Offshoring and Job Stability: Evidence from Italian Manufacturing*

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Abstract

This paper studies the relationship between offshoring and job stability in Italy in the period 1995–2001 by using a large administrative dataset on manufacturing workers. We find that the international fragmentation of production has a negative impact on job stability. Offshoring to low income countries significantly reduces job stability, but the effect depends on workers' skills. Intermediates purchases from developing economies foster white collar workers' job-to-job transitions within manufacturing, whilst they drive blue collar workers out of manufacturing. Therefore, policy interventions should especially focus on this latter category of workers in case of firms offshoring to low income countries.

Keywords: Offshoring, job stability, manufacturing, duration analysis, proportional hazard
JEL classification codes: C41, F14, F16, J62

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1 Introduction

In the last decades low labour cost countries have gained a growing role in the process of international fragmentation of production. At the same time, the rapid spread of ICTs across the world has favoured the tradability of some service activities. These phenomena have raised concerns about job security, especially of low skill workers and employees performing routinely and simple tasks. They might indeed be more exposed to the process of international fragmentation of production. As a consequence, a large strand of the theoretical and empirical literature on trade and labour has tried to understand the effects of offshoring of materials and services on productivity, on the equilibrium employment, and on wage differentials between high skill and low skill workers.[1]

The theoretical literature, however, has devoted less attention to the short run dynamics caused by offshoring, although they might be extremely relevant from a policy perspective and a careful analysis of them is fundamental to understand and, in case, reduce the associated adjustment costs. The offshoring of some production phases or some tasks may result in cost saving, boosting productivity and expanding the output and the relative demand of the factor more intensively used in the offshoring sector (Arndt, 1997; Grossman and Rossi-Hansberg, 2008). However, these productivity gains from offshoring are not always compared to the short run welfare losses generated by the possible rise in unemployment. The short run effects, reproduced in two sector models with low or no inter-sector mobility, highlight the theoretical possibility of increased unemployment from offshoring in the sector (Mitra and Ranjan, 2007, 2010). It is essentially an empirical matter to ascertain whether and to what extent an increase in offshoring intensity causes an increase in job dismissals and, consequently, a reduced employment stability. This is a relatively less researched area consisting of very recent works (Egger, Pfaffermayr, and Weber, 2007; Geishecker, 2008; Baumgarten, 2009; Munch, 2010; Bachmann and Braun, 2011) which provide evidence about the effects of foreign competitive pressure on the employees' probability to keep their job.

Our aim is to explore the effect of offshoring on job stability from an empirical point of view. We match sector level measures of offshoring with employees' information on job durations and we test whether offshoring of materials and knowledge intensive business services (KIBS) affect the job stability in Italian manufacturing sectors. Administrative data on job matches are infor-

[1] See Feenstra and Hanson (1996, 1999) and Amiti and Wei (2004) for seminal contributions in this field.

mative about employees' characteristics and destination states in case of job mismatch. We exploit this rich piece of information to understand if the impact is heterogeneous between white and blue collars and if transitions out of manufacturing and transitions to different manufacturing jobs are differently affected by offshoring. This second part of the analysis sheds light on inter sectoral reallocations of workers. As high adjustment costs are often associated with such reallocations, we provide relevant policy suggestions to design effective interventions in cushioning such costs.

A further contribution of our study consists in understanding whether the effect of offshoring on job stability depends on the origin country of intermediates. Since the type, the quality, and the technological content of intermediates may differ across origin countries and the offshoring activity may have different underlying reasons according to the income level of the trade partner, we distinguish between input purchases from high and low income countries. When low skilled production processes are delocalised to developing countries, firms benefit from lower labour cost and might exploit the competitive advantage in more technological intensive activities. As a matter of fact, there might be unclear consequences in terms of firm productivity, cost savings, competitiveness, and returns in market shares (Lööf and Andersson, 2010; Jabbour, 2010; Harrison and McMillan, 2007; Cadarso, Gomez, Lopez, and Tobarra, 2008; Falk and Wolfmayr, 2008; Lo Turco and Maggioni, 2012) and the issue boils down to an empirical matter.

Anticipating our findings, purchases of foreign intermediates from developing countries reduce the Italian manufacturing employees' job stability of workers. More in detail, offshoring to low income economies raises the blue collars' probability to experience a transition out of manufacturing, while it fosters the job-to-job transitions within manufacturing of white collar workers. We find no significant role played by the offshoring to high income countries.

Our work is structured as follows. Section 2 reviews the main literature dealing with the labour market impact of trade openness and offshoring. Section 3 presents the data and the sample. In Section 4 we report some empirical facts concerning the evolution of the Italian labour market and the job exit rates. Section 5 describes the econometric model for analysing the impact of offshoring on job stability. The estimation results are presented and commented in Section 6. Section 7 concludes.

2 Literature Review

Although the main focus of the theoretical and empirical literature on offshoring and the labour market has been on the effects of offshoring on the skilled/low skilled relative wage (Feenstra and Hanson, 1996, 1999; Arndt, 1997; Egger and Falkinger, 2001)recently, the theory has devoted more attention on the unemployment-trade nexus in models with labour market frictions (Davis and Harrigan, 2007; Egger and Kreickemeier, 2009, 2010; Felbermayr, Prat, and Schmerer, 2008; Helpman and Itskhoki, 2010; Dutt, Mitra, and Ranjan, 2009). In the long run, these models predict that the equilibrium unemployment might be either positively or negatively affected by trade liberalisation. The specific role of offshoring in the short run is taken into account by Mitra and Ranjan (2007) and Mitra and Ranjan (2010), who predict a positive link between offshoring and unemployment when the labour force is immobile across sectors: offshoring causes cost saving and, thereby, a price reduction in the final good, so that more resources are directed to the relatively more rewarding non offshoring sector and unemployment rises in the offshoring sector. However, it is an empirical question whether the large productivity improvements and the entrance of new firms induced by competitiveness gains in the offshoring sector in the end are likely to reduce or increase the probability of workers to exit their job.
As a matter off fact, some empirical works close to our research line exploit employee level databases to understand the actual relationship between trade and the individual probability of job-mismatch[2]. For the United States the evidence on manufacturing workers suggests that, although trade shocks seem to play a minor role in the incidence of layoff spells, the increase in layoffs and the average duration of joblessness are positively related to the industry import exposure (Kruse, 1988; Hungerford, 1995). Also, employment instability is found to rise with an appreciation of the import exchange rate (Goldberg, Tracy, and Aaronson, 1999). The specific role of offshoring practices has not been explored by this piece of research.

For Europe, this literature is more recent and made up of very few contributions. Egger, Pfaffermayr, and Weber (2007), studying the employment

[2]Some further contributions, instead, have investigated the consequences of openness on job creation and destruction at the industry or firm-level (Davis and Haltiwanger, 1999; Kletzer, 2000; Klein, Schuh, and Triest, 2002; Davidson and Matusz, 2005; Nucci and Pozzolo, 2010). Although these analyses convey a general insight on the potential restructuring effects driven by openness, they do not fully highlight the consequences of openness in manufacturing for the individual probability of job-mismatch. This is a limit in inferring the social and welfare consequences of trade integration. In this respect, individual level studies may be more suitable for this purpose.

transition probabilities between sectors by means of a dynamic fixed-effects multinomial logit model, find that an increase in the share of intermediate goods imports negatively affects the probability of Austrian workers to stay in or change into the manufacturing sector, especially for industries with a comparative disadvantage. The findings for the Danish manufacturing by Munch (2010) in the period 1992–2001 are more reassuring as the quantitative impact of offshoring is rather small, even if it increases the job change hazard rate, the job separation rate, and the unemployment risks of low-skilled workers. Three recent studies for Germany convey different and somehow conflicting results. Geishecker (2008) estimates a duration model on the German manufacturing between 1991 and 2000, exploiting monthly information on job spells. He finds that offshoring, defined in the narrow sense (Feenstra and Hanson, 1996), significantly raises the individual risk of leaving employment. No statistically significant difference in the impact of offshoring is found across skill groups, as measured by the educational attainment. This evidence contrasts with Bachmann and Braun's (2011) findings.
Using a different administrative dataset on individual workers' employment histories recorded on a daily basis, they find that in the manufacturing sector the probability of moving to non-employment rises with offshoring only for medium-skilled and older workers. Also, their findings corroborate the evidence of a limited impact of offshoring on the overall job stability in the manufacturing sector and show that offshoring increases job stability in the service sector. Finally, Baumgarten (2009) contributes to the literature by examining the relationship between offshoring and job tasks. His findings reveal that in the manufacturing sector the adverse effect of offshoring is reduced for non-routine and interactive tasks.

Our study is in line with the latter group of works. We exploit microdata on individual job spells matched with sector level measures of offshoring retrieved from the IO tables. We have information on job durations on monthly basis as in Munch (2010) and Geishecker (2008). We focus on both material and service offshoring as in Baumgarten (2009). Nevertheless, differently from previous works, we will also consider a broad measure of material offshoring. The latter includes all intermediate imports and not only imports from the same manufacturing sector thus allowing for a large scope of material input-labour substitutability. Moreover, as far as service imports are considered, our focus will be on offshoring of KIBS: we mean to to explicitly take into account the possible negative impact of imports of high skill intensive services on white collar jobs.

Finally, an important contribution that we provide is the split of material imports by origin country. None of the previous studies has considered

a heterogeneous effect of offshoring on the job stability according to the origin country of the import flow. Nevertheless, some of the literature dealing instead with the effects of offshoring on the firm labour demand supports the importance of such an investigation. Harrison and McMillan (2007) show that imports from foreign affiliates located in low income economies reduce home employment in US multinationals, while imports from affiliates located in high income countries positively affect it. Out of the evidence on multinational firms, Lo Turco and Maggioni (2012), at the firm level, and Cadarso, Gomez, Lopez, and Tobarra (2008) and Falk and Wolfmayr (2008), at the industry level for Spain and the EU respectively, show a a similar finding on imports from low income economies. This evidence motivates our guess on the possibility of different offshoring effects on the job exit rate stemming from different motivations for imports, i.e. cost saving versus technology search.

