a gross output measure (e.g. it takes account of intermediate inputs).

**Figure 2: Total factor productivity, growth rate (%)**




Note: mean values across 83 industries (due to data cleaning).

It is to note the somewhat pessimistic performance in the annual growth rates of the TFP during the 1990s, as compared to previous years. This is attenuated in the JIP measure, which portrays a less volatile pattern. Notice too that while both measures calculated in this paper are adjusted by non-CRS, the other is not. Another difference is that, despite being the same data, the JIP's methodology addresses the estimation of the TFP growth from an industry by industry perspective which makes use of specific input indices (see Jorgenson and Griliches, 1967, and Gollop and Jorgenson, 1980).[15] In

[15] For instance: "the index of capital input is derived by the aggregation of several types

spite of these differences, the correlation coefficients with the JIP measure for 1980-2005 are 0.63 (value-added) and 0.68 (gross output).

The use of labor and capital indices which accounted for the quality of labor and capacity utilization is said to come as a sophistication over previous estimations on the Japanese TFP (Fukao *et al.*, 2004). However, due to the aggregation entailed by our approach and the assumed exogeneity of the TFP variable, I simply use the number of workers and the real capital stock as the input variables. These TFP measures are later used in the econometric analysis.

*4.2. 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.[16] 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:

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

where the change in the offshoring index at the country level ($\Phi$) 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

of assets, structures, and equipment. The labor input index is an aggregate of the number of workers cross-classified by sex, age, employment status, and educational attainment" (Fukao *et al.*, 2007).

[16] See Horgos (2009), Hummels *et al.* (2001), and Strauss-Kahn (2004), who also undertake decomposition analyses along these lines.

the share of industry output to total output ($\theta$), to focus on the change in the offshoring intensity ($\delta$). 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 4 breaks down the sources of growth for the index during the whole sample and in two subsamples (1980-1990 and 1990-2005).

**Table 4: Sources of growth of the offshoring index**

| | *Within* | *Between* | *Total (w+b)* | *Within/Total* |
|---|---|---|---|---|
| OSS | | | | |
| 1980-1990 | 1.37 | 0.01 | 1.38 | 99.0% |
| 1990-2005 | -0.51 | -0.06 | -0.57 | 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 | 5.19 | 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 3. 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 3), *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 3. 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.[17] All in all, the index performs acceptably well for the whole sample yet less smoothly during the fading 1990s.

*4.3. Econometric analysis*

Having determined the suitability of the index, I now proceed to gauge the employment and productivity effects relying on panel data analysis. Prior to the discussion of the results, some general remarks on the estimation methodology need be made. In addition, table 5 below provides the summary statistics of the main variables.

**Table 5: Summary, 1980-2005 (means across 83 industries)**

| | Variable | Observations | Mean | Max. | Min. | Std. dv. |
|---|---|---|---|---|---|---|
| Offshoring | $OSS_{it}$ (%) | 2158 | 2.13 | 25.11 | 0.54 | 1.34 |
| indices | $OSM_{it}$ (%) | 2158 | 8.03 | 114.12 | 0.62 | 12.58 |
| Productivity | $\tau'_{Vit}$ (%) | 2158 | 1.97 | 126.16 | -120.39 | 13.49 |
| growth | $\tau'_{Oit}$ (%) | 2158 | 1.30 | 35.45 | -29.32 | 5.19 |
| rates | $\tau_{JIPit}$ (%) | 2158 | 0.46 | 34.42 | -36.41 | 5.20 |
| Inputs and | $L_{it}$ (workers) | 2158 | 554,525 | 7,285,919 | 1,767 | 983,149 |
| Output | $K_{it}$ (real, million yen) | 2158 | 8,436,522 | 123,477,018 | 60,968 | 15,885,311 |
| | $Y_{it}$ (real, million yen)* | 2158 | 3,406,296 | 38,767,333 | 34,133 | 5,121,855 |
| Wages | $w_{it}$ (avg., real, million yen) | 2158 | 5.15 | 34.84 | 0.33 | 3.38 |

*: gross value-added (factor prices).

