Institutional Members: CEPR, NBER and Università Bocconi

WORKING PAPER SERIES

Off-Shoring and Productivity Growth in the Italian Manufacturing Industries

Francesco Daveri and Cecilia Jona-Lasinio

Working Paper n. 339

March 2008

IGIER – Università Bocconi, Via Salasco 5, 20136 Milano –Italy
http://www.igier.uni-bocconi.it

Forthcoming
CESifo Economic Studies, 03/2008

Off-shoring and productivity growth in the Italian manufacturing industries (*)

Francesco Daveri
Università di Parma and IGIER

Cecilia Jona-Lasinio
ISTAT and LUISS

We study the relation between the off-shoring of intermediates and services and productivity growth in the Italian manufacturing industries in 1995-2003. Our results indicate that the off-shoring of intermediates within the same industry ("narrow off-shoring") is beneficial for productivity growth, while the off-shoring of services is not. We also find that the way in which off-shoring is measured may matter considerably. The positive relation between off-shoring of intermediates and productivity growth is there with our direct measures based on input-output data but disappears when either a broad measure or the Feenstra-Hanson off-shoring measure employed in other studies are used instead.

JEL Classification numbers: F16, F23, O4

(*) We are very thankful to Massimiliano Iommi and Antonio Affuso, who shared with us the burden of preparing the data set for this project. Massimiliano is a component of our research team in a broader project on the use of input-output tables to measure the productivity counterpart of off-shoring in European countries. We also thank Giuseppe Bertola, Rosario Crinò, Paolo Epifani and the participants in the CESifo Munich Productivity and Growth Conference for their insightful comments on an earlier draft. Francesco Daveri gratefully acknowledges research funding from the University of Parma and Italy's Ministry of the University and Research.

1. Introduction

The off-shoring of activities of manufacturing firms and industries often features at the centre-stage of the political arena for its allegedly negative effects on domestic employment. Such political worries have somehow obscured the very reason that pushes a company to delocalize its activities: the search for efficiency gains. In this paper, we concentrate on this somewhat less popular issue, using symmetric input output tables to analyze the productivity counterpart of intermediates and services off-shoring for twenty-one Italian manufacturing industries and evaluate whether and which type of off-shoring is paralleled by productivity enhancements.

During the 2004 US presidential campaign, the concern that outsourcing had gone too far, creating more hardships than necessary for American unskilled workers was one of the hot political issues. Not by chance academic research on this topic has mostly focused on such effects. Among many others, Feenstra and Hanson (1996, 1999) provided evidence for the US, Head and Ries (2002) for Japan and Hijzen, Gorg and Hine (2005) for the UK. In line with the predictions of traditional trade theory, these papers find that international outsourcing leads to increased demand and increases in the wage premium for high skilled workers. [1]

Yet, as shown by various studies, off-shoring has also been a crucial ingredient to enable the American economy to take full advantage of the potential productivity gains brought about by the IT revolution. In their research geared to evaluate the savings incurred by off-shoring customer services to India, McKinsey Global Institute (2003) calculated that each dollar spent in off-shoring generated more than 1.10 dollars of benefits for the US economy, as a result of lower labor costs, reorganized production and reallocation of workers to more productive domestic uses. Consistently with this evidence, the statistical analysis for US firms and industries (Amiti and Wei, 2004 and 2006) has also indicated that the off-shoring of services and, less strongly, of intermediates has generally been associated to productivity gains.

The picture is more mixed for Europe. McKinsey Global Institute (2004, 2005) estimated that the extent of the off-shoring gains is lower in Germany than in the US, essentially because, due to wage differentials between the destination countries, the German off-shoring of services to Eastern Europe entails lower cost savings than the US off-shoring of services to India. The statistical evidence on other European countries has not yet provided to date a convincing case for the presence of productivity-enhancing effects of the off-shoring of intermediates and services. The only cross-country study we are aware of is due to Egger and Egger (2006), where the relation between off-shoring (as such) and productivity is negative in the short run and positive in the long run. They used a CES production function and data from twenty-two manufacturing industries of

[1] A longer list of references and an informed discussion of the main issues is in the detailed survey by Olsen (2006).

sixteen European countries around the mid Nineties. With firm-level data for individual European countries, empirical results are instead diverse between countries. In a study on the Irish electronics industry, Gorg and Hanley (2005) found a positive and significant productivity effect of materials but not of services. In a more recent paper on manufacturing plants, Gorg, Hanley and Strobl (2007) found evidence of positive effects for services off-shoring, but for exporting firms only. This is at odds with the findings of Criscuolo and Leaver (2005) for the UK, where TFP-enhancing effects have been detected for non-exporting and non-multinational firms.

Italy has been largely missing from research on this topic. This scholarly lack of interest is partly explained by the genuine delay with which Italian companies took advantage of outsourcing as a means for diversifying production. The few exceptions to this pattern (Helg and Tajoli, 2005, and Lo Turco, 2006)[2] estimate the productivity impact of materials and services outsourcing in a period when the extent of off-shoring was very small. Lo Turco finds rather sizable results for intermediates and industry-dependent results for services off-shoring, with a positive relation in traditional manufacturing industries and a negative relation for the most technologically advanced industries.

In this paper, we employ industry data to provide novel empirical evidence on the relation between off-shoring and productivity growth in the Italian manufacturing industries. We do that for a period (1995-2003) during which Italy has witnessed both sharply declining productivity growth [3] and, in parallel, an acceleration of the opening up of its economy, also implemented by shifting abroad some manufacturing activities previously carried out within the domestic borders. Hence our research question is whether and to what extent manufacturing off-shoring has counteracted the declining productivity trends lately experimented by the Italian economy.

Our descriptive evidence indicates that not all manufacturing industries off-shored production to the same extent and at the same time; in most cases, though, the data show that off-shoring took off in 1999-2003. This is consistent with parallel evidence on the late diffusion of information technologies (ICT) in the Italian economy with respect to other OECD countries. Yet this also indicates that the previous studies that restricted their attention on data up to 1997-98 may be usefully complemented here.

[2] Lo Turco (2006) estimates the impact of material and services outsourcing on the productivity of Italian manufacturing industries in 1985-1997. Service off-shoring had differentiated effects across industries: it was positive for “traditional” and “other manufacturing” industries, negative in the most technologically advanced industries. The period of analysis in our research (1995-2003) only marginally overlaps with the period under investigation in her study (1985-97). Helg and Tajoli (2005), on the other hand, did not investigate the issue as such and restricted their attention to the relation between outward processing of inputs to be re-exported back to the country of origin and labor demand.

[3] A recent detailed study with industry data is in Daveri and Jona-Lasinio (2005). Other studies include Bassanetti, Iommi, Jona-Lasinio and Zollino (2004), where evidence has been provided on aggregate and industry productivity developments in the Italian economy, with the goal of computing the growth contributions of the different factors of production.

To answer our research question, we look at the partial correlation between our off-shoring indicators and labor productivity growth in regressions, where the growth rate of value added per full time equivalent employed (a measure of "labor productivity") is explained by the growth of capital-labor ratios (so as to control for capital deepening), ICT and R&D intensity, industry and period fixed effects controls, as well as intermediate and service off-shoring indicators – our main variables of interest. Given that off-shoring in all likelihood is also simultaneously affected by how well a given industry is doing as well as by a number of other determinants, we also provide instrumental variable estimates aimed to control for the reverse causality problems associated to the potential feedback effect of past capital accumulation and other industry and period specific influences on off-shoring decisions.

Our estimates indicate that not all types of off-shoring significantly correlate with productivity growth. The type of good being off-shored indeed matters: the off-shoring of intermediates is positively related to productivity growth, while the off-shoring of services is not robustly related to productivity growth. Moreover, the positive relation between the off-shoring of intermediates and productivity is there only when the endogeneity bias is made up for through IV estimation.

Taken at face value, our instrumental-variables results imply that the change in the imported intermediate shares in an average Italian manufacturing industry (some 0.7 percentage points per year in 1995-2003) may account for an increase of about .15 or .2 percentage points of the yearly growth rate of labor productivity. Intermediate off-shoring may have thus accounted for some 10 to 15% of the yearly increase in labor productivity in manufacturing (equal to +1.2 percentage point per year). Hence we conclude that the off-shoring of materials has partly counteracted the declining forces at work in the Italian economy, but certainly not provided enough impetus to more than offset them. The off-shoring of services has been instead essentially unrelated to productivity growth.

In addition to providing evidence for a country whose experience with off-shoring has been little investigated, we believe that our study also includes a more methodological contribution. Our off-shoring measures are based on an original data set inclusive of symmetric input-output tables recently released by the Italian statistical institute. Such tables, by splitting the imported and domestic content of the inter-industry transactions of goods and services in the economy, allow us to directly measure the extent of intermediate and services off-shoring on the part of manufacturing industries. This is different and – in our opinion – preferable to using the methodology previously employed by Feenstra and Hanson (and repeatedly used in the other studies in this area). Since their measure is unobserved, the extent of outsourcing has to be inferred from trade data assuming that any purchasing industry would import intermediates or services in the same proportion as any other industry in the economy.

Our calculations do not have to rely on such restrictive and, based on our data, unwarranted assumptions. We provide a direct measure of off-shoring and then econometrically test whether using our indicator or the Feenstra-Hanson indicator makes a big difference. It seems it does. We find a positive relation between the off-shoring of intermediates and productivity growth when using our direct measure of off-shoring. However, the correlation disappears altogether when the standard Feenstra-Hanson measures of off-shoring are employed.

The structure of the paper is as follows. In section 2, we discuss measurement issues and provide a comparison between our off-shoring estimates with those obtained from the Feenstra-Hanson methodology. In section 3, we take a look at productivity and off-shoring trends in EU countries focusing in particular on the Italian economy. In section 4, we specify our empirical framework and present our results. Section 5 concludes.

