Production offshoring and the skill composition of Italian manufacturing firms: a non-parametric analysis

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Abstract

This work explores the effects of production offshoring on the workforce skill composition of manufacturing firms. Its aim is to assess if the firms' strategy to offshore production determines a domestic employment bias in favor of high-skilled workers. Using three repeated cross-sections of firm-level data over the period 1995-2003, we test the effect of production offshoring on the skill composition by looking at different measures of skills by occupational title and by employing a quasi-experimental analysis based on propensity score matching. Our results point to a modest, and in some cases down-skilling, impact of offshoring on the skill composition of Italian manufacturing: in particular, we find that firms that farmed out production activities in 1998-2000 generally employ a lower share of skilled, non manual, workers with respect to the counterfactual of non-delocalizing firms. Despite the usual findings about the negative impact of international delocalization on low-skilled employment, we find that middle-managers are the most affected category. Such evidence may find a twofold explanation: on the one hand, skilled workers can decline more than unskilled workers because of a substitution effect that is driven by the will of reducing not only redundant activities, but also to outsource complementary skill-intensive activities such as control and coordination for which middle-managers are employed for. On the other hand, skilled workers may decline in absolute terms, because of a quantity effect that occurs when firms decide to transfer managerial staff in order to coordinate and supervise the activities shifted abroad.

Keywords: production offshoring, skill composition, propensity score matching
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1. Introduction

During the last three decades the way goods are manufactured has dramatically changed. Next to an extensive use of IT capital, imported materials, intermediate services and skilled labor, an increasing replacement of low-skill employment is occurring due to the fact that firms de-locate low-skill intensive activities towards less developed, cheap labor, countries. Trade flows, import competition and foreign direct investments (FDI), thus, result in a reorganization of production through which home firms can specialize on the high-value-added phases of production while economizing on production costs.

The international relocation of production and service activities has received a lot of attention in recent times, and often in relation of the increasing fear of domestic job losses, particularly concerning blue collars and low-skilled personnel. Traditionally, two main explanations have been given to account for the shift in demand away from low-skilled workers in industrialized countries.

The first refers to non-neutral technological change that, by fostering the demand for more qualified workers within technologically advanced industries, tends either to increase the wage inequality in relatively flexible labor markets (like in the US and UK) or to increase the relative unemployment of less qualified workers in relatively more rigid ones (as in Germany, France, Denmark and Italy)[3]

The second claims for increased international trade and globalization, according to which labor is relocated in a way that determines a shift of activities involving unskilled workers toward less-developed countries, while keeping high skill-intensive activities at home, thus increasing the domestic firms' comparative advantage in the production of high-value added goods.

However, recent international evidence (Mann, 2003; Brainard and Litan, 2004; Amiti and Wei, 2005) has also shown that the increasing digitization and globalization of production are enabling firms not only to offshore to low wage countries pure manufacturing stages, but also services like software programming, medical diagnosis, lab research, product development and analytical activities,

3 For a review of theoretical and empirical models of skill-biased technological change see Chennels and Van Reenen (2002), Piva (2004) and Antonietti (2007).

thus creating the conditions for the transfer of IT, knowledge-intensive, jobs and workers.

Therefore, it is worth to distinguish between two strategies of international delocalization of production: one characterized by a vertical, or *defensive*, nature and one by a horizontal, or *asset seeking*, nature. While the former is designed to save on production costs through the relocation of low value activities towards cheap-labor countries, the latter is, instead, driven by the will to search for new market opportunities or specific competencies not directly available at home. The employment effects deriving from these two strategies may be different: while, on the one hand, there is wide consensus on the skill upgrading effect of vertical delocalization, less evident are the consequences on the demand for skilled labor in the home country: if it is true that a higher demand may arise because of the need for control, coordination and supervisory skills, it is also true that a higher outflow of skilled personnel may occur if these competences are required directly at the host country or if the firm off-shores IT and knowledge-intensive activities previously developed at home.

On this purpose, Italy represents an interesting laboratory because the employment effects of production offshoring do not only affect the single firm, but also the economic context in which the firm is localized. In fact, the spatial division of production activities may generate not only a flow of technological knowledge, competencies and information outside local production systems, such as industrial districts or clusters of firms, but also an increase of uncertainty and a decrease in their attractiveness, thus leading to a possible future shortage of specialized personnel (Corò, Tattara and Volpe, 2006; Prota and Viesti, 2006; Spaventa and Monni, 2007).

Our contribution to the debate moves in two directions. First, differently from the main literature that is typically interested at analysing the strategies of multinational firms, we focus on a sample composed primarily by small and medium firms located in Italy. Second, we test the human capital impacts of production offshoring by setting up a quasi-experimental exercise based on propensity score matching, thanks to which we can compare the skill composition

of offshoring firms to a suitable counterfactual sample of non-offshoring firms, thus controlling for sample selection without relying on specific functional forms of the objective functions.

The article is structured as follow. Section 2 briefly sketches the empirical literature developed around skill-biased effects of production offshoring. Section 3 describes data and the empirical methodology adopted. Section 4 presents and discusses the main results achieved and Section 5 concludes.

2. Background literature

Even if it has often been considered a 'hot topic' for both international trade and labor economists, the impact of globalization and the international division of labor on the employment and wage rate of firms and countries involved is still ambiguous.

The question if the international relocation of production activities determines a change in the skill intensity of jobs is still unanswered, especially in Italy (Piva and Vivarelli, 2004): what seems clear is that such effect depends on the type of offshoring strategy adopted, the unit of analysis considered and the empirical methodology employed.

The literature on the skill composition effects of offshoring can be divided in two main lines of research, according to the perspective through which offshoring is conceived.

