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Skill upgrading, wage gap and international trade: firm-level evidence for Italian manufacturing firms

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Skill upgrading, wage gap and international trade: firm-level evidence for Italian manufacturing firms

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Abstract

This paper aims at investigating the evolution of the employment and wage structure of Italian manufacturing firms in the early 2000s. The work analyzes whether skills and wage movements have been taken place between or within sectors, and within sector, between or within firms. We show that most of the changes are reported within firms and that the rise in the share of skilled workers in the wage bill is due to an increase in the relative demand for skilled labor. The analysis reveals that the relative price of the skilled factor does not adjust positively: the wage premium inside firms indeed falls. The results also suggest that while the relative number of hours worked by skilled workers within firms rises, the hourly wage premium falls. The drop in the hourly wage premium is even larger than that in the annual wage gap. Finally, we observe that the within-firm skill upgrading is strongly and significantly related to trade activities. On the contrary, a firm's change in wage premium is uncorrelated to its level of commitment to international exposure.

Keywords: heterogeneous firms, wage premium, skill upgrading, international trade
JEL codes: F16, J21, J24

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1. Introduction

The increasing share of skilled workers in labor force and the widening of the wage gap over the last three decades are largely documented for the U.S. and other OECD countries. The argument is nowadays very much debated and several studies concentrate on those factors underpinning movements in the relative demand for skills.

The early empirical literature, based on industry data, agrees that the skill-biased technical change has been the major responsible for the skill upgrading and the rising wage gap (Katz and Murphy, 1992; Bound and Johnson, 1992; Machin and VanReenen, 1998). This conclusion is supported by the fact that most of the variation in skill utilization occurs *within* industries.[1] Explanations based on product demand shifts, such as international trade as modeled in standard trade theories, predict instead shift of workers *between* sectors. Countries having a more skilled labor force specialize in industries that use such factor more intensively. As a result of an expansion of trade, workers should move from contracting industries towards expanding ones, changing the aggregate ratio between skilled and unskilled workers and their relative wages.

However, at least some of the observed within sector changes in labor composition and relative wages can be attributed to international trade once intra-industry heterogeneity is allowed for, and the possibility that firms active in a given sector differ in terms of their international involvement is acknowledged. In line with this view, recent works reconsider the role played by trade in the shifts of employment and wages. Empirical literature, increasingly based on firm level data, recognizes that differences of international involvement within industries may be associated with diversities in skill composition and in relative wage (Bernard and Jensen, 1997; Biscourp and Kramarz, 2007; Manasse and Stanca, 2006). Indeed, exporters pay higher wages and have more skilled workers than their domestic counterparts (Bernard and Jensen, 1995; Serti et al., 2010).[2] Theoretically, new models of firm-heterogeneity have identified several channels through which international trade could be responsible for *within* industry shifts (Yeaple, 2005; Kugler and Verhoogen, 2012; Verhoogen, 2008).

Consistent with the increasing attention given by theoretical and empirical literature to the link between firms' heterogeneity and distributional patterns, this paper aims at investigating the employment structure and the wage dynamic of Italian manufacturing firms in the early 2000s. After exploring the skill and wage movements across sectors and firms, the work relates the changes in skill intensity and wage premium to the firms' level of commitment to trade activities. Specifically, the paper is developed along three different lines of analysis.

First, we detect the direction of skill and wage changes. We decompose the aggregate share of skilled workers in wage bill in changes in the skill utilization and changes in wage premium. We further disentangle these movements in shifts between or within sectors, and

[1] According to the skill biased technical change view, rapid technological change, especially when associated with the widespread introduction of computers, modifies the workforce composition, increasing the employment share of skilled workers and reducing the demand for unskilled workers and thereby their wages.

[2] A large number of micro-level studies looks, instead, at the relationship between innovation and skilled workers (See Vivarelli, 2012, for a recent survey of the literature). Other works consider the relationship between trade, technology and skills composition (Meschi et al., 2011; Caselli, 2014; Bloom et al., 2011).

within sector, between or within firms. Our main contribution rests in providing a framework that combines consistently the industry level analysis with the firm one. The direction of the movements is crucial to understand the theoretical framework that applies best to investigate which are the factors behind these changes.

Second, we perform a decomposition exercise that accounts for changes in the hourly wage premium and skill intensity. Indeed, labor market reforms in favor of greater flexibility introduced in Italy during the period examined may have induced firms to operate over the structure of the workforce by changing the relative number of hours worked by the skilled workers, i.e. through the intensive margin. Considering annual rather than hourly wages, as generally done in literature, may indeed be misleading. Changes in the average hours worked at the firm will eventually be accounted in factor prices (annual wages) rather than in quantity movements (total hours employed).

Third, we investigate whether firms involved in international trade exhibit peculiar characteristics in terms of variation of workforce composition and wage gap. The available information on both imports and exports enables us to differentiate between these two trade activities. This distinction has important implications as it helps overcome a frequent limitation in international trade literature, which has been mainly focused on exports while imports have largely been left out of empirical studies.[3] Moreover, we assess whether changes in the wage premium and the skill structure of trading firms are related to the country of destination and origin. This empirical exercise is helpful in examining whether different competencies are required for firms exporting (or importing) to different markets.

Our analysis suggests that there has been a restructuring process in terms of skill composition among Italian manufacturing firms during the early 2000s. In line with what have been observed in other studies (Bugamelli et al., 2008), our work provides evidence of a skill upgrading mechanism which mainly occurs within firms. The analysis reveals that trade activities are linked to this firms' reallocation process of jobs between skilled and unskilled workers. Although we can not give any causal interpretation to our results, the findings are consistent with the hypothesis that the strong and sharp increase in competitive pressure following the international integration of markets matched with the process of European integration, triggered a restructuring process that occurred within rather than across firms. Indeed, we observe that exporters and importers, which are likely the ones that suffered more form the rising international competition, have reallocated more greatly jobs towards skill intensive workers.