3 The Data and Sample

To analyse the impact of offshoring on job security in the Italian labour market, we combine micro data on job durations and workers' characteristics with sector level data on offshoring, import penetration, technological change, efficiency, and regional proxies for the labour market conditions.

Micro data are from a longitudinal dataset provided by the Institute for the Development of Vocational Training (ISFOL) and based on the administrative records collected by the Italian Institute for National Social Security (INPS). INPS collects data on all Italian workers employed in the private sector through an administrative procedure based on firms' declarations. Because of the administrative nature of the data we have the exact monthly duration for each job spell. However, it is worth to notice that each time we observe a worker's transition out of our database we have no way of knowing whether this ends into unemployment, into a job in the public sector, into a work as self employed or out of the labour force. We think, however, that the lack of information on the final state of the workers exiting our database does not represent a limitation for our work since our focus is on the consequences of offshoring for the transitions of workers within and out of manufacturing, regardless of their final destinations[3].

[3]Furthermore, we are not able to distinguish between job spells that end due to the firm ending its activity from the other spells. The variables concerning the firm starting and ending dates contain several missing values, and several closing dates unreasonably do not have the corresponding sarting dates. So we preferred not to use this piece of information. We believe that this condition does not pose a serious limitation to our study, since the identification of spells from firm closure could just help to identify the channels through which

Form all the INPS records, ISFOL collects information on every worker born on the 10^{th} of March, June, September and December of each year. Thus, 1 worker out of about 91 is included in the sample and the whole data set is composed by more than 2,470,000 observations on about 963,000 job spells for about 310,000 workers in the years 1985-2002.[4]

From this database, we select a sample of fresh job matches which started between January 1995 and December 1998 and we follow them on a monthly basis until the end of 2001. We keep only manufacturing workers aged between 20 and 50. For each worker we retain only the first job spell in the first year the worker appears in the database. We calculate the corresponding job duration in months. Due to the ending of the observation period in December 2001, we treat as right-censored the job spells which are not completed yet in December 2001.[5]

The restriction of our sample to jobs started in the period 1995–1998 is due to two reasons. First, we cannot use older job spells since data on our main explanatory variable, offshoring, are not available before 1995. Second, we prefer not to use job spells started later than 1998, as the Italian labour market went through a series of institutional changes, mainly introducing atypical forms of job arrangements. This restriction is, therefore, aimed at avoiding job heterogeneity driven by institutional changes in the labour market.

In our analysis we also use other variables at worker level in modelling job duration: the daily gross wage, the individual age, work experience calculated as the total work experience since 1985 and until the moment of entering our sample, the number of previous jobs since 1985, and a set of indicators for gender, white collar, nationality, firm size, region, and sector.[6] These variables are time-constant and their value is fixed at the moment of entry into our sample. Table C.2 in Appendix C reports their descriptive statistics.

Concerning the sectoral offshoring, the relative indicators are retrieved from the National import-use IO tables provided by the Italian Institute of Statistics (ISTAT). They can be computed only on a 2-digit NACE Rev. 1 sector and yearly basis. To measure material offshoring intensity, we use a narrow indicator defined, in line with the previous literature (Feenstra and Hanson,

offshoring may operate in the labour market.

[4]For a detailed description of the dataset, see Centra and Rustichelli (2005)

[5]Given the small number of observations with a complete spell longer than 60 months, we right-censor observations lasting more than 60 months in order to reduce the computational time in model estimation.

[6]Given the administrative nature of the data, information on education, family composition, and family background are not available.

1996, 1999), as

$$OFF_{narrow\ jt} = \frac{IM_{jit}}{TI_{jt}} \quad \text{for } j = 1, ..., m \text{ and } j = i \tag{1}$$

where, manufacturing sectors where the worker is employed are the ones indexed by $j = 1, ..m$, IM_{jjt} is, for each j manufacturing sector, the cost of intermediate inputs from the foreign sector j at time t, and TI_{jt} is the total of domestic and imported non energy inputs used in sector j. In other words, this is a measure of within industry intermediate inputs substitution, since it represents the share of intermediate costs which is shifted to the same industry abroad.

However, the process of input substitution may involve intermediates from other industries, previously produced within the boundaries of the firm as intermediates or purchased from domestic suppliers for the final good production. Thus, we compare the performance of the narrow measure of offshoring to a broad one, which takes into account the degree of both intra and inter-industry substitution:

$$OFF_{broad\ jt} = \frac{\sum_{i=1}^{m} IM_{jit}}{TI_{jt}} \quad \text{for } j = 1, ..., m. \tag{2}$$

thus, this indicator captures the role of imports of sector j from all manufacturing sectors.

Finally, in the empirical analysis we will also test the role of the offshoring of KIBS[7] measured as:

$$OFF_{Kibs\ jt} = \frac{\sum_{i=m+1}^{n} IM_{jit}}{TI_{jt}} \quad \text{for } j = 1, ..., m. \tag{3}$$

where the KIBS sectors are the ones indexed by $m + 1$ to n in the economy.

In order to take into account the different type, quality and technology level of inputs purchased from different trading partners, we compute the measures of material offshoring by income level of the origin countries. We follow the traditional way to construct offshoring indicators split by origin when the origin of foreign intermediates can not be detected from the IO tables (Cadarso, Gomez, Lopez, and Tobarra, 2008; Falk and Wolfmayr, 2008). Then, we combine IO tables with total sector import share by origin country. The resulting offshoring measures to high and low income countries are

[7]According to the definition of the EU Economic Commission (2009), KIBS are services belonging to NACE Rev. 1 sectors 72, 73 and 74.

defined as:

$$OFF^{c}_{narrow\ jt} = \frac{IM_{jit} * \left(\frac{M^{c}_{it}}{M_{it}}\right)}{TI_{jt}} \text{ for } i = j$$

$$OFF^{c}_{broad\ jt} = \sum_{i} \left[\frac{IM_{jit} * \left(\frac{M^{c}_{it}}{M_{it}}\right)}{TI_{jt}}\right]$$

where IM_{ji} measures the imported intermediates from sector i used in sector j (from IO Tables), while M_i and M^c_{it} are retrieved from WITS-COMTRADE database and respectively measure the total sector i imports (of which imports of intermediates represent only one component), and the total imports from country c, with $c = High/Low$ indexing the income level of the exporting countries[8]. Unfortunately, we are not able to split KIBS imports by origin, due to the difficulty to retrieve data on imported services out of the IO tables, nevertheless it is sensible to presume that the bulk of these imports originates from high income economies.

Our baseline specification includes further controls to account for sector and geographic time-varying heterogeneity that might affect the job exit rate, other than offshoring. At the sector level, we make use of: i) the extent of ICT sector capital deepening, measured as the logarithm of the sectoral capital stock in office machines, telecommunication apparatus, and software over total employment; ii) the sectoral labour productivity, measured as sectoral value added over the total employment; iii) an overall measure of sectoral import penetration calculated as the ratio of sector imports to the summation of sector output and imports minus sector exports. These variables are from ISTAT National Accounts, apart from imports together with the definition of high and low income countries that are retrieved from the WITS-COMTRADE database. Finally, we use two time-varying variables controlling at regional level for the state of the labour market: the regional unemployment rate and the regional estimated share of informal employment, both gathered from ISTAT. Table C in Appendix C reports the list of all the variables used in the analysis with their definition, while Table C.4 displays the pairwise correlations of variables at sectoral and regional level.

[8]The high and low income country groupings directly come from the WITS database and are based on the World Bank country classification.

4 Descriptive Analysis

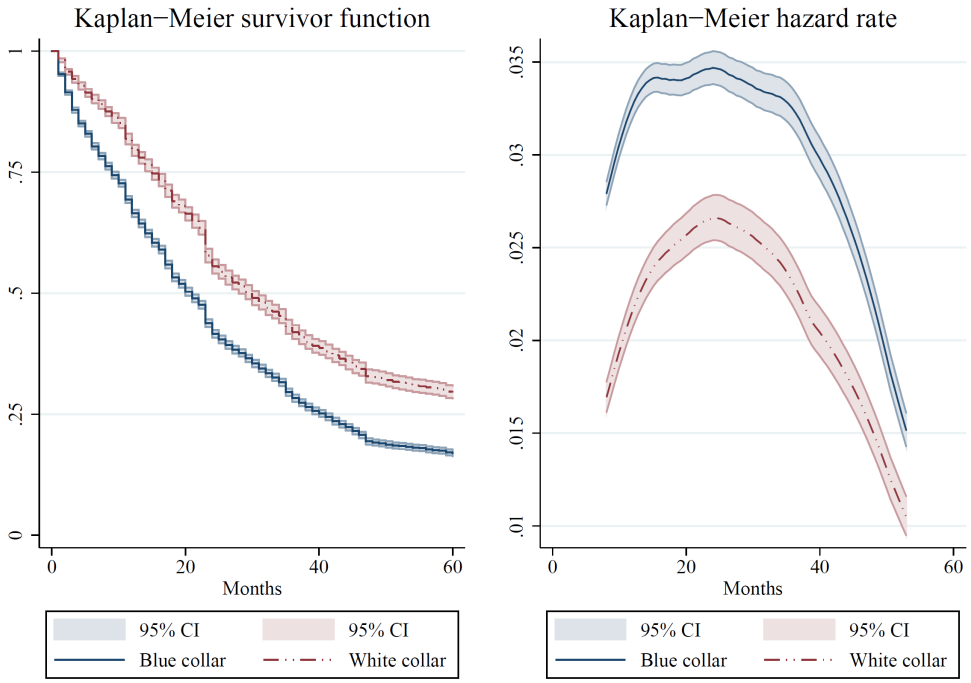
Turning now to the evidence on exit rates from our data, Table 1 displays the transitions out of the current job and the job-to-job transitions by destination sector. Most of the job mismatches in the private sector end with a transition out of employment in the private sector (65% of the total exits) and only 20% of job transitions happen within the same 2 digit sector. However, focusing on the spells ending with a transition into a new job, it is more likely that the worker will be employed in the same 2-digit sector: about 58% of workers who end a work relationship and enter a new job stay in the same sector of activity. Thus, there is evidence of a role played by sector specific human capital. Transitions across sectors might be difficult and require important training costs for workers in order to acquire the needed abilities and skills to perform the new job. Nevertheless, the Table shows that the transitions to another 2-digit sector are not so rare and the involved workers often also change the main sector of activity (primary/manufacturing/services). These transitions may reflect the structural change of an industrial developed economy towards more advanced, skill and technological intensive activities - especially services - that goes with the industrial growth and international affirmation of emerging countries. This process of tertiarisation of the economy, which could be pushed and speeded up by the internationalisation of production, finds some empirical support in Table 1: when a change occurs in the main sector the most important destination sector is the service sector.