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. However, since we

[17] 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.

are dealing with dynamic panels where we assume a large number of cross-sections ($N$) compared to the number of periods ($T$), the OLS and fixed effects estimators are inconsistent. In particular, whereas the former tends to overestimate the autoregressive coefficient the latter tends to underestimate it.

Moreover, in our case it also becomes important to address the potential endogeneity of the offshoring variable, 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 would do the job. This is hardly the case though and, on top of that, the endogeneity of the offshoring variable is further magnified due to the presence of measurement errors.

Hence, I deem it necessary to rely on GMM estimation. To remove the permanent industry-specific effects from our final estimating equations,[18] we need to transform the variables either into first-differences (Arellano and Bond, 1991) or orthogonal deviations (Arellano and Bover, 1995). Potential measurement problems underlying the offshoring index would lead us to opt for the latter, since first-differencing tends to amplify such problems through larger variances.[19]

Therefore, to study the effects of offshoring on both employment and productivity I present several estimations based on the GMM estimator (both in first differences and orthogonal deviations). When possible, the coefficients of all specifications are *reparametrized* to show the total effects concentrated in period $t$. Joint Wald tests are presented along the estimations to ensure that this is possible and the coefficients do not cancel out. More, some of these specifications include time dummies to control for period specific shocks common to all industries. These time dummies are also used (no transformation involved) as additional instruments to the specific ones used in the final equations. For the labor demand in equation (8) I use period-specific (predetermined) instruments and exogenous ones. Specifically, they involve all valid lags of the dependent variable from $t-2$ to $T$ on the one hand, and the first two lags of real wages and capital, $w_{it-1}, w_{it-2}, K_{it-1}, K_{it-2}$,

[18] These are equation (8) in section 3.2 for the employment analysis and equation (18) in section 3.3 for the productivity analysis.

[19] Another method would be system GMM, which combines the estimation of an equation in first differences with an equation in levels. However, this approach is not undertaken here for it was not available while running our regressions in Eviews.

all in logs, on the other hand.[20] For the TFP equation I use the lags of the dependent variable from $t-2$ to $T$, as well as the first two lags of other explanatory variables. Finally, the validity of the instrument sets and of the overidentifying restrictions is tested using the conventional Sargan test. The consistency of the GMM estimates also depends on the absence of serial correlation in the errors. In this regards, the $m2$ statistic proposed by Arellano and Bond (1991) tests for the absence of second-order serial correlation in the residuals.

*4.3.1. Employment effects*

To capture the employment effects of offshoring I estimate the labor demand equation in (8) using the GMM estimator. Our variables of interest are $OSS$ and $OSM$, and since these are not transformed into logarithms, they should be interpreted as semi-elasticities. Table 6 below shows the equations estimated by difference GMM (GMM-DIF) and GMM in orthogonal deviations (GMM-OD), with and without a full set of year dummies. As for the assumed GMM weighting, all four equations are estimated with the Arellano-Bond 2-step estimator, which updates weights once.[21]

Notice that all the equations are characterized by a large persistence coefficient, indicating a strong inertia in the industries' aggregate level of employment. The Wald test for the lagged employment coefficient being equal to 1 (unit root) is strongly rejected in all cases. Related to this, Agnese and Sala (2009) estimate a system of structural equations for Japan consisting of a labor demand and a labor supply equations.[22] Even though offshoring is not considered there, the labor demand equation appears with a high autoregressive coefficient (0.89). Also to note is the similarity between the estimated coefficients, or short-run elasticities, of the real wages. In the present work this elasticity ranges between -0.02 and -0.03, while in the previously referred paper is approximately -0.04. This would imply a long-run elasticity of 0.37 in the work by Agnese and Sala (see p.432) and values around the 0.4-0.6

[20] This strategy is employed by Layard and Nickell (1986) who estimate a labor demand function similar to (8) in a dynamic (unbalanced) panel of 1031 observations (140 firms, years 1976-1984).

[21] The standard errors for the two-step estimator may not be reliable (see Arellano and Bond, 1991).