The analysis shows that the relative price of the skilled factor does not adjust positively as a consequence of the rise in the demand for skilled labor. The wage premium inside firms indeed falls, which means that the wage gap narrows.[4] Moreover, the movements in wage premium seem to be mostly uncorrelated to firms' trade characteristics that instead discriminate over the shifts in the skill intensity. The fact that relative prices do not adjust to factor movements can be at least partly explained by the Italian wage bargaining mechanism which inhibits any wage-productivity link (Schindler, 2009).[5] In general, the fall in the wage

[3]See Crino' (2012) for a study on the effect of imported inputs on the relative demand for high-skill labor.

[4]This result is in line with the findings of Naticchioni and Ricci (2010) that observe a decreasing trend of wage inequality using Italian household income and wealth data for the period 1993-2006.

[5]Manasse and Manfredi (2014), using sectoral level data, suggests that in Italy in contrast with Germany

premium may be related to the implementation in Italy, during the period examined, of labour market reforms aimed at increasing the labor market flexibility. Some scholars have argued that the enhanced flexibility has mostly concerned younger skilled workers entering the labor market. Despite a higher level of educational attainment, they have suffered a relative loss in entry wages compared with the preceding generations (Rosolia and Torrini, 2007).

Our paper relates to the flourishing empirical literature that identifies trade as a possible source of movements in skill intensity and wage differentials. A first set of papers decompose the aggregate change in wages and employment structure in between and within movements across sectors and firms. Bernard and Jensen (1997) propose a decomposition analysis at both industry and firm level that considers separately the movements in the skill intensity and in the relative wage bill ratio. Biscourp and Kramarz (2007) elaborate an harmonized framework that integrates the industry level with the firm level analysis. However, the authors study only the skill structure of the workforce rather than dealing with both movements in relative employment and wage ratio. Manasse and Stanca (2006) propose a decomposition that nests the wage bill with employment and wage but run the analysis only at the firm level without accounting for industrial differences. Our main contribution consists in providing a decomposition framework that combines consistently the industry level analysis with the firm one and that contemporaneously takes into account changes in skill intensity and wage differentials. A second set of recent contributions directly tackles the issue of causality in the relationship between exporting, wages and skill composition (Bustos, 2011; Brambilla et al., 2012; Verhoogen, 2008).[6] Although we cannot interpret our results in any causal sense, our analysis provides empirical support for the relationship between trade activities and firms' employment and wage structures. We confirm previous findings and extend the analysis in a number of directions.

Our work is also related to the few empirical papers that consider the restructuring process undertaken by Italian manufacturing firms in the last decades as the effects of international competition and technological changes. Bugamelli et al. (2008) suggest that the single market and the euro had the effect of triggering a restructuring process that occurred within rather than across firms. They observe a shift of business focus from production to upstream and downstream activities and a corresponding reduction in the share of blue collar workers within firms. Vivarelli and Piva (2001) find that the reorganization process of production has a significant impact on workers and on the upgrading of the labor force.

The rest of the paper is structured as follows. Section 2 describes the dataset and the construction of the variables that will be used in the empirical analysis. Section 3 outlines the industry and firm level decomposition framework and shows the results of this decomposition. Section 4 provides evidence on the role of trade in driving firms' skill reallocation and wage premium changes. Section 5 concludes.

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wages do not substantially reflect sector productivity in the short run, while in the long-run, they tend to rise in sectors in which productivity falls.

[6]Other works matched employer-employee data to study the relationship between exports and workers' wages. See, among others, Frias et al. (2012); Schank et al. (2007); Macis and Schivardi (2012).

Table 1: Variables codes and coverages

Variable Name	Notation	Source	Years covered
Total wage bill	WB	Micro.3	2001-2006
Wage bill to skilled workers	WB_{sk}	Micro.3	2001-2006
Wage bill of unskilled workers	WB_{un}	Micro.3	2001-2006
Number of employees	L	Micro.3	2001-2006
Skilled workers	L_{sk}	Micro.3	2001-2006
Unskilled workers	L_{un}	Micro.3	2001-2006
Total hours worked	H	Micro.3	2001-2006
Hours worked by skilled labor	H_{sk}	Micro.3	2001-2006
Hours worked by unskilled labor	H_{un}	Micro.3	2001-2006
Exports	Exp	COE	2001-2006
Imports	Imp	COE	2001-2006

Note: Table reports the variables used in the empirical analysis and their relative time availability

2. Data

The empirical analysis is based upon two firm-level datasets collected by the Italian Statistical Office (ISTAT), namely 'Statistiche del Commercio Estero' (COE) and the accounting dataset Micro.3.[7] The link between Micro.3 and COE is done by means of the Italian Register of Accounting firms coding system (ASIA).

The COE dataset is the official source for the trade flows of Italy and it reports all cross-border transactions performed by Italian firms during the period 2001-2006. The database includes the value of the transactions, on a yearly basis, of the firm as disaggregated by countries of destination for exports and markets of origin for imports.[8]

Data on firm level characteristics are obtained from Micro.3, which includes census data on Italian firms with more than 20 employees from all sectors of the economy, these are observed over the period 1998-2006.[9] Since 1998, census data cover the population of firms with over 99 employees, and collect information of firms in the employment range 20-99 through a 'rotating sample'. In order to complete the coverage of firms in that range, from 1998 onward Micro.3 complements census data with data from the compulsory financial statement of limited liability companies.[10] A legitimate concern is whether the database Micro.3 is representative enough of the Italian manufacturing industry. The representativeness

[7]The dataset has been made available for work after careful screening to avoid disclosure of individual information. The data were accessed at the ISTAT facilities in Rome.