Table 1: Transitions Out of Employment and Job-to-Job Transitions

Transitions	Absolute frequency	Relative frequency (%)
Out of employment	*36,075*	*65.46*
From Primary	4,947	8.97
From Manufacturing	13,365	24.25
From Services	17,763	32.23
To another 2 digit NACE sector	*7,935*	*14.40*
From Primary to Manufacturing	520	0.94
From Primary to Services	1,355	2.46
From Manufacturing to Primary	233	0.42
From Manufacturing to Services	1,292	2.34
From Services to Primary	282	0.51
From Services to Manufacturing	1,020	1.85
Within Primary	10	0.02
Within Manufacturing	1,714	3.11
Within Services	1,509	2.74
To the same 2 digit NACE sector	*11,101*	*20.14*
Total	*55,111*	*100*

Now, an important source of heterogeneity that may affect the job stability of workers is the skill level of the job, regardless of the sector where the individual is employed. We split the workers between white and blue collars. For manufacturing, representing the focus of our empirical analysis, Figure 1 shows employees' probability of job surviving and job exit rate by occupation. White collar workers are much more likely to preserve their job position than blue collar workers. This is consistent with the idea that low skill intensive workers are more exposed to foreign competition, economic slowdown, technological progress, and other external pressures that may drive individuals out of their occupations.

Figure 1: Kaplan-Meier Survivor and Hazard Functions by Occupation in Manufacturing Sectors



In what follows, the aim of the paper is to understand whether the process of production fragmentation across countries has significantly contributed to the above descriptive changes in job stability.

In the last decades developing countries have gained a growing role in world trade of the intermediates. Also, there has been a further integration among developed countries stemming from the deepening of market business relationships with foreign suppliers and customers and the increased importance of the intra-firm trade flows within cross-border groups. As a

consequence, Italy has experienced a growth in the shares of imported inputs and our aim is to infer the effect of this expansion in offshoring activities on the evolution of the job stability. As we can see from Figure C.1 in the Appendix, in the period 1995-2004 offshoring of materials increased in most sectors, although not monotonically and with some heterogeneity. For example, in sectors *Paper and paper products* (NACE sector 21) and *Editing and printing* (NACE sector 22) material offshoring has been characterised by alternate phases of growth and drop. Instead, the purchases of intermediates from abroad significantly raised in sectors *Textiles*, *Apparel* and *Leather products and footwear* (NACE sectors 17, 18 and 19). Moving the attention on KIBS, the picture is more clearcut: even in activities where the imports of material intermediates were declining or staying stable, the purchase of KIBS from abroad always was expanding and this is strictly linked with the rapid advances and diffusion of ICTs across the world that has fostered the tradability of services, and among them especially the ones more intensive in knowledge and skills, and has driven to internal reorganisations of production processes within firms. However, the Figure C.1 also displays that material offshoring is still more important than knowledge intensive service offshoring in terms of magnitude of shares.

Some further insights can be gathered by splitting the material offshoring according to the origin of inputs. Input purchases from developing countries have significantly increased in levels and with respect to the offshoring shares to developed countries. Nonetheless, high income countries are still the main partners of Italy in the trade of intermediates, with shares that are greatly larger than the ones of developing countries. Only in some low skill and traditional sector, especially *Apparel* and *Leather products and footwear*, low income countries represent the most important sources of materials (Figure C.2).

5 Econometric Framework

5.1 Mixed Proportional Hazard Job Separation Rates

In order to detect the impact of offshoring on job separation rates we make use of a mixed proportional hazard (MPH) framework with time-varying variables. As we only observe the labour market state occupied at the end of each month, the observed durations are measured in discrete time. We model the discrete time process as if it was generated by a grouped continuous-time model as in van den Berg and van der Klaauw (2001). By doing so, the parameters do not depend on the time unit of observation (Flinn and Heckman,

1982).

Job duration is defined as the time until the job is terminated, either because of a transition to another job or because of a transition out of employment. Let $\mathbf{x}$ denote the vector of explanatory variables which are constant over time and $\mathbf{z}$ the set of time-varying covariates. The variable t (with $t \in \mathbb{N}_0$) denotes the job duration as measured from the moment of job inflow, while the variable τ (with $\tau \in \mathbb{N}_0$) denotes calendar time. The job separation rate of a spell started at time τ and after t months is specified in the following MPH form

$$\theta\big[t|\mathbf{x}, \mathbf{z}(\tau+t), v\big] = \exp\big[\alpha(t) + \boldsymbol{\beta}'\mathbf{x} + \boldsymbol{\delta}'\mathbf{z}(\tau+t)\big]v, \tag{4}$$

where

- $\exp[\alpha(t)]$ is the piecewise constant baseline hazard capturing the duration dependence. The time axis of each job spell is divided into Q intervals $I_q = [h_q, h_{q+1})$ with $q = 1, \ldots, Q$, $h_1 < h_2 < \ldots < h_Q$, $h_1 = 1$, and $h_Q = \infty$.[9] The baseline hazard function can be rewritten as

$$\exp\big[\alpha(t)\big] = \exp\Big[\sum_{q=1}^{Q} \alpha_q d_q(t)\Big], \tag{5}$$

  where $d_q(t)$ is a dummy indicator equal to one if the job separation occurs during interval I_q and α_q is the corresponding intensity parameter.[10]
- $\mathbf{x}$ is a K dimensional vector of time-invariant covariates controlling for observed heterogeneity.
- $\mathbf{z}(\tau+t)$ is a J dimensional vector of time-variant covariates, among which offshoring indexes and a set of further variables controlling for time-variant heterogeneity at the transition month $(\tau+t)$.
- $\boldsymbol{\beta}$ and $\boldsymbol{\delta}$ are the parameter vectors associated (and conformable) to the time-variant and time-invariant covariates, respectively.
- v is the non-negative time-invariant individual heterogeneity which is assumed to be independent on $\mathbf{x}$ and $\mathbf{z}$.

In order to avoid strict assumptions on the distribution of the unobserved heterogeneity, we assume that v has a discrete distribution like in Heckman and Singer (1984). We choose the number of points of support on the basis of information criteria (Hannan-Quinn and Akaike information criteria), as suggested by Baker and Melino's (2000) and Gaure, Røed, and Zhang's (2007)

[9] We split the time axis into 9 intervals at 3, 6, 9, 12, 18, 24, 30, and 36 months.

[10] α_1 is normalized to 0. This normalisation is innocuous as the scale of the job separation rate is captured by v.

Monte Carlo simulations. We always end up with choosing the model with one point of support, i.e. there is evidence of no unobserved heterogeneity.

5.2 The Likelihood Function

In our sample we observe both complete and incomplete job spells. The contribution to the likelihood function of a complete job spell started at calendar time τ and terminated after t months is derived in Appendix A and takes the following form

$$\begin{aligned} L(t|\mathbf{x},\mathbf{z},v;\Theta) &= \prod_{r=1}^{t-1}\exp\Big\{-\theta\big[r|\mathbf{x},\mathbf{z}(\tau+r),v\big]\Big\} \\ &- \prod_{r=1}^{t}\exp\Big\{-\theta\big[r|\mathbf{x},\mathbf{z}(\tau+r),v\big]\Big\} \\ &= \prod_{r=1}^{t-1}\exp\Big\{-\exp\big[\alpha(r)+\boldsymbol{\beta}'\mathbf{x}+\boldsymbol{\delta}'\mathbf{z}(\tau+r)\big]v\Big\} \\ &- \prod_{r=1}^{t}\exp\Big\{-\exp\big[\alpha(r)+\boldsymbol{\beta}'\mathbf{x}+\boldsymbol{\delta}'\mathbf{z}(\tau+r)\big]v\Big\} \\ &\equiv S(t-1|\mathbf{x},\mathbf{z},v)-S(t|\mathbf{x},\mathbf{z},v), \end{aligned} \tag{6}$$

where Θ is the set of parameters to be estimated. As we specify the discrete time-process as if it was generated by a grouped continuous-time model, the contribution to the likelihood function of exiting a job spell after t months is given by the difference between the probability of job surviving for $t-1$ months and the probability of surviving for t months.