The first bulk of studies looks at offshoring as a foreign investment strategy of the firm, and, in this respect, distinguishes between vertical and horizontal FDI (Markusen *et al.,* 1996; Lipsey, 2002). The former is mainly driven by the will of exploiting the differences in factors endowments and prices and leads to a net decrease in domestic employment (Agarwal, 1997; Braconier and Ekholm, 2000; Mariotti, Mutinelli and Piscitello, 2003). The latter, instead, is driven by the will to replicate in foreign countries the whole production process of the home country, with the aim of getting access to new markets and global opportunities and with the effect of increasing the skill intensity of domestic jobs and employment (Markusen *et al.,* 1996; Blömstrom, Fors and Lipsey, 1997;

Mariotti, Mutinelli and Piscitello, 2003).

However, if the evidence generally agree on the total employment effects of FDI, less explored is the issue of the effect of FDI on the human capital composition of the workforce. In other words, does investing in cheap-labor countries lead to a skill upgrading at home?

Head and Ries (2002) try to answer this question by looking at Japanese multinationals in the period 1965-1990: their results point to a positive relationship between offshoring and the demand for skilled labor only if the former turns towards developing countries and only when the unit of analysis is the single firm. Similarly, Hansson (2004) finds that the production delocalization towards less developed countries contributes to the general increase in the average level of qualification within Swedish multinationals. For Italy, Barba Navaretti and Castellani (2004) and Castellani, Mariotti and Piscitello (2006) find a skill upgrading effect of foreign investments by multinationals primarily due to the international relocation of low value-added segments of the production process that lead to a lower demand for low-skill labor at home.

In contrast with these results, Slaughter (2000), looking at 32 US manufacturing industries in the 1980s, does not show clear results in favour of the positive relationship between FDI and the employment of skilled workers at home.

Another group of studies, instead, focuses on the trade dimension of offshoring and consider it as a strategy of international fragmentation of the production process. According to Jones and Kierzkowski (2001), international fragmentation can be thought as a process of splitting up and spread of previously integrated stages of production over an international network of production sites. More specifically, production offshoring refers to the de-localization of manufacturing activities towards a low-cost country or region[4]. To the extent that this practice determines a reorganization of the production process, it implies a labor recomposition within domestic firms.

4 Alternatively, the *Oxford English Dictionary* defines offshoring as the action or practice of moving or basing a business operation abroad, usually to take advantage of lower costs (http://dictionary.oed.com/).

The evidence available from international trade literature provides general support for the skill-biased nature of production relocation. Wood (1994), for instance, calculates that import competition determines a reduction in the demand for unskilled labor by 30% in 1990. On the same line are Sachs and Shatz (1994), who conclude that production internationalization exerts a double effect on overall labor composition: it is not only the cause of a general decrease in manufacturing but, together with technological change, is a determinant of the decline in the relative demand for low-skilled workers. Moreover, Feenstra and Hanson (1996) give some evidence that, for the period 1972-1990, international outsourcing is responsible of a 30% to 50% rise in the demand for skilled workers, and, thus, for a rise in income inequality.

For the UK, Anderton and Brenton (1999) estimate that, between 1970 and 1986, imports from low-wage countries determine a negative impact of about 40% on the wage-bill share and relative employment of low-skilled workers. This result is further reinforced by Hijzen *et al.* (2004), who show that, between 1982 and 1996, international outsourcing has a strong negative impact on the demand for semi-skilled and unskilled labor.

For France, Strauss-Khan (2003), using input-output tables and labor data, finds that the highly increasing vertical specialization, i.e. the share of imported inputs in production, is the main determinant of the sharp decline in the share of unskilled workers between 1977 and 1993, passed from -15% in the period 1977-85 to -25% between 1985 and 1993.

For Austria, instead, a positive and significant effect on skills comes out only for proxies of international trade like export openness and outsourcing, while a negative effect arises when considering import penetration (Dell'mour *et al.*, 2000).

For what concerns Italy, the scanty evidence seems to support the positive relationship between skills and offshoring. Helg and Tajoli (2005) compare the effect of international fragmentation of production on the skill ratio in Italy and in Germany and show that a positive and significant impact emerges only for the

former, while for the latter a negative effect seems to prevail[5].

Concluding, the most recent literature on skill-bias international fragmentation of production seems to generally stress the negative impact of production offshoring on the employment and pay of unskilled relative to skilled workers. However, what also emerges is that country specific effects, different measurement and econometric techniques matter in explaining these effects. Indeed, whether international delocalization is a sufficiently large phenomenon in order to account for any economically significant skill-bias effects is, therefore, an empirical matter.

3. Methodology and data

Empirical studies testing for the skill-biased international trade are generally based on the estimation of labour demand equations, typically in a transcendental logarithmic form (Christensen *et al.*, 1973; Berman *et al.*, 1994).

However useful, this approach suffers some limitations. First of all, it relies on a simple cost or production function framework, which is subject to a set of *ad hoc* restrictions in order to assure its tractability: optimization restriction, homogeneity assumptions and the specific parametric form that constraints the parameters to assume specific values. Second, limited information is usually provided on labour composition and firms characteristics, these latter being particularly important if one believes that firms endogenously choose to invest abroad by looking at previous experience and at the composition of its internal assets. Thus, a possible problem of sample selection may arise, according to which the set of firms which decide to transfer production stages abroad cannot be thought as randomly drawn from the population.

Our contribution to the debate is to bypass these issues by employing a semi-parametric approach based on PSM (Rosenbaum and Rubin, 1983) developed within the evaluation literature in a context of observational data

5 Similar results for the German case emerge also in Fitzenberger (1999) and Falk and Koebel (2000), who find no evidence that international outsourcing of production and services positively affect the skill composition of manufacturing workforce. Rather, Fitzenberger leaves technology the dominant role in shifting away the employment of unskilled workers.