[8]ISTAT collects data on trade based on transactions. The European Union sets a common framework of rules but leaves some flexibility to member states. A detailed description of requirements for data collection on trade in Italy is provided in the Appendix A. Although only annual values which exceeds a threshold are reported in the dataset, this is unlikely to affect our analyses as the transactions collected cover about 98% of the total Italian trade flows (http://www.coeweb.istat.it/default.htm).

[9]The database has been built as a result of collaboration between ISTAT and a group of LEM researchers from the Scuola Superiore Sant'Anna, Pisa. See Grazzi et al. (2009) for more details.

[10]Limited liability companies (societa' di capitali) have to provide a copy of their financial statement to the Register of Firms at the local Chamber of Commerce.

Table 2: Number of active, continuous, exporting and importing firms

Year	Active firms	Continuous Firms	Exporters	Importers
2001	10683		8971	9118
2002	9966	4472	7981	8079
2003	11923	4893	9837	9972
2004	11461	6683	9094	8661
2005	11167	6551	8977	8490
2006	11187	6588	8986	8614

Note: Active firms are those firms that are present in the sample in that specific year, continuous firms are those that are active in that year and in the next one.

of Micro.3 has been checked in relation to data from Eurostat: the coverage provided by Micro.3 for the whole Italian economy is fairly large: around 40% for employment and 50% when considering the value added (Grazzi et al., 2009).

The Micro.3 database contains information on a number of balance sheet items. For the purpose of our work we utilize: value added, sales, value of production, tangible fixed assets, number of employees and number of hours worked, wage bill and workforce composition.[11] Data on employment, wage bill and number of hours worked are available separately for manual workers (including blue collars, assistants, trainees and home-based workers[12]) and non-manual workers (executives and clerks[13]). We consider production and non-production workers as a proxy for unskilled and skilled labor, respectively. Ideally, we would rather work with more specific information on the demographic components of the firm workforce in order to further investigate the skill structure and the wage skill premium. Although this categorization is rather imprecise, Goldberg and Pavcnik (2007) note that cross tabulations of matched worker and employer surveys at the plant level in the United States and the United Kingdom indicate a close relationship between the production/non-production status of workers and their educational level. Table 1 reports the main variables used in the empirical analysis and their relative sources.

After merging these two databases, we obtain an unbalanced panel of active manufacturing firms over the sample period, as shown in Table 2. The Table reports also the number of continuous firms that are those firms that are active at time t and $t+1$. Indeed, the empirical analysis that follows is based on year by year growth rates, thus making use of those firms that produce on a continuous basis for at least two years. In Appendix B we check whether we introduce any sample-selection bias when considering the balanced dataset. Table 2 also distinguishes between the number of exporters and the number of importers. Approximately two-thirds of manufacturing firms are internationalized over the 2001-2006 period.[14]

[11]Nominal variables are in million euros and are deflated using 2-digit industry-level production prices indices provided by ISTAT.

[12]Respectively, *operai*, *commessi*, *apprendisti* and *lavoratori a domicilio*.

[13]Respectively, *dirigenti* and *impiegati*.

[14]Note that the high percentage is partly explained by the fact that in our sample only firms with more than 20 employees are considered. Since smaller firms are less likely to enter foreign markets, either by means of exports or imports, we end up with a larger fraction of internationalized firms compare to the universe of

Table 3: Descriptive statistics: Employment and Wages

Sample	$\frac{WBsk}{WB}$ (1)	WP (2)	SI (3)	W (4)	Wsk (5)	Wun (6)	L (7)	Lsk (8)	Lun (9)	Obs (10)
Overall	48.92	140.61	34.79	25.10	35.30	19.66	10077	3506	6571	66387
2001	47.68	141.35	33.73	24.06	34.01	19.00	1785	602	1183	10683
2002	47.89	144.66	33.10	24.27	35.11	18.91	1268	420	848	9966
2003	48.39	141.43	34.21	24.89	35.20	19.53	1742	596	1146	11923
2004	49.44	140.66	35.15	25.36	35.67	19.77	1765	620	1145	11461
2005	50.36	139.50	36.10	25.81	36.00	20.05	1761	636	1125	11167
2006	49.35	137.13	35.99	26.00	35.66	20.58	1757	632	1125	11187
Small	36.31	141.79	25.97	19.00	26.94	16.52	840	218	622	26186
Medium	43.79	138.49	31.64	23.31	32.27	19.16	3674	1166	2508	32142
Large	53.08	139.44	38.08	27.12	37.81	20.55	5563	2122	3441	7429
North	49.04	139.80	35.10	25.52	35.66	20.03	7793	2739	5054	46263
Centre	53.81	139.89	38.50	25.31	35.40	19.01	1365	528	837	10862
South	37.66	146.33	25.75	20.84	30.49	17.47	919	239	679	9262
Domestic	33.31	142.53	23.39	18.52	26.40	16.11	418	99	319	7997
Only exporters	32.46	139.14	23.35	18.93	26.33	16.67	267	62	204	5456
Only importers	46.26	145.44	31.86	23.44	34.07	18.43	351	111	238	4544
Imp & Exp	49.82	139.66	35.69	25.61	35.76	19.99	9041	3232	5809	48390

Notes: Values are averages on active firms over the sample 2001-2006. Employment is in thousands. Column 1: ratio between the wage bill of skilled workers and the total wage bill. Column 2: ratio of the annual wage rate of non production workers over the average wage, i.e. wage premium. Column 3: ratio of skilled workers in employment, i.e. skill intensity. Columns 4-6: average wage for all workers (W), for skilled (Wsk) and unskilled (Wun). Columns 7-9: average number of employees (L), of skilled workers (Lsk) and unskilled ones (Lun).