2. Measurement and data issues

2.1 Off-shoring and outsourcing: definitions

Before measuring off-shoring, it is important to clarify the difference between off-shoring and outsourcing. According to the OECD (OECD, 2007a), "outsourcing" refers to the decision of the firm to source inputs from more efficient producers, either domestically or internationally, and either within or outside the boundaries of the firm. "Offshoring" instead refers to firms' purchases of intermediate goods and services from foreign providers, or to a transfer of particular activities within the firm to a foreign location. Hence the cross-border aspect is the main feature of off-shoring including both *international outsourcing* (where production of goods and services is partially or totally transferred abroad to independent parties) and *international in-sourcing* (where activities are transferred to foreign affiliates).

Up to now the measurement of off-shoring has not been an easy task. This is because the public surveys necessary to measure it are only available in few OECD countries. Therefore the standard measurement practice in this respect is to use *indirect* measures based on trade and input-output data (OECD, 2007a).

In this paper we provide a *direct* measure of off-shoring activities by industry, using symmetric input-output tables recent released by the Italian Statistical Institute. Such tables, by splitting the imported and domestic content of the inter-industry transactions of goods and services, allow us to quantify the extent of intermediate and service off-shoring on the part of manufacturing industries.

But, at the same time, these data do not allow to distinguish between imports from affiliated and unaffiliated firms that are both included in our off-shoring index.

In the next sub-section, we compare our measurement choices with those used in previous studies.

2.1.2 Our measures of off-shoring vs. other measures: definitions

Our basic data source consists of symmetric input-output tables (industry-by-industry matrices) obtained rearranging both supply and use tables in a single matrix with an identical classification of industries (or products respectively) for both rows and columns. The input-output tables are at basic prices, at the 60-sector level (according to the NACE Rev. 1.1 classification) for 1995-2003. [4] This dataset enables us to present industry evidence over 1995-2003 on the extent of off-shoring of intermediates and market services as well as their productivity counterpart for Italy's manufacturing industries. Intermediate purchases is obtained adding up the purchases of each industry i from the other manufacturing industries inclusive of industry *i*. Purchases of market services includes the purchases of each manufacturing industry from market service providers that belong to "transports, storage and communications", "finance and insurance", and "business services". The other variables used in the econometric analysis are from ISTAT-National Accounts.

As anticipated above, from a methodological point of view, the main contribution of our paper, compared to previous industry studies, is the measurement of off-shoring by means of *direct* data on imported goods and services.

This is at variance with most studies undertaken before (the only exception being the exercise by Bracci, 2006) where off-shoring was only indirectly measured from standard input-output tables where the imported and the domestically produced components of the various inputs were not separately accounted for. Without primary information on imported inputs, the standard practice is the methodology of Feenstra and Hanson (1999) based on *the import proportionality assumption*. The Feenstra-Hanson (FH onwards) index can be written as:

$$FH = \sum_{j} \left[\frac{X_j^i}{Y_i} \right] * \left[\frac{M_j}{C_j} \right] \qquad (1)$$

where X_j^i is input purchases of good *j* by industry *i*, Y_i is total non-energy input used by industry *i*, M_j is import of good *j*, and C_j is the domestic demand of good *j*. This is what Feenstra and Hanson call a *broad* measure of foreign outsourcing, i.e. the share of imported intermediate inputs over total intermediate costs. Thus, according to their methodology, the off-shoring of, say, the electronics industry would be equal to the share of the intermediate purchases of electronics from other

[4] See Wixted, Norihiko and Webb (2006), and Mantegazza and Mastrantonio (2006).

manufacturing industries over its total non-energy costs corrected by the import share of each intermediate over total absorption *for the entire economy*. Hence this definition embodies the hard-to-swallow assumption that any manufacturing industry would resort to intermediates to the same extent in a particular year. The same would clearly apply when the off-shoring of services is to be computed. Based on this measure they also define a *narrow* measure of off-shoring by restricting the attention to those inputs that are purchased from the same industry as the one in which the good is being produced. The narrow index is obtained when i=j in equation (1).[5]

Our off-shoring intensities are calculated as well following the *broad* and *narrow* definitions described above but, at variance with Feenstra and Hanson, we abandon the so called "proportionality" assumption that any manufacturing industry would resort to intermediates or market services to the same extent. Instead, using the industry data on imported intermediates provided by import matrices,[6] we are able to look directly at the value of imported intermediate inputs of each industry from and within each sector. Our "DJ" measure (DJ from Daveri and Jona-Lasinio) of broad off-shoring is thus:

$$DJ_B = \sum_j \left[\frac{Z_j^i}{N_i} \right] \qquad (2)$$

Where Z_j^i is the import of intermediate inputs of good *j* by industry *i*, N_i is the amount of total non-energy intermediate inputs used by industry *i*. This index measures the *broad off-shoring of intermediates* as the share of intermediate inputs that each manufacturing industry imports from all industries (including the industry itself) over the total purchases of non-energy intermediate inputs. We use the same index to measure the broad *off-shoring of market services* defined as the share of imported business and financial services over total non-energy intermediates.

In addition to that, we also construct a narrow index of off-shoring:

$$DJ_N = \left[\frac{Z_i^i}{K_i} \right] \qquad (3)$$

Where Z_i^i is the import of intermediate inputs of good *i* by industry *i*, K_i is the total purchases of intermediate inputs by industry *i* from industry *i*. In short, DJ_N is obtained as the ratio between the diagonal elements of the import and use matrices.

In a nutshell, under the proportionality assumption, it is implicitly assumed that an industry uses an import of a particular product in proportion to its *total use* of that product. Thus if an industry such

[5] They also calculate a *differential measure of outsourcing* as the difference between their broad and narrow off-shoring measures.

[6] The matrix of imported intermediates is obtained from trade statistics on imports by product and firm; see Bracci, Astolfi and Giordano (2006) for methodological details.

as motor vehicles uses steel in its production process (as intermediate input) and 10 per cent of all steel is imported, it is assumed that 10 per cent of the steel used by the motor vehicle industry is imported. Further the proportionality assumption does not consider that some industries, like aircraft for example, might use only domestically-produced steel while others might rely totally on imports (OECD, 2000). Methodological work done by the OECD suggests that the bias introduced by the adoption of the import proportionality assumption (strictly dependent also from the sector aggregation level) results in underestimating by 6 per cent the amount of imports that are classified as being intermediate inputs (Planting, 1990).

2.1.3 Our measures of off-shoring vs. other measures: what Italy's data show

In this sub-section, we take a look at Italy's data to compare and investigate the differences between the direct (DJ) and indirect (FH) measures of off-shoring calculated as shown in the previous section. This is to provide an indication of the extent of the bias in the FH indirect off-shoring measures. As shown below, it is not nil.

Table 1 and 2 presents our evidence on the degree of off-shoring of, respectively, intermediates and services for twenty-one manufacturing industries as well as an average manufacturing industry in the Italian economy. In the bottom part of each table, we also report the correlation coefficients between the various off-shoring measures, both along the cross section and time series dimension, essentially to gain a better understanding of whether measurement matters or not.

Altogether, the data in Table 1 and 2 indicate that it does considerably. For this very reason, we start from the discussion of such measurement issues, comparing similarities and differences of the various indices, and only at a later stage we move to a synthetic description of the off-shoring phenomenon in the Italian manufacturing industries.

Consider the off-shoring data for intermediates in Table 1. From the correlation matrices in the bottom part of the table (see the (b) panel: DJ vs. FH), one learns that our direct measure of off-shoring is not always very highly correlated with the FH measure of off-shoring. In particular, the DJ and FH narrow measures bear a zero correlation coefficient along the time series dimension, while their correlation is instead higher in the cross-sectional dimension (with correlation coefficients of 0.40 in 1995 and 0.56 in 2003). Correlation is instead much higher in both dimensions for the broad indicator of intermediate off-shoring.

For the average manufacturing industry in Italy, the DJ manufacturing index takes much higher value than the FH index. This is particularly apparent for the narrow index, which takes values of

36.4 and 41.9 percentage points, respectively, in 1995 and 2003. The FH indices take instead - much lower - values of 6.8 and 6.9 points. [7]

The data in Table 1 show that the bias of the off-shoring intensities measured according to the FH indices is usually downward. This is apparent for those sectors which rely heavily on imported inputs such as chemical and pharmaceutical industry showing DJ narrow indices three times higher than FH narrow. The range of intervals taken by the DJ measure for chemicals in 1995-2003 goes from 62.4 to 73.9 percentage points; the corresponding FH index was between 18.2 and 21.1 percentage points. The differences between the broad indices are instead slightly smaller and amount to some 10 percentage points. On the other hand, the DJ indices are lower for those industries depending on a smaller scale on imported intermediates such as the case of tobacco industry. In 1995, DJ narrow is 2.3 percentage points while FH narrow is 3 percentage points (see the appendix for a more detailed analysis of these differences).

Altogether, our results may be seen as generally supportive of the findings of Planting (1990): the import proportionality assumption is associated to a downward bias that varies across industries but is certainly not negligible. Furthermore, this bias does not seem to be constant over time: while the average DJ values for the off-shoring of intermediates markedly trend up in 1995-2003, the FH measure would instead indicate a stagnating trend. If our direct measures – as we are inclined to believe- are closer to the true measures of off-shoring than the indirect measures, this implies that using the FH indices in the empirical analysis (as most previous studies have done) would seriously under-estimate the entity of off-shoring both point-wise and over time.

As to the off-shoring of market services (see Table 2), the correlation between DJ and FH indexes is high in the cross-section (0.8 across industries) and a little bit lower in the time series dimension (0.6 over time). Unlike for the off-shoring of intermediates, the FH measure of market services off-shoring over-states the extent of off-shoring as measured by our DJ direct measure.

