Dipartimento di Economia
Università degli Studi di Parma
Via Kennedy 8
43100 Parma

Francesco Daveri - Cecilia Jona-Lasinio

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Francesco Daveri
Università di Parma and IGIER

Cecilia Jona-Lasinio
ISTAT

Abstract

We employ input-output tables to study the relation between off-shoring and productivity growth in the Italian manufacturing industries in 1995-2003. Our results indicate that not all types of off-shoring are positively related to productivity growth. In particular, the international outsourcing 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 disappears when our direct measure of off-shoring is replaced with the Feenstra-Hanson measure employed in other studies.

JEL: F16; F23; O4
Keywords: International trade, Productivity growth; offshoring; Italian economy

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1. Introduction

International outsourcing (or, in short, off-shoring) of activities on the part of manufacturing firms and industries often features at the center-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.

No doubt, the country where costs and benefits of off-shoring have been most clearly scrutinized by the public opinion is the United States. During the 2004 presidential campaign, the concern that outsourcing had gone too far creating more hardships than necessary for American unskilled workers has been one of the hot political issues. Not by chance academic research on this topic has mostly focused on such effects.[1] Yet, in parallel, an array of McKinsey and other business consultancy studies have found that the off-shoring of activities has also been a crucial ingredient to enable the American economy to take full advantage of the potential productivity gains brought about by the celebrated IT revolution. Consistent with these pieces of evidence, the statistical analysis for US firms and industries (see Amiti and Wei, 2004, 2006) has also indicated that the off-shoring of services and, less strongly, intermediates has been associated with productivity gains.

The evidence is more scant for other OECD countries. McKinsey (2004, 2005) found that the economic benefits from off-shoring were lower for French and German manufacturing firms than for US firms. Recent studies employing micro data tend to find a positive correlation between service off-shoring and productivity for the UK and Ireland. The evidence on the correlation between the off-shoring of intermediates and productivity is instead more mixed, either insignificant or outright negative depending on industries and countries. We discuss these previous results more extensively in section 4.

The only systematic study on the relation between off-shoring and productivity growth we are aware of is due to Egger and Egger (2005), where a short-run negative relation has been found to hold contrasting data from twenty-two manufacturing industries of sixteen European countries

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

around the mid Nineties. In the same study, the expected positive relation has been detected in the long run.

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. Recent exceptions to this pattern (described in more detail in section 4) estimate the productivity impact of materials and services outsourcing in a period when the extent of off-shoring was very small, finding rather sizable results for intermediates and industry-dependent (and rather counter-intuitive) 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 provide a detailed account of the more recent input-output data for the Italian manufacturing industries. We find that the analysis of Italy's off-shoring data is not the mere addition of yet another country to a growing literature of country studies, but provides interesting insight *per se*. For sure, the picture for Italy may be seen as mirroring in reverse the American or the UK picture. First, in the last few years, as documented in a number of studies,[2] Italy has been on a declining productivity path. At the same time, though, it has gone through an acceleration of the process of opening up, also implemented by delocalizing abroad the manufacturing of activities previously carried out within the domestic borders (OECD, 2006). The big question here would thus boil down to uncover what has failed so dramatically in the Italian economy compared to the previous decades of fast growth and rapidly rising living standards. Yet, while providing a full-fledged answer is beyond our scope in this paper, the undertaking we are after here is to document whether outsourcing occurred on a commensurately smaller scale in Italy compared to other countries and whether, in turn, this may at least partly account for Italy's disappointing productivity performance. This is not the only possibility, though: another, perhaps more puzzling, option may be that delocalization did occur in Italy - against all odds - but it has not brought about the expected productivity gains. This would open the question of why this was the case. In both cases, useful lessons may be learned for other countries as well.

To answer these questions, we take advantage of a data set inclusive of *symmetric* input-output tables (I-O tables from here onwards) to present industry evidence on the extent of international outsourcing and then contrast our direct measures of outsourcing (DJ from here onwards) with productivity growth data for Italy's manufacturing industries in 1995-2003.

[2] 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.

In our work, we draw on recently released data not used in previous studies on the Italian economy. Hence, compared to earlier studies, our empirical analysis has a methodological twist of novelty, for we quantify off-shoring using *direct* data on imported produced goods and services. This is preferable to using the methodology of Feenstra and Hanson (FH from here onwards) employed in previous studies such as Amiti and Wei. The FH method of computing international outsourcing assumes that any manufacturing industry would employ imported intermediates in the same proportion: the same would apply to market services. By using symmetric I-O tables, we do not have to rely on such restrictive assumptions and can thus – as a side result - provide evidence of the extent of the bias in the calculation of off-shoring entailed by the FH methodology.

Providing a direct measure of off-shoring not based on untested assumptions is perhaps a useful undertaking in itself. But the real meat of our paper is in its econometric part, where the partial correlation of our constructed measures of off-shoring with productivity growth data is computed. We do that by conditioning the growth rate of value added per full time equivalent employed ("labor productivity") on the growth of capital-labor ratios so as to clean labor productivity growth of its capital deepening component. In this way, we are able to evaluate the counterpart of industry and period fixed effects, as well as intermediate and service off-shoring indicators, on total factor productivity (TFP). Given the likely endogeneity of off-shoring with respect to both growth rates and levels of industry productivity as well as a number of other determinants, off-shoring is instrumented and the validity of alternative instruments such as the lagged values of capital accumulation, IT investment and other unmeasured period and industry effects is tested.

Our descriptive evidence indicates that not all manufacturing industries off-shored production to the same extent. Moreover, the data show that off-shore outsourcing took off in most industries in 1999-2003. This conforms to expectations and to parallel evidence on the diffusion of information technologies (ICT) in the Italian economy, where the diffusion of ICT has occurred later than in most 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.

Overall, the statistical evidence from both OLS and IV estimates shows a remarkably consistent pattern of correlation. First of all, it clearly appears that not all types of off-shoring positively correlate with productivity growth. The type of good being outsourced indeed matters: the off-shoring of intermediates is positively related to productivity growth, while the external outsourcing of services is either not related or – more often – even negatively related to productivity growth. Second, measurement also matters. The positive relation between intermediate off-shoring and productivity growth is there for our preferred (direct and "narrow") measure of off-shoring. The correlation is instead somewhat weaker when a "broad" measure of off-shoring is employed.

Interestingly, the correlation disappears altogether when the Feenstra-Hanson measures of outsourcing are employed. We find this result of general interest, over and above the discussion of the case of Italy.

The structure of the paper is as follows. In section 2, we discuss measurement issues and provide evidence on broad productivity and off-shoring trends in the Italian manufacturing industries. In this section, we also compare our off-shoring estimates with those obtained from the Feenstra-Hanson methodology. In section 3, we specify our empirical framework and present our results. Section 4 relates our results with those obtained in previous studies. Section 5 concludes.