[22] Their dataset contains data at the country level from the OECD Economic Outlook, which is used to carry out a time-series analysis for the years 1972-2006.

range, as can be deduced from table 6.[23] One final resemblance lies in the fact that the capital variable in levels does not enter the labor demand equation. For all specifications in table 6 I fail to reject the Wald of both the current and lagged coefficients of capital being jointly non-significant, so the variable enters in differences. This means that what we have as $\Delta \ln K_{it}$ is the real investment.[24]

With the exception of the capital variable, all other variables enter the equations both in levels and differences. This means that the short-run elasticities (or semi-elasticities, for the offshoring variables) can be directly read from the estimated coefficients of the variables in levels. This reparametrization is made possible because the coefficients of the current and lagged variables (easily) pass the Wald tests of joint significance. But prior to analyzing the effect of offshoring on employment it is necessary to spend a word on our misspecification tests, also reported in table 6.

Under the null hypothesis that the over-identifying restrictions are valid, the Sargan statistic is distributed as a $\chi^2(k-p)$, where $k$ is the instrument rank and $p$ the number of estimated coefficients. Thus, not rejecting the Sargan test is indicative of the exogeneity of the instruments used. Notice that for the regressions without period dummies, (1) and (3), these tests are easily passed, yet when period dummies are included, like in (2) and (4), these tests are only passed at the margin. As for the $m2$ statistic, specification (1) seems to suffer of autocorrelation of second order in the residuals, so the estimates are not consistent. As for the rest the null hypothesis is rejected, and in particular for (3), it is strongly rejected.[25] Let us now take a closer look at the offshoring coefficients.

[23] From equation (8) we have that the long-run elasticity of employment to a change in real wages can be simply expressed as: $\varepsilon_w^{LR} = \dfrac{\hat{\theta}_4}{1-\hat{\theta}_1}$

[24] Agnese and Sala (2008) study the harming effects of a sharp decline in real investment in Japan. Their simulations suggest that this has been decisive in explaining the sudden upsurge in the unemployment rate during the 1990s, perhaps as a practical consequence of comparatively lower productivity rates.

[25] An option to perform this test directly in Eviews was not available. For this reason I had to reestimate all models adding the residuals lagged two periods, both as explanatory variable and instrument. Perhaps under the hypothesis of no correlation the $t$ statistic of the added variable is distributed as $N(0,1)$, but this has not been proved.

## Table 6: Labor demand, GMM estimation

(83 industries, 1980-2005)