Descriptive statistics for the main variables of interest are reported in Table 3. Between 2001 and 2006, the wage bill ratio increases over almost each year, which reflects a fairly large increase in the skill intensity (SI). On the contrary, the wage premium (WP) is somewhat shrunk. The drop in the wage differential is mainly driven by the fact that the average wage of unskilled workers (Wun) is increasing while that of skilled employees remains fairly constant (Wsk). The Table also confirms the large heterogeneity across firms in the sample, in terms of both wages and employment structure. Large firms and those located in the North of Italy pay substantially greater nominal wages than small and medium firms and they employ the largest share of skilled workers. Finally, much heterogeneity is also detected between firms with different level of participation into international markets. Internationalized firms have a larger share of skilled workers in the wage bill compared to domestic ones. They also employ relatively more skills and have a larger wage premium. Moreover, they pay much higher wages to both types of workers relative to those that only operate in the domestic market.

Italian active firms.

3. Wage and employment decomposition

In this section we decompose the change in the relative wage bill into the respective contribution of skill intensity and wage premium. Each of these components is further disaggregated into the between and within contributions. While the former reflects reallocations of employment and wages that occur between different sectors/firms, the latter identifies changes that occur within individual sectors/firms. Our contribution rests in providing a framework that combines consistently the industry level analysis with the firm one. In addition, we also tailor this framework to the decomposition for the hourly skill intensity and hourly wage premium.

3.1. Industry and firm level decomposition

Following the approach adopted by Biscourp and Kramarz (2007), we run the decomposition analysis both at the industry and firm level. However, we extend their analysis by combining valuations on skill intensity and wage differentials as in Manasse and Stanca (2006). We start with the industrial decomposition with the following equation

$$\underbrace{\Delta\frac{WB_{sk}}{WB}}_{\text{WBtot}} = \Delta\sum_s \frac{W_{sk_s}}{W}\frac{L_{sk_s}}{L} = \underbrace{\sum_s \Delta\frac{W_{sk_s}}{W}\overline{\left(\frac{L_{sk_s}}{L}\right)}}_{\text{Wtot}} + \underbrace{\sum_s \Delta\frac{L_{sk_s}}{L}\overline{\left(\frac{W_{sk_s}}{W}\right)}}_{\text{Ltot}} \tag{1}$$

where the overall change in the wage bill ratio $\Delta\frac{WB_{sk}}{WB}$ is given by the sum of the sectoral (s) wage and employment contributions, $Wtot$ and $Ltot$ respectively. The first term ($Wtot$) is the sum of all changes in wage premium, weighted by the time average share of skilled workers in workforce. The second term ($Ltot$) is the sum of all changes in skill intensities, weighted by the time average of the wage premium. Indeed, changes in skill intensities and wage premium are gauged together by keeping at each stage the other variable constant. Both movements can be further disentangled into the *within* and the *between* sectoral components which represent shifts inside and between different sectors. Therefore, each component of equation 1 can be written as

$$\begin{aligned} Wtot &= \sum_s \Delta\frac{W_{sk_s}}{W}\overline{\left(\frac{L_{sk_s}}{L}\right)} = \\ &= \left[\underbrace{\sum_s \Delta\frac{W_{sk_s}}{W_s}\overline{\left(\frac{W_s}{W}\right)}}_{\text{Wwit}} + \underbrace{\sum_s \Delta\frac{W_s}{W}\overline{\left(\frac{W_{sk_s}}{W_s}\right)}}_{\text{Wbet}}\right]\overline{\left(\frac{L_{sk_s}}{L}\right)} \end{aligned} \tag{2}$$

$$Ltot = \sum_s \Delta \frac{L_{sk_s}}{L} \overline{\left(\frac{W_{sk_s}}{W}\right)} = \\ = \left[\underbrace{\sum_s \Delta \frac{L_{sk_s}}{L_s} \overline{\left(\frac{L_s}{L}\right)}}_{\text{Lwit}} + \underbrace{\sum_s \Delta \frac{L_s}{L} \overline{\left(\frac{L_{sk_s}}{L_s}\right)}}_{\text{Lbet}} \right] \overline{\left(\frac{W_{sk_s}}{W}\right)} \tag{3}$$

where $Wwit$ and $Wbet$ represent the *within* and *between* sectoral components of the $Wtot$ variable and, similarly, $Lwit$ and $Lbet$ represent *within* and *between* sectoral contributions of the $Ltot$ variable.

Moving from sectoral to firm-level analysis, the wage bill ratio movement for each industry s ($\Delta \frac{WB_{sk_s}}{WB_s}$) can be written as the sum of the contributions coming from those firms belonging to the sector

$$\underbrace{\Delta \frac{WB_{sk_s}}{WB_s}}_{WBtot_s} = \Delta \sum_{i \in s} \frac{W_{sk_i}}{W_s} \frac{L_{sk_i}}{L_s} = \underbrace{\sum_{i \in s} \Delta \frac{W_{sk_i}}{W_s} \overline{\left(\frac{L_{sk_i}}{L_s}\right)}}_{Wtot_s} + \underbrace{\sum_{i \in s} \Delta \frac{L_{sk_i}}{L_s} \overline{\left(\frac{W_{sk_i}}{W_s}\right)}}_{Ltot_s}. \tag{4}$$

where the subscript i identifies a firm belonging to s and $Wtot_s$ and $Ltot_s$ are, as before, the wage and employment components but for a single sector s. The two sectoral components can be further disentangled into the respective *within* and *between* firm-level movements for sector s as follows