2. Measurement and facts on off-shoring and productivity growth in the Italian manufacturing industries

2.1 Measuring the extent of off-shoring

Definition "Outsourcing" is the purchase of intermediates and services outside a manufacturing company which were previously performed by in-house employees. In turn, outsourcing may take place in various guises, within or outside the country. If the outsourced inputs or services are produced outside the country, this is labeled "off-shoring" (or "off-shore outsourcing").[3]

Data Our basic data source consists of Italian symmetric input-output tables (industry by industry matrix) obtained rearranging both supply and use tables in a single matrix with identical classification of industries (or products respectively) applied for both rows and columns. The input-output tables are at basic prices, at the 60-sector level (according to the NACE Rev1.1 classification) for years 1995-2003[4]. This enables us to present industry evidence over 1995-2003 on the extent of international outsourcing 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".

Measurement As mentioned in the introduction, our empirical analysis has a methodological twist of novelty compared to previous sectoral studies, for – thanks to symmetric I-O tables - we can

[3] The trade-related aspects of outsourcing have also attracted increasing attention in the literature. In line with traditional trade theory most papers find that international outsourcing (moving low skill intensive production to low skill abundant countries) leads to increased demand and increases in the wage premium for high skilled workers in the US and the UK. In this paper, we are not concerned with the international trade dimension of outsourcing. See Olsen (2006) for a definition.

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

quantify domestic and international outsourcing using *direct* data on imported and domestically produced goods and services. This is at variance with most studies undertaken before (the only exception being the exercise by Bracci, 2006) where the international component of outsourcing 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. Absent primary information on imported inputs, standard practice is the methodology of Feenstra and Hanson (1999) based on *the import proportionality assumption*. They measure the intensity of off-shoring activities as the share of imported intermediate inputs over total intermediate costs. Therefore according to their methodology, the international outsourcing (or off-shoring) of, say, the electronics industry would be equal to the share of the intermediate purchases of electronics from other 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. This is what they call a *broad* measure of foreign outsourcing. The same would clearly apply when international outsourcing of services is to be computed. Based on this measure FH calculate also a *narrow* measure of outsourcing by restricting the analysis to those inputs that are purchased from the same industry as the good being produced. Then they calculate what they call *differential outsourcing* as the difference between their broad and narrow outsourcing measures. So far these measures have been the most widely used by the empirical literature because imported intermediate product matrices were not accessible. In this paper, we calculate, for the first time in Italy, direct measures of international outsourcing using imported I-O tables. Therefore our evidence is not based on such restrictive assumptions and we can also provide an indication of the extent of the bias in the outsourcing measures obtained according to the indirect methods. As shown below, it is not nil.

In this paper we provide evidence of international outsourcing by means of three indices. The first one is an indicator of *narrow off-shoring of intermediates*. This is defined as the share of intermediate inputs that each manufacturing industry imports from the same industry abroad over total intermediate inputs in that industry. The second index measures the *broad off-shoring of intermediates*. This is calculated 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. Thirdly, we also measure the broad *off-shoring of market services* – an index defined as the share of imported business and financial services over total non-energy intermediates.

2.2 Facts on off-shoring and productivity growth in the Italian manufacturing

2.2.1 Productivity trends

As extensively documented in Daveri and Jona-Lasinio (2005) and more concisely in Table 1, the Italian economy has displayed disappointing productivity trends since 1995, both in manufacturing and services. Table 1 indicates that the productivity slowdown has been particularly abrupt, though, for manufacturing, which accounts for as much as two thirds of the productivity slowdown of the last ten years or so. This is at odds with the former decade: the mild (with today's eyes) productivity slowdown in the 1970s was mainly driven by the productivity slowdown in market services (and construction), with labor productivity in manufacturing still growing at steadily high rates (3% per year or so).

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, although slightly scattered around over time. 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%). In the more recent years, productivity growth 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%).

Non-durable production includes textiles, wearing and leather – all "Made-in-Italy" landmark industries. If the productivity of non-durable producers declines, this is particularly worrisome, because fast-growing productivity is the only means to restore profits and maintain jobs in such industries threatened by low-cost production from Asia and Eastern Europe.

Durable production, in turn, is meant to be the most likely vehicle of introduction of technical change and new modes of production (and therefore the industry with the potentially highest productivity growth rate). Depending on the availability of such things as human capital, R&D investment and the like, we may expect to see these industries to make a bigger or a smaller share of value added and employment in a given country. But they are anyway supposed to grow fast, no matter what. If this is not the case (and the negative productivity growth rate of about 3% per year in 2000-03 indicates that this is really not being the case in Italy), there are good reasons to be worried. Moreover, this contrasts with secular growth rates in these industries in the neighborhood of (positive) three per cent per year in the 1970s and the 1980s through 1995.

In 1995-2003, manufacturing total factor productivity (TFP) declined by about half a percentage point per year, equally for non-durable and durable producers, and not too dissimilarly from constructions and market services. Such a decline was particularly sizable for the industries producing non-durable goods in 1995-00: in these industries, TFP growth fell to -0.2% per year in 1995-2000 from +1.9% in 1980-95. TFP growth stayed instead roughly constant at about +1.3% in 1995-2000 for durable producers, but then markedly fell to -3.4% in 2000-03. This scattered timing of declines quite closely matches labor productivity developments in these industries.

Non-durable goods producing industries include producers of consumer and intermediate goods, with the production of intermediates (notably chemicals and pharmaceuticals) being the fastest growing industries in the Italian economy in 1980-95. This was no longer the case in 1995-03, when TFP growth zeroed in chemicals (from 6% in the previous years). More generally, the growth debacle has been striking in all the Made-in-Italy consumer industries, such as “Textiles and Wearing”, “Leather, leather products and Footwear”, “Wood and wood products”, although timing and intensity of the growth reduction was somehow different in the various industries. The decline in “Leather and Footwear” has been unusually abrupt in 1995-00 (falling to -1.7%, from 2.5% in 1980-95) and much deeper than in the other “Made-in-Italy” industries in 2000-03, where a decline of 4.3% per year was recorded.

In industries producing durable goods, as mentioned above, TFP kept growing in the second half of the 1990s, but then it fell more dramatically than in the rest of the manufacturing sector in the first years of the 2000s. In the production of machinery and equipment (which includes many of the industries traditionally classified among the high-tech industries), TFP fell by 4.4% per year in 2000-03 – a cumulated decline of about 14% in three years. This was mainly driven by the negative 6.4% per year in the production of electrical and optical equipment – the industry including, among other things, the production of personal computers and cellular phones (whose diffusion has, in contrast, proceeded at a very fast pace over this period).

In many such industries, capital-labor ratios increased faster than labor productivity, in parallel with sharp TFP declines. This is consistent with the aggregate evidence of rising value added shares of capital and rising capital-output ratios. The steadiness in the growth of capital-labor ratios in non-durable and durable manufacturing throughout 1995-2003 is particularly striking. In this period of time, in these industries the growth of labor productivity zeroed or became negative, but the capital-labor ratios continued to grow at about the same rates as in 1995-00 and 1980-95. This applies to textiles, leather and footwear and chemicals. All of these industries are examples of particularly abrupt declines in TFP growth and particularly sharp increases in the value added share of capital;

in these industries, however, capital-labor ratios continued to grow by 3-4% per year, slightly - but only slightly - below the growth rates in 1980-95.

2.2.2 Off-shoring trends

Now, we take a look at off-shoring data to sum up the main features of the off-shoring phenomenon in the Italian manufacturing industries before delving into the econometric analysis of the next section.