(Angrist, Imbens and Rubin, 1996; Heckman, 1990, 1997; Heckman, Hichimura and Todd, 1997; Heckman, LaLonde and Smith, 1999; Sianesi, 2004; Wooldridge 2001; Smith and Todd, 2005). On this purpose, PSM is a more flexible technique with respect to standard labour demand estimation, because it does not force the imposition of a parametric specification and it allows to handle the selection bias along with the problem of (time-invariant) unobserved heterogeneity when the outcome variable is appropriately constructed by exploiting the repeated cross section structure of the data.

Next to this, PSM is particularly helpful in order to draw some conclusions on the skill composition effects occurring within offshoring firms, since it allows the comparison with a suitable counterfactual sample of firms that, in the same period and with the same attributes, have not delocalized production. The association to Psm of a difference-in-differences estimation, in particular, allows also to control for any possible unobserved selection bias arising when only a certain type of firm chooses to offshore production (Calinedo and Hujer, 2005; Smith and Todd, 2005).

Operationally, the Difference-In-Differences-Propensity Score Matching (DID-PSM henceforth) approach consists in a two step procedure. For our purpose, we estimate, at first, the probability of being an offshoring firm (the propensity score) conditional on the vector of firm characteristics X. These latter are supposed not only to affect the firm's decision to offshore production, but also to have an influence on the dependent variable, i.e. the skill composition of the labor-force. In this respect, we consider a set of controls on firm's geographical location, sector[6] of economic activity, size, age and the belonging to a group.

Following the empirical literature on the determinants of offshoring (Abraham and Taylor, 1996; Girma and Görg, 2004; Barba Navaretti, Castellani and Disdier, 2006) we also include variables capturing firm's previous delocalization activity - represented by a FDI dummy at time t-1[7] - firm's

6 We use the Pavitt taxonomy instead of a standard ATECO classification of economic sectors in order to avoid the possibility of perfect identification of the sample during the estimation.

7 Since the 1995-97 Survey questionnaire does not include a direct question on international delocalization, we use the dummy on FDI as a proxy.

technology - given by a R&D dummy - labor cost per employee, firm's average productivity and capital intensity. Finally we include a variable of financial profitability represented by returns on investments (for a description of the variables see Table A1 in the Appendix).

At the second stage, we use the propensity score obtained to estimate the average treatment effect on the treated (ATT). In our case the outcome variables are the DID (in levels) of the skill ratios of the workforce and the DID (in levels) of each occupational categories (top managers, middle managers, clerks and manual workers, see Table A2 in the Appendix) on total firm employment.

In the first stage, the estimation of the probabilities is obtained through a probit regression, which gives as coefficients the estimated probabilities of cross-border offshoring. The fitted values of the binary model are then used in order to correctly align the units on their common characteristics and the mean comparison in the second stage is performed on the counterfactual units so aligned, that is on the units lying over the common support.

At this stage, a first issue we need to address is the balancing property of the propensity score. In order to test for it, we implement the procedure developed by Becker and Ichino (2002), according to which, if the balancing property is satisfied, the exposure to treatment can be thought to be random[8].

In the second stage of the estimation we apply the DID-PSM, in which we decide to adopt (i) the nearest neighbour (NN) algorithm (Dehejia and Wahba, 1999), and (ii) a caliper, or radius, estimator (CM) (Cochran and Rubin, 1973). Since NN matching pairs each treated firm to one counterfactual firm, the closest neighbour of the treated unit, it likely minimizes the bias at the expenses of the efficiency. Usually a trade-off between variance and bias arises when applying one or the other of the available algorithms for the matching estimation. In our case, in order to reduce the loss in efficiency that NN bears on, we use an oversampling version of NN and one with caliper (replacement) of the NN. In so doing we allow the comparison of each treated unit to more than a single closest counterfactual unit (Smith and Todd 2005; Caliendo, Hujer and Thomsen 2005).

8 See Becker and Ichino (2002) for a detailed description of the procedure for testing the balancing property.

In summary, the main aim of the DID-PSM score matching method is to generate a set of non-offshoring firms among all those that do not relocate production and being as more similar as possible to the treated (offshoring) firms in order to get a proxy of what would have happened to domestic skill composition within offshoring firms provided that they had not chosen to displace activities outside national borders.

3.4. Data

We test these predictions on a sample of Italian manufacturing firms drawn from the last three waves (VII, VIII and IX) of the Survey on Manufacturing Firms (*Indagine sulle Imprese Manifatturiere*) conducted by Capitalia (ex Mediocredito Centrale) and covering the period 1995-2003. For the three surveys, interviews have been respectively conducted in 1998, 2001 and 2004 over all firms with more than 500 employees and over a representative sample of firms with more than 11 and less than 500 employees, stratified by geographical area, sector of economic activity and size. In our analysis we use a repeated cross-section of firms appearing in all three waves, 1995-97, 1998-2000 and 2001-03. Each of the three waves gather information on 4.497, 4.680 and 4.289 units respectively, while the number of observations we obtain from merging the three cross-sections is 414.

As it can be noted in the Table 1, the major part of the observations in our restricted sample is constituted by small and medium small firms (74,5%). Supplier dominated and specialized suppliers firms represent the only sectors out of four having experienced production offshoring[9], so that firms belonging to scale intensive and science-based sectors have been dropped in order to avoid the generation of bad matches[10]. After this additional cleaning, the number of units decreases to 330.