The discussion about whether the narrow measure of international outsourcing is an appropriate measure of outsourcing is ongoing. At present, though, the narrow measure is the only one in line with the WTO mode 1 definition of off-shoring (Olsen, 2006). Hence, in what follows, we preferentially employ the narrow indices of material off-shoring. For services, instead, we necessarily have to rely on the broad index of service off-shoring.

Having highlighted measurement issues –further stressed in the statistical analysis of the next section – it is also worth spending a few words to describe the nitty-gritty of off-shoring trends in the European countries and then specifically in the Italian manufacturing industries, concentrating on our indices of (narrow) intermediates and (broad) services off-shoring.

[7] For a detailed analysis of the differences between DJ and FH off-shoring measures, see the Appendix.

3. A first look at the data on off-shoring and productivity growth in Italy

In this section we focus on a descriptive analysis of the Italian data to provide more detailed evidence of the declining productivity growth as well as of the increasing tendency to off-shore manufacturing activities in the Italian manufacturing sector.

In many EU countries, the slowdown of labor productivity growth was paralleled by a rising tendency to off-shore manufacturing activities. The case of Italy, with its dramatically declining productivity path and accelerating opening up and delocalization, is particularly striking in this respect.

According to the March 2007 release of the EU-KLEMS data, labor productivity growth in the EU countries slowed down significantly from 2.4% in 1980-1995 to 1.4% in 1995-2004. The European productivity slowdown is staggering particularly if compared with the parallel growth acceleration experienced by the US economy since 1995 (from 1.3% over 1970-95 to 2.4% in 1995-2004). However, the EU-KLEMS data document a wide variation of productivity growth rates across EU countries. At the low end of the productivity ranking, one finds Italy (only +0.6% per year in the last ten years, down from +2.4% per year in 1970-1995) and Spain (only +0.3%, down from +2.9% in 1970-1995).

As extensively documented in Daveri and Jona-Lasinio (2005) and more concisely in Table 3, the Italian economy has indeed displayed disappointing productivity trends since 1995, both in manufacturing and services. Table 3 shows that manufacturing productivity growth first declined to one per cent per year in 1995-2000 and then turned negative by one percentage point in 2000-2003, with the data for the more recent years (2004 and 2005) confirming such negative trends.

This is startling for such a declining path manifested itself rather uniformly in the whole manufacturing sector. In 1995-2000, labor productivity growth fell first and substantially in non-durable goods industries from 3.1% to 0.7%, while labor productivity for durable producers slowed down just a bit (from 2.7% to 1.7%). More recently, productivity growth really collapsed for durable producers as well (-2.7% in 2000-2003) and further slowed down by another percentage point for non-durable producers (from 0.7% to -0.2%).

In this period of time, however, the manufacturing sector became increasingly involved in the globalization of the production process. As of 2003, the latest year for which data are available, the average manufacturing industry in Italy bought imported intermediates for some 40% of its total non-energy inputs, up by some five percentage points since 1995.

The industries that most heavily rely on the off-shoring of intermediates are those producing durable goods (particularly those producing computers and other office machines). Yet the

industries showing the sharpest share increases in 1995-2003 (wearing apparel (+33.6%), office machinery and computers (+28.5%) and chemicals and pharmaceuticals (+11.5%)) were not necessarily among those most extensively engaged in materials off-shoring in 1995.
Likewise for other countries, the share of imported market services is instead much lower for Italy as well. Our broad off-shoring index shows that an average Italian manufacturing industry would import less than 1.5% of its non-energy inputs in 1995 and less than 2% in 2003. While this mildly upward trend is shared by all manufacturing industries, this phenomenon is particularly apparent for the industry producing computers and other office machines, that exhibits a +6.4% in 1995-2003.

INSERT FIGURE 1 ABOUT HERE

Figure 1 provides the time trends of productivity, narrow material and service off-shoring. In 1995-2003, the average intensity of materials off-shoring and labor productivity exhibit parallel increases. During the same period of time, service off-shoring shows a more pronounced increase than labor productivity. The scatter-plots reported below (Figure 2 and 3) provide snapshots of the positive correlation between productivity growth and material off-shoring and the lower correlation between productivity growth and service off-shoring.

INSERT FIGURE 2 AND 3 ABOUT HERE

In the next section we will examine in a more formal way the linkage between off-shoring and productivity growth in a multivariate framework.

4. The statistical evidence on the relation between off-shoring and productivity growth in the Italian manufacturing industries

In this section we first describe the conceptual framework and the empirical strategy underlying our results and then present our main results on the relation between off-shoring and productivity growth in the Italian manufacturing industries.

4.1 Conceptual framework

4.1.1 The production function framework

Our empirical analysis takes the firm's production function framework as a benchmark. This suggests that it would be desirable to use micro data. And indeed the empirical research in the last fifteen years or so has made it clear that there is no such a thing as a "representative firm" in any given industry. Industries and branches are made up of very diverse individual firms and establishments. There are large and persisting differences in productivity performance between individual units. Moreover, there is large-scale re-allocation of outputs and inputs between producers, also and perhaps mostly within industries, and the re-allocation from less productive to more productive businesses has been shown to contribute significantly to aggregate productivity growth in a variety of OECD countries. But to calculate our off-shoring indicators we need input-output tables that are only available at the industry level. Thus we implement our analysis at the industry level.

Secondly, for notational convenience, we embody in our specification the assumption of constant returns to scale from the very beginning. As mentioned below, this assumption is not rejected by our data on Italy’s manufacturing industries (see footnote 9 below).

Thirdly, we consider a value-added production function, instead of an output-based one. The full-fledged production function underlying equation (3) would have (real) output on the left–hand side and capital, labor, intermediate materials and services on the right-hand side. This would allow us to differentially treat the substitutability of such inputs with respect to capital and labor. Specifying the production function in terms of value added, however, lessens the endogenous input choice problem that plagues the estimates of production functions. Under the assumption of separability between the value added and the intermediates functions, the dependent variable may instead be real output less (real) materials and services. This implies that (the logs of) materials and services are no longer an argument in the production function.

Subject to these preliminary remarks and assumptions, in each period t, the constant-returns-to-scale value-added-based production function for industry *i* at time *t* is the following:

$$\ln(Y_{i,t}) = \ln(A_{i,t}) + \beta_K \ln(K_{i,t}) + (1-\beta_K)\ln(L_{i,t}) \qquad (3)$$

Where industry value added Y (in logs) is a log-linear function of the labor input L, capital services K and the efficiency parameter A. Now we turn our attention on the question of why off-shoring may affect efficiency and thus productivity.

4.1.2 The links between off-shoring and productivity

The off-shoring of some activities is meant to affect efficiency, or the shift parameter in the production function in various ways.

First of all, off-shoring may involve a static effect on efficiency and hence productivity due to specialization, for the off-shoring firm, by its decision to outsource, may relocate fragments of production, less efficiently implemented in house, to a subsidiary located abroad.

Barred coordination diseconomies and other adjustment costs, this process will involve positive productivity effects for the firm as a whole, thanks to the related specialization gains. Delocalization may, however, involve positive or negative productivity effects for the plant located in the country of origin, depending on the type of activities being off-shored. If the Italian car-maker Fiat were to delocalize the production of some car components to Romania, say, to take advantage of lower wage levels in Romania than in Italy, and then re-import them back as inputs to the assembly phase of the various components in its Turin plant, this would be good for Italy's productivity. Things would differ, though, were Fiat to shift its headquarters from Turin to Dublin, say to take advantage of the lower Irish tax rates on profits. Whether these effects are positive or negative eventually depends on the factor endowment of the country and the factor intensities of the activity being outsourced. In this latter case, the productivity level of the multinational corporation named Fiat would go up but Italy's productivity would likely fall as a result of off-shoring.

The same process discussed above may also take place *between* rather than within firms. The off-shoring of activities would thus entail some resource reallocation with the related productivity effects for the industry rather than for the firm itself. This is possibly of particular relevance for the off-shoring of service inputs: a US company may find it profitable to carry out some back-office legal and accounting tasks, such as computing and information handling and processing activities, in India over night. This effect is, however, probably less important for the off-shoring of materials.

Finally, and perhaps more conjecturally, off-shoring may also originate in *dynamic efficiency* effects This may be due to "learning-by-offshoring" effects if firms improve their methods of operation by importing back the services produced by the off-shored inputs, or thanks to the use of bigger or newer varieties of new materials or services, in turn associated to productivity gains if the efficiency parameter in the production function allows for an Ethier variety-of-intermediates effect.

Having said so, however, it should be recalled that, with our industry data, we will be unable to single out which one of these various channels is more relevant empirically.

To keep things simple, we assume that the efficiency parameter A log-linearly depends on an exogenous term - possibly different between industries and time periods - as well as on (the logs of) the off-shoring of intermediates (*osm*) and services (*oss*), both measured as discussed in the previous section, as follows:

$$\ln(A_i) = \beta_{A,i} + \beta_m \ln(osm_i) + \beta_s \ln(oss_i) \qquad (4)$$

Whether the specialization or the factor endowment effect is more important is an empirical matter. If the estimate of either β_m or β_s is positive, we will interpret this as evidence that the positive specialization effect is bigger than the – potentially negative - factor endowment effect.

4.2 Empirical strategy

Our intended goal here is to identify some partial correlation between off-shoring and productivity growth by estimating the coefficients of the off-shoring variables in equation (4).

To obtain an empirically usable equation for estimating the relation between off-shoring and labor productivity growth, we take the time variation of (3), we substitute the expression for the log of A from equation (4) into equation (3), take the time variation of (3) and subtract the growth of the labor input on both sides. This gives us an expression that relates the growth rate of labor productivity to the growth rate of the capital-labor ratio, the growth rate of intermediates and services off-shoring.