Off-shoring intensities are calculated following the *broad* and *narrow* definitions described above and first introduced by Feenstra and Hanson (1999). 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 the import matrix[5], we are able to look directly at the value of imported intermediate inputs of each industry from and within each sector. At this stage, however, we cannot distinguish between the imports from affiliated and unaffiliated firms: both are included in our off-shoring measures. [6]

Table 2 and 3 presents our evidence on the degree of international outsourcing 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 2 and 3 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 2. From the correlation matrices in the bottom part of the table (see the (b) panel: DJ vs. FH) , one learns that our direct measure ("DJ" from Daveri and Jona-Lasinio) 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-

[5] 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.

[6] In the future, we will consider the combination of I-O data on imported intermediates with information on the activities of multinationals to distinguish between *off-shoring* (intermediate purchases from foreign firms) and *international in-sourcing* (intermediate purchases from foreign subsidiaries). By including both measures simultaneously we will be able to infer to what extent the organizational model of off-shoring or intra-firm matter.

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 values 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. These differences are mainly determined by the adoption of the import proportionality assumption used to calculate the FH indices. The same assumption is also largely adopted in the construction of the import matrices by most of OECD countries[7] (OECD, 2000). By means of this technique 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 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). They also show that for those sectors which rely heavily on imported inputs (such as the *chemical and pharmaceutical* industry also according our results) the downward bias associated with the assumption can be as much as one-third (Planting, 1990). The same reasoning hold with respect to the FH index where the adoption of the import proportionality assumption implies a downward bias estimate of the imported intermediate inputs. Moreover this implies also that the dynamics of FH and DJ are different because while the FH index implicitly follows the same trend of the imported final goods the DJ mostly reproduce that of the imported intermediates. As a consequence, while the average values of DJ reveal that, in 1995-2003, the trend for off-shoring intermediates is upwards, the FH measure indicates that the trend has been stagnating. 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 3), the correlation is low both in the cross-sectional and time series dimension (around 0.15 across industries and some 0.30 over time). Unlike

[7] The Italian import matrix is constructed by means of the direct method (Bracci, 2007).

for the off-shoring of intermediates, the FH measure of market services of-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 out-sourcing 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 Italian manufacturing industries, concentrating on our indices of (narrow) intermediates and (broad) services off-shoring. After all, as far as we know, this is the first time that symmetric I-O tables are used to capture the off-shoring phenomenon in Italy.

As of 2003, the latest year for which data are available, the average archetypal manufacturing industry in Italy would buy imported intermediates for some 40% of its total non-energy inputs. For this representative industry, the average off-shoring intensity of materials went up by 5.3% since 1995 - a likely consequence of the growing openness of the Italian manufacturing sector over this whole period. 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). Among the industries producing non-durable intermediates, “chemicals and pharmaceuticals” buys abroad three fourths of its intermediates, while, among the industries producing consumer goods, wearing and apparel buys abroad about half of its non-energy inputs. Yet the correlation coefficient measuring the extent to which an industry would resort to off-shoring in 1995 and its subsequent off-shoring share increase is instead rather low (0.07; see the lower panel in Table 2). In fact, 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 among the highest material outsourcers in 1995. During the same period of time, pulp and paper (-6.8%), other transport equipment (-5.9%) and radio, TV and other TLC equipment (- 4.8%) showed the most significantly decreasing shares.

Our pieces of evidence can be compared – and at first sight appear remarkably consistent - with the available evidence on the international fragmentation of production (IFP) provided by Helg and Tajoli (2005). Their evidence shows that industries can be roughly divided in two main groups. The so-called “traditional” sectors (textiles, apparel, shoes and, to some extent, furniture) are particularly prone to the international fragmentation of production. In these industries, production is more likely to be broken down in a sequence of steps – often sharply diversified by factor intensity -

that may occur in different places and, possibly, countries. In Germany, the practice to process abroad a large share of apparel production started more than a decade ago. As a result, as much as one fifth of total production was re-imports of apparel. In Italy, the apparel sector is also the most heavily affected, although to a much smaller extent. In both countries, an increased use of outward processing trade (OPT) is quite visible in a number of sectors, with particular evidence for the apparel industry.

The second group of industries for which OPT is relevant is the subset of high-tech industries: office machinery, communication equipment, precision instruments, and transport equipment. The reasons for IFP in these industries are probably different than in the industries in the traditional group. Here too, assembly of components has been increasingly standardized and made more intensive in unskilled labor. But in high-tech industries, fragmentation may be – and often is – also driven by technological differences among countries and by technological inter-linkages, rather than by wage differentials. In both Italy and Germany, the communication equipment industry is the most involved in the use of IFP within this second group, showing an increasing trend in OPT until the mid-1990s, but a slowdown in the last year of the sample.

In line with the evidence available 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, with this share going up to less than 2% as of 2003. This upward trend is a general feature of all the manufacturing industries, however. This is particularly apparent for the industry producing computers and other office machines, that exhibits a +6.4% in 1995-2003.

As stated above, we are particularly interested in the relationship between off-shoring and productivity growth, though. Hence Figure 1 and 2 provide respectively the time trends of productivity and narrow off-shoring of materials and the tendency of productivity and service off-shoring. In 1995-2003, the average off-shoring intensity of materials and productivity shows an increasing and very similar trend. During the same period of time, service off-shoring shows a more pronounced increase than labor productivity. Thus the data indicate that there is a positive relationship between material off-shoring and productivity growth while the evidence for the international outsourcing of services is more mixed.

The scatter-plots of productivity growth *vs* material off-shoring (Figure 3) and of productivity *vs* service off-shoring (Figure 4) substantiate this picture. In the next section we will examine in a more formal way whether off-shoring partially correlates to faster productivity growth in a multivariate framework.

3. The statistical evidence on the relation between off-shoring and productivity growth in Italy

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

3.1 Conceptual framework and empirical strategy

The production function framework The value-added-based production function for industry *i* is given by:

$$\ln(Y_i) = \ln(A_i) + \beta_K \ln(K_i) + \beta_L \ln(L_i) \qquad (1)$$

where value added Y (in logs) is a log-linear function of labor L, capital K and the efficiency parameter A. In turn, the efficiency parameter A (in log) depends linearly on an exogenous term (not modeled here) as well as on the off-shoring of intermediates (*osm*) and services (*oss*) - measured as discussed in the previous section above - as follows:

$$\ln(A_i) = \beta_A + \beta_m osm_i + \beta_s oss_i \qquad (2)$$

There are three main channels through which off-shoring may affect industry productivity. First, off-shoring may involve a static efficiency gain for firms, by their decision to outsource, they may relocate abroad fragments of production which would otherwise be less efficiently implemented within the industry inside the country. This is merely a *compositional effect* that raises the average productivity for the industry. Second, *off-shoring may trigger resource reallocation across firms and between firms*, in turn associated to efficiency gains for the industry. This is possibly of particular relevance for the off-shoring of service inputs, such as computing and information handling and processing activities, while it is probably less important for the off-shoring of materials. Third, and perhaps slightly more conjecturally, off-shoring may also originate in *dynamic efficiency gains*. 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 (1982) variety-of-intermediates effect. Having said so, it should be recalled that, with our industry data, we will be unable to distinguish between these various channels. Our intended goal here is to partial out illustrative correlation between our variables of interest.