The contribution to the likelihood function of a job spell started at calendar time τ and incomplete after t months because right censored at the end of the observation period is given by the survivor function evaluated at t months:

$$\begin{aligned} L^c(t|\mathbf{x},\mathbf{z},v;\Theta) &\equiv S(t|\mathbf{x},\mathbf{z},v) \\ &= \prod_{r=1}^{t}\exp\Big\{-\theta\big[r|\mathbf{x},\mathbf{z}(\tau+r),v\big]\Big\} \\ &= \prod_{r=1}^{t}\exp\Big\{-\exp\big[\alpha(r)+\boldsymbol{\beta}'\mathbf{x}+\boldsymbol{\delta}'\mathbf{z}(\tau+r)\big]v\Big\}. \end{aligned} \tag{7}$$

Let c_i be an indicator variable equal to one when the job spell of individual i is right censored and 0 if completed. Under the assumption that the dis-

tribution of the unobserved heterogeneity is discrete, we can integrate it out when constructing the likelihood function of individual i with job duration t_i :

$$\mathscr{L}_i(t_i|\mathbf{x}_i,\mathbf{z}_i;\Theta)=\sum_{m=1}^{M}p_m\left[L_i^c(t_i|\mathbf{x}_i,\mathbf{z}_i,v_m;\Theta)\right]^{c_i}\left[L_i(t_i|\mathbf{x}_i,\mathbf{z}_i,v_m;\Theta)\right]^{(1-c_i)}. \quad (8)$$

The log-likelihood function sums the logarithm of Equation (8) over all the individuals in the sample, i.e. $\mathscr{L}=\sum_{i=1}^{N}\mathscr{L}_i(t_i|\mathbf{x}_i,\mathbf{z}_i;\Theta)$.

5.3 Identification

In duration models, the failure to control for selectivity issues due to unobserved heterogeneity can lead to substantial biases in the estimation of the structural parameters of the hazard function. We control for the selection on unobservables on the basis of a discrete distribution with an unknown number of points of support, unknown probability masses, and unknown location of the points of support. Elbers and Ridder (1982) showed that under the MPH assumption, exogenous time-invariant regressor variation, and an auxiliary assumption on the first moment of the unobserved heterogeneity distribution, the model components are non-parametrically identified. If exogenous information from time-varying variables is available, like in this study, the MPH assumption is not necessary for identification and the impact of the covariates on the hazard function can be allowed to be heterogeneous over time (Brinch, 2007).

A further concern in credibly identifying the impact of offshoring on job stability is time-varying heterogeneity. There might indeed be other time-varying determinants of job stability which, if left out of the model specification, could give rise to spurious effects. In order to address this potential problem, we include in the model specification a rich set of time-varying variables at national, regional, and sectoral levels which might explain the job duration distribution. More in detail, we will control for: i) time dummies to take into account idiosyncratic changes, like those determined in legislation changes; ii) unemployment rate and the share of informal workers to control for the state of the labour market; iii) sectoral ICT per employee; iv) the sectoral labour productivity which is a proxy for the efficiency and evolution in the sector; v) the import penetration ratio which captures the competitive pressure from foreign firms in the same sector, and may also reflect the general trade openness of the sector.

Finally, the combination of micro data about the duration of individual

job spells and sectoral level indicators for offshoring helps in mitigating endogeneity concerns related to reverse causality. It is indeed unlikely that the individual behaviour is able to affect the sectoral performance in terms of foreign intermediate purchases.

6 Estimation Results

Table 2 reports the estimation results of the job hazard function described in the previous section. The first two columns present the analysis for the sample of all employees. Consistently with our expectations, the sectoral purchases of foreign intermediate inputs significantly increase the worker's probability of experiencing a job separation. This positive effect on the job exit rate is robust to the definition of the offshoring measure (narrow or broad).[11] Concerning the magnitude of the effect, we find that an increase by 10 percentage points in the narrow (broad) offshoring increases the monthly job exit rate by 0.35% (0.31%). Moreover, the purchases of KIBS abroad has a furher negative effect on the job stability in manufacturing.[12]

Hence, the general process of fragmentation of production across countries seems to significantly affect labour saving firm organisation choices. The resulting higher dynamism in the labour market may drive to the rise of important adjustment costs in terms of increased unemployment, and need for the re-training of workers. Anyway, it might also represent an opportunity for the economic system to undergo structural changes that may improve and strengthen its competitiveness.

As mentioned above, in order to disentangle the true effect of offshoring from the spurious one determined by further time-varying heterogeneity, we included among the covariates a set of time-varying controls at sectoral and geographical level. The sectoral import penetration is aimed at controlling for the growing international integration among countries and the resulting stronger competitive pressures. We find that tougher foreign competition positively and significantly affects the job hazard rate. Thus, the general process of globalisation seems to increase the job instability due both to the fragmentation strategies the domestic firms may engage in and to the growing flows of foreign goods entering the domestic market.

[11] This finding contrasts with Geishecker (2008), who finds no support for a significant effect of the broadly defined offshoring.

[12] A 10 percentage points increase in KIBS increases the job hazard rate of about 5.9/5.1%, depending on the narrow/broad definition used in the analysis to measure the material offshoring.

Table 2: Estimation Results of the Systematic Part of the Job Hazard Function

	All employees		White collars		Blue collars	
	(1)	(2)	(3)	(4)	(5)	(6)
Female	-0.014	-0.014	-0.073*	-0.074*	0.014	0.013
	[0.020]	[0.020]	[0.040]	[0.040]	[0.023]	[0.023]
Age	-0.137***	-0.137***	-0.064**	-0.064**	-0.155***	-0.155***
	[0.011]	[0.011]	[0.026]	[0.026]	[0.012]	[0.012]
WhiteCollar	-0.194***	-0.194***				
	[0.021]	[0.021]				
Italian	-0.228***	-0.228***	-0.373***	-0.371***	-0.218***	-0.218***
	[0.044]	[0.044]	[0.127]	[0.127]	[0.046]	[0.046]
ln(wage)	-0.064***	-0.064***	-0.075	-0.076*	-0.086***	-0.086***
	[0.023]	[0.023]	[0.046]	[0.046]	[0.027]	[0.027]
WorkExp	-0.517***	-0.517***	-0.510***	-0.508***	-0.534***	-0.532***
	[0.051]	[0.051]	[0.094]	[0.094]	[0.062]	[0.062]
PrevJobs	-0.148	-0.148	-0.412	-0.424	-0.062	-0.066
	[0.206]	[0.206]	[0.428]	[0.429]	[0.237]	[0.237]
Quarter2	0.374***	0.374***	0.390***	0.390***	0.366***	0.366***
	[0.022]	[0.022]	[0.048]	[0.048]	[0.024]	[0.024]
Quarter3	0.669***	0.668***	0.755***	0.754***	0.645***	0.645***
	[0.026]	[0.026]	[0.057]	[0.057]	[0.029]	[0.029]
Quarter4	0.810***	0.809***	0.864***	0.860***	0.795***	0.794***
	[0.028]	[0.028]	[0.063]	[0.063]	[0.032]	[0.032]
FirmSize2	-0.096***	-0.096***	-0.144**	-0.143**	-0.083***	-0.084***
	[0.024]	[0.024]	[0.059]	[0.059]	[0.026]	[0.026]
FirmSize3	-0.119***	-0.118***	-0.151***	-0.150***	-0.111***	-0.112***
	[0.023]	[0.023]	[0.053]	[0.053]	[0.026]	[0.026]
FirmSize4	-0.185***	-0.185***	-0.177**	-0.175**	-0.192***	-0.192***
	[0.038]	[0.038]	[0.071]	[0.071]	[0.045]	[0.045]
FirmSize5	-0.317***	-0.317***	-0.288***	-0.286***	-0.338***	-0.339***
	[0.026]	[0.026]	[0.057]	[0.057]	[0.030]	[0.030]
OFF_{Kibs}	0.587***	0.512***	0.661***	0.454**	0.346**	0.333*
	[0.130]	[0.125]	[0.210]	[0.185]	[0.174]	[0.177]
OFF_{narrow}	0.035***		0.016		0.043***	
	[0.012]		[0.022]		[0.014]	
OFF_{broad}		0.031***		0.047***		0.023**
		[0.009]		[0.016]		[0.011]
$ImpPen_j$	0.382***	0.372***	0.437**	0.376**	0.326***	0.331***
	[0.087]	[0.087]	[0.178]	[0.179]	[0.099]	[0.100]
$Unemp^{reg}$	-1.489	-1.518	-7.335*	-7.473*	0.308	0.309
	[1.679]	[1.680]	[4.423]	[4.436]	[1.825]	[1.825]
$InformalLab^{reg}$	-3.570*	-3.596*	0.77	0.563	-2.929	-2.898
	[1.834]	[1.835]	[4.581]	[4.587]	[2.013]	[2.014]
LP_j	-0.227	-0.149	-0.224	-0.146	-0.291	-0.217
	[0.150]	[0.152]	[0.244]	[0.241]	[0.208]	[0.209]
ICT_j	1.261	1.182	-0.352	-0.712	2.404*	2.566**
	[1.088]	[1.083]	[2.231]	[2.204]	[1.267]	[1.266]
Constant	-1.211	-2.058**	-2.625	-3.887**	-0.331	-0.89
	[0.897]	[0.923]	[1.820]	[1.815]	[1.131]	[1.168]
NT	511,919	511,919	146,218	146,218	365,701	365,701
N	19,259	19,259	4,589	4,589	14,670	14,670
Log-likelihood						

Notes: * Significant at 10% level; ** significant at 5% level; *** significant at 1% level. Standard errors are in brackets. Dummy indicators for regions, years, sectors are included in all estimations but not reported for the sake of brevity. The reference category ia made up of Italian male employees working in firms smaller than 20 employees in the sector of *Furniture and other manufacturing industries*, entering the sample in the first quarter of 1995, and living in Sardinia.