We estimate a panel regression that relates the growth rate of value added per full-time equivalent employed worker in manufacturing industry *i* at time *t* (gLP_{it}; with i=1,..21; t=1995, ..,2003) to a set of industry (D_i) and period (D_t) fixed effects, the growth rates of the industry capital labor ratios (gKL_{it}) as well as the growth rates of the off-shoring variables, namely the cost shares of imported intermediates and services.

In short, our baseline specification is as follows:

$$gLP_{it} = \gamma(gKL_{it}) + \beta_m \Delta(osm)_{it} + \beta_s \Delta(oss)_{it} + \sum \beta_t D_t + \sum \beta_i D_i + \beta_X X_{it} + e_{it} \qquad (5)$$

Where the last three terms indicate that the error term is decomposed into industry-invariant period-specific components, time-invariant industry specific components and a white-noise residual that varies across both time and industry dimensions.

The dependent variable in equation (5) is the growth rate of per-worker industry value added. It is thus worthwhile to point out that the full-fledged production function underlying equation (3) would have (real) output on the left–hand side and capital, labor, intermediate materials and services on the right-hand side. Yet this more complete formulation would be subject to a well known empirical specification problem, *i.e.* the endogeneity of input demands. Namely, the optimal quantity of inputs demanded by the firm/industry depends on the unobserved Solow residual that features as the error term in the output equation, thereby inducing a correlation between the error term and the explanatory variables of the regression. Yet, under the assumption of separability between the value added and the intermediates functions, the dependent variable may be (real) value added, that is real output less (real) materials and services. This does not eliminate the endogenous input choice problem (capital and labor are still on the right-hand side), but makes it easier to handle.

On the right-hand side of the equation, the inclusion of industry and period fixed effects serves the purpose of allowing for the growth of A to differ across industries and over time.

The presence of industry fixed effects is motivated by the fact that, in most OECD countries, TFP often grows at lower rates in non-durable-good than in durable-good manufacturing – a potential explanation being that technological change is slower for non-durable than for durable producers. But even within these two categories, TFP may well grow at different rates over sustained periods of time; this warrants the inclusion of individual industry fixed effects.

Period fixed effects are instead appended to capture unobservable influences on productivity growth that are common to all industries, such as those stemming from business cycle fluctuations. As seen below, such industry and period specific influences on productivity growth are both statistically significant, with one important exception to be discussed when appropriate.

Equation (5) also includes other potential determinants of labor productivity growth (the Xs variables) such as the IT investment share over total non-residential investment and the GDP share of R&D spending.

In some specifications, we alternatively employ "imputed" TFP growth rates as an alternative dependent variable. "Imputed TFP growth" obtains by subtracting from labor productivity growth the capital deepening component, in turn computed multiplying the growth rate of the capital-labor ratio times one third, *i.e.* the most frequently used numerical proxy for the value added share of capital. This may be seen as a robustness check for it may be the case that, in spite of our attempts of instrumenting it, we may still be unable to fully eliminate the upward bias from the estimated coefficients of the capital-labor ratio. It is thus instructive to learn what happens to the estimated values of our parameters of interest (those attached to the off-shoring variables) in case we give up estimating the capital coefficient and simply impute its most plausible value borrowed from national accounting data.

We start estimating equation (5) for twenty-one manufacturing industries over 1995-2003 by OLS with period and industry-specific dummy variables and heteroskedasticity-consistent standard errors. Our potential sample size might thus be equal to 168 observations, but, so as to keep OLS and IV estimates as comparable as possible, we use only the seven time series observations between 1996 and 2003. In this way, our sample always includes 147 observations, the product of twenty one (industries, our cross-sectional dimension) times seven (years, our time series dimension).

Even upon choosing value added as a dependent variable (as discussed above), a remaining key estimation issue of equation (5) is the possible endogeneity of right-hand side variables, namely the growth rate of the capital-labor ratio and the off-shoring indicators.

As first pointed out by Hulten (1979), the demand of capital services depends on TFP, which is partly captured by the error term in (5). This induces a correlation between the error term and one of the regressors which makes the OLS estimates of the capital-labor coefficient potentially biased upwards. [8]

Yet, particularly important for our purposes here, off-shoring may also be the result of - rather than the cause of - productivity growth (or levels). High productivity or fast-growing firms may more likely engage in global diversification of production. If this were the case, then a positive correlation between off-shoring and productivity may simply reflect a selection effect (only the most dynamic firms engage in off-shoring activities) rather than an efficiency-enhancing effect of

[8] If the growth rate of the capital-labor ratio is positively correlated with the growth rate of TFP, the OLS estimate of the capital-labor ratio coefficient is biased upwards.

off-shoring. The link may also work in the opposite direction, though. It may thus be the case that low-growth or less productive firms in distress engage in off-shoring as an extreme means to improve their economic prospects and chances of survival.

In other words, there may well be a reverse causation bias in our OLS coefficients of off-shoring, but the direction of the bias may be positive or negative and cannot be a priori predicted. If the same set of firms engages in off-shoring in each period, an industry dummy in a time differenced equation would do to fix this problem. If instead the relation between off-shoring and productivity growth is time varying, it is important to allow for other instruments of off-shoring. This is why in the second batch of our estimates we present the results of IV (actually: two-stage least squares) estimation. We will see that, for Italy's manufacturing industries, the second chain of causation – not the first one - is seemingly consistent with the evidence at hand.

Instruments and identification From the discussion in the previous sub-section, we learned that we have at least three potentially endogenous variables on the right-hand side of our regressions: the growth of the capital-labor ratio, the off-shoring of materials and the off-shoring of services. The question is how to best deal with this endogeneity.

A good potential instrument is one that only affects productivity growth through the instrumented variable and, at the same time, is highly correlated with the variable to instrument.

Our instruments for the three right-hand side variables are the growth of the capital-labor ratios lagged once, the log-levels of the same variable lagged twice, a set of industry and period fixed effects and an indicator of once-lagged IT investment shares over total investment in each industry.

The crucial identifying assumption of our empirical specification is which of the chosen instruments affect the growth rate of labor productivity through the capital deepening channel (the capital-labor ratios) and the off-shoring indicators and which ones also go through the residual, which is usually interpreted as the TFP growth rate (netted out of the efficiency effects of off-shoring).

In principle, both period and industry fixed effects should affect labor productivity through both channels. In practice, as seen below, we experimented that, in our sample, the industry fixed effects are never significant in the second stage of the IV estimation, while period fixed effects are always significant in both stages. This is not what we would expect ex-ante, for, as mentioned above, there is evidence that TFP growth rates (a close correlate of the first-stage residuals in this regression) differ across industries for reasons that likely go beyond changes in materials and services off-shoring. As shown in the section documenting Italy's productivity slowdown, though, TFP growth equally collapsed throughout the period across all manufacturing industries. This may explain why industry fixed effects do not play a role as additional controls at the second stage of our IV regressions.

Hence, to sum up, the fact that period fixed effects also enter our instrument list as included instruments while industry fixed effects only belong to the list of the excluded instruments is not a maintained assumption but rather a result of our estimation.

The other predetermined variables (the once-lagged growth rate of the capital-labor ratio and the log of the twice-lagged capital-labor ratio) also belong to the list of excluded instruments for they are unlikely to be related to the residual.

For diagnostic purposes, we use the p-values of the Sargan-Hansen test to evaluate the validity of our instruments and the values of the Shea partial R-squared of each endogenous regressor to evaluate their relevance.

4.3 Results

4.3.1 LSDV estimates

Table 4 presents the results of our LSDV (least squares dummy variables) estimates of equation (5) using various indicators of intermediates off-shoring.

In column (1)-(4), the narrow index of materials off-shoring is employed, with various specifications in each column slightly different from each other. The regression in column [1] only includes period fixed effects. Yet, if other factors make productivity growth different across industries, then the estimates in column [1] would suffer from a fixed effects bias. This is why the regression in column [2] includes both period and industry fixed effects. In turn, the regressions in column [3] and [4] have IT investment and the GDP share of R&D appended as additional time-and industry-varying controls likely to affect productivity growth.

In column [5]-[8], we check whether the relation between off-shoring and productivity depends on measurement. In column [5] and [6], a broad indicator of materials off-shoring is employed instead of a narrow one, with and without IT investment as a control variable. In column [7] and [8], the Feenstra-Hanson measure of narrow materials off-shoring and broad services off-shoring appear instead, with and without IT investment appended.

The fit of each regression in Table 4 is usually good. The value of R-squared is some 55% when period fixed effects only are included (see column [1]) and it goes sizably up to some 65-70% when fixed effects are appended as well, with minor differences across specifications.

The period fixed effects are always significant. The industry fixed effects are always statistically significant as well, which indicates that the estimates in column [1] are biased. The coefficient of the capital-labor ratio is always highly significant and positive, with the values of the very precisely estimated coefficients ranging between .75 (when the broad indicators of intermediates off-shoring are employed) and .95 (when the FH indicators are used). With our ("DJ") narrow indicators, the estimated coefficient lies in between these two extremes, at some .85. These estimates are, however, presumably biased upwards. Out two-stage least squares estimates discussed below indicate that this is indeed the case.[9]

Our main variables of interest are the various off-shoring indicators. They are almost never statistically significant. The narrow indicator of intermediates off-shoring turns out negatively related to productivity growth in column [3], when IT investment is appended as an additional control. Otherwise, it is insignificant. The DJ broad measures of materials off-shoring are never significant. With the FH off-shoring measures, the estimated coefficient of materials is zero when IT investment is left out of the regression and instead becomes positive and statistically significant when IT investment is included as a regressor (and turns out significant with a negative sign).