Empirical specification To obtain an empirically usable equation for estimating the relation between off-shoring and labor productivity growth, we take the time variation of (1) and (2) and subtract the growth of the labor input on both sides.

To evaluate the productivity counterpart of 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,..22; 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 our variables of interest, the international outsourcing of intermediates and services.

In some specifications, we alternatively employ “imputed” TFP growth at the industry level 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, the most frequently used numerical proxy for the value added share of capital.

For robustness check purposes, in some specification, we also append other potential determinants of labor productivity growth such as the IT investment share over total non-residential investment and the GDP share of R&D spending.

To sum up, our baseline specification is as follows:

$$gLP_{it} = const + \gamma(gKL_{it}) + \beta_m \Delta(osm)_{it} + \beta_s \Delta(oss)_{it} + \sum \beta_t D_t + \sum \beta_i D_i + e_{it} \qquad (3)$$

We start estimating equation (3) for twenty-one manufacturing industries over 1995-2003 by OLS, with heteroskedasticity consistent standard errors. To keep OLS and IV estimates as comparable as possible, we use only seven time series observations. In this way, our sample always includes 147 observations, the product of twenty one (industries, our cross-sectional dimension) times seven (years, 1996-2003, our time series dimension).

A key estimation issue of equation (3) is the possible endogeneity of all 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 for capital services depends on TFP, which is partly captured by the error term in (3). This induces a correlation between the error term and one of the regressors which makes OLS estimates potentially biased.

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 firms may be more likely to engage in global diversification of production. Yet the reverse causation may also be negative. It may 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 cannot be easily a priori predicted. If the same set of firms engage 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 (two-stage least squares) estimation.

Instruments and identification 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. Amiti and Wei (2006) – drawing on the results in Freund and Weinhold (2002) - have employed the number of Internet users in the countries the United States imports most of its service inputs as instruments for service off-shoring. The instrument for material off-shoring in their paper is the freight cost of intermediate inputs.

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, the once-lagged changes in off-shoring rates, a set of industry and period fixed effects and two indicators of once-lagged IT investment shares over total investment in each industry (inclusive or exclusive of investment in communication equipment).

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 however, 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 so. Hence, the main maintained assumption of our IV estimates is that *period fixed effects enter our instrument list as included instruments while industry fixed effects belong to the list of the excluded instruments*. The other predetermined variables (the growth rate of capital-labor ratios and the changes in off-shoring rates) also belong to the list of excluded instruments for they are unlikely to be related to the residual. 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 of the endogenous regressor to evaluate their relevance.

3.2 Results

OLS results We start discussing the results from OLS estimation and then comment our IV estimates.

Table 4 presents the results of our baseline OLS estimates of equation (3) using the narrow indicator of intermediates off-shoring under various specifications. In column (1) and (4) of Table 4, the contemporaneous correlation between off-shoring indicators and labor productivity is looked at, without and with the industry fixed effects. Then, in column (2) and (5), we look at the correlation between once-lagged off-shoring and productivity growth, while both contemporaneous and lagged variables are simultaneously allowed for in the specifications whose results are reported in column (3) and (6).

The fit of each of the regression in Table 4 is usually good (between 55% and 70% of the total variance). The coefficient of the capital-labor ratio is always highly significant and positive, with values of the very precisely estimated coefficients ranging between .75 and .85. The off-shoring indicators are not always significant, however.

The most robust correlation is the one between lagged intermediates off-shoring and LP growth, which is positive and significant (sometimes weakly at the 10% level) in all cases, with point-wise estimates between .08 and .15 The contemporaneous correlation between intermediate off-shoring and LP growth is instead zero or even negative as in column (6). As far as services off-shoring is concerned, correlation is more often zero or even negative for contemporaneous off-shoring.

A notable generalization from this set of results is thus that lagged off-shoring is seemingly more positively (or less negatively) correlated with LP growth than contemporaneous off-shoring. Moreover, if one runs the test that the sum of the contemporaneous and lagged coefficients is equal to zero, the restriction is not rejected for both intermediates and services off-shoring.

This pattern of correlation is moreover broadly similar to the one obtained in Table 5 (see column (1)-(3)), where a broad indicator of off-shoring is employed instead of the narrow one.

Things change substantially, instead, when the – so far standard - Feenstra-Hanson (FH) measures of off-shoring are used instead. While the estimated coefficient for the capital-labor ratios remain highly significant and range between .80 and .95, the FH off-shoring variables appear to exhibit a markedly different pattern of significance compared to both narrow and broad measures of off-shoring. This is not too surprising keeping in mind the preliminary comparison between the DJ and FH indices carried out in the previous section. In any case, this strongly indicates the importance of directly measuring off-shoring as opposed to imputing import propensities as was done in most empirical studies so far. In a nutshell, FH indices are not significant at all leads and lags. Employing them instead of our DJ measures would lead to sharply different conclusions.

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 at a preliminary stage when TFP growth is computed, under the assumptions of constant returns to scale and perfectly competitive factor markets, as a residual from the growth of labor productivity after imputing the value of one third for the value added share of capital. Doing so, we obtain regressions results whose pattern of statistical significance stays is very similar to the ones in Table 4, except that lagged intermediates off-shoring is even more significantly positive and contemporaneous services off-shoring is more significantly negative. The size of the point-wise estimated coefficients is not very different, though.

Finally, at least for this part on the OLS estimation, we supplemented the regressor list with some other likely determinants of industry labor productivity growth, such as the shares of investment in information and communication technologies (we try both IT *and* ICT investment) over total non-residential investment for each industry. In Table 7, we restrict ourselves to report the results that extend those in Table 4, column 3 and 6. Other specifications simply replicate such results.

As made clear in column (3), the once-lagged IT investment share is significantly correlated with a positive sign of about .20 to labor productivity growth in the regression with both period and industry dummies. Yet this correlation is not there in other specifications, with contemporaneous IT investment or when ICT investment is employed as a proxy for investment in new technologies (see column (4)) or when industry dummies are omitted (see column (1) and (2)). IT investment is also insignificantly related to labor productivity growth in other specifications (not reported here) where IT investment is measured as a share of machinery investment. In column (5) and (6), in addition to the IT investment controls, we also appended another control to the regressor list, namely the twice-lagged GDP share of R&D spending. This variable is never significant. In any case, in Table 7, the significance of the off-shoring variables stays unchanged, irrespective of whichever control is appended.

IV 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, the regression findings from IV estimation are presented in Table 8. Here we run regression (3) with the list of instruments described in the previous sub-section and, more precisely, at the bottom of Table 8.

In all columns, there is a common excluded instrument list inclusive of a set of industry dummies, the once-lagged growth rate of the industry capital-labor ratios, the twice-lagged log-level of the capital-labor ratio and the once-lagged changes in the off-shoring shares of intermediates (narrow) and services (broad, necessarily). As discussed above, the - common to all regressions – list of the included instruments is made of period dummies only.