9 This is in line, for instance, with Capitalia (2001) and Fortis (2005), who find that the most involved sectors in offshoring practices are textile and clothing, leather and shoes and machinery.
10 We replicate the same estimations for the whole matched sample of 414 firms without reaching significantly different outcomes. In the paper we only show the results concerning the restricted sample; full-matched sample estimations are available on request.

Table 1. Sample structure by economic sector and employment size

Size	Supplier Dominated	Specialized Suppliers	Total
11-20	30	11	41
21-50	68	52	120
51-250	72	54	126
251-500	15	10	25
501+	9	9	18
Total	**194**	**136**	**330**

Source: authors' elaborations from the Survey of Manufacturing Firms, 1995-2003.

Table 2 shows that only 16 (about 5%) of the 330 firms have chosen to offshore production. Such a figure, however, overestimates the percentage of offshoring firms in the complete Capitalia sample coming from the VIII wave of the Survey on Manufacturing Firms, which is equal to the 1.9% of the entire sample (Capitalia, 2001). Another important aspects that should be stressed is that, differently from to the original 1998-2000 cross-section – in which the share of offshoring firms progresses along with their employment size - in our merged sample small and medium firms show a higher propensity to delocalize than large firms. Even if this can represent a bias of representativeness, it should be noted that our cleaning procedure allows to replicate a quasi-experiment in which we 'isolate' only firms that are present in each wave of the Survey, located in the most active environments (sectors) with respect to the 'treatment' of interest and maintaining the general employment size distribution with respect to the original cross-sections.

Table 2. Production offshoring by Pavitt sector and employment size

Offshoring	**Num. Obs.**			**Frequency**		
No	314			95.15		
Yes	16			4.85		
Total	330			100.00		
Offshoring	**Supplier Dominated**			**Specialized Suppliers**		**Total**
No	185			129		314
Yes	9			7		16
Total	194			136		330
Offshoring	**11-20**	**21-50**	**51-250**	**251-500**	**501+**	**Total**
No	39	114	122	22	17	314
Yes	2	6	4	3	1	16
Total	41	120	126	25	18	**330**

Source: authors' elaborations from the Survey of Manufacturing Firms, 1995-2003.

4. Estimation and results

Some first interesting observations can be drawn by looking at the trend of the variables used to construct the outcomes of the DID-PSM in the time span 1995-2003. Figures A1-A2 in the Appendix show the trends of the employment composition by skill ratios and occupational categories for firms lying on the common support. As far as the skill ratios are concerned, the ratio between non-manual (managers, middle-managers and clerks) and manual workers (blue-collars) does not show any relevant difference over the time span considered (1995-2003) because both components seem to follow a very similar trend.

When we disaggregate the skill ratio by its occupational components, the evidence about the trends becomes more heterogeneous. When we look at the ratio between the total management (top and middle) and blue collars (manuals), we note an upskilling trend for treated units in front of a quite stable path for untreated ones, thus leading to positive skill differentials between 2001-03 and 1998-2000 as well as 1998-2000 and 1995-97, but probably a small differential between the first and the last triennium. When we focus on middle management over blue collars, instead, a negative differential emerges due to the quite oscillatory trend of the skill ratios for offshoring firms in front of a quite stable, even increasing, trend for non-offshoring firms. When we finally include clerks at the denominator, the figures show a general higher profile in the relative employment of skilled workers for treated units[11].

In order to have a clear picture, we also look at the trend of each single occupational category. While clerks and manuals do not show relevant difference in the trends between treated and untreated firms, the employment of top and middle-managers seems to show quite abrupt shifts.

Before proceeding with the comments of the main results of DID-PSM it is convenient to spend some words on the determination of the propensity score and the presence of firms on common support.

As stated above, the procedure adopted to test for the balancing property

11 To this results contributes quite heavily the number of firms in the two groups on the common support: 16 at maximum for delocalizing firms; 104 for non delocalizing firms.

of the propensity score is the one developed by Becker and Ichino (2002). After having estimated the probability of offshoring production stages, we (Tables A3.1-A3.3): "*split the sample in k equally spaced intervals of the propensity score* […]*; within each interval test that the average propensity score of treated and control units do not differ; if the test fails in one interval, split the interval in halves and test again [and] continue until, in all intervals, the average propensity score of treated and control units do not differ; within each interval, test that the means of each characteristic do not differ between treated and control units*" Becker and Ichino (2002, p. 3). In our case, the balancing property is satisfied[12].

As far as the distribution of the firms on the common support is concerned, Figure A3 and Table A3.3 show that two offshoring firms do not lie on the overlapping support. This means that, in the matching estimation, two treated units do not have appropriate counterfactual units and they cannot be considered for the comparison procedure.

Tables 3 to 5 present the main results achieved from the propensity score matching estimation. The outcome from the first stage is, instead, listed in the Appendix (Tables A3.1, A3.2 and A3.3).

In order to account for the heterogeneous composition of the labor force, we define different skill variables and we estimate the impact of our 'treatment', i.e. offshoring, on their variation over time. We first start with the most aggregate indicator, that is the ratio between non-manual and manual workers, the former including high skilled occupations such as top and middle managers and clerks, while the latter comprising low-skilled occupations as production workers (blue-collars).

Both NN propensity score with oversampling and NN with caliper, which works in the same direction as allowing for replacement in terms of trading between bias and variance, show that the effect of production offshoring on the ATT is always negative but not significantly different from zero. This means that firms choosing to externalize production do not seem to face any particular aggregate skill re-composition dynamics over the sample period.