As to services off-shoring, the estimated coefficients are again usually equal to zero. They turn out significant with a negative sign only in the regression where period fixed effects are included. But when industry fixed effects are included as well, their statistical significance disappears.

Altogether, it seems fair to conclude that, from the OLS estimates, there is no evidence of a robustly significant relation – either positive or negative - between off-shoring and labor productivity growth.

Yet the OLS pattern of correlation is presumably affected by the likely two-way causation between off-shoring and productivity as well as by the fact that the growth of the capital-labor ratio is also positively correlated with TFP, thus with the error term. This is why now we turn to instrumental variable estimation.

4.3.2 Instrumental variables results

As discussed in the previous sub-section, a zero OLS coefficient may simply hide some offsetting reverse causation at work. To lessen the simultaneity bias that plagues the OLS coefficient, regression findings from 2SLS estimation are presented in Table 5.

Here we run regression (5) with the list of instruments described in the previous sub-section and, again for expositional clarity, at the bottom of Table 8.

In all columns, the list of excluded instruments includes the once-lagged growth rate of the industry capital-labor ratios, the twice-lagged log-level of the capital-labor ratio. These variables are meant to proxy for labor productivity growth, potentially related to both current capital accumulation and off-shoring. The once-lagged IT investment share is also appended: preliminary testing indicates that this is a non-redundant instrument; hence we include it.

[9] We also tested whether the assumption of returns to scale is consistent with our data. It is seemingly so. If one re-estimates the regression in the main text appending the growth rate of the labor input as an additional regressor, the estimated coefficient for this latter variable is statistically insignificant. This applies to both OLS and IV regressions.

We also report the results for both cases when industry fixed effects are treated as included or excluded instruments. Conceptually, it would be preferable to have both as included instruments, for a priori one would expect the second stage to be affected by both period and industry fixed effects. In practice, however, as shown in the even columns in Table 5, regressions with industry fixed effects among the included instruments show much worse regression diagnostics than those regressions where the list of included instruments is only made of period fixed effects. To see this, one can compare the results and regression diagnostics in the even columns (with only period FE) to those in the odd columns (with both period and industry FE). In the latter cases, the Shea partial R-squared dramatically falls very close to zero and the Hansen test shows p-values of zero. Hence our preferred formulation is the one implicit in the odd columns, while we disregard the results reported in the even columns.

Two-stage least squares regressions give us three main findings. First of all, instrumenting for the growth of the capital-labor ratios – somehow expectedly - does make the estimated coefficient lower than in the LSDV case. Correcting for the endogeneity of K/L gives rise to lower – and perhaps more plausible - estimates of β_k close to .5 or .6 when the narrow indicator of material off-shoring is used as a regressor. Estimates stay higher and close to .85-.90 when either broad or FH indicators of materials off-shoring are used instead.

Secondly, the coefficient of the off-shoring of intermediates is now positive and statistically significant, with a point-wise estimate of some .25 when the narrow DJ indicator is used. This result disappears, however, when either a broad indicator or the FH indicators are used instead.

How do we explain the difference between LSDV and 2SLS results? One plausible explanation, also corroborated by first-stage regression results, is that the 2SLS results for intermediates are positive for they net out the – seemingly negative – effects of past capital accumulation and capital endowment on off-shoring. Our results seem to indicate that lagging-behind industries off-shored more.

Thirdly, the growth of services off-shoring is instead – as in the LSDV case- not robustly correlated to productivity growth. In one case only, the off-shoring of services turns out positively related to productivity growth and it is when the FH indicator of narrow off-shoring is used. The partial correlation between our DJ narrow measure and productivity growth is instead zero.

Our empirical specification is very similar to some of the specifications adopted by Amiti and Wei (2006) in their study on the US economy. Amiti and Wei have provided evidence that off-shoring of services is associated with productivity gains in the US manufacturing industries between 1992 and 2000, while the evidence for intermediate off-shoring is more mixed. One may wonder whether these differences reveal something genuinely different in how off-shoring and which type of off-shoring correlate with productivity growth (materials in Italy and services the US) or instead they are simply the figment of differences in measurement or other estimation details. For sure, their off-shoring indicator is constructed using the Feenstra-Hanson indirect method, which we have shown to provide very different results from ours. It would be interesting to learn how their results would change had they adopted a direct indicator of off-shoring.

To further check our results, in Table 6, we present results for “imputed TFP” regressions. The goodness of such regression is that the growth of the capital labor ratio is conditioned out of the dependent variable of our main regressions (the growth rate of labor productivity) at a preliminary stage. We do so, as explained above in the previous section, because we are unsure that our instruments are really doing a good job in cleaning out endogeneity from the growth of the capital labor ratio. After all, our lowest bound estimate for the capital-labor ratio is 5, a rather high number anyway for a coefficient supposed to capture the value added share of physical capital. When this value added share is computed from national accounting data, its value is not too far from one third. Hence, we may ask how our results would change if the coefficient of the capital labor ratio were equal to one third.

The results in Table 6 answer this question. Although the goodness of fit of the regressions is much poorer than those in Table 5, the set of regression results for the off-shoring variables is not much different from what we see in that previous table. The only statistically significant correlation is the 2SLS estimate of the narrow off-shoring of intermediates, with its point-wise coefficient of .3 being not much different from the estimate obtained in Table 5. The estimated correlation of services off-shoring is instead usually zero, with the exception of a statistically significant and negative LSDV coefficient in column [1]. This significance, however, disappears when the more solid instrumental variables estimation is carried out.

Altogether, our results indicate that the relation between off-shoring and productivity growth is not a robust one and much depends on the definition of off-shoring and how it is measured. The positive relation between off-shoring and productivity is there for intermediates, but not for services. Moreover, this result is not there for any indicator of off-shoring, but only for the narrow DJ indicator.

How about the numerical implications of our estimates? To answer this question, we have to keep in mind that the change in the imported intermediate shares in the representative Italian manufacturing industry amounts to some 0.7 percentage points per year in 1995-2003. With this average, our results imply that the off-shoring of intermediates may account for an increase of the yearly growth rate of labor productivity of .15 or .2 percentage points - some 10 to 15% of the yearly increase in labor productivity in manufacturing (equal to +1.2 percentage point per year) in

1995-2003 in the Italian economy. Hence, our results indicate that the off-shoring of intermediates has partly counteracted the declining forces at work in the Italian economy, without providing enough impetus to more than offset such forces. No such effect is visible for the off-shoring of services.

5. Conclusions

In this paper, we explored the correlation between off-shoring and productivity growth in the Italian manufacturing industries in a period of sharp productivity slowdown for the Italian economy. Our two main results are that the off-shoring of intermediates is robustly and positively associated to growth in the Italian manufacturing industries, while the off-shoring of services is not.

The lack of correlation between services off-shoring and productivity growth is a puzzling result and it deserves some further discussion. First of all, as mentioned in the introduction, the lack of correlation between services off-shoring and productivity growth is not an exclusive feature of our study. For instance, Gorg and Hanley (2005) also document an essentially zero correlation between services off-shoring and productivity in the Irish electronic industry. In a more recent paper, Gorg, Hanley and Strobl (2007) find instead a positive effect, but for exporting manufacturing firms only. All in all, this begs the question of why such a variability of results arises.

One of the proposed explanations for this lack of correlation is that not enough time has elapsed since off-shoring took place. In other words, on impact, it may well be that neither the compositional nor the structural gains from delegated production are enough to offset transitional adjustment costs (resulting in waste and X-inefficiency). If this is the case, then the estimated coefficients of services off-shoring may turn out negative in a regression relating the growth rate of labor productivity to its determinants. If this explanation is a good explanation, then the estimated zero (or negative) coefficient will gradually shift into a positive coefficient as time goes by.

Whether this explanation is a convincing explanation or not remains to be seen. For sure, however, establishment level analysis for a sample of UK and Japanese firms (see Girma and Gorg (2004), Criscuolo and Leaver (2005) for UK and Hijzen et al. (2006) for Japan) indicates that a positive relationship between international outsourcing and (labor and total factor) productivity growth is there for some countries. This somehow weakens the adjustment cost explanation for the lack of correlation.

Another potential explanation is that the zero or outright negative effect of services off-shoring on productivity is not transitional and is instead a consequence of the fact that, depending on each country's factor endowment, the most productive services activities may be off-shored out of the country. Italian firms may have tried to escape the existing domestic inefficiencies due to insufficient liberalization in the market for such services. A recent model potentially consistent with this interpretation is due to Barba Navaretti, Bertola and Sembenelli (2008).

On the measurement side, we find our result that the FH measures of off-shoring are not much correlated with our direct measures of general interest, over and above the case of Italy. In future work, we intend to explore further whether this result is a stable feature of other data sets and countries.

References

Amiti, M. and S.-J. Wei (2006), "Service offshoring and productivity: evidence from the United States", NBER Working Paper w11926, January

Barba Navaretti, G., G. Bertola and A. Sembenelli (2008), "Offshoring and immigrant employment: firm-level theory and evidence", University of Turin, January

Bassanetti, A., M. Iommi, C. Jona-Lasinio and F. Zollino (2004), "La crescita dell'economia italiana tra ritardo tecnologico e rallentamento della produttività", Banca d'Italia, *Temi di Discussione* # 539, December 2004

Bracci, L.(2006), "Una misura della delocalizzazione internazionale", ch.4 in ICE, *Rapporto sul Commercio Estero*, 2006, Roma.

Bracci, L., (2007), "Compilation of use table of imports: the Italian experience", paper presented at the 16th International Input-Output Conference, Istanbul – Turkey, 2-6 July 2007

Bracci, L., Astolfi, R., Giordano, A. (2006), La rappresentazione delle importazioni per settore di attività economica e di utilizzazione, presented at the seminar "La revisione generale dei conti nazionali del 2005", 21-22 June 2006, Istat, Rome.