Each column differs in some respect from one another, though. Once-lagged IT investment shares are instruments in the list of the excluded instruments in column (1), (3), (5), (7) and (8), while ICT investment shares are in column (2), (4) and (6).

The specification in column (3) and (4) differs from the one underlying the results in column (1) and (2) in that, in column (3) and (4), lagged changes in off-shoring rates are dropped from the list of the instruments.

The specification in column (5)-(8) is the same as in (1)-(4) (one by one), except that the dependent variable in (5)-(8) is now imputed TFP growth rather than labor productivity growth.

Notably, the Shea partial R-squared tend to be rather high, while the p-values of the Hansen over-identification tests are all very far from the threshold value of .05. In a nutshell, there is no apparent sign of lack of validity or relevance of our chosen instruments. We thus tend to put a high level of confidence in our quantitative results.

The main results in Table 8 tend to again confirm the pattern of significance observed for the OLS estimates. First of all, the off-shoring of materials is always statistically significant (sometimes weakly) with point-wise estimates ranging between .15 and .30. The coefficient of services off-shoring is instead rather imprecisely measured. When its sign is precisely determined, it is negative (as in the OLS case) with a very high size (in absolute value).

Finally, we also checked that the results obtained here still apply for other indicators of off-shoring. It turns out that for the indirect FH measures of off-shoring the results are the same as in the OLS case (overall lack of significance). For the broad indicators of off-shoring, the IV estimates indicate that such off-shoring indicators correlate less precisely with both labor productivity and TFP growth, unlike in the OLS case.

4. Relations with the literature

Our two main econometric 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 or is even negatively related. In this section, we discuss how our results fit in the existing literature.

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. According to their results, however, service off-shoring would account for as much as 11-13% of the growth of labor productivity over that period of time (the golden age of the new economy), while material off-shoring, if significant, would account for at most a mere 5% of the overall increase of labor productivity. The question is 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. More research is needed to sort out this type of questions.

In the most comprehensive study to date, Egger and Egger (2006) analyze the consequences of material off-shoring on the productivity of low skilled workers in 12 European countries from 1993 to 1997. They find that, in spite of the short-run negative effects brought about by the product and labor market imperfections that plague the EU, material off-shoring still entails a positive long-run impact. According to their estimates, in 1993-97, the rise of international outsourcing contributed some 3.3% of the total increase in the productivity of unskilled labor. Their conclusions are however hard to evaluate both qualitatively and quantitatively for they are obtained through non linear methods of estimation that make the calculation of average correlation very sensitive to potential outliers and particularly hard to compare with ours.

Third, in their study on the first half of the 1990s, Gorg and Hanley (2003) also document a positive impact of service off-shoring on productivity in the Irish electronic industry. But a negative productivity effect would ensue when the analysis is extended to all Irish manufacturing industries over a longer time period. Hence, it should be pointed out that the statistically insignificant relation between the off-shoring of services and productivity growth has already been found for other European countries and industries. The proposed explanation 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 outsourcing variables 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) and 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,[8] which somehow weakens the adjustment cost explanation for the lack of correlation.

As to Italy, Lo Turco (2006) estimates the impact of material and services outsourcing on the productivity of Italian manufacturing industries in 1985-1997. Her results indicate that material outsourcing accounted for 15-18% of overall labor productivity growth of the entire period. Service off-shoring had different sector effects: positive for "traditional" and "other manufacturing" industries, negative in the most technologically advanced industries. The period of analysis in our research (1995-2003) only partly overlaps with the period under investigation in this other study (1985-97). It is therefore hard to disentangle the potential source of differences in ours and her results. 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. Yet the potential productivity gains of outsourcing activities within or outside the domestic borders go well beyond that and involve such diverse things as the contracting out of engineering and drafting as well as accounting, computer and janitorial services, which are not included in a narrow measure of off-shoring activities. This is what we did in our study here.

Finally, the lack of robustness or outright insignificance of IT investment is at odds with the results obtained by Stiroh (2003) for the US economy and van Ark, Inklaar and McGuckin (2004) for the EU economy. This result is instead consistent with the evidence provided by Daveri (2004), where it was shown that the mentioned results of van Ark, Inklaar and McGuckin on the importance of IT diffusion as determinants of productivity growth in Europe were heavily dependent on the classification criterion adopted to distinguish IT-using from non-IT-using industries.

5. Conclusions

In this paper, we were after two main goals. First we aimed to quantify the extent of international outsourcing in the Italian manufacturing sector using recently released supply-and-use input-output tables. Our second goal was to identify the productivity counterpart of our off-shoring indicators and compare our results with those obtained in previous studies.

Both OLS and IV estimates show a rather consistent pattern of correlation, indicating a more robust correlation between the off-shoring of intermediates and productivity variables, and a more noisy (or outright negative) relation between services off-shoring and productivity growth. The empirical

[8] Additional evidence broadly consistent with these findings is also available for the Netherlands, Denmark, and Austria. See Griffith, Huergo, Mairesse and Peters (2005), and Jensen, Ørberg, Kirkegaard, and Søndergaard Laugesen (2006).

estimates we regard as most plausible tend to show a clear pattern that we aim to further substantiate in future work for other European countries and data sets.

Finally, it also turns out that the results obtained from our indicator of outsourcing are quite different from those arising from the commonly used Feenstra-Hanson measures of off-shoring. This is – we believe- another useful contribution of our paper.