**Dependent variable: ln $L_{it}$**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | **GMM-DIF** | **GMM-DIF** | **GMM-OD** | **GMM-OD** |
| **ln $L_{it-1}$** | 0.95† | 0.95† | 0.95† | 0.95† |
| | (0.001) | (0.01) | (0.001) | (0.005) |
| **ln $w_{it}$** | -0.03† | -0.02† | -0.03† | -0.03† |
| | (0.001) | (0.009) | (0.001) | (0.002) |
| **Δ ln $w_{it}$** | -0.07† | -0.06† | -0.10† | -0.10† |
| | (0.001) | (0.01) | (0.002) | (0.01) |
| ***$OSS_{it}$ / 100*** | **1.02**† | **0.92** | **1.03**† | **0.53**‡ |
| | (0.07) | (0.71) | (0.06) | (0.25) |
| **Δ *$OSS_{it}$ / 100*** | -0.50† | * | -0.59† | * |
| | (0.03) | | (0.13) | |
| ***$OSM_{it}$ / 100*** | **-0.26**† | **-0.14** | **-0.33**† | **-0.23**‡† |
| | (0.01) | (0.14) | (0.01) | (0.13) |
| **Δ *$OSM_{it}$ /100*** | -0.46† | * | -0.47† | * |
| | (0.03) | | (0.03) | |
| **ln $K_{it}$** | * | * | * | * |
| | | | | |
| **Δ ln $K_{it}$** | 0.27† | 0.20† | 0.21† | 0.17† |
| | (0.004) | (0.06) | (0.01) | (0.06) |
| **<u>Joint tests (Wald)</u>:** | | | | |
| **ln $L_{it-1}$ = 1** | $\chi^2(1)$ = 2,440 | $\chi^2(1)$ = 13.07 | $\chi^2(1)$ = 2,912 | $\chi^2(1)$ = 73.25 |
| | *p-value* = 0.00 | *p-value* = 0.00 | *p-value* = 0.00 | *p-value* = 0.00 |
| **ln $w_{it}$ + ln $w_{it-1}$ = 0** | $\chi^2(1)$ = 503.2 | $\chi^2(1)$ = 9.59 | $\chi^2(1)$ = 1,013 | $\chi^2(1)$ = 142.3 |
| | *p-value* = 0.00 | *p-value* = 0.00 | *p-value* = 0.00 | *p-value* = 0.00 |
| ***$OSS_{it}$* + *$OSS_{it-1}$* = 0** | $\chi^2(1)$ = 131.6 | - | $\chi^2(1)$ = 276.9 | - |
| | *p-value* = 0.00 | | *p-value* = 0.00 | |
| ***$OSM_{it}$* + *$OSM_{it-1}$* = 0** | $\chi^2(1)$ = 115.2 | - | $\chi^2(1)$ = 461.3 | - |
| | *p-value* = 0.00 | | *p-value* = 0.00 | |
| **ln $K_{it}$ + ln $K_{it-1}$ = 0** | $\chi^2(1)$ = 0.90 | $\chi^2(1)$ = 2.16 | $\chi^2(1)$ = 1.28 | $\chi^2(1)$ = 1.98 |
| | *p-value* = 0.34 | *p-value* = 0.14 | *p-value* = 0.25 | *p-value* = 0.16 |
| **Sargan test:** | $\chi^2(76)$ = 90.19 | $\chi^2(53)$ = 68.65 | $\chi^2(76)$ = 82.49 | $\chi^2(53)$ = 66.24 |
| | *p-value* = 0.18 | *p-value* = 0.07 | *p-value* = 0.28 | *p-value* = 0.10 |
| ***m*2 test:** | z = -16.83 | z = -1.63 | z = 0.38 | z = 1.68 |
| | *p-value* = 0.00 | *p-value* = 0.10 | *p-value* = 0.70 | *p-value* = 0.10 |
| **Period dummies** | **no** | **yes** | **no** | **yes** |
| **s.e.** | 0.05 | 0.05 | 0.04 | 0.04 |
| **Adj. $r^2$** | 0.05 | 0.11 | 0.96 | 0.96 |
| **observations** | 1,992 | 2,075 | 1,992 | 2,075 |

*: strongly non-significant, individually or jointly (variable removed).

Note: all specifications estimated with Eviews and based on equation (8). GMM-DIF is the Arellano-Bond (1991) estimator in first differences and GMM-OD the Arellano-Bover (1995) estimator in orthogonal deviations. Both are estimated using the 2-step method by Arellano and Bond (1991), so the standard errors may not be reliable. Results from 1-step estimations with the GMM-DIF were rather similar. The offshoring indices (%) are divided by 100 so as to interpret the semi-elasticities directly. Standard errors in parentheses and †, ‡, and ‡† the usual levels of significance: 1%, 5%, and 10%; Δ is the difference operator.

All labor demand equations show a positive effect of services offshoring and a negative effect of materials offshoring. This is not counterintuitive at all, since both types of offshoring entail very different processes. The dissimilarities go from radically different managerial strategies to different business relations with providers or local partners, as well as a rather disparate perception on the degree of customer satisfaction. Services offshoring very often includes more dynamic activities involving more highly trained workers. In this sense, relocating services 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". Remember that our setting does not allow for spillovers effects between industries, so both the positive and negative effects should be thought as taking place *within* the same industry.[26]

For instance, specification (1) shows that services and materials offshoring have short-run semi elasticities of 1.02 and -0.26 respectively. That is, an increase of 1 percentage point in any of the offshoring variables explains, on average, a change of 1.02 and -0.26 percent in employment. In turn, long-run elasticities are 20.4 and -5.2. The same reasoning applies to the rest of the specifications. Table 7 below sums up the information on the elasticities of employment to offshoring, both in the short ($\varepsilon_{SR}$) and long run ($\varepsilon_{LR}$).