Criscuolo C. and M. Leaver (2005), "Offshore Outsourcing and Productivity", mimeo

Daveri, F. (2004), "Delayed IT usage: is it really the drag on European productivity?", *CESifo Studies*, 397-421

Daveri, F., and C. Jona-Lasinio (2005), "Italy's decline: getting the facts right", *Giornale degli Economisti e Annali di Economia*, December

Deardorff, A.V. (2001), "Fragmentation in simple trade models", *North American Journal of Economics and Finance*, Vol.12

Ekholm K. and K.Hakkala (2005), "Effect of Offshoring on Labor Demand: Evidence from Sweden", IUI Working Paper No.654

Egger H. and P. Egger (2006), "International Outsourcing and the Productivity of Low-skilled Labour in the EU", *Economic Inquiry*, 44, 1

Feenstra R.C. and G.H. Hanson (1996), "Globalization, Offshoring and Wage Inequality", *American Economic Review*, 86(2)

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

Girma S. and H. Gorg (2004), "Outsourcing, Foreign Ownership, and Productivity: Evidence from UK Establishment level data", *Review of International Economics*, 12, 15

Gorg H. and A.Hanley (2003), "International Outsourcing and Productivity: evidence from plant level data", Research Paper 2003/20, 1-23 University of Nottingham

Griffith, R. Huergo, J.Mairesse and Peters (2005), "Innovation and productivity across four European countries", mimeo, March

Helg, R. and L. Tajoli (2006), "Patterns of international fragmentation of production and the relative demand for labor", *The North American Journal of Economics and Finance*

Hijzen A., H.Gorg and R.C.Hine, (2005), "International Outsourcing and the Skill Structure of Labor Demand in the United Kingdom", *The Economic Journal* 115 (506), 860–878

Hijzen A., T.Inui and Y.Todo, (2006), "Does Offshoring Pay? Firm-Level Evidence from Japan", RIETI Discussion Paper Series 07-E-005

Jones R. and H. Kierzkowski, (2001), “A framework for fragmentation”, in Cheng and Kierzkowski (eds.), *Fragmentation and International Trade*, Oxford University Press

Lorentowicz A., D.Marin and A.Raubold, (2005), “Is Human Capital Losing from Outsourcing? Evidence for Austria and Poland”, CESIFO WP N. 1616

Lo Turco, A., (2006), “International Outsourcing and Productivity in Italian Manufacturing Sectors”, mimeo

Mantegazza S. and L. Mastrantonio (2006), “Il nuovo schema supply and use”, ISTAT - Metodi e Norme.

McKinsey Global Institute (2003), *Offshoring: Is It a Win-Win Game?* McKinsey and Company.

McKinsey Global Institute (2004), *Can Germany Win from Offshoring*? McKinsey and Company.

McKinsey Global Institute (2005), *How Offshoring of Services Could Benefit France*, McKinsey and Company.

OECD (2000), The OECD Input-Output database, Sources and Methods, http://www.oecd.org/dataoecd/48/43/2673344.pdf

OECD (2006), *Economic Factbook*, Paris

OECD (2007a), *Synthesis report on global value chains*, DSTI/IND (2007)5

OECD (2007b), *Offshoring and Employment: trends and policy implications*, DSTI/EAS/IND/SWP (2005)2/REV2

Olsen (2006), “Productivity impacts of offshoring and outsourcing: a review”, OECD STI Working Paper, 2006/1, March.

Pilat D., A.Cimper, K.Olsen and C.Webb (2006), *The changing nature of manufacturing in OECD economies*, STI Working paper 2006/9

Planting M. (1990), “Estimating the Use of Imports by Industries,” paper presented at the Annual Meeting of the Southern Regional Science Association, Washington, DC, March 22-24

Wixted B., N.Yamano and C.Webb, (2006), “Input-output analysis in an increasingly globalised world: applications of OECD’s harmonized international tables”, OECD STI/Working Paper, 2006/7

APPENDIX: Comparing the DJ and FH measures of off-shoring

As extensively discussed in section 2.2, the import proportionality assumption implies biased estimates of the off-shoring of intermediate inputs. We find that the measures of the intensity of intermediates off-shoring obtained from the FH index are severely biased downwards in our data set.

To see why this may be the case, take the example of a shirt. According to the import proportionality assumption the import of a shirt should be considered entirely as an import of a *final* product. But that shirt could be also an *intermediate input* of a textile firm that off-shored its production process to a foreign or a subsidiary firm abroad and that has now imported the shirt to sell it in the domestic market as its own product. Without considering the correct *destination* of the product, in this case, the ratio between imported and total inputs would be downward biased.

Furthermore, the use of the ratio between *total* imports and *total* domestic demand (this is the second element in the FH formula) entails the implicit assumption that each industry features the same proportion of intermediates and final goods over its total costs. Instead, our data indicate that (1) intermediates are usually the bulk of total imports and a very minor fraction of domestic demand; (2) for those sectors heavily depending on imported intermediates the share of imported intermediates over total intermediates is higher than the share of total imports over total domestic demand; (3) the opposite holds for the industries relying to a lesser extent on imported intermediates.

As an example, consider two industries, chemicals that heavily depends on imported intermediates and tobacco that employs little imported intermediates. Table A1 reports the values of total and intermediate imports and domestic demand as well as the ratios between these variables for chemicals and tobacco in 1995. The data show that the weight attached according to the FH methodology to imported intermediates in chemicals would be 0.37. This in turn would lead to a value of the FH broad index of 27.3 (the product of the share of input purchases over total non-energy input (73.7 percentage points) times 0.37; see the corresponding line in Table 1), while the "true" share of imported intermediates over total domestic demand of intermediates is 12.4. This shows that the FH measure underestimates the imported intermediates for those sectors characterized by a high share of imported intermediates. The opposite holds for the tobacco industry. In our data, the FH indices are, on average, downward biased estimates of imported intermediates.

Table A1 – Import and Uses: final vs intermediate products (1995) - *Basic prices*

	Chemicals	**Tobacco**
Total imports (M)	22659	861
Total domestic demand or uses (C)	60747	2187
Imported intermediates (M_{int})	20964	5
Imported final product (M_{fin})	1695	856
Intermediate uses (C_{int})	47199	329
Final uses (C_{fin})	28142	1887
M/C	0.37	0.39
M_{int}/C_{int}	12.37	0.01
M_{fin}/C_{fin}	0.06	0.45

Source – ISTAT National Accounts

Figure 1 – Labor productivity, narrow materials and service off-shoring: 1995-2003