12 The output of the Becker and Ichino (2002) module is not fully reported but it is available upon request.

In order to shed more light on this result, we further disaggregate the previous variable in order to analyse the dynamics of each single skill category for the treated and the untreated observations. On this purpose, we identify other four skill variables, whose difference-in-differences constructions are reported in Table A.2: top and middle managers over blue-collars; middle managers over blue-collars; top and middle managers over clerks plus blue-collars; middle-managers over clerks plus blue-collars.

Table 3 shows again the results for the first two of these variables. In particular, when looking at the effect of production offshoring on *DID_TM+MM/Man* we still note a negative but not significant outcome. The outcome changes when we look at the second skill variable, i.e. *DID_MM/Man*, in which, at the numerator, we identify the probably most skilled component of the workforce. When we allow the propensity score to use the same non-treated observations more than once and we increase the maximal allowed difference in the propensity score of treated and matched control units, or when we pass to a CM estimation, we find a negative – even if of a modest entity - and statistically significant result. This means that offshoring firms face a decrease in the employment of skilled personnel, relative to the unskilled.

Very similar results seem to emerge from Table 4, when we simply add clerks at the denominator of both skill ratios. Again, offshoring does not seem to particularly affect the difference over time of (*DID_TM+MM/C+Man*), i.e. skilled non-manual over unskilled, both manual and non-manual). A significant and negative effect, even if of small magnitude, emerges when looking at the ratio between (skilled) middle managers and (unskilled) blue collars plus clerks. Manufacturing firms exposed to the offshoring treatment are more likely to suffer a deskilling re-composition of their workforce over time.

We finally consider the dynamics of each single skill-occupational category. In this case we observe the difference in the relative employment of top managers, middle manages, clerks and blue-collars for the treated and the control units. In line with previous results, Table 4 and Table 5 show that the most significant effect – even if small - of production relocation is on the relative

employment of middle-managers, still with a negative sign.

We can interpret these results in different ways. On the one hand, differently from previous empirical literature on Italy, the defensive nature of the offshoring strategy may be a vehicle of a 'substitution effect' that sometimes can be detrimental for the most skilled component of the workforce. In other words, the fact of de-locating production activities to cheap-labor countries may reduce the overall scale of the domestic activity, thus reducing more significantly, or more intensively, the demand for those skills - like coordination, control, design and so on – in which middle-managers are specialized, with respect to a decrease in the demand for manual skills, at least in the short run.

A second, possible explanation, concerns the fact that the cost-driven strategy of production relocation may hide a strategy of new markets seeking, or of replication of the domestic production and business model[13], then involving the more or less temporary transfer of managerial staff to the host country. This result can be in line with some recent evidence, according to which Italian firms that offshore production activities to cheap-labor countries are like to move part of their managerial skills because of the need to coordinate and manage new, external units of production directly in the place of destination where such skills lack (Mariotti and Mutinelli, 2005; Spaventa and Monni, 2007).

However, the picture emerging from this exercise should be taken with caution. Our data, in fact, suffer some limitations: first of all, the number of offshoring firms is quite low, so that the analysis should be compared to an experiment and our results should be thought as the expression of 'symptoms' more than of real 'pathologies'. Second, we restricted our sample to traditional and specialized suppliers sectors, with the consequence of loosing some representativeness of the firms' entire population and reducing the field of application of our results. Finally, we consider a relatively short period of time, i.e. three years after the treatment, in which, probably, the real labor market effects of production offshoring are not fully emerged and consolidated.

13 We can think, for instance, at small and medium firms located in Veneto that have somehow replicated the industrial district model in countries like Slovakia and Romania.

Table 3. The skill composition effects of production offshoring in Italy, 1995-2003

	Outcome Variables								
	DID_NMan/Man			DID_TM+MM/Man			DID_MM/Man		
Algorithm	**Effect**	**st. err.**	**Firms out of the common support**	**Effect**	**st. err.**	**Firms out of the common support**	**Effect**	**st. err.**	**Firms out of the common support**
Nearest neighbour with oversampling									
2	0.064	0.167	2	-0.023	0.041	2	-0.0	0.017	2
5	-0.066	0.153	2	-0.027	0.037	2	-0.020	0.020	2
10	-0.019	0.110	2	-0.015	0.033	2	-0.027	0.020	2
Nearest neighbour with replacement									
caliper 0.01	-0.020	0.184	2	-0.069***	0.034	2	-0.043	0.017	2
caliper 0.02	-0.005	0.194	2	-0.057**	0.070	2	-0.040***	0.019	2
caliper 0.05	0.033	0.197	2	-0.022	0.043	2	-0.038**	0.021	2

Note: the standard errors are computed by bootstrapping using 50 replications.

Table 4. The skill composition effects of production offshoring in Italy, 1995-2003

	Outcome Variables								
	DID_ TM+MM/C+Man			DID_MM/C+Man			TM/Employment		
Algorithm	**Effect**	**st. err.**	**Firms out of the common support**	**Effect**	**st. err.**	**Number of delocalizing firms off common support**	**Effect**	**st. err.**	**Firms out of the common support**
Nearest neighbour with oversampling									
2	-0.018	0.034	2	-0.024*	0.013	2	0.009	0.020	2
5	-0.016	0.030	2	-0.028**	0.013	2	0.013	0.020	2
10	-0.009	0.030	2	-0.025*	0.013	2	0.017	0.017	2
Nearest neighbour with replacement									
cal 0.01	-0.006	0.029	2	-0.04***	0.012	2	-0.014	0.017	2
cal 0.02	-0.045*	0.026	2	-0.032**	0.014	2	-0.007	0.016	2
cal 0.05	-0.016	0.032	2	-0.030**	0.015	2	-0.015	0.022	2

Table 5. The skill composition effects of production offshoring in Italy, 1995-2003