Another relevant phenomenon that may potentially affect the labour market dynamics is technological change. Contrary to some previous evidence (Geishecker, 2008), the advancements in technology, measured by the sectoral ICT capital stock, do not explain the job exit rate. Concerning the remaining controls at sectoral and regional level, neither the regional unemployment rate nor the state of the industry (approximated by the logarithm of the sectoral labour productivity) have a significant effect, while the presence of informal work has a positive impact on the job stability. The latter finding can be explained by at least two arguments. First, the informal labour market might expand in a period of upturn and therefore it might be negatively correlated with the job hazard rate. Secondly, an increase in the informal labour market, once we control for the unemployment rate, could suggest that firms are more intensively using a cheap source of labour, with an increase in competitiveness and in the stability of both formal and informal jobs. Finally, we briefly comment on the estimated coefficients of the time invariant covariates that are broadly in line with those previously found for other advanced countries. White collar workers and workers with Italian nationality have a significant lower probability of experiencing a job separation. Additionally, both the wage and previous working experience are positively associated with job durations. As in Munch (2010), we show that older workers are less likely to exit the job. This finding contrasts with Geishecker (2008) who, instead, displays a decreasing job stability with the worker age. Also, firm size matters and being employed in a larger firm decreases the job exit rate. This might be explained by the fact that bigger firms are less sensitive to the business cycle and shocks in the market. Differently from the results for other countries (Geishecker, 2008; Bachmann and Braun, 2011; Baumgarten, 2009), we find that men and women have the same job exit rate.

So far, we have considered offshoring to have a homogeneous impact on job stability regardless of the type of employees' tasks and activities. This is however a strong assumption since workers with a higher skill level and committed with knowledge and technology intensive tasks may be less substitutable with foreign inputs than workers performing simple and routinely jobs. The increasing international integration might affect more the low skilled than the high skilled because of both their relative scarcity in advanced countries and the growing role of low skilled labour abundant countries in world trade flows. In particular, offshoring practices are often meant more to spare on the labour intensive fragments of production than to acquire new technologies from abroad (OECD, 2007).

In order to test whether offshoring differently affects the job security of workers according to their skills, we make use of the distinction between blue

and white collars. The columns from (3) to (6) of Table 2 show the estimations of our single risk model split by skill level. According to both measures of offshoring, broad and narrow, the purchases of foreign inputs increase the job instability of blue collar workers. Also, a positive and significant effect of offshoring is detected on the probability of white collars' job separation by the broad indicator, but a non-significant impact is found when the narrow measure is used. Thus, the evidence of an increased job instability driven by offshoring is stronger and more robust for unskilled workers. Even if we trust that the narrow measure of offshoring is able to better capture the delocalisation of the phases of the production process constituting the core business of the firm, it might be that some heterogeneity is still not properly caught. In the next subsection we control therefore for another source of potential heterogeneity, that is the origin of the offshored intermediates.

Interestingly, services purchased abroad significantly increase the job hazard rate of both groups of workers, even if the magnitude of the effect is larger for white collars. This is maybe due to the fact that KIBS are characterised by very high knowledge requirements and need specific abilities. As a consequence, KIBS are usually performed by high skill workers and it is more likely that their delocalisation abroad substitutes for white more than blue collars.

The estimated parameters of the remaining covariates are not so sensitive to the split of the sample in white and blue collar workers. There are nevertheless some exceptions. The employees' gender seems to be relevant for white collars, and surprisingly female white collar workers are less likely to experience a job separation, although the coefficient is significant only at the 10% level. The average wage presents a higher coefficient in absolute value with a higher degree of significance for blue collars, thus revealing that the ones highly paid, possibly the more specialised ones, are also the ones more likely to preserve their job. At regional level, the unemployment rate reduces the job instability of white collars. Even if this may seem slightly counterintuitive, it may be the case that the unemployment rate mainly concerns and captures the availability of blue collars. Thus, the possibility to substitute the current unskilled workers with the unemployed ones that may be more productive or hired at lower wage may allow the firm to become more competitive, strenghten its position and, thus, increase the job stability of the other workers, namely the skilled ones. This is confirmed by the positive effect, even if not significant, of the unemployment rate on the job hazard rate of unskilled workers. Finally, the ICT capital stock increases the job instability of blue collars, disclosing that the investments in office machines, softwares and telecommunication apparatus, more than substituting skilled workers, may drive to a reorganisation of the firm production processes toward more

skill intensive techniques and pratices.

The role for the origin of imports

Emerging and low labour cost countries have experienced a strong expansion during the time window under analysis, both in terms of economic growth and trade flows in intermediates. Their increased role in the global context has risen worries about the job stability for workers in advanced economies even if the most part of foreign inputs in high income countries still comes from other developed partners.

There are different reasons behind the input flows according to the origin countries and these differences may lead to heterogeneous outcomes for the labour market. Aware of this, we take into account the importance of the country where the production is offshored to and, especially, we cross heterogeneous import origins with the different occupation skills. We expect offshoring to low income countries to play the major role on the recent labour market evolution, due to its recent growth in magnitude and to its general labour saving purpose. In opposite, imports from high income countries usually coincide with the search for better technology. In what follows, we only display the results for our offshoring measures and other sectoral and regional variables for the sake of brevity.[13]

Using both the broad and the narrow measures of offshoring, Table 3 shows that, focusing on the sample of all workers, the main negative impact for the job stability is caused by the process of production fragmentation to developing countries. Input purchases from high income countries have no significant effect on the job hazard rate. Offshoring of KIBS still contributes to reduce the probability of workers to preserve their jobs.

The most interesting insights are however delivered when we take simultaneously into account the two heterogeneity sources, worker skills and origin of inputs. It is evident that material offshoring to low income countries represents a detrimental factor for the stability of the blue collars' jobs. A 10 percentage point increase in the narrow (broad) offshoring share increases the monthly exit rate of blue collar workers by 1.4% (1.3%). This is in line with prior empirical evidence and also supported by Lo Turco and Maggioni (2012), who find that in Italy offshoring affects the firm labour demand only if it is towards low income countries.[14] In contrast, material offshoring to high

[13]The results for variables at individual level are available from the authors upon request.

[14]The negative effect of offshoring to developing countries on the firm labour demand displayed in Lo Turco and Maggioni (2012) is especially important in Traditional Sectors, defined as the ones belonging to the group "'Supplier-Dominated"' Sectors according to the Pavitt's taxonomy, where the share of low skilled workers is usually higher.

income countries, only when computed according to the broad definition, increases the probability for white collars of experiencing a job separation. If purchases from advanced economies consist of more knowledge intensive goods, then they may well substitute for white collars, especially in the case of material imports not directly related to the core business of the firm. As a matter of fact, taking a vehicle manufacturer as an example, imports of computers may well substitute for the work of some of the firm administrative employees, so as importing advanced technology electronic devices may well turn engineers and designers redundant. Both imports are not included in the narrow definition of offshoring, while they belong to the broad one and they only affect white collar workers.

Imports of KIBS, as before, positively impact the job hazard rate of both groups of workers, and, mimicking the previously finding, the magnitude of this effect is higher in the case of white collars.

The above results are robust to a number of sensitivity checks. First, we relaxed the imposed proportionality of offshoring variables and tested whether freshly hired workers are more strongly affected by an increase in offshoring activities. The results showed that the offshoring effect is homogeneous, regardless of the worker's tenure. Secondly, we tested whether heterogeneous effects could be detected on differently aged workers and, differently from Bachmann and Braun (2011), we found no such evidence. Finally, we substituted output for non energy intermediates in the denominator of our offshoring measures and all the estimation results of interest stay unchanged. All these sensitivity checks are not shown here for the sake of brevity, but they are available from the authors upon request.

Competing risks

So far, we have studied the job stability in a single risk framework, without distinguishing between different destination states. In what follows, we re-estimate the duration model in a competing risks framework with two risks of job exit: transition to another job in the manufacturing sector and transition out of the manufacturing sector.[15] We decide to focus on job-to-job transitions within manufacturing and on transitions out of manufacturing since the welfare consequences of these transitions may be very different. Transitions out of manufacturing employment have immediate detrimental effects for the economy in terms of deterioration of sectoral specific human capital and, thereby, higher risk of future nonemployment, skill obsolescence,

[15]The derivation of the likelihood function in the competing risks framework is reported in Appendix B.

Table 3: Estimation Results of Offshoring by Occupation and Origin Countries

	All employees		White collars		Blue collars	
	(1)	(2)	(3)	(4)	(5)	(6)
OFF_{Kibs}	0.590***	0.525***	0.647***	0.469**	0.323*	0.306*
	[0.131]	[0.127]	[0.208]	[0.185]	[0.175]	[0.181]
OFF^{High}_{narrow}	0.02		0.037		0.004	
	[0.015]		[0.024]		[0.019]	
OFF^{Low}_{narrow}	0.084***		-0.112		0.140***	
	[0.029]		[0.082]		[0.031]	
OFF^{High}_{broad}		0.016		0.057***		-0.014
		[0.011]		[0.018]		[0.015]
OFF^{Low}_{broad}		0.078***		-0.071		0.126***
		[0.025]		[0.069]		[0.027]
$ImpPen_j$	0.380***	0.376***	0.437**	0.380**	0.319***	0.337***
	[0.087]	[0.087]	[0.177]	[0.178]	[0.100]	[0.100]
$Unemp^{reg}$	-1.611	-1.636	-7.138	-7.289	0.054	0.038
	[1.683]	[1.683]	[4.424]	[4.432]	[1.830]	[1.830]
$InformalLab^{reg}$	-3.661**	-3.661**	0.942	0.738	-3.106	-3.058
	[1.834]	[1.835]	[4.588]	[4.592]	[2.014]	[2.013]
LP_j	-0.224	-0.163	-0.235	-0.136	-0.306	-0.259
	[0.150]	[0.151]	[0.243]	[0.242]	[0.207]	[0.208]
ICT_j	0.603	0.555	0.776	0.055	1.019	1.06
	[1.156]	[1.130]	[2.314]	[2.246]	[1.343]	[1.325]
Constant	-1.599*	-2.404**	-1.917	-3.035	-1.039	-1.55
	[0.920]	[0.942]	[1.858]	[1.882]	[1.147]	[1.177]
NT	511,919	511,919	146,218	146,218	365,701	365,701
N	19,259	19,259	4,589	4,589	14,670	14,670
Log-likelihood						

Notes: * Significant at 10% level; ** significant at 5% level; *** significant at 1% level. Standard errors are in brackets. Dummy indicators for regions, years, sectors are included in all estimations but not reported for the sake of brevity. The reference category ia made up of Italian male employees working in firms smaller than 20 employees in the sector of *Furniture and other manufacturing industries*, entering the sample in the first quarter of 1995, and living in Sardinia.

and costs related to re-training programmes. Instead, job-to-job transitions within manufacturing might not represent a real damage, as they might put an end to bad job matches and move employees towards more technology and knowledge intensive firms and/or sectors, which are also less exposed to international competition.