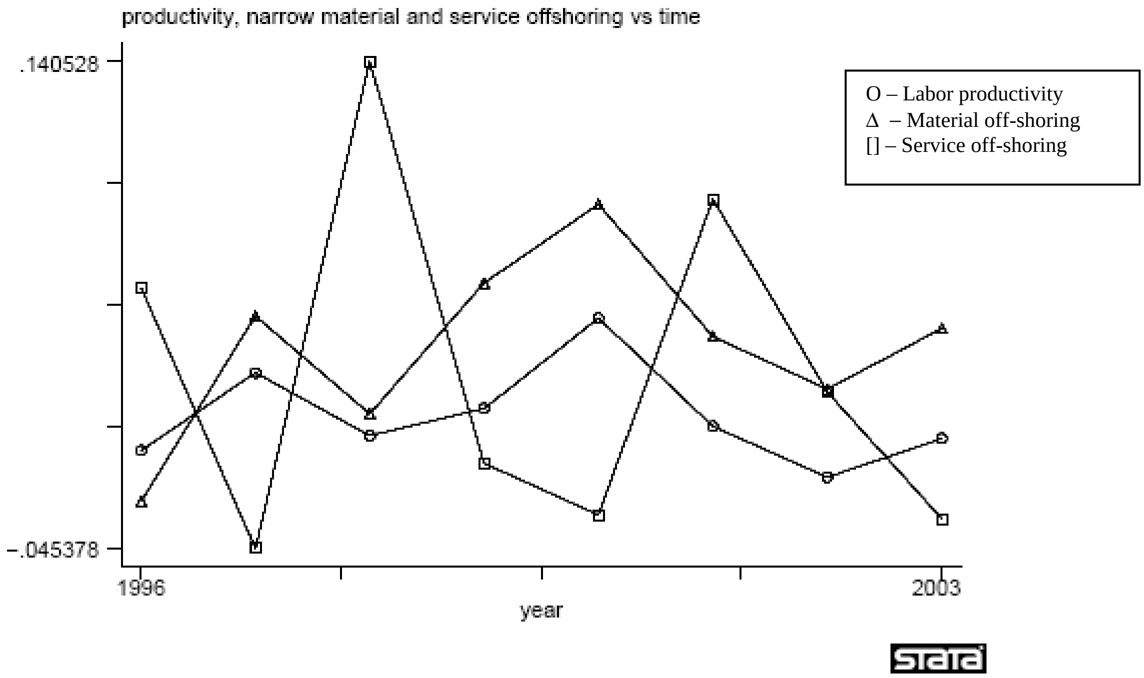

Figure 2 – Labor productivity vs narrow off-shoring of materials

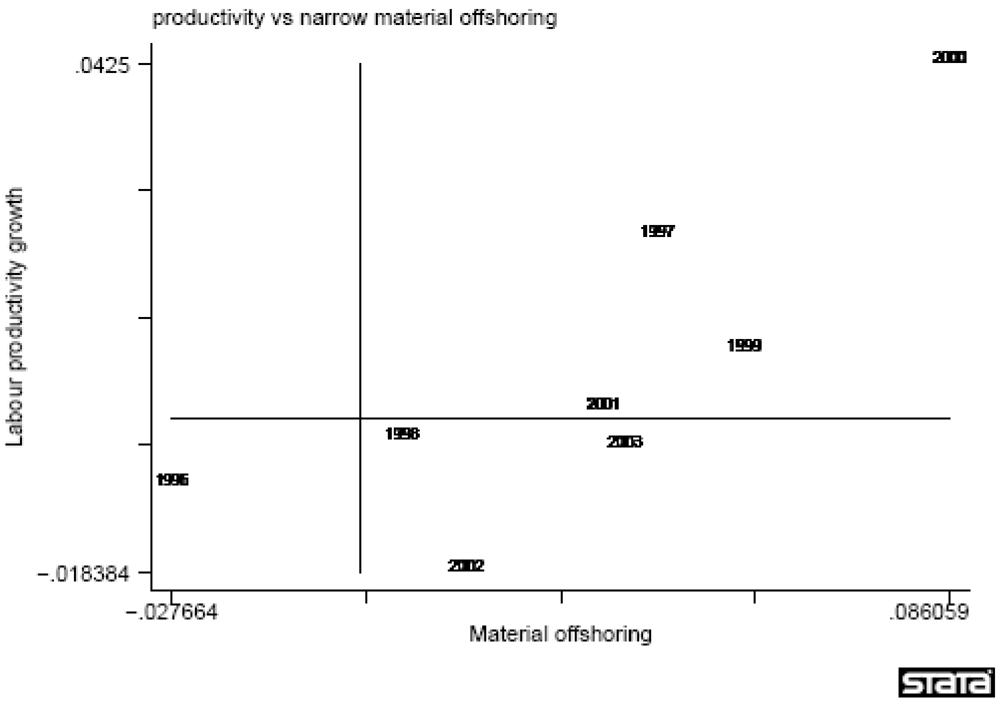

Figure 3 – Labor productivity vs service off-shoring

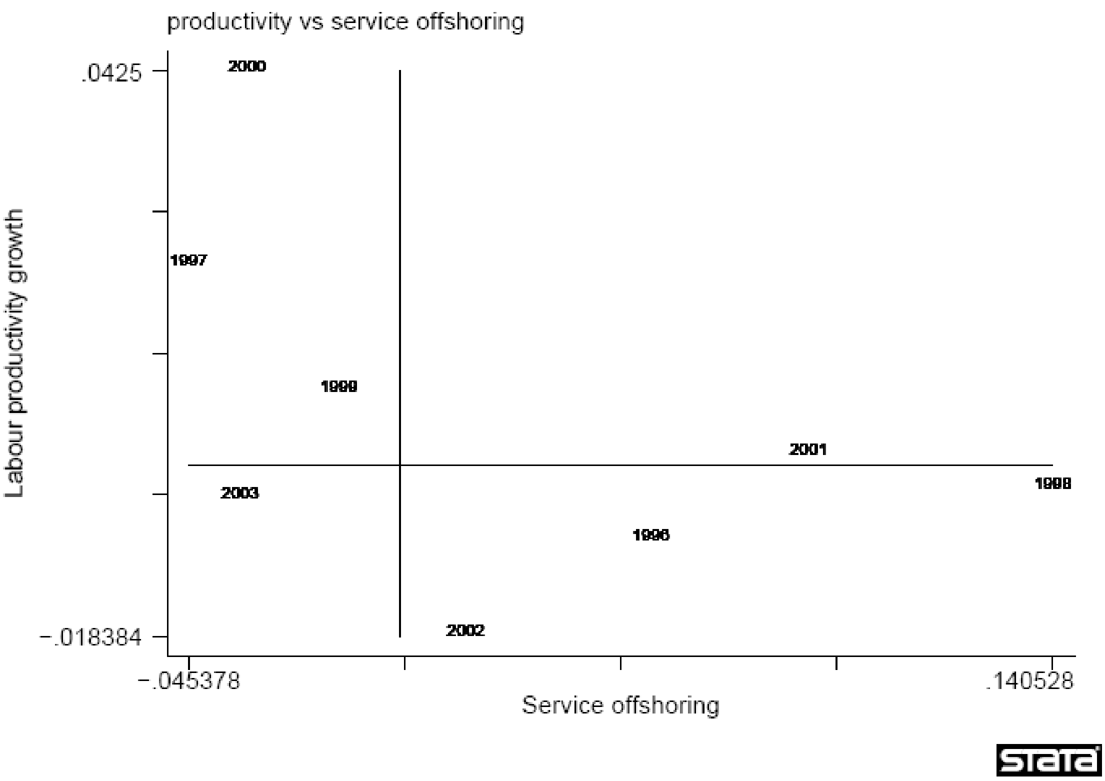

Table 1: Off-shoring indices for intermediate products in the Italian manufacturing industries

	DJ - narrow index			DJ - broad index			FH - narrow index			FH - broad index		
	1995	**2003**	**Δ(1995-03)**	**1995**	**2003**	**Δ(1995-03)**	**1995**	**2003**	**Δ(1995-03)**	**1995**	**2003**	**Δ(1995-03)**
Food products and beverages	23.8	27.0	3.2	8.5	9.3	0.8	4.1	3.8	-0.3	5.5	5.5	0.0
Tobacco	2.3	13.4	11.1	7.6	5.8	-1.8	17.6	4.0	-13.6	20.5	10.7	-9.9
Textiles	24.9	26.8	1.9	20.7	22.3	1.6	9.7	9.4	-0.3	12.9	13.0	0.1
Wearing and apparel	15.7	49.3	33.6	12.4	19.1	6.7	2.8	4.4	1.6	10.6	14.7	4.0
Leather	23.4	31.6	8.2	16.2	20.4	4.1	6.9	10.2	3.3	12.3	16.8	4.5
Wood and wood products	22.1	22.2	0.1	15.0	14.7	-0.3	8.4	8.2	-0.2	11.4	11.2	-0.1
Pulp, paper and paper products	57.1	50.3	-6.8	28.4	25.0	-3.4	8.8	6.3	-2.5	16.0	12.1	-3.9
Publishing and printing	7.8	6.3	-1.6	15.8	12.4	-3.4	0.9	0.6	-0.4	3.0	1.8	-1.2
Chemicals and pharmaceuticals	62.4	73.9	11.5	40.0	43.7	3.8	18.2	21.1	2.9	27.3	30.6	3.4
Rubber and Plastics	17.6	18.2	0.5	29.9	29.1	-0.9	2.8	3.3	0.5	11.5	12.4	0.8
Non-metallic mineral products	14.0	11.5	-2.5	11.4	9.8	-1.7	2.6	2.2	-0.4	5.4	4.0	-1.4
Basic metals	72.0	83.3	11.3	31.4	30.2	-1.2	13.9	11.8	-2.1	23.9	23.8	-0.1
Fabricated metal products	9.6	8.6	-1.1	18.0	15.8	-2.2	2.1	2.5	0.4	6.5	6.6	0.0
Machinery and equipment n.e.c.	43.8	47.3	3.5	14.0	14.9	0.9	3.9	4.2	0.4	18.8	18.7	-0.1
Office machinery and computers	70.8	99.3	28.5	52.3	52.4	0.1	3.4	3.2	-0.1	39.6	35.5	-4.0
Electrical machinery & apparatus nec	38.5	42.1	3.7	21.3	21.2	-0.1	4.3	4.5	0.2	16.5	17.0	0.5
Radio, TV and TLC equipment	82.6	77.7	-4.8	45.0	45.4	0.3	12.8	12.9	0.0	27.3	27.7	0.4
Medical, precision and optical instr's	57.1	64.9	7.9	29.7	29.6	-0.1	7.4	7.4	0.0	27.8	27.1	-0.7
Motor vehicles, trailers and semi-trails	60.8	58.9	-1.9	24.8	30.0	5.2	8.0	14.6	6.6	36.1	41.7	5.7
Other transport equipment	32.9	47.7	14.8	23.4	27.4	4.0	4.3	9.1	4.8	15.3	27.4	12.1
Furniture; manufacturing n.e.c.	24.8	19.0	-5.9	22.5	20.9	-1.6	0.7	1.4	0.6	7.3	8.8	1.5
Average manufacturing industry	36.4	41.9	5.5	23.3	23.8	0.5	6.8	6.9	0.1	16.9	17.5	0.6

Correlation matrices

	DJ 95	**DJ 03**	**DJ Δ(95-03)**	**FH 95**	**FH 03**	**FH Δ(95-03)**
(a) Narrow vs. broad index	0.81	0.84	0.53	0.49	0.67	0.86

(b) DJ vs. FH	**(b1) Narrow index**						**(b2) Broad index**					
	DJ 95	**DJ 03**	**DJ Δ(95-03)**	**FH 95**	**FH 03**	**FH Δ(95-03)**	**DJ 95**	**DJ 03**	**DJ Δ(95-03)**	**FH 95**	**FH 03**	**FH Δ(95-03)**
DJ 1995	1.00						1.00					
DJ 2003	0.92	1.00					0.97	1.00				
DJ Δ(1995-03)	0.07		1.00				0.02		1.00			
FH 1995	0.40			1.00			0.72			1.00		
FH 2003		0.56		0.73	1.00			0.79		0.92	1.00	
FH Δ(1995-03)			0.00	-0.38		1.00			0.69	-0.04		1.00

Note: DJ=Daveri-Jona; FH=Feenstra-Hanson. Source: own calculation from ISTAT – National Accounts