	Outcome Variables								
	MM/E			Clerks/E			Manuals/E		
Algorithm	**Effect**	**st. err.**	**Firms out of the common support**	**Effect**	**st. err.**	**Number of delocalizing firms off common support**	**Effect**	**st. err.**	**Firms out of the common support**
Nearest neighbour with oversampling									
2	-0.018*	0.010	2	0.022	0.058	2	0.029	0.086	2
5	-0.023**	0.010	2	0.003	0.040	2	0.013	0.051	2
10	-0.019**	0.010	2	-0.008	0.031	2	0.004	0.036	2
Nearest neighbour with replacement									
cal 0.01	-0.026**	0.013	2	0.016	0.058	2	-0.052	0.102	2
cal 0.02	-0.025**	0.010	2	0.019	0.055	2	-0.052	0.090	2
cal 0.05	-0.023**	0.010	2	0.017	0.063	2	-0.064	0.101	2

5. Conclusions

In this work we look at the existence of a skill composition effect of production offshoring on the Italian manufacturing workforce. In order to control for selection bias and unobserved heterogeneity we use a difference-in-differences propensity score estimator, that, although grounded on identification assumptions, is not based on a parametric specification of the relations of interests and does not rely on optimization restrictions.

The results achieved give the impression that the offshoring strategy of the Italian manufacturing firms does not exert an evident impact on the skill composition of the workforce. In line with previous results (Piva and Vivarelli, 2004), the strategy of production offshoring seems to have an overall modest effect on domestic occupational categories and on the skill intensity of jobs.

Where a significant effect emerges, however, middle-managers seem to be the most affected category, as expressed by the negative trend of their relative employment ratio.

This piece of evidence may find a twofold explanation. On the one hand, the trasfer of production stages may also involve the loss of those complementary, and more knowlege-intensive, activities – like control, supervision, design, coordination – for which high-skilled personnel are required. On the other hand, the initially defensive nature of delocalization can also hide a strategy of new markets seeking or horizontal replication of domestic activities, thus claiming for the transfer of managerial staff, like engineers, designers, production and project managers, to host countries in which they lack.

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Appendix

Table A1-Variable definitions and summary statistics

VARIABLE	DEFINITION	MEAN	STD. DEV.	MIN	MAX
Dependent variable of the first stage probit regression					
d_deloc00	Dummy delocalization	.048	.215	0	1
Control variables					
Lnage	Natural logarithm (2003-year of firm's set-up)	3.402	.572	1.945	7.602
nw	Liguria, Lombardia, Piemonte, Valle d'Aosta	.457	.498	0	1
ne	Emilia-Romagna, Friuli Venezia-Giulia, Trentino Alto-Adige, Veneto	.300	.458	0	1
cen	Abruzzo, Lazio, Marche, Molise, Toscana, Umbria	.160	.367	0	1
south	Basilicata, Calabria, Campania, Puglia, Sardegna, Sicilia	.081	.274	0	1
suppldom	Textiles, footwear, food and beverage, paper and printing, wood	.587	.492	0	1
specsupp	Machinery and equipment, office accounting and computer machinery, medical optical and precision instruments	.412	.492	0	1
lsize	Nat. log average employment size 1998-2000	4.147	1.097	2.335	8.542
group9507	= 1 if the firm belongs to a group at 31.12.1997; =0 otherwise	.227	.419	0	1
group9800	= 1 if the firm belongs to a group at 31.12.2000; =0 otherwise	.257	.437	0	1
Export and FDI					
d_fdi97	=1 if the firm has effected FDIs in R&D in 1995-97; =0 otherwise	.239	.427	0	1
Technology					
d_res97	=1 if the firm has invested in R&D in 1995-97; =0 otherwise	1.581	.494	0	1
d_res00	=1 if the firm has invested in R&D in 1998-2000; =0 otherwise	.496	.500	0	1
Unit labor costs					
lcla9597	Nat. log. labor costs per employee 1995-97	3.453	.620	1.873	5.617
lcla9800	Nat. log. labor costs per employee 1998-2000	3.297	.259	2.256	4.230
Productivity					
lfatta9597	Nat. log. sales per employee 1995-97	5.245	.760	3.536	7.395
lfatta9800	Nat. log sales per employee 1998-2000	3.444	.386	2.753	4.774
Capital intensity					
litna9597	Nat. log. net capital assets per employee 1995-97	3.411	1.009	-.366	5.826
litna9800	Nat. log. net capital assets per employee 1998-2000	3.315	.875	-.274	5.443

Profitability					
roi9597	Log Returns on investments 1995-1997	2.824	0.895	-1.111	5.775