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

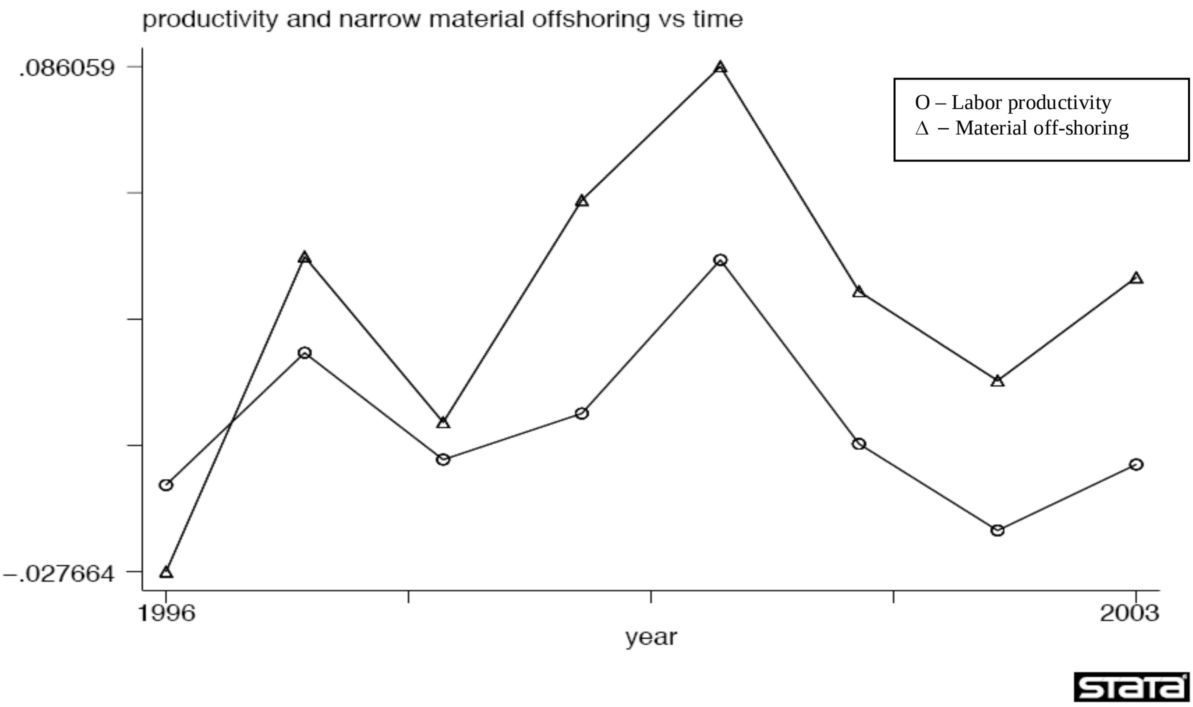

Figure2 – Labor productivity & service off-shoring

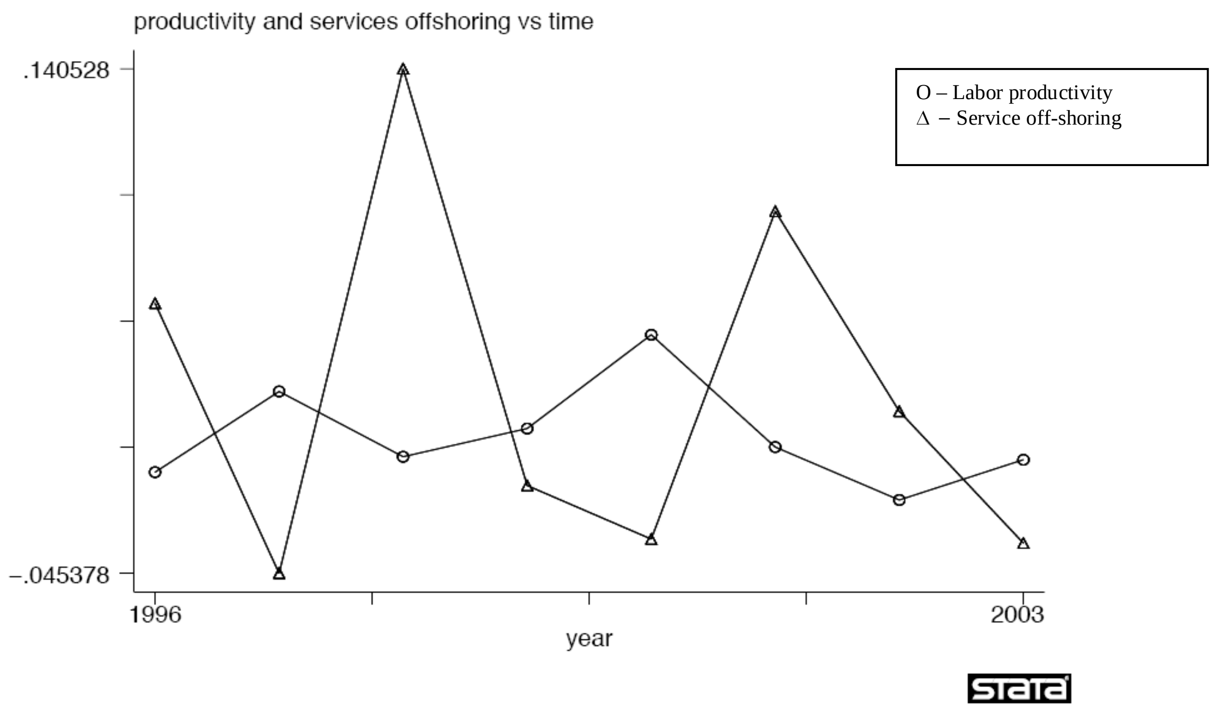

Figure 3 – Labor productivity vs narrow off-shoring of materials

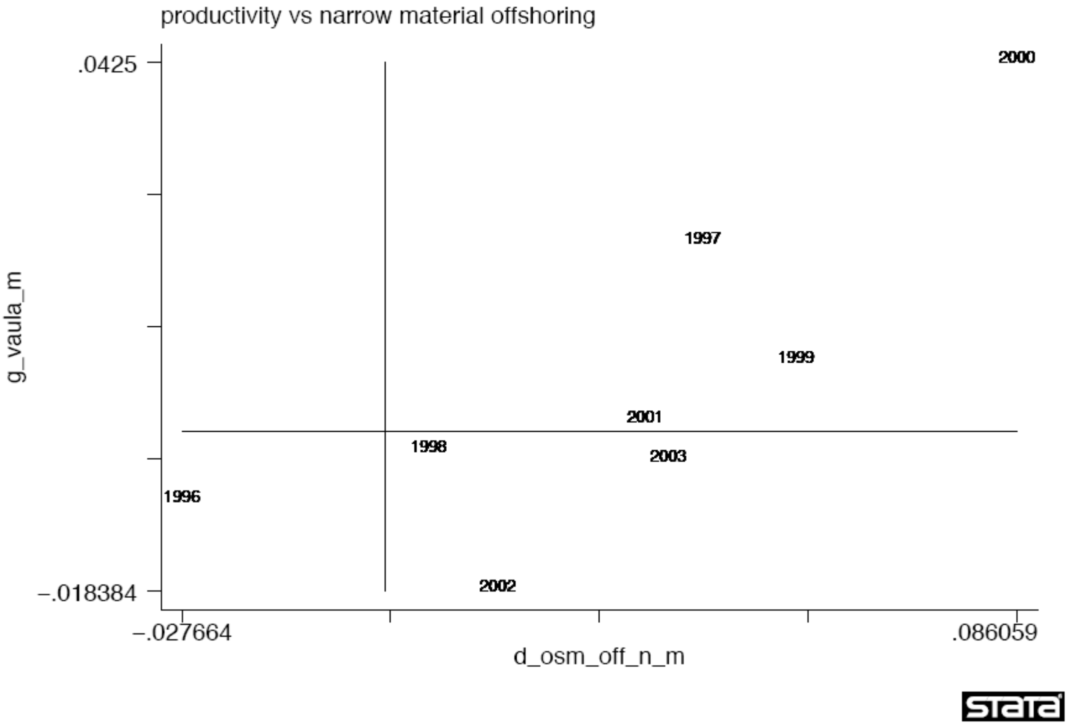

Figure 4 – Labor productivity vs service off-shoring

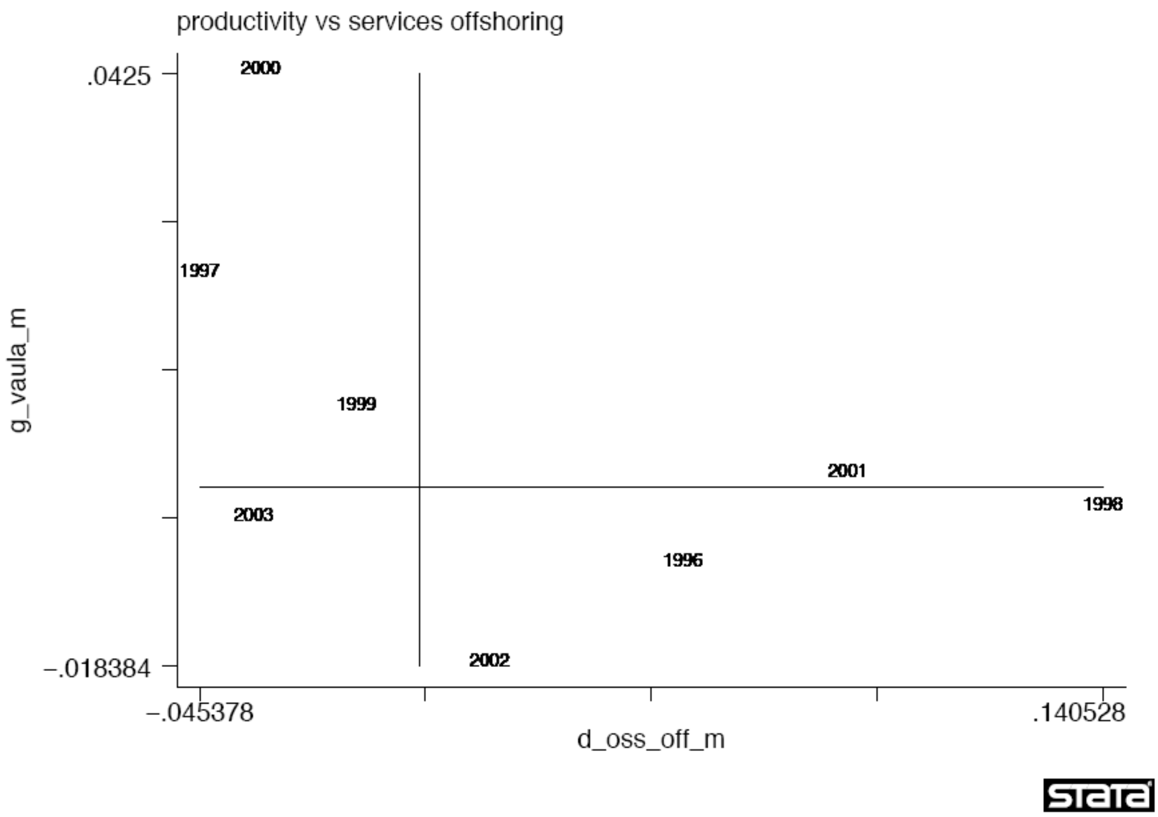

Table 1: Growth of labor productivity in Italy, 1970-2003, main industry groups					
	1970-80	**1980-95**	**1995-03**	1995-00	2000-03
Economy	**2.4**	**1.8**	**0.6**	1.1	-0.2
Agriculture	**3.1**	**4.3**	**2.7**	5.2	-1.5
Manufacturing	**2.8**	**3.0**	**0.2**	1.0	-1.0
-- non-durables	**2.7**	**3.1**	**0.3**	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 2: 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**	**∆(1995-03)**	**1995**	**2003**	**∆(1995-03)**	**1995**	**2003**	**∆(1995-03)**	**1995**	**2003**	**∆(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 instrs	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 ∆(95-03)**	**FH 95**	**FH 03**	**FH ∆(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 ∆(95-03)**	**FH 95**	**FH 03**	**FH ∆(95-03)**	**DJ 95**	**DJ 03**	**DJ ∆(95-03)**	**FH 95**	**FH 03**	**FH ∆(95-03)**
DJ 1995	1.00						1.00					
DJ 2003	0.92	1.00					0.97	1.00				
DJ ∆(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 ∆(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 3: Off-shoring of market services in the Italian manufacturing industries

	DJ - broad index			FH - broad index		
	1995	**2003**	**∆(1995-03)**	**1995**	**2003**	**∆(1995-03)**
Food products and beverages	0.4	0.5	0.1	2.3	1.1	-1.2
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	1.3	0.9	-0.4
Chemicals and pharmaceuticals	1.2	1.2	0.1	34.2	40.3	6.2
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 instr's	4.4	5.4	1.0	5.1	6.5	1.4
Motor vehicles, trailers and semi-trail's	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	0.2	0.2	0.0
Average manufacturing industry	**1.3**	**1.8**	**0.5**	**3.7**	**4.8**	**1.1**

Correlation matrices
Broad index, DJ vs. FH

	DJ 95	**DJ 03**	**DJ ∆(95-03)**	**FH 95**	**FH 03**	**FH ∆(95-03)**
DJ 1995	1.00					
DJ 2003	0.93	1.00				
DJ ∆(1995-03)	0.78		1.00			
FH 1995	0.14			1.00		