Table 2: Off-shoring of market services in the Italian manufacturing industries

	DJ - broad index			FH - broad index		
	1995	2003	Δ(1995-03)	1995	2003	Δ(1995-03)
Food products and beverages	0.4	0.5	0.1	0.7	1.1	0.5
Tobacco	0.6	0.4	-0.2	1.1	1.6	0.5
Textiles	0.6	0.8	0.2	0.9	1.5	0.6
Wearing and apparel	1.0	1.2	0.2	1.2	2.6	1.3
Leather	0.5	0.6	0.1	1.0	1.7	0.7
Wood and wood products	1.0	1.2	0.2	0.9	1.3	0.4
Pulp, paper and paper products	1.2	1.0	-0.2	2.2	2.3	0.1
Publishing and printing	1.2	1.3	0.1	0.7	0.6	-0.1
Chemicals and pharmaceuticals	1.2	1.2	0.1	2.6	4.3	1.7
Rubber and Plastics	0.6	0.6	0.0	1.3	2.2	0.8
Non-metallic mineral products	0.4	0.3	-0.1	1.2	1.1	-0.1
Basic metals	0.2	0.3	0.0	2.8	4.6	1.7
Fabricated metal products	0.5	0.5	0.0	1.0	1.4	0.4
Machinery and equipment n.e.c.	0.8	0.9	0.1	2.7	3.4	0.7
Office machinery and computers	4.7	11.1	6.4	6.1	8.8	2.7
Electrical machinery and apparatus	2.1	2.3	0.2	2.4	3.6	1.2
Radio, TV and tlc equipment	2.8	4.9	2.1	4.3	5.8	1.6
Medical, precision and optical instrs	4.4	5.4	1.0	5.1	6.5	1.4
Motor vehicles, trailers and semi-trails	0.9	0.9	0.1	3.9	5.1	1.2
Other transport equipment	1.1	1.2	0.1	2.3	4.8	2.4
Furniture; manufacturing n.e.c.	1.1	1.3	0.2	0.7	1.1	0.4
Average manufacturing industry	**1.3**	**1.8**	**0.5**	**2.1**	**3.1**	**1.0**
Correlation matrices						
Broad index, DJ vs. FH						
	DJ 95	DJ 03	DJ Δ(95-03)	FH 95	FH 03	FH Δ(95-03)
DJ 1995	1.00					
DJ 2003	0.93	1.00				
DJ Δ(1995-03)	0.78		1.00			
FH 1995	0.82			1.00		
FH 2003		0.79		0.97	1.00	
FH Δ(1995-03)			0.60	0.73		1.00
Note: DJ=Daveri-Jona; FH=Feenstra-Hanson						

Source: own calculation from Istat (National accounts)

Table 3: Growth of labor productivity in Italy, 1970-2003, main industry groups					
	1970-80	**1980-95**	**1995-03**	1995-00	2000-03
Economy	**2.4**	**1.8**	**0.6**	1.1	-0.2
Agriculture	**3.1**	**4.3**	**2.7**	5.2	-1.5
Manufacturing	**2.8**	**3.0**	**0.2**	1.0	-1.0
-- non-durables	**2.7**	**3.1**	**0.3**	0.7	-0.2
-- durables	**2.9**	**2.7**	**0.0**	1.7	-2.7
Utilities	**-0.4**	**0.8**	**5.5**	3.7	8.7
Construction	**1.9**	**1.0**	**0.1**	0.5	-0.5
Business sector services	**1.8**	**1.1**	**0.1**	0.5	-0.5
Public services	**1.4**	**0.7**	**0.4**	0.8	-0.1
Source: Daveri and Jona-Lasinio, 2005					

Table 4 – Off-shoring and labor productivity growth – LSDV estimates, various off-shoring indicators								
Dependent variable: yearly growth rate of value added per full-time equivalent employed (21 industries, 1995-03)								
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Off-shoring indicator (materials=Osm; services=Oss)	Narrow Osm, Broad Oss	Narrow Osm, Broad Oss	Narrow Osm, Broad Oss	Narrow Osm, Broad Oss	Broad Osm, Broad Oss	Broad Osm, Broad Oss	FH narrow Osm, FH Oss	FH narrow Osm, FH Oss
Growth of K/L ratio	.86*** (.15)	.87*** (.16)	.84*** (.15)	.89*** (.16)	.78*** (.17)	.74*** (.17)	.96*** (.12)	.91*** (.11)
Growth of materials off-shoring share	.00 (.05)	-.08 (.05)	-.09** (.04)	-.08 (.05)	-.02 (.09)	-.03 (.09)	.12 (.08)	.13* (.08)
Growth of services off-shoring share	-.26** (.12)	-.16 (.14)	-.14 (.14)	-.15 (.14)	-.22 (.13)	-.20 (.14)	-.12 (.09)	-.13 (.08)
$(IT/total\ INV)_t$	-	-	-.14 (.09)	-.13 (.09)	-	-.12 (.09)	-	-.16* (.09)
$(R\&D/GDP)_{t-1}$	-	-	-	-.01 (.01)	-	-	-	-
Period dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimation method	LSDV	LSDV	LSDV	LSDV	LSDV	LSDV	LSDV	LSDV
R-Squared	.57	.69	.70	.70	.68	.68	.66	.67
RMSE	.057	.050	.049	.049	.051	.050	.052	.051
# observations	147	147	147	147	147	147	147	147

Notes

- Standard errors are heteroskedasticity consistent.

Table 5 - Off-shoring and productivity growth – 2SLS estimates, various off-shoring indicators								
Dependent variable: yearly growth rate of value added per full-time equivalent employed (21 industries, 1995-03)								
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Off-shoring indicator (materials=Osm; services=Oss)	Narrow Osm, Broad Oss	Narrow Osm, Broad Oss	Broad Osm, Broad Oss	Broad Osm, Broad Oss	FH narrow Osm, Broad Oss	FH narrow Osm, Broad Oss	Narrow Osm, Broad Oss	
Included instruments list	Period FE	Period FE + Industry FE	Period FE	Period FE + Industry FE	Period FE	Period FE + Industry FE	Period FE	
Growth of K/L ratio	.62*** (.18)	.70 (.47)	.81*** (.22)	.73* (.44)	.87*** (.22)	.74* (.40)	.49** (.20)	
Growth of materials off-shoring share	.24** (.11)	-.60 (.79)	-.36 (.29)	.50 (.44)	-.19 (.14)	.40 (.37)	.28** (.12)	
Growth of services off-shoring share	-.23 (.20)	.31 (.72)	.46* (.24)	-.23 (.44)	.37** (.19)	-.23 (.43)	-.05 (.09)	
IT investment share	-	-	-	-	-	-	-.07 (.06)	
Estimation method	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	
R-Squared (centered)	.41	.44	.35	.48	.28	.51	.19	
RMSE	.061	.060	.064	.057	.067	.055	.071	
# observations	147	147	147	147	147	147	147	
Shea partial R-Squared for first-stage regressions of endogenous regressors								
growth of K/L ratio	.25	.07	.20	.06	.22	.06	.29	
gr. of material off-shoring	.23	.01	.22	.07	.21	.04	.24	
gr. of services off-shoring	.26	.09	.15	.05	.14	.03	.60	
IT/investment share	-	-	-	-	-	-	.85	
Hansen over-identification test								
Chi-sq(27): p-value	.42	.00	.56	.00	.69	.00	.73	

Notes

- List of excluded instruments: growth of K/L at (t-1), log-level of K/L at (t-2), IT investment share of total non-residential investment in all columns. Industry fixed effects are also in the list in column [1], [3], [5] and [7].
- List of included instruments: period fixed effects in all columns. Industry fixed effects are in the list in column [2], [4] and [6].

The reported value of the centered R-squared refers to the second stage of each regression
Standard errors are heteroskedasticity consistent.

Table 6 – Other robustness checks: off-shoring and imputed TFP growth LSDV and 2SLS estimates								
Dependent variable: yearly growth rate of "imputed TFP" (21 industries, 1995-03)								
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Off-shoring indicator (materials=Osm; services=Oss)	Narrow Osm, Broad Oss	Narrow Osm, Broad Oss	Narrow Osm, Broad Oss	Broad Osm, Broad Oss	Broad Osm, Broad Oss	FH narrow Osm, Broad Oss	FH narrow Osm, Broad Oss	
Included instruments list	Period and Industry FE	Period FE	Period FE + Industry FE	Period FE	Period FE + Industry FE	Period FE	Period FE + Industry FE	
Growth of materials off-shoring share	.01 (.06)	.30*** (.12)	-.44 (.74)	.40 (.47)	.75 (1.50)	-.36* (.21)	.24 (.35)	
Growth of services off-shoring share	-.35*** (.12)	-.32 (.21)	.16 (.71)	-.61 (.38)	-.81 (1.69)	.43* (.24)	-.17 (.48)	
Estimation method	LSDV	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	
R-Squared (centered)	.47	.06	-.17	.12	.06	-.29	.26	
RMSE	.055	.066	.073	.064	.066	.077	.058	
# observations	147	147	147	147	147	147	147	
Shea partial R-Squared for first-stage regressions of endogenous regressors								
growth of material off-shoring	-	.27	.01	.15	.01	.28	.05	
growth of services off-shoring	-	.25	.13	.16	.00	.14	.04	
Hansen over-identification test								
Chi-sq(27): p-value	-	.53	.43	.81	.32	.82	.39	

Notes

- Dependent variable: "imputed total factor productivity" (TFP), computed as the difference between the growth rate of labor productivity (as in previous tables) and the product of one third (the commonly accepted value for the value added share of capital) and the growth rate of the capital-labor ratio in each industry
- List of excluded instruments: growth of K/L at (t-1), log-level of K/L at (t-2), IT investment share of total non-residential investment in all columns. Industry fixed effects are also in the list in column [1], [3], [5] and [7].
- List of included instruments: period fixed effects in all columns. Industry fixed effects are in the list in column [2], [4] and [6].

The reported value of the R-squared refers to the second stage of each regression
Standard errors are heteroskedasticity consistent.