**Table 7: Short and long run elasticities (offshoring)**

| | (1) | | (2) | | (3) | | (4) | |
|---|---|---|---|---|---|---|---|---|
| | *OSS* | *OSM* | *OSS* | *OSM* | *OSS* | *OSM* | *OSS* | *OSM* |
| $\varepsilon_{SR}$ | 1.02 | -0.26 | 0.92 | -0.14 | 1.03 | -0.33 | 0.53 | -0.23 |
| $\varepsilon_{LR}$ | 20.4 | -5.2 | 18.4 | -2.8 | 20.6 | -6.6 | 10.6 | -4.6 |

Note: as calculated from table 6; elasticities on (2) are not statistically significant.

Remember from table 3 the different evolution in both offshoring indices. For our period of analysis we can see that while $OSS$ raised, on average,

[26]For an analysis of offshoring 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.

from 1.22 to 2.04 percent (0.82 percentage points), $OSM$ went from 2.72 to 10.45 percent (7.73 percentage points). Combining this information with the long-run elasticities in the second line of table 7, and with the change in employment, it is possible to quantify the effects of both kinds of offshoring on the Japanese labor market. To do that I will only focus on the long-run elasticities as estimated from specifications (3) and (4). In (2) the coefficients are not statistically significant and specification (1) shows signs of second-order correlation in the residuals. Notice, however, that the elasticities calculated from (1) and (3) are rather similar.

According to the JIP database, the level of employment in Japan for our restricted sample of 83 industries grew, on average, about 18 percent during 1980-2005 (around 100,000 workers). Multiplying the estimated long-run elasticities times the average change in the offshoring variables,[27] and expressing that as a proportion of the average change in employment, allows us to get an idea of the size of the effect of offshoring on employment.

From the estimation in (3) this implies an increase, on average, of around 1,000 workers due to services offshoring and a loss of 2,900 workers due to materials offshoring. The net average loss is of approximately 1,900 workers during 1980-2005. From (4) I estimate an average increase of about 500 workers due to services offshoring and a loss of 2,000 due to materials offshoring, totaling a net average loss of nearly 1,500. Since both total magnitudes are negative they should be interpreted as the number of jobs that fail to open due to offshoring. Indeed, they only represent a small fraction of the total increase in employment: between 1.9 percent in specification (3) to 1.5 in (4).[28]

Table 8 goes over the offshoring-induced changes in Japanese employment in more detail. As can be seen from the table, the relative impact of $OSS$ and $OSM$ is minor, both individually and overall. Aggregating these figures, our estimations suggest that, during 1980-2005, the total loss of jobs as a result of offshoring was negligible. Estimated figures range from 160,000 in specification (3) to 125,000 in (4) or, which is the same thing, from 1.9 to 1.5 percent of the total growth in employment.

[27] These changes must be divided by 100 to keep consistency with the variable as entering the estimated equation.

[28] Recall that this analysis, due to its very characteristics, omits both the possible spillover effects between industries, and the fact that some of them may, individually, be experiencing different effects of offshoring from those averages presented here.

**Table 8: Average employment effects of offshoring**

| | (3) | | (4) | |
|---|---|---|---|---|
| | **Δ workers** | **%** | **Δ workers** | **%** |
| *OSS* | 951 | 0.9 | 489 | 0.5 |
| *OSM* | -2,872 | -2.8 | -2,001 | -2.0 |
| **Total** | -1,921 | -1.9 | -1,512 | -1.5 |

Note: average employment increase was 101,425 workers (or 18%).

*4.3.2. Productivity effects*

To see if offshoring has any effect on productivity growth I estimate the reduced-form equation in (18) relying once again on GMM estimation. As argued before, our variables of interest are believed to be determined endogenously. One more time, $OSS$ and $OSM$ ought to be understood as semi-elasticities, for these variables are not transformed into logarithms. Table 9 below shows different alternative specifications estimated with the GMM-OD estimator alone (Arellano-Bond 2-step). The reason for this is that both the offshoring and productivity variables are probably measured with errors. As observed earlier, taking first differences (GMM-DIF estimator) to remove the permanent industry-specific effects tends to amplify such problems through larger variances.