$$Wtot_s = \sum_{i \in s} \Delta \frac{W_{sk_i}}{W_s} \overline{\left(\frac{L_{sk_i}}{L_s}\right)} = \\ = \left[\underbrace{\sum_{i \in s} \Delta \frac{W_{sk_i}}{W_i} \overline{\left(\frac{W_i}{W_s}\right)}}_{Wwit_s} + \underbrace{\sum_{i \in s} \Delta \frac{W_i}{W_s} \overline{\left(\frac{W_{sk_i}}{W_i}\right)}}_{Wbet_s} \right] \overline{\left(\frac{L_{sk_i}}{L_s}\right)} \tag{5}$$

$$Ltot_s = \sum_{i \in s} \Delta \frac{L_{sk_i}}{L_s} \overline{\left(\frac{W_{sk_i}}{W_s}\right)} = \\ = \left[\underbrace{\sum_{i \in s} \Delta \frac{L_{sk_i}}{L_i} \overline{\left(\frac{L_i}{L_s}\right)}}_{Lwit_s} + \underbrace{\sum_{i \in s} \Delta \frac{L_i}{L_s} \overline{\left(\frac{L_{sk_i}}{L_i}\right)}}_{Lbet_s} \right] \overline{\left(\frac{W_{sk_i}}{W_s}\right)} \tag{6}$$

where $Wwit_s$ and $Wbet_s$ represent the *within* and *between* firm-level components of the

$Wtot_s$ variable. Similarly, $Lwit_s$ and $Lbet_s$ represent *within* and *between* firm-level contributions of the $Ltot_s$ variable.

We then aggregate all movements occurred within each industry, i.e. between and within firms, as a weighted sum of all sectoral $Ltot_s$ and $Wtot_s$ contributions. Since $Ltot_s$ and $Wtot_s$ are the combination of between and within components, we can obtain the overall movement as a weighted sum of $Lbet_s$, $Lwit_s$, $Wbet_s$ and $Wwit_s$ as follows

$$\begin{aligned}\underbrace{\left(\Delta\frac{WB_{sk}}{WB}\right)^{within}}_{WBtot^{wit}} &= \sum_s \underbrace{\overline{\left(\frac{L_s}{L}\right)}Ltot_s}_{\overline{Ltot_s}} + \sum_s \underbrace{\overline{\left(\frac{WB_s}{WB}\right)}Wtot_s}_{\overline{Wtot_s}} = \\ &= \sum_s \underbrace{\overline{\left(\frac{L_s}{L}\right)}Lbet_s}_{\overline{Lbet_s}} + \sum_s \underbrace{\overline{\left(\frac{L_s}{L}\right)}Lwit_s}_{\overline{Lwit_s}} + \sum_s \underbrace{\overline{\left(\frac{WB_s}{WB}\right)}Wbet_s}_{\overline{Wbet_s}} + \sum_s \underbrace{\overline{\left(\frac{WB_s}{WB}\right)}Wwit_s}_{\overline{Wwit_s}}\end{aligned} \tag{7}$$

where we identify each weighted component with an upper bar. We use as weights the relative importance of each sector over all the economy in terms of employment and wage bills, respectively.[15] The weighted aggregation of all these components gives the weighted wage bill variation that has occurred within industries. Note that the weighted average of all movements occurred between and within firms in each sector approximates the within movements computed at the industry level, i.e. $WBtot^{wit} = Lwit + Wwit$.

While decomposition in equation (7) allows to consistently combine the industry level analysis with the firm one, it does not take into account possible restructuring processes that take place through the intensive margin, i.e. the number of hours worked. Indeed, labor market reforms in favor of labor flexibility introduced in Italy in the latest 90s and in the early 2000s may have induced firms to operate over the structure of the workforce by changing the relative number of hours worked by the skilled workers. In particular, the Treu Law (Law 197/1997) addressed the employment issue by introducing temporary contracts and providing incentives for part-time work. Efforts to increase labor flexibility were taken forward with the 2003 Biagi reform (Law 30/2003), which deregulated the use of atypical work arrangements, such as temporary agency work (staff-leasing) and part time work, and introduced new forms of atypical work arrangements such as on-call jobs (*lavoro intermittente*), job sharing and occasional work (*lavoro a progetto*).

Therefore, we move further in the decomposition of relative movements in wages to investigate whether the fall in the annual wage premium follows quantity rather than price adjustments. In particular, the drop in the wage premium may be driven by a reduction in the relative number of hours worked by the skilled factor rather than by a fall in the hourly wage premium enjoyed by non-manual workers. Considering annual rather than hourly wages, that is aggregating together the number of hours worked with the hourly wage rate, as generally done in literature, may be misleading. Changes in the average hours worked at the firm will eventually be accounted in factor price (annual wages) rather than in quantity movements

[15] Results are robust to the use of alternative weighting functions, for example if we apply as weights the relative importance of sectors in terms of wage bills to all types of contributions.

(total hours employed). Thus, we disentangle the sectoral wage premium component ($Wtot_s$) of equation 4 into the quantity ($Htot_s$) and price ($HWtot_s$) movements. In turn, these shifts can be separated into *between* and *within* changes. Details on the hourly decomposition formula are reported in Appendix C.

3.2. Results

All wage and employment structure changes are computed on a yearly basis and then averaged over the span of interest. This approach has the advantage of increasing the number of observations as it requires to balance the panel over only two consecutive years.[16] We start our analysis at the industry level, by distinguishing between movements of workers and wages across and within sectors. Industries are defined by means of the 2-digits NACE nomenclature, which defines 22 manufacturing sectors.[17] The overall wage bill ratio movement is firstly split into the $Wtot$ and $Ltot$ components as shown in equation 1. Then, the two contributions are further disentangled in the *within* and *between* parts as done in equations 2 and 3. Panel a of Table 4 reports the components from the industry level decomposition over the whole span and by sub-periods.