Table 4 displays the estimation results of the competing risks proportional hazard model with the indicator of offshoring split by country groups. The upper and bottom panels display the effects for out of manufacturing transitions and job-to-job transitions, respectively. The input purchases from low income countries only significantly increase the transitions out of manufacturing for the total sample of employees. Offshoring to developed countries displays instead no role. However, when we separately consider white and blue collar workers, the detrimental effect of offshoring to low income countries on the job stability only concerns blue collar workers. A 10 percentage point increase in the narrow (broad) offshoring share increases the blue collars' monthly exit rate out of manufacturing by 1.1% (0.9%). Thus, consistently with our expectations, the process of delocalisation of production towards developing countries throws only blue collars out of the labour market.

A very different picture is gathered for within manufacturing job-to-job transitions. Offshoring to developing countries mainly causes job-to-job transitions for white collar workers. Thus, the delocalisation of production phases to low income countries seems to involve some reorganisation in the firm production processes that drives skilled workers toward other manufacturing jobs.

The role of offshoring to high income countries is not clearcut. Even if offshoring to high income countries has no impact on worker's probability of exiting manufacturing sector, there is evidence of a mild positive effect on the probability of changing work for unskilled workers. However, this effect is significant only at the 10% level and it is detected only through the broad measure of offshoring.

Turning the attention on the flows of KIBS from abroad, they do not contribute to the workers' exits from manufacturing sector, while, contrary to our expectations, they seem to affect more the job-to-job transitions of blue collars than those of white collars. This is partially in contrast with the results from the single risk model showing a stronger impact on white collars. Anyway, it could be driven by the small number of white collar workers that do not allow to precisely identify an effect through a competing risks model.

Finally, the results concerning the other sectoral and regional variables show, in general, no significant effect, apart from the sectoral import penetration which seems to both lead to job-to-job transitions and drive workers out

of manufacturing especially when they are unskilled. There is evidence therefore that blue collar workers are more exposed to the growing international integration across countries. Also, regional unemployment and the regional presence of informal job contribute to mildly reduce the possibility of white collars to experience a transition to another job, while the sectoral efficiency seems to negatively impact on job-to-job transitions of blue collars.

Summing up, the overall analysis shows that it is mainly the purchase of inputs from low labour cost economies to increase the job separations. This effect is however heterogeneous according to the workers' skill level. While for blue collar workers this effect mainly consists of a greater probability to be driven out of manufacturing, skilled workers experience a transition to another manufacturing job following the sectoral process of delocalisation. Thus, the main focus of policy intervention should be on low skilled workers, who are those mostly affected by the process of fragmentation of production across countries and, more in general, by the deeper and deeper integration of countries, as also shown by the indicator of import penetration.

7 Conclusions

The consequences of offshoring activities in advanced countries depend on the time horizon. The theoretical possibility of increased job exit rates from offshoring in the short run is offset by the long run productivity gains accruing to all the workers involved in manufacturing production. Nevertheless, it may well take a long time before the firm may reap the gains from increased spacialisation and succeed in increasing its competitiveness. Meanwhile, the adjustment process may produce long-lasting economic and social costs. Regardless of the potential long run benefits of delocalisation, the short run consequences of offshoring are a relevant issue from the policy viewpoint, since any policy intervention should be firstly concerned with restraining the immediate welfare costs and with easing the transition to a new equilibrium. For this reason, the focus of our work is on the impact of offshoring on employees' job stability.

In the empirical analysis, we have used two types of duration models. First, we have estimated a single risk model to understand the impact of offshoring on the general job exit rate. Second, in a competing risks framework, we have analysed the potential heterogenous impact of offshoring on the transitions out of manufacturing and on the job-to-job transitions within manufacturing.

Our findings suggest that the process of international fragmentation of production contributed to significantly reduce the job stability in the Italian manufacturing sector. The effect of offshoring is however heterogeneous

Table 4: Estimation Results of the Competing Risks Models

	All employees		White collars		Blue collars	
	(1)	(2)	(3)	(4)	(5)	(6)
			Out of manufacturing			
OFF_{Kibs}	0.220	0.175	-0.010	-0.067	0.287	0.247
	[0.189]	[0.186]	[0.343]	[0.32]	[0.229]	[0.225]
OFF^{High}_{narrow}	0.016		0.008		0.020	
	[0.021]		[0.040]		[0.024]	
OFF^{Low}_{narrow}	0.091**		0.030		0.105**	
	[0.036]		[0.081]		[0.045]	
OFF^{High}_{broad}		0.007		0.014		0.007
		[0.016]		[0.029]		[0.019]
OFF^{Low}_{broad}		0.083***		0.037		0.092***
		[0.033]		[0.067]		[0.039]
$ImpPen_j$	0.368***	0.369***	0.225	0.213	0.399***	0.404***
	[0.132]	[0.133]	[0.266]	[0.267]	[0.154]	[0.154]
$Unemp^{reg}$	-0.011	-0.011	0.019	0.019	-0.021	-0.021
	[0.025]	[0.025]	[0.053]	[0.053]	[0.028]	[0.028]
$InformalLab^{reg}$	-0.013	-0.012	0.037	0.037	-0.020	-0.020
	[0.027]	[0.027]	[0.056]	[0.056]	[0.031]	[0.031]
LP_j	-0.010	0.036	0.353	-0.362	-0.179	-0.120
	[0.248]	[0.248]	[0.464]	[0.465]	[0.292]	[0.292]
ICT_j	0.080	0.079	-0.265	-0.277	0.204	0.207
	[0.178]	[0.173]	[0.370]	[0.358]	[0.204]	[0.199]
			Job to job within manufacturing			
OFF_{Kibs}	0.767***	0.661***	0.373	0.263	0.865***	0.762***
	[0.181]	[0.172]	[0.392]	[0.372]	[0.204]	[0.195]
OFF^{High}_{narrow}	0.040*		0.060		0.029	
	[0.022]		[0.043]		[0.026]	
OFF^{Low}_{narrow}	0.079		0.226**		0.038	
	[0.047]		[0.093]		[0.054]	
OFF^{High}_{broad}		0.037**		0.040		0.033*
		[0.017]		[0.035]		[0.020]
OFF^{Low}_{broad}		0.081**		0.185**		0.055
		[0.040]		[0.078]		[0.046]
$ImpPen_j$	0.325***	0.312***	0.503**	0.504**	0.274**	0.296**
	[0.117]	[0.118]	[0.022]	[0.224]	[0.138]	[0.140]
$Unemp^{reg}$	-0.043*	-0.044*	-0.088*	-0.088*	-0.026	-2.753
	[0.024]	[0.024]	[0.050]	[0.050]	[0.027]	[2.718]
$InformalLab^{reg}$	-0.047*	-0.048*	-0.135**	-0.135**	-0.026	-2.759
	[0.026]	[0.026]	[0.059]	[0.588]	[0.030]	[2.987]
LP_j	-0.372*	-0.261	-0.258	-0.089	-0.407*	-4.460
	[0.194]	[0.197]	[0.435]	[0.447]	[0.217]	[3.697]
ICT_j	0.156	0.126	0.229	0.230	0.141	1.010
	[0.159]	[0.155]	[0.326]	[0.321]	[0.184]	[1.809]
NT	511,919	511,919	146,218	146,218	365,701	365,701
N	19,259	19,259	4,589	4,589	14,670	14,670
Log-likelihood	-60,507.4	-60,505.1	-14,318.4	-14,318.2	-46,179.1	-46,177.8

Notes: * Significant at 10% level; ** significant at 5% level; *** significant at 1% level. Standard errors are in brackets. Dummy indicators for regions, years, sectors are included in all estimations but not reported for the sake of brevity. The reference category ia made up of Italian male employees working in firms smaller than 20 employees in the sector of *Furniture and other manufacturing industries*, entering the sample in the first quarter of 1995, and living in Sardinia.

across skill groups and depends on the origin country of inputs. As a matter of fact, imports of intermediates from low labour cost countries appear to significantly and more strongly reduce the job stability of workers. However, while these foreign input flows foster the within manufacturing job-to-job transitions for white collars, they instead contribute to drive blue collars out of manufacturing. Therefore, the most detrimental effects of offshoring are experienced by this latter category of workers. Also, we provide evidence that the competitive pressure from foreign countries on the domestic markets, captured by the sectoral import penetration, increases the probability of unskilled workers to exit the manufacturing sector. This suggests that the general international integration process, captured by both the expansion in offshoring activities and the increased import penetration, is driving the dismantling of manufacturing activities, at least of those activities characterised by less knowledge/technology intensity and by more routinely tasks. As a consequence, policy makers should especially devote their attention to displaced low skilled workers and should ease their re-training and their skill upgrading, in order to foster their transition to more knowledge intensive jobs, which are less affected by the international competition in terms of job displacement.