Table A2. Outcome variables

Outcome variables construction	
DIDNonManuals/Manuals (**DID_NMan/Man**)	[(NonManuals/Manuals)$_{03}$-(NonManuals/Manuals)$_{00}$]- [(NonManuals/Manuals)$_{98}$-(NonManuals/Manuals)$_{95}$]
DIDTopMng+MidMng/ Manuals (**DID_TM+MM/Man**)	[(Managers+MidMans/Manual)$_{03}$-(Managers+MidMans/ Manuals) $_{00}$] – [(Managers+MidMans/Manuals)$_{98}$ - (Managers+MidMans/Manuals)$_{95}$]
DIDMidMng/Manuals (**DID_MM/Man**)	[(MidMans/Manuals)$_{03}$-(MidMans/Manuals)$_{00}$]- [(MidMans/Manuals)$_{98}$-(MidMans/Manuals)$_{95}$]
DIDTopMng+MidMng/ Clerks+Manuals (**DID_ TM+MM/C+Man**)	[(Managers+MidMans/ Clerks+Manuals)$_{03}$- (Managers+MidMans/ Clerks+Manuals) $_{00}$] - [(Managers+MidMans/ Clerks+Manuals)$_{98}$ - (Managers+MidMans/ Clerks+Manuals)$_{95}$]
DIDMidMng/Clerks+Manuals (**DID_MM/C+Man**)	[(MidMans/Clerks+Manuals)$_{03}$- (MidMans/Clerks+Manuals)$_{00}$]- [(MidMans/Clerks+Manuals)$_{98}$- (MidMans/Clerks+Manuals)$_{95}$]
DIDTopMng/TotalEmp (**DID_ TM/E**)	[(Managers/TotalEmployees)$_{03}$- (Managers/TotalEmployees) $_{00}$] - [(Managers/TotalEmployees)$_{98}$ - (Managers/TotalEmployees)$_{95}$]
DIDMidMng/TotalEmp (**DID_ MM/E**)	[(MidMans/TotalEmployees)$_{03}$- (MidMans/TotalEmployees) $_{00}$] -[(MidMans/TotalEmployees)$_{98}$ - (MidMans/TotalEmployees)$_{95}$]
DIDClerks/TotalEmp (**DID_ Clerks/E**)	[(Clerks/TotalEmployees)$_{03}$- (Clerks/TotalEmployees) $_{00}$] - [(Clerks/TotalEmployees)$_{98}$-(Clerks/TotalEmployees)$_{95}$]
DIDManuals/TotalEmp (**DID_ Man/E**)	[(Manuals/TotalEmployees)$_{03}$- (Manuals/TotalEmployees) $_{00}$] - [(Manuals/TotalEmployees)$_{98}$-(Manuals/TotalEmployees)$_{95}$]

Table A3.1. First-stage probit regression

Dependent variable: **d_deloc00**	**Coef.**	**S.E.**	**z**
lnage	0.565**	0.264	2.14
nw	-0.659	0.482	-1.37
ne	0.223	0.415	0.54
south	0.129	0.652	0.20
lsize	0.157	0.178	0.88
specsupp	0.623*	0.356	1.75
group97	-0.257	0.463	-0.56
group00	0.655	0.451	1.45
d_res9597	-0.224	0.315	-0.71
d_res00	-0.455	0.356	-1.28
d_fdi9597ue	-0.358	0.375	-0.96
roi9597	0.003	0.004	0.72
roi9800	-2.012	3.133	-0.64
litna9597	-0.351	0.317	-1.11
litna9800	0.218	0.280	0.78
lfatta9597	-1.469**	0.755	-1.95
lfatta9800	1.934**	0.761	2.54
lcla9597	1.874**	0.790	2.37
lcla9800	-2.231**	0.935	-2.39
constant	-5.108**	2.483	-2.06
Log likelihood		-49.906	
Number of obs		326	
LR chi2(21)		27.85	
Prob > chi2		0.086	

Table A3.2. Description of the propensity score in the common support region

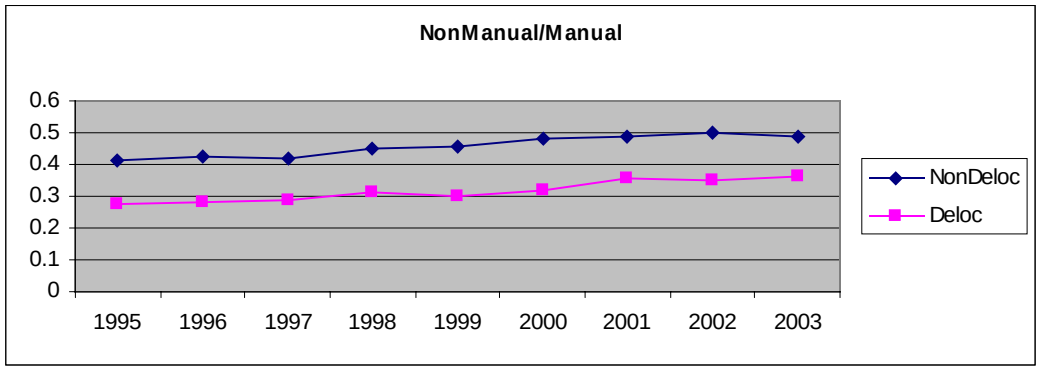
	Percentiles	**Smallest**		
1%	0.030	0.029		
5%	0.031	0.030		
10%	0.033	0.030	Obs	140
25%	0.045	0.030	Sum of Wgt.	140
50%	0.074		Mean	0.104
		Largest	Std. Dev.	0.097
75%	0.114	0.378		
90%	0.214	0.401	Variance	0.009
95%	0.304	0.406	Skewness	3.181
99%	0.406	0.757	Kurtosis	17.918

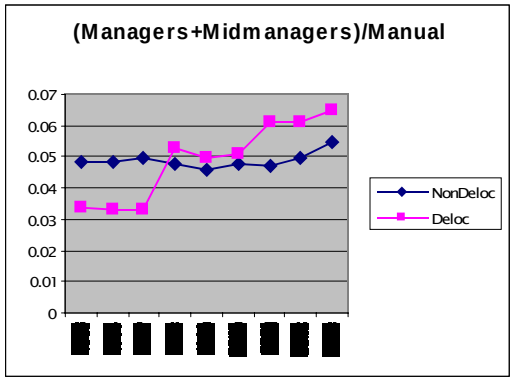
Table A3.3. Inferior bound, number of treated and number of controls in each block