Over the whole span the wage bill ratio component ($WBtot$) increases on average by almost 0.26% per year, which means that the share of non-production workers in wage bill rises. This increase is driven by a large quantity adjustment partially offset by a negative price one: $Ltot$ grows by almost 0.45% annually while $Wtot$ falls by -0.19 % per year. In other words, over the span between 2001 and 2006, on average, we observe a rise in the demand for skilled labor not followed by a relative price adjustment in factors.

Most of the $Ltot$ and $Wtot$ movements occur within sectors. $Lwit$ increases by 0.472% per year while $Wwit$ drops by 0.210% annually. This reflects that, on average, inside sectors unskilled labor is substituted with skilled one, but that unskilled worker wages rise relatively faster than those of skilled ones, i.e. the wage differential narrows. Concerning the *between* components, we note that the $Lbet$ slightly falls by 0.022% per year, while $Wbet$ rises by 0.020% annually. In other words, between 2001 and 2006 occurs a relative expansion of employment in unskilled-intensive sectors, but sectors that mostly rise their overall wage bill are those that pay, on average, higher wage premium. The between changes are however very marginal if compared with the within movements.

We replicate the analysis by dividing the sample into two sup-periods, between 2001-2003 and 2003-2006 to detect possible differences within the time span under investigation. In the first interval the rise in the use of skilled labor ($Ltot$) is more moderate compared to the second period. At the same time, while we detect a negative $Wtot$ between 2001 and 2006, the same component is positive, but very small, for the first three years while is negative and big in the second interval. The decomposition analysis reveals that most of the employment

[16]Taking a balance panel over a longer time period (e.g. 2001-2006) may also introduce a bias. Indeed, because small firms are more likely to exit (Geroski, 1995; Sutton, 1997) using a larger interval increases the probability of selecting only large firms. Also, using a longer interval might end up in selecting the more productive firms that extensively use skilled workers.

[17]We exclude from the analysis industry 16 (Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting material) because of the small number of active firms in this sector.

Table 4: Industry and firm level wage bill share decomposition

Panel a: Industry decomposition

Component	01-06	01-03	03-06
$WBtot$	0.259	0.385	0.172
$Ltot$	0.449	0.296	0.555
$Lwit$	0.472	0.383	0.533
$Lbet$	-0.022	-0.087	0.022
$Wtot$	-0.190	0.089	-0.383
$Wwit$	-0.210	0.051	-0.405
$Wbet$	0.020	0.037	0.022

Panel b: Firm decomposition

Component	01-06	01-03	03-06
$WBtot^{wit}$	0.290	0.44	0.18
$\overline{Ltot_s}$	0.638	0.333	0.847
$\overline{Lwit_s}$	0.629	0.383	0.798
$\overline{Lbet_s}$	0.009	-0.050	0.048
$\overline{Wtot_s}$	-0.348	0.115	-0.666
$\overline{Wwit_s}$	-0.340	0.084	-0.631
$\overline{Wbet_s}$	-0.008	0.030	-0.035

Notes: All components are annual means averages (%). The decomposition is done for the period 2001-2006 and for two sub-periods, 2001-2003 and 2003-2006. Panel a: Industry level wage bill share decomposition. Panel b: Firm level wage bill share decomposition.

and wage movements has taken place in the second half of the period examined.

Our results are not fully comparable with those from previous analyses because of the methodology adopted, the degree of sectoral disaggregation and the time span considered. Still, our results are very much in line with both nature and magnitude of those obtained by Biscourp and Kramarz (2007) for France. On the contrary, for US, Bernard and Jensen (1997) find a substantial higher *between* component, even if it does not exceed the *within* contribution. Moreover, they detect an increasing wage gap between skilled and unskilled workers, around 0.17% per year.

After the sectoral-level decomposition we investigate, within each sector, the firm-level movements using equations 5 and 6. We then aggregate all sectoral contributions as in equation 7 in order to obtain the weighted wage bill variation that has occurred *within* industries, i.e. *between* and *within* firms. Indeed, $WBtot^{wit}$ approximates the sum of the two within components at the industry level, $Lwit$ and $Wwit$, that are shown in panel a of Table 4.[18] In line with previous literature, the firm level decomposition shows similar patterns in the nature of movements to those at the industry level. Indeed, most of the directions (the signs) of the shifts match those obtained in the industry analysis. The magnitudes of these movements are slightly larger at the firm level, especially for the components related to the employment. The change in the weighted non-production share in the wage bill $WBtot^{wit}$ is mostly driven by a quantity adjustment, i.e. an increase in $\overline{Ltot_s}$. The share of skilled workers in employment rises faster in the second period, around 0.85% per year, against the smaller increase by 0.33% in the sub-period between 2001 and 2003. As observed at the industry level, the relative wage share of non production workers $\overline{Wtot_s}$ does no adjust in response to an aggregate increase in the relative demand. Again, the wage component is small but positive (around 0.11% per year) between 2001 and 2003, while large and negative (around -0.67%) in the second interval. Also at the firm level, the employment and wage movements have been stronger in the second period, between 2003 and 2006.

[18]The scant difference between the two measures results from the approximation errors introduced when weighting the contribution from sectors.

Table 5: Hourly firm level wage bill share decomposition

Component	01-06	01-03	03-06
$WBtot^{wit}$	0.322	0.529	0.185
$\overline{Htot_s}$	0.338	-0.494	0.893
$\overline{Hwit_s}$	0.091	-0.197	0.283
$\overline{Hbet_s}$	0.247	-0.298	0.610
$\overline{HWtot_s}$	-0.701	0.568	-1.547
$\overline{HWwit_s}$	-0.483	0.151	-0.906
$\overline{HWbet_s}$	-0.217	0.417	-0.640
$\overline{Ltot_s}$	0.685	0.455	0.838
$\overline{Lwit_s}$	0.696	0.532	0.805
$\overline{Lbet_s}$	-0.011	-0.076	0.033

Notes: All components are annual means averages (%). The decomposition is done for the period 2001-2006 and for two sub-periods, 2001-2003 and 2003-2006.