FH 2003		0.16		1.00	1.00	
FH ∆(1995-03)			0.29	0.85		1.00

Note: DJ=Daveri-Jona; FH=Feenstra-Hanson.

Source: own calculation from Istat (National accounts)

Table 4 - OLS estimates: Off-shoring and labor productivity growth

Dependent variable: yearly growth rate of value added per full-time equivalent employed (21 industries, 1995-03)

	[1]	[2]	[3]	[4]	[5]	[6]
Off-shoring indicator (materials=OSM; services=OSS)	Narrow OSM, Broad OSS	Narrow OSM, Broad OSS	Narrow OSM, Broad OSS	Narrow OSM, Broad OSS	Narrow OSM, Broad OSS	Narrow OSM, Broad OSS
Growth of K/L ratio	.79*** (.15)	.79*** (.08)	.74*** (.12)	.87*** (.16)	.73*** (.11)	.75*** (.12)
$\Delta(OSM)_t$	.00 (.05)	-	-.01 (.01)	-.08 (.05)	-	-.08** (.04)
$\Delta(OSM)_{t-1}$	-	.15*** (.05)	.12** (.05)	-	.11*** (.04)	.08** (.04)
$\Delta(OSS)_t$	-.26** (.12)	-	-.20* (.12)	-.16 (.14)	-	-.10 (.12)
$\Delta(OSS)_{t-1}$	-	.08 (.11)	.10 (.10)	-	.17 (.12)	.20 (.12)
Period dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	No	No	No	Yes	Yes	Yes
R-Squared	.57	.59	.63	.69	.70	.73
RMSE	.054	.052	.050	.050	.049	.046
# observations	147	147	147	147	147	147
# industries	21	21	21	21	21	21

Notes: Standard errors are heteroskedasticity consistent.

Table 5 - OLS estimates: alternative indicators of off-shoring						
Dependent variable: yearly growth rate of value added per full-time equivalent employed (21 industries, 1995-03)						
	[1]	[2]	[3]	[4]	[5]	[6]
Off-shoring indicator (materials=OSM; services=OSS)	Broad OSM, Broad OSS	Broad OSM, Broad OSS	Broad OSM, Broad OSS	Feenstra-Hanson (FH) narrow OSM, FH broad OSS	FH narrow OSM, FH broad OSS	FH broad OSM, FH broad OSS
Growth of K/L ratio	.78*** (.17)	.75*** (.11)	.68*** (.14)	.95*** (.14)	.82*** (.15)	.87*** (.16)
$\Delta(OSM)_t$	-.02 (.09)	-	.02 (.09)	.42 (.48)	-	.61 (.48)
$\Delta(OSM)_{t-1}$	-	.28*** (.10)	.23** (.11)	-	-.96 (.84)	-1.21 (.85)
$\Delta(OSS)_t$	-.22 (.13)	-	-.18 (.12)	-.63 (.56)	-	-1.06 (.75)
$\Delta(OSS)_{t-1}$	-	.14 (.12)	.14 (.12)	-	-.70 (.52)	-1.07* (.63)
Period dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared	.68	.71	.73	.64	.65	.66
RMSE	.051	.048	.047	.053	.053	.052
# observations	147	147	147	147	147	147
# industries	21	21	21	21	21	21

Notes: Standard errors are heteroskedasticity consistent.