Appendix

A The Likelihood function with Single Risk

In what follows, we suppress the set of observed and unobserved characteristics for the sake of keeping the notation as simple as possible. We are however implicitly conditioning on them. In the data duration is measured in discrete time. We assume that the discrete time process is generated by some underlying continuous time process. Since we have monthly data, we do not exactly know when the job exit occurs within two consecutive months. Hence, the contribution to the likelihood function of a complete job spell after t months is the unconditional probability $\Pr(t-1 \leq T < t)$. It can be rewritten as the difference of two survivor functions, i.e.

$$\Pr(t-1 \leq T < t) = \Pr(T \geq t-1) - \Pr(T > t). \tag{A.1}$$

The survivor function until the end of the $(t-1)$-th month is given by

$$\begin{aligned}\Pr(T \geq t-1) &= \exp\Big\{ -\int_0^{t-1} \exp\big[-\theta(r)\big]dr \Big\} \\ &= \exp\Big\{ -\int_0^{1} \exp\big[-\theta(r)\big]dr - \int_1^{2} \exp\big[-\theta(r)\big]dr - \dots \\ &\dots \quad -\int_{t-2}^{t-1} \exp\big[-\theta(r)\big]dr \Big\}.\end{aligned}$$

Under the assumption that the job hazard rate is constant within two consecutive months, the hazard rates can be taken out of the integrals, yielding

$$\Pr(T \geq t-1) = \prod_{r=1}^{t-1} \exp\big[-\theta(r)\big] \equiv S(t-1). \tag{A.2}$$

We can similarly formalize $Pr(T > t)$. At this point we have all the components of the contribution to the likelihood function in (A.1), which is equal to the one in Equation (6).

B The Likelihood Function with Competing Risks

In a competing risks framework, at each point of time the origin spell can be terminated because of multiple reasons. Suppose that after t months of job tenure, an employee makes a transition to the destination state k ($k = 1, \dots, K$). D_k is an indicator variable equal to 1 if an employee makes a transition to k and 0 otherwise. The contribution to the likelihood function is the unconditional probability of jointly observing the departure from the origin state and the transition to k after t months of job tenure. Formally, this probability is $\Pr(t-1 \leq T < t, D_k = 1)$ and can be rewritten as the product of the survivor function and of a conditional probability, i.e.

$$\Pr(T \geq t-1)\Pr(t-1 \leq T < t, D_k = 1 | T \geq t-1). \tag{B.1}$$

The survivor function in the origin state for $t-1$ months is given by

$$\begin{aligned}\Pr(T \geq t\text{–}1) &= \exp\Big\{ -\int_0^{t-1} \sum_{k=1}^{K} \theta_k(r)dr \Big\} \\ &= \exp\Big\{ -\int_0^{1} \sum_{k=1}^{K} \theta_k(r)dr - \int_1^{2} \sum_{k=1}^{K} \theta_k(r)dr - \dots - \int_{t_s-2}^{t_s-1} \sum_{k=1}^{K} \theta_k(r)dr \Big\},\end{aligned}$$

< where $\theta_k(r)$ is the transition intensity towards the destination state k, i.e. the instantaneous probability of moving to k conditional on surviving r months in the origin state. As in the single risk case, the K transition intensities are assumed to have a MPH form. Assuming that the transition intensities are constant within two consecutive months, we obtain

$$\Pr(T \geq t-1) = \prod_{r=1}^{t-1} \exp\left\{ -\sum_{k=1}^{K} \theta_k(r) \right\} \equiv S(t-1). \tag{B.2}$$

The conditional probability in (B.1) can be written as

$$\Pr(t-1 \leq T < t, D_k = 1 | T \geq t-1) = \frac{\int_{t-1}^{t} \theta_k(\tau) \exp\left\{ -\int_0^r \sum_{k=1}^{K} \theta_k(r) dr \right\} d\tau}{\exp\left\{ -\int_0^{t-1} \sum_{k=1}^{K} \theta_k(r) dr \right\}} \tag{B.3}$$

and under the assumption that the transition intensities are constant within two consecutive quarters, Cockx (1997) shows that Equation (B.3) can be rewritten as

$$\left[1 - \exp\left\{ -\sum_{k=1}^{K} \theta_k(t) \right\} \right] \times \frac{\theta_k(t)}{\sum_{j=1}^{K} \theta_j(t)}. \tag{B.4}$$

Multiplying (B.2) by (B.4) yields the contribution to the likelihood function of a complete job spell ending in k.

The contribution to the likelihood function of an incomplete (right censored) job spell is simply given by the survivor function, i.e. by

$$\Pr(T \geq t) = \prod_{r=1}^{t} \exp\left\{ -\sum_{k=1}^{K} \theta_k(r) \right\} \equiv S(t).$$

C Additional Figures and Tables

Table C.2: Summary Statistics of Time-Constant Covariates Fixed at Job Entry

	Mean	Std. Dev.	Min.	Max.
Female	0.324	0.468	0.000	1.000
Age	31.112	8.359	20.000	50.000
WhiteCollar	0.238	0.426	0.000	1.000
BlueCollar / Apprentice	0.762	0.426	0.000	1.000
Italian	0.965	0.183	0.000	1.000
ln(wage)	4.006	0.444	-3.553	7.759
WorkExp	16.893	31.968	0.000	286.000
PrevJobs	0.466	0.736	0.000	7.000
Year of entry in the sample				

Continued on next page

Table C.2 – continued from previous page

	Mean	Std. Dev.	Min.	Max.
1995	0.323	0.468	0.000	1.000
1996	0.241	0.427	0.000	1.000
1997	0.230	0.421	0.000	1.000
1998	0.206	0.404	0.000	1.000
Quarter of entry in the sample				
January-February-March	0.336	0.472	0.000	1.000
April-May-June	0.241	0.428	0.000	1.000
July-August-September	0.195	0.396	0.000	1.000
October-November-December	0.229	0.420	0.000	1.000
Region				
Piemonte	0.099	0.299	0.000	1.000
Valle d'Aosta	0.002	0.045	0.000	1.000
Lombardia	0.242	0.429	0.000	1.000
Trentino Alto Adige	0.014	0.117	0.000	1.000
Veneto	0.136	0.343	0.000	1.000
Friuli Venezia Giulia	0.029	0.169	0.000	1.000
Liguria	0.019	0.137	0.000	1.000
Emilia Romagna	0.112	0.315	0.000	1.000
Toscana	0.072	0.258	0.000	1.000
Umbria	0.014	0.119	0.000	1.000
Marche	0.042	0.200	0.000	1.000
Lazio	0.043	0.203	0.000	1.000
Abruzzo	0.028	0.164	0.000	1.000
Molise	0.004	0.060	0.000	1.000
Campania	0.048	0.214	0.000	1.000
Puglia	0.042	0.202	0.000	1.000
Basilicata	0.009	0.093	0.000	1.000
Calabria	0.008	0.090	0.000	1.000
Sicilia	0.025	0.155	0.000	1.000
Sardegna	0.012	0.110	0.000	1.000
Sector				
15 - Food and beverage	0.095	0.294	0.000	1.000
17 - Textile	0.060	0.238	0.000	1.000
18 - Clothing	0.070	0.255	0.000	1.000
19 - Leather and leather products	0.048	0.214	0.000	1.000
20 - Lumber and wood (no furniture)	0.032	0.177	0.000	1.000
21 - Paper and paper products	0.016	0.124	0.000	1.000
22 - Editing and printing	0.030	0.171	0.000	1.000
24 - Chemicals	0.047	0.211	0.000	1.000
25 - Plastic materials and rubber	0.046	0.210	0.000	1.000
26 - Non-metallic mineral products	0.055	0.228	0.000	1.000
27 - Iron and steel	0.029	0.168	0.000	1.000
28 - Metallic products	0.189	0.392	0.000	1.000
29 - Machines	0.096	0.294	0.000	1.000
30 - Office machines	0.014	0.119	0.000	1.000
31 - Electrical machines	0.051	0.219	0.000	1.000
32 - Broadcasting and communications equipment	0.025	0.155	0.000	1.000
33 - Surgical and medical instruments	0.021	0.144	0.000	1.000
34 - Vehicles	0.024	0.152	0.000	1.000
35 - Other vehicles	0.013	0.114	0.000	1.000
36 - Furniture and other manufacturing industries	0.038	0.190	0.000	1.000
Firm size in number of employees				
$(0, 20]$	0.362	0.481	0.000	1.000
$(20, 49]$	0.152	0.359	0.000	1.000
$(49, 249]$	0.212	0.409	0.000	1.000
$(249, 549]$	0.061	0.240	0.000	1.000
550 or more	0.213	0.410	0.000	1.000
# of individuals N		19,259		