Most of the movements in the relative employment and wage shares are recorded *within* firms. This is in line with what found in the firm level analysis by Bernard and Jensen (1997), Manasse and Stanca (2006) and Biscourp and Kramarz (2007). The positive $\overline{Lwit_s}$ component reflects that, on average, firms substitute unskilled with skilled labor. In particular, the share of skilled workers in employment rises very fast between 2003 and 2006, around 0.80% per year against the smaller increase by 0.39% over the period between 2001 and 2003. In addition, as we observed in the sectoral analysis, the *within* shift in the relative demand for skilled workers is not followed by an increase in their relative wage ($\overline{Wwit_s}$). The wage premium slightly rises, by about 0.008%, over the period between 2001 and 2003, but it drops substantially, around -0.63 %, over 2003 and 2006. Concerning the *between* firm-level movements we observe that for both components, $Lbet_s$ and $Wbet_s$ the contribution is negligible and close to zero. Indeed, the employment and wage movements are substantially *within* firms.

As a final step, we further disentangle the relative wage movements into the between and within shifts in the hourly skill intensity and hourly wage premium. The drop in the annual wage premium we observed in the firm-level analysis (panel b of Table 4) may be driven both by a fall in the hourly wage premium enjoyed by non-manual workers and by a reduction in the relative number of hours worked by the skilled factor.

Table 5, which reports the results for the hourly decomposition, reveals that fall between 2001 and 2006 in the annual wage premium *within* firms is driven by a strong and negative price adjustment $\overline{HWwit_s}$.[19] Concerning the number of hours worked we observe that the

[19]Since data on hours worked by manual and non manual employees are not available for all the 29,187 observations of the previous decomposition, we have to work with a slightly smaller sample of 28,533 firms. Note that overall $WBtot_s^{wit}$ (0.322%) is only marginally different from that computed over the whole sample (0.29%). Indeed, the reduced sample do not introduce any particular bias.

strong reduction in the hourly wage gap goes together with an increase rather than a decrease in the $\overline{Hwit_s}$ component. The positive $\overline{Hwit_s}$ component suggests that firms substitute unskilled with skilled workers not only in terms of jobs, at the extensive margin, but also in terms of hours, at the intensive margin. Thus, the drop in the annual wage gap is the result of a large and negative $\overline{HWwit_s}$, partially offset by a positive $\overline{Hwit_s}$ movement.

The between contributions, $\overline{Hbet_s}$ and $\overline{HWbet_s}$, are very large and have the same signs of their relative within components. In particular, the number of hours worked per skilled worker grows faster across firms that have a larger hourly skill intensity (positive $\overline{Hbet_s}$), while hourly average wages change greatly across firms that pay smaller hourly wage premium (negative $\overline{HWbet_s}$). The *between* components even if large substantially offset each other.

Looking at the two time intervals we observe that the small movements in the annual wage components detected between 2001 and 2003 in Table 4 are basically driven by the offsetting of the number of hours (H) and hourly wage (HW) components. Indeed, the H and HW components are very similar in magnitude but with opposite signs. On the contrary, in the second time span hourly wage movements ($\overline{HWtot_s}$, $\overline{HWwit_s}$, $\overline{HWbet_s}$) are much larger than changes in the number of hours worked ($\overline{Htot_s}$, $\overline{Hwit_s}$, $\overline{Hbet_s}$).

Some important conclusions can be drown from the decomposition analysis. First, while the results form the industry and the firm level analysis are consistent, changes at the firm level are much greater in magnitude that those at the industry level. In addition, most of the movements are reported within sectors, and inside sectors the greatest variation in skill intensity and wage premium occurs inside firms. Second, the share of skilled workers in the wage bill rises because of an increase in the relative demand for skilled labor. Firms, on average, substitute unskilled with skilled workers over the entire span, increasing the skill intensity of their workforce. The reallocation of workers towards skilled labor has been much faster in the second part of the period analyzed. Third, workers move towards more unskilled intensive sectors. This shift points to the peculiar specialization of Italy in the production of unskilled intensive traditional goods. However, inside sectors more skilled intensive firms expand at the expense of those firms that use relatively more unskilled labor. Forth, the relative price of the skilled factor does not adjust positively as a consequence of the rise in the demand for skilled labor. Indeed, the wage premium inside firms falls. Moreover, the annual wage changes are pushed by a substantial fall in the hourly wage premium enjoyed by skilled workers. As the hourly wage premium falls, firms increase the average numbers of hours worked by the skilled factor. This rise partially offsets the overall effect of the substantial fall in the hourly wage premium over the annual wage gap. Thus, the fall in the hourly wage premium is even larger than that in the annual wage premium.

4. Does trade play a role?

The finding of the decomposition analysis that shifts occur especially within sectors, and inside sectors, within firms, points to models that account for firms' heterogeneity. In what follows we focus on firm level dynamics and we provide evidence of the role of trade in driving firms' skill reallocation and wage premium changes. We start by performing the decomposition for different categories of firms, according to their level of commitment to exporting and importing activities. We then move to a regression framework in order to validate the evidence emerged from the decomposition framework.

Table 6: Firm level wage bill share decomposition: sub-samples averages by trade activities and productivity

Status	$\overline{WBtot_s^{wit}}$	$\overline{Ltot_s}$	$\overline{Wtot_s}$	$\overline{Lwit_s}$	$\overline{Lbet_s}$	$\overline{Wwit_s}$	$\overline{Wbet_s}$	Obs
All	0.290	0.638	-0.348	0.629	0.009	-0.340	-0.008	29187
Hexp	0.184	0.408	-0.224	0.461	-0.053	-0.239	0.015	14567
Lexp	0.103	0.193	-0.090	0.132	0.060	-0.068	-0.022	14620
Himp	0.075	0.256	-0.181	0.333	-0.078	-0.163	-0.018	14567
Limp	0.215	0.352	-0.137	0.266	0.085	-0.149	0.011	14620

Notes: all components are annual means averages (%) over the period 2001-2006. *Hexp* groups those firms that export more than the median value of their sector, while *Lexp* those that export less than the median value. *Himp* groups those firms which import more than the median value, while *Limp* those that import less than it.