In order to avoid omitted variables biases I follow Fariñas and Martín (2009) and try to control for human capital intensity. For this I use the share of high-skill workers that comes with the JIP database.[29] Further, following Hijzen *et al.* (2006) I control for the R&D expenditure, which is a natural driver of the productivity growth. Since this variable does not come with the JIP, I decide to use a proxy instead. This is the investment in information technologies (as a share of GDP); particularly, the real value of the investment in software by industries. We should expect both these controls to have a positive effect on the TFP growth rate.

All reduced-form equations in table 9 are run on our output-based TFP growth variable ($\dot{\tau}'_O$). The other two measures ($\dot{\tau}'_{VA}$ and $\dot{\tau}'_{JIP}$) do not produce satisfying results, as neither do the specifications without period dummies.

[29] The JIP database offers data by industry on six different occupations: (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. Our human capital variable is set equal to the sum of the first two categories, which are those occupations usually involving a higher degree of specialization.

Also, the explanatory variables enter the regressions both in levels and differences. However, the control variables are not significant even though the null fails to be rejected at the margin for our human capital variable in (2') and (3'). Lagged terms of offshoring are not included since these are strongly non-significant, thus suggesting an immediate effect upon productivity.

**Table 9: TFP growth, GMM estimation**
(83 industries, 1980-2005)

**Dependent variable: $\Delta\ \tau'_{Oit}$**

| | (1') | (2') | (3') | (4') | (5') | (6') |
|---|---|---|---|---|---|---|
| | **GMM-OD** | **GMM-OD** | **GMM-OD** | **GMM-OD** | **GMM-OD** | **GMM-OD** |
| $\Delta\ \tau'_{Oit-1}$ | | | 0.009 | | 0.008 | 0.008 |
| | | | (0.01) | | (0.01) | (0.01) |
| $OSS_{it}$ / 100 | **0.32** | **0.66‡†** | **0.73‡†** | **0.84‡†** | **0.93‡†** | **0.86‡†** |
| | (0.36) | (0.40) | (0.42) | (0.46) | (0.51) | (0.51) |
| $OSM_{it}$ / 100 | **0.02** | **0.08‡** | **0.07‡†** | **0.08‡** | **0.07‡†** | **0.06** |
| | (0.03) | (0.04) | (0.04) | (0.04) | (0.04) | (0.04) |
| $H_K$ | | 0.09 | 0.08 | 0.07 | 0.05 | 0.05 |
| | | (0.08) | (0.08) | (0.08) | (0.09) | (0.09) |
| $\Delta\ H_K$ | | -1.42† | -1.39† | -1.36† | -1.31† | -1.32† |
| | | (0.27) | (0.26) | (0.24) | (0.23) | (0.24) |
| *R&D* | | | | 0.09 | 0.10 | 0.07 |
| | | | | (0.15) | (0.16) | (0.16) |
| Δ *R&D* | | | | | | -0.22 |
| | | | | | | (0.20) |
| **Period dummies** | **yes** | **yes** | **yes** | **yes** | **yes** | **yes** |
| **Sargan (p-value):** | 0.51 | 0.32 | 0.33 | 0.32 | 0.35 | 0.32 |
| **Adj. $r^2$** | 0.10 | 0.09 | 0.09 | 0.08 | 0.08 | 0.09 |
| **observations** | 2,075 | 1,660 | 1,660 | 1,660 | 1,660 | 1,660 |

Note: all specifications estimated with Eviews and based on equation (18). GMM-OD is the Arellano-Bover (1995) estimator in orthogonal deviations (Arellano-Bond 2-step). Results from 1-step estimations with the GMM-DIF or using $\tau_{VAit}$ and $\tau_{JIPit}$ as dependent variables were ambiguous. Results without period dummies were also not significant. The offshoring indices (%) are divided by 100 so as to interpret the semi-elasticities directly. Standard errors in parentheses and †, ‡, and ‡† the usual levels of significance: 1%, 5%, and 10%; Δ is the difference operator, $H_K$ the share of high-skill workers, and *R&D* the share of software investment in GDP.