Table C.1: Definition of Variables

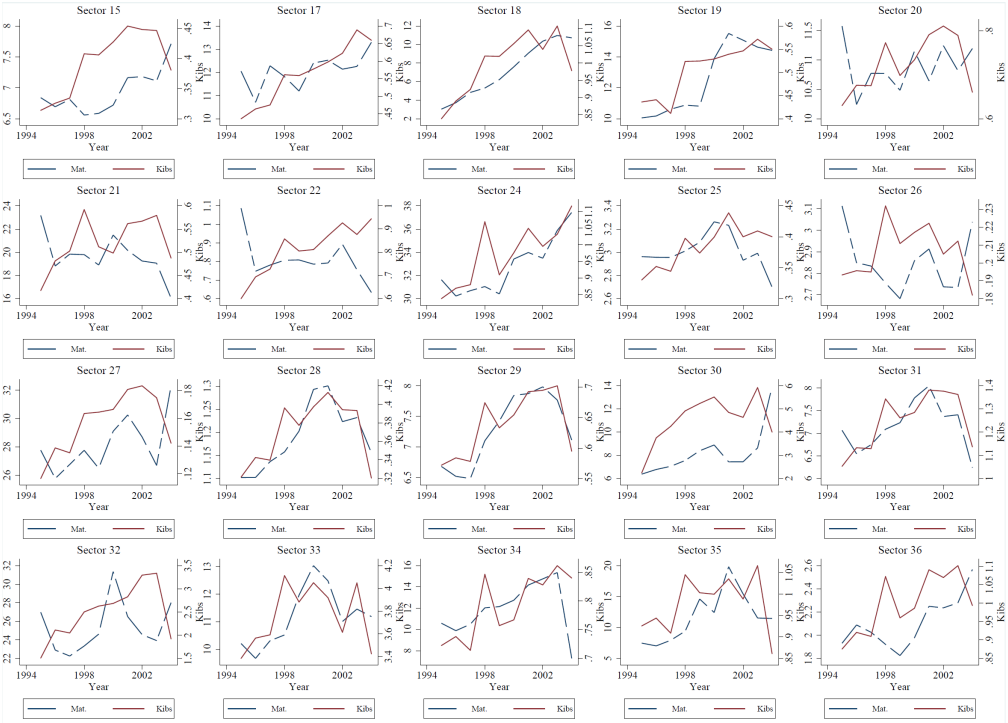
Variable	Description
Female	Dummy for the employees' gender. 1 for Female, 0 for Male. Source: ISFOL database
Age	Age of the employee (in years). Source: ISFOL database
WhiteCollar	Dummy for the skill level of job. 1 for white collar jobs, 0 for Blue Collar jobs. Source: ISFOL database
Italian	Dummy for the employees' nationality. 1 for Italian workers, 0 for migrants. Source: ISFOL database
ln(wage)	Logarithm of the daily gross wage. Source: ISFOL database
WorkExp	Worker experience computed as the number of months the employee has worked till the start of the current job. Source: ISFOL database
PrevJobs	Number of previous jobs of the worker. Source: ISFOL database
Quarter2	Dummy with value 1 for workers hired in the months April-May-June. Source: ISFOL database
Quarter3	Dummy with value 1 for workers hired in the months July-August-September. Source: ISFOL database
Quarter4	Dummy with value 1 for workers hired in the months October-November-December. Source: ISFOL database
FirmSize2	Dummy with value 1 for workers employed in firms with more than 20 employees but less than 50. Source: ISFOL database
FirmSize3	Dummy with value 1 for workers employed in firms with more than 50 employees but less than 250. Source: ISFOL database
FirmSize4	Dummy with value 1 for workers employed in firms with more than 250 employees but less than 550. Source: ISFOL database
FirmSize5	Dummy with value 1 for workers employed in firms with more than 550 employees. Source: ISFOL database
OFF_{Kibs}	Offshoring of KIBS. Source: Istat and WITS-COMTRADE
OFF_{narrow}	Narrow indicator of Offshoring of Material Intermediates. Source: Istat and WITS-COMTRADE
$\text{OFF}_{narrow}^{High}$	Narrow indicator of Offshoring of Material Intermediates to High Income Countries. Source: Istat and WITS-COMTRADE
$\text{OFF}_{narrow}^{Low}$	Narrow indicator of Offshoring of Material Intermediates to Low Income Countries. Source: Istat and WITS-COMTRADE
OFF_{broad}	Broad indicator of Offshoring of Material Intermediates. Source: Istat and WITS-COMTRADE
$\text{OFF}_{broad}^{High}$	Broad indicator of Offshoring of Material Intermediates to High Income Countries. Source: Istat and WITS-COMTRADE
OFF_{broad}^{Low}	Broad indicator of Offshoring of Material Intermediates to Low Income Countries. Source: Istat and WITS-COMTRADE
ImpPen_j	Sectoral Import Penetration Ratio. Source: Istat and WITS-COMTRADE
Unemp^{reg}	Regional Unemployment Rate. Source: Istat
InformalLab^{reg}	Regional estimated share of illegal (informal) employment. Source: Istat
LP_j	Logarithm of the sectoral labour productivity (Value Added/Employment). Source: Istat
ICT_j	Logarithm of the sectoral capital stock in office machines, telecommunication apparatus and software over the total sectoral employment. Source: Istat

Table C.3: Summary Statistics of Time-Varying Covariates at Sampling Date

	Mean	Std. Dev.	Min.	Max.
OFF_{Kibs}	0.695	0.671	0.116	4.919
OFF_{narrow}	7.907	7.866	0.748	31.630
$\text{OFF}^{High}_{narrow}$	6.545	7.086	0.730	29.667
$\text{OFF}^{Low}_{narrow}$	1.362	1.803	0.017	7.535
OFF_{broad}	19.824	9.102	8.882	54.819
$\text{OFF}^{High}_{broad}$	3.280	1.838	0.977	7.966
OFF^{Low}_{broad}	16.668	8.996	7.646	51.465
ImpPen_j	0.226	0.246	0.011	1.292
Unemp^{reg}	8.945	4.748	3.900	24.200
InformalLab^{reg}	13.130	3.988	10.200	28.300
ICT_j	-5.878	0.948	-7.180	-1.952
LP_j	3.63	0.278	2.69	4.36
# of individuals N		19259		

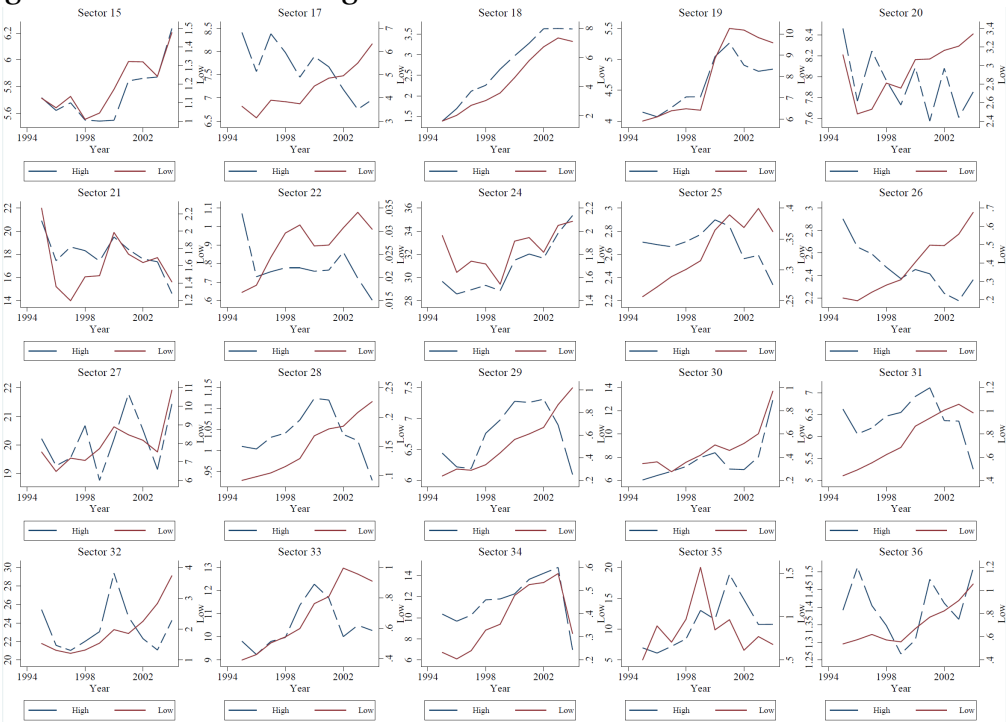
Source: ISFOL database.

Figure C.1: Evolution of Material and Service Offshoring by 2 digit NACE Manufacturing Sector



Notes: The graphs present two scales, the one on the vertical axis on the left for material offshoring and the one on the right for offshoring of KIBS. Sector names are reported in Table C.2.
Source: WITS-COMTRADE database and ISTAT.

Figure C.2: Offshoring evolution split by origin of material intermediates and 2 digit NACE Manufacturing Sector



Notes: The graphs present two scales, the one on the vertical axis on the left for material offshoring to high income countries and the one on the right for offshoring to low income countries. Sector names are reported in Table C.2.
Source: WITS-COMTRADE database and ISTAT.

Table C.4: Pairwise Correlations

	OFF_{narrow}	OFF_{broad}	OFF_{Kibs}	OFF^{High}_{narrow}	OFF^{Low}_{narrow}	OFF^{High}_{broad}	OFF^{Low}_{broad}	$ImpPen_j$	$Unemp^{reg}$	$InformalLab^{reg}$	VA_j	ICT_j
OFF_{narrow}	1.000											
OFF_{broad}	0.623	1.000										
OFF_{Kibs}	0.170	0.649	1.000									
OFF^{High}_{narrow}	0.974	0.660	0.221	1.000								
OFF^{Low}_{narrow}	0.506	0.114	-0.125	0.297	1.000							
OFF^{High}_{broad}	0.599	0.980	0.660	0.674	-0.041	1.000						
OFF^{Low}_{broad}	0.264	0.223	-0.021	0.085	0.792	0.025	1.000					
$ImpPen_j$	0.105	0.096	0.115	0.167	-0.194	0.148	-0.235	1.000				
$Unemp^{reg}$	-0.008	-0.012	0.038	-0.008	-0.005	-0.007	-0.026	-0.065	1.000			
$InformalLab^{reg}$	0.000[§]	-0.012	0.046	-0.006	0.021	-0.013	0.004	-0.082	0.892	1.000		
VA_j	-0.245	-0.582	-0.670	-0.199	-0.272	-0.542	-0.223	0.318	-0.086	-0.081	1.000	
ICT_j	0.451	0.784	0.800	0.510	-0.039	0.806	-0.029	0.100	0.016	0.022	-0.658	1.000

[§] Not significantly different from zero at the 10% level. All the other correlations are significant at the 1% level.

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