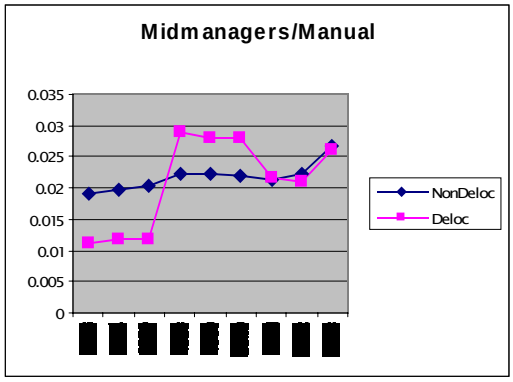
Inferior of block of pscore	**dummy**	**offshoring**	
		1998-2000	
	0	**1**	**total**
0.0292903	112	10	100
0.2	10	5	15
0.4	2	0	2
0.6	0	1	1
Total	124	16	140
The final number of blocks is 4:			
this number of blocks ensures that the mean propensity score is not different for treated and controls in each blocks			

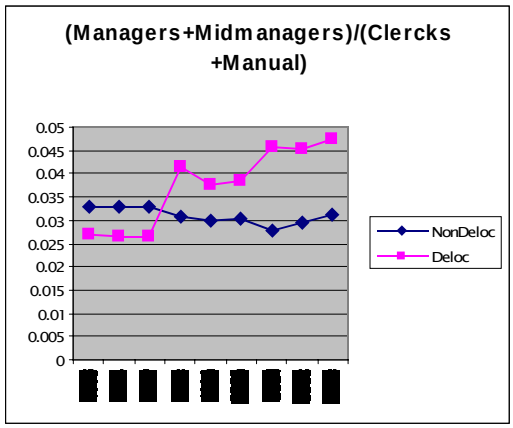
Notes: the output is the one reported in the STATA module developed by Becker and Ichino (2002).

Figure A1 – Trends in the skill ratio for treated and untreated firms on the common support









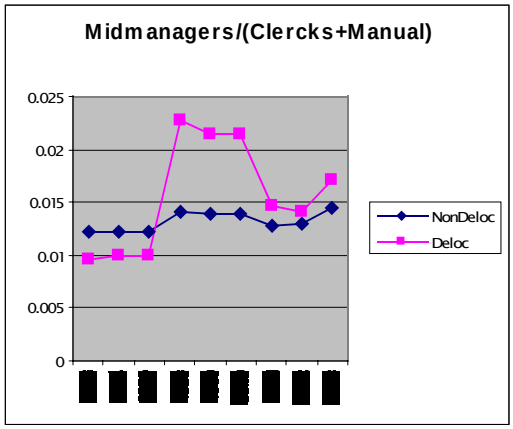


Figure A2 – Occupational categories trends in delocalizing and non-delocalizing firms common support

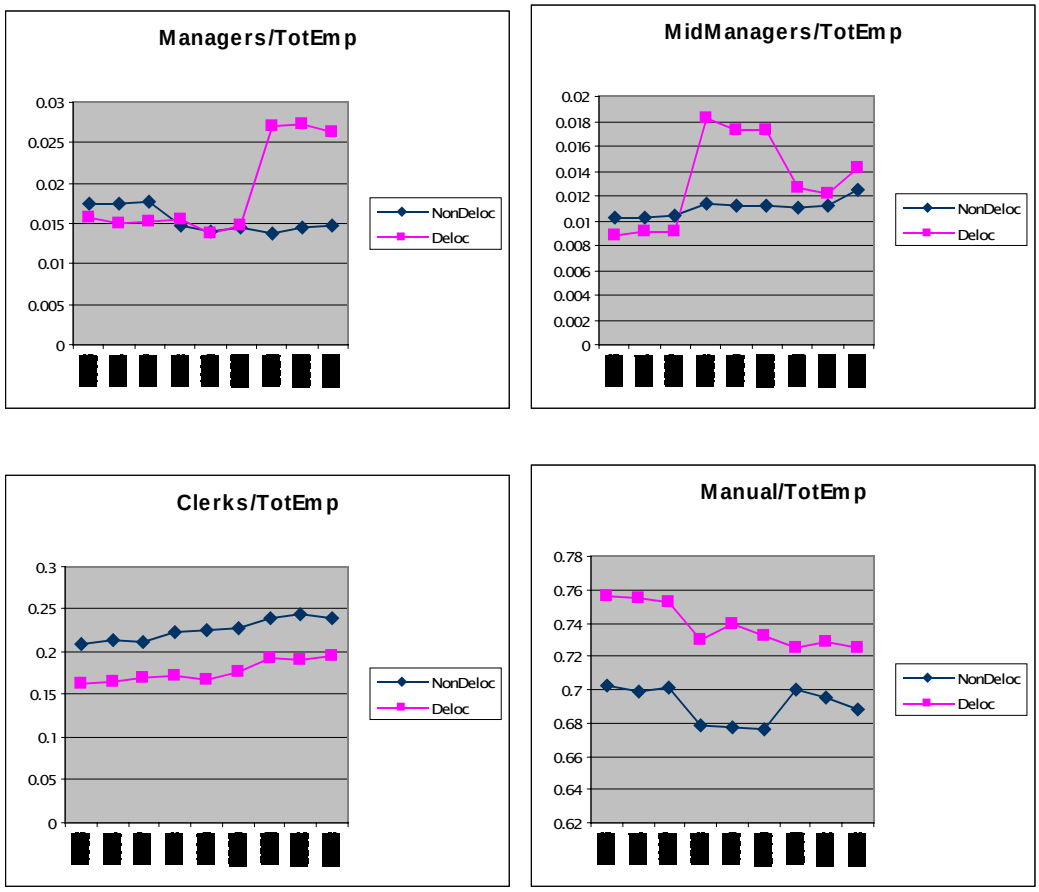


Figure A.3 Common support for all firms

D=0 **D=1**