Notice that both coefficients of services and materials offshoring appear with a positive sign, yet for the former the effect is significantly larger. According to the definitions of our variables, a 1 percentage point expansion in services offshoring would bring about an increase in the TFP growth rate ranging from 0.66 to 0.93 percent. On the other hand, for materials offshoring it goes from 0.06 to 0.08 percent.[30] These results are consistent with

[30]The values from (1') are not considered since it is to expect some bias due to an omitted variables problem.

those by Hijzen *et al.* (2006), who find that productivity growth would rise by 0.17 percent. Their study is from 12,564 Japanese manufacturing firms during 1994-2000. There, offshoring is measured directly and includes both the value of subcontracting at arm's length and the purchases of intermediate inputs from a firm's foreign affiliates. However, their broad measure does not account for the differences between services and materials inputs.

Multiplying the means of services and materials offshoring from table 5 times the estimated coefficients from table 9 gives the results in table 10. These suggest that for the average offshoring industry, the average annual TFP growth is from 1.4 to 1.98 percentage points higher than had it not engaged in services offshoring. For materials offshoring this goes from 0.48 to 0.64 additional percentage points. Hijzen *et al.* (2006), in turn, find that offshoring firms show a higher average TFP growth by 1.8 percentage points.

**Table 10: Average productivity effects of offshoring**

| | (2') | (3') | (4') | (5') | (6') | Hijzen *et al.* (2006) |
|---|---|---|---|---|---|---|
| *OSS* | 1.40 | 1.55 | 1.79 | 1.98 | 1.83 | 1.80 |
| *OSM* | 0.64 | 0.56 | 0.64 | 0.56 | 0.48 | |
| in percentage points | | | | | | |

Note: means of $OSS$ and $OSM$ are 0.02 and 0.08 respectively (table 5).

## 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 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 productivity boost or in response of economic scarcity. We have seen in this paper how offshoring might be employment-friendly (e.g. services offshoring) and how this innovative practice might hold the key as regards productivity improvement, something Japan is certainly in need for.

To provide a full-fledged account of the issue for Japan, this paper first reviews the main literature and finds its applicability to our special case, then analyzes the measurement issues to assess the phenomenon adequately, and finally offers an econometric analysis for the whole economy during the period

1980-2005. Manufacturing as well as services industries are here considered, and both materials and services offshoring are brought into the analysis. The data show materials offshoring to be of much greater importance than services offshoring, in spite of the communications revolution tapping in every corner of the globe. Moreover, with the ghost of the lost decade still looming over the economy, services offshoring remains on rather modest levels. Enough to say that its growth rate was slightly higher than that for materials during the 1980s, just to recede during the 1990s in a considerable proportion (in fact, the average annual rate was negative during the 1990s and onwards).

The results of the econometric analysis suggest a positive employment effect of services offshoring which explains between 0.5 to 1 percent of the average rise in employment. Materials offshoring, oppositely, appears with a negative sign, and the effect on employment goes from 2 to 3 percent of jobs that fail to open out of the average increase in employment. The net negative effect is around 1.5 to 2 percent approximately, which is a rather negligible figure. However, this should be taken with care, because no spillover effects among industries have been considered. Moreover, we must not forget about the aggregation of our analysis, which might be hiding some relevant information on the real effect of offshoring on particular industries. In general, the results presented here are robust to different specifications of the dynamic labor demand, whether it refers to the control variables or the dependent variable (additional results were omitted for the sake of brevity).

On the productivity side the results are also encouraging. Positive effects of both types of offshoring are found. The effect, for the average offshoring industry, goes from a 1.40 to an almost 2 percentage point increase in the average annual TFP growth rate for services offshoring. These results are similar to those obtained by Hijzen *et al.* (2006) for Japan. For materials offshoring the numbers are smaller, perhaps as a consequence of the nature of the tasks developed (usually involving a large number of low-skilled workers), and imply an increase of 0.48 to 0.64 percentage points.

As seen here, offshoring presents some frequently overlooked advantages. First, the realization of the principle of comparative advantages cannot escape the picture if we consider offshoring as a particular form of trade, suggesting that the negative employment effects have been largely exaggerated. And second, the results offered here point in the direction of potential productivity gains. However, one is left to wonder how much it will take for policy-makers to start realizing this fact and avoid hindering the natural process of profit-seeking and efficiency-seeking with well-intended measures.

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