Table 6 - OLS estimates: Off-shoring and "imputed TFP" growth						
Dependent variable: Total factor productivity (TFP) growth TFP computed as a residual. Imputed value added share of capital: 1/3 for all industries and all periods (21 industries, 1995-03)						
	[1]	[2]	[3]	[4]	[5]	[6]
Off-shoring indicator (materials=OSM; services=OSS)	Narrow OSM, Broad OSS	Narrow OSM, Broad OSS	Narrow OSM, Broad OSS	Narrow OSM, Broad OSS	Narrow OSM, Broad OSS	Narrow OSM, Broad OSS
$\Delta(OSM)_t$	.10 (.09)	-	.05 (.06)	.01 (.06)	-	-.01 (.05)
$\Delta(OSM)_{t-1}$	-	.22*** (.07)	.16*** (.06)	-	.17*** (.06)	.12** (.05)
$\Delta(OSS)_t$	-.44*** (.11)	-	-.31*** (.10)	-.35*** (.13)	-	-.22* (.12)
$\Delta(OSS)_{t-1}$	-	.11 (.13)	.12 (.11)	-	.21 (.13)	.21 (.14)
Period dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	No	No	No	Yes	Yes	Yes
R-Squared	.29	.33	.43	.47	.52	.58
RMSE	.059	.058	.054	.055	.052	.050
# observations	147	147	147	147	147	147
# industries	21	21	21	21	21	21

Notes: Standard errors are heteroskedasticity consistent.

Table 7 - OLS estimates: Off-shoring and labor productivity growth, with additional controls						
Dependent variable: yearly growth rate of value added per full-time equivalent employed (21 industries, 1995-03)						
Off-shoring indicators: Narrow OSM, Broad OSS	[1]	[2]	[3]	[4]	[5]	[6]
Added controls	IT investment / total non-residential investment	ICT investment / total non-residential investment	IT investment / total non-residential investment	ICT investment / total non-residential investment	1. IT investment / total non-residential investment 2. R&D spending/ GDP	1. ICT investment / total non-residential investment 2. R&D spending/ GDP
Growth of K/L ratio	.74*** (.12)	.76*** (.12)	.76*** (.11)	.72*** (.11)	.75*** (.11)	.71*** (.12)
$\Delta(OSM)_t$	-.01 (.01)	-.02 (.05)	-.07* (.04)	-.07 (.05)	-.07* (.04)	-.07 (.05)
$\Delta(OSM)_{t-1}$	.12** (.05)	.12** (.05)	.08** (.04)	.08** (.04)	.08** (.04)	.08** (.04)
$\Delta(OSS)_t$	-.20* (.12)	-.18 (.13)	-.13 (.12)	-.12 (.12)	-.12 (.12)	-.12 (.12)
$\Delta(OSS)_{t-1}$	.10 (.10)	.12 (.10)	.20* (.11)	.19 (.13)	.20* (.11)	.20 (.12)
$(IT/total\ INV)_{t-1}$	-.01 (.04)	-	.20*** (.07)	-	.19*** (.07)	-
$(ICT/total\ INV)_{t-1}$	-	-.04 (.04)	-	.11 (.11)	-	.12 (.11)
$(R\&D\ spending/GDP)_{t-2}$	-	-	-	-	-.01 (.01)	-.01 (.01)
Period dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	No	No	Yes	Yes	Yes	Yes
R-Squared	.63	.63	.75	.73	.75	.74
RMSE	.051	.050	.045	.046	.045	.046
# observations	147	147	147	147	147	147
# industries	21	21	21	21	21	21

Notes: Standard errors are heteroskedasticity consistent.

Table 8 - IV (2SLS) estimates: Off-shoring and productivity growth								
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Dependent variable	LP	LP	LP	LP	TFP	TFP	TFP	TFP
Off-shoring indicator (materials=Osm; services=Oss)	Narrow Osm, Broad Oss	Narrow Osm, Broad Oss	Narrow Osm, Broad Oss	Narrow Osm, Broad Oss	Narrow Osm, Broad Oss	Narrow Osm, Broad Oss	Narrow Osm, Broad Oss	Narrow Osm, Broad Oss
Instrument list ("Basic" list defined in the footnote below)	Basic + IT	Basic + ICT	Basic + IT – lagged offshoring	Basic + ICT – lagged offshoring	Basic + IT	Basic + ICT	Basic + IT – lagged offshoring	Basic + ICT – lagged offshoring
Growth of K/L ratio	.94*** (.20)	.88*** (.26)	.62*** (.18)	.75*** (.20)	-	-	-	-
Δ(offshoring of materials)	.16* (.10)	.18* (.11)	.24** (.11)	.21** (.11)	.28** (.12)	.30*** (.11)	.30*** (.12)	.32*** (.11)
Δ(offshoring of services)	-.33 (.22)	-.59* (.32)	-.23 (.20)	-.42 (.27)	-.62*** (.18)	-.58*** (.17)	-.32 (.21)	-.28 (.21)
R-Squared	.48	.44	.41	.47	.16	.14	.06	.00
RMSE	.057	.060	.061	.058	.063	.063	.066	.068
# observations	147	147	147	147	147	147	147	147
Shea partial R-Squared for first-stage regressions of endogenous regressors								
- growth of K/L ratio	.32	.35	.24	.29	-	-	-	-
- Δ(materials off-shoring)	.30	.31	.23	.24	.31	.30	.27	.27
- Δ(services off-shoring)	.27	.21	.26	.16	.32	.33	.25	.26
Hansen over-identification test								
Chi-sq(27): p-value	.39	.41	.42	.56	.43	.74	.53	.64

Notes
- Dependent variable: growth rate of labor productivity (LP; column [1]-[4]) and "imputed total factor productivity" (TFP; column [5]-[8])
- The "basic" instrument list includes industry fixed effects, growth of K/L at (t-1), log-level of K/L at (t-2) and the lagged values of Δ(offshoring) of intermediates and services as excluded instruments and period fixed effects as included instruments.
- The "basic" list of instruments is supplemented by either "IT" or "ICT" investment shares. "IT" is the share of hardware and software investment in each industry over total non-residential investment in the same industry. "ICT" is the share of hardware, software and communication equipment investment in each industry over total non-residential investment in the same industry.
- The results in column [3], [4], [7] and [8] are obtained dropping the lagged values of Δ(offshoring) of intermediates and services of the instrument list.
- The reported value of the R-squared for the IV regressions refers to the regression second stage
- Standard errors are heteroskedasticity consistent.