4.1. Firm level decomposition by trade status

To give an initial intuition about the main drivers of movements in wages and employment we perform the firm-level decomposition for different categories of firms. We consider the whole span 2001-2006 and we distinguish between those firms with a value of exports above the median computed for each sector, which we define high-exporters (*Hexp*), from those with a value below it, the low-exporters (*Lexp*). Analogously, for imports we identify *Himp* those firms that import a larger value than the median while *Limp* those that import less than it. Thus, we calculate the different components of equation (7) by categories. Results are reported in Table 6.

The figures suggest that export as well as import activities discriminate on the changes in the share of skilled workers in the wage bill. The export status accounts for a substantial part of the skill intensity component. While we observe a within firm employment shifts also in firms that are low intensive exporters, the principal contribution comes from high intensive exporting firms, which have a $\overline{Lwit_s}$ component that is almost more than three times larger than that of less exporting ones. One of the major findings from this decomposition analysis is that the smallness of the $\overline{Lbet_s}$ component over the whole sample results from the aggregation of larger contributions with opposite signs by different categories, which almost offset each other. In particular, $\overline{Lbet_s}$ is positive among low intensive exporters, while negative for high intensive exporters.

This result is in line with what found by Manasse and Stanca (2006) on Italian data over the period 1989-1995. The authors argue that the negative sign of the $\overline{Lbet_s}$ component among exporters stands for the peculiar trade specialization pattern in Italy. More precisely the authors argue that the Italian comparative advantage favors those exporters that produce traditional goods, thus firms that are relatively more unskilled intensive.

Concerning the changes in the wage premium we observe that export activity is discriminant both over the within and between components. More precisely, intensive exporters are responsible for the drop in wage differentials (large and negative $\overline{Wwit_s}$), but they are the ones that increase their average wage faster (positive $\overline{Wbet_s}$). This suggests that in these firms, wages rise in overall with respect to the less intensive exporters, but faster for the unskilled workers than for the skilled ones.

Also import activities play a role on both within and between movements. In particular, firms that are more active in the import market reallocate much faster workers toward skilled labor inside their firms than the low intensive importers. The $\overline{Lwit_s}$ for high intensive importers is indeed more than 25% larger then that for low intensive ones. In addition, similarly to what we see about export activities, high intensive importers account for the the negative $\overline{Lbet_s}$ component. With respect to $\overline{Wtot_s}$, we observe that the import category discriminates only over the *between* component. The negative $\overline{Wbet_s}$ reported for these firms represents a drop in the ratio between the average wage paid by intensive importers and the average wage paid at the sector level.

The decomposition analysis by firms' categories seems to suggest that trade activities discriminate over most of the *within* changes in both skill intensity and wage premium. More intensive exporters and importers modify faster their composition of skills in the workforce, substituting unskilled with skilled labor. However, the evidence emerged from the decomposition framework may results from a spurious relation of firms' trade activity with productivity and size. To account for other firms' level determinants we move, in the next section, to a regression framework.

4.2. Determinants of Skill intensity and Wage differentials

To what extent firms' trade activities explain changes in the skill intensity and wage premium? In order to test the effect of trade on the process of skill reallocation and on changes in wage premium we use the following regression framework

$$\Delta Share^{y}_{i,t} = \alpha + \beta_1 D^{Exp}_{i,t-1} + \beta_2 D^{Imp}_{i,t-1} + \sigma \ln TFP_{i,t-1} + \omega Controls_{i,t} + \epsilon_{i,t} \tag{8}$$

where i indicates the firm, and the superscript y denotes either the skill intensity (SI) or the wage premium (WP). The dependent variable, therefore, represents a firm's annual growth rate either of the skill intensity or of the relative wage of skilled workers. The dummy variables $D^{Exp}_{i,t-1}$ and $D^{Imp}_{i,t-1}$ denote whether firm i at time $t-1$ is an exporter or an importer, respectively. The omitted (reference) group is the non-trading firms. We account for possible effects of firms' productivity on skill composition and wage by including the (log) of TFP.[20] The variable $Controls$ denotes a vector of characteristics including dummies for size together with year, sectoral and provincial dummies.

Our interest lies in the value of the coefficients β_1 and β_2 that tell us the effects on a firm's skill intensity and wage premium growth rate of the two categories of internationalized firms with respect to the non-internationalized firms. Precisely, β_1 captures how exporters differ with respect to domestic firms, while β_2 represents the impact of being an importer on the same baseline. Results are reported in Table 7 for skill intensity, columns 1-2, and wage premium, columns 3-4. For each dependent variable we start by including in the regression only the export dummy (columns 1 and 3) and then add the import status dummy (columns 2 and 4).

[20]We estimate Total Factor Productivity (TFP) following the IV-GMM modified Levinsohn-Petrin procedure proposed in Wooldridge (2009), where material costs are used as a proxy for intermediate inputs. Capital is proxied by tangible fixed assets at book value (net of depreciation). Results, available upon request, are robust if we employ labour productivity.

Table 7: Skill intensity and wage premium growth rate: the role of trade

	ΔSI		ΔWP	
	(1)	(2)	(3)	(4)
D^{Exp}_{t-1}	0.115***	0.078*	0.008	0.011
	(0.044)	(0.040)	(0.016)	(0.017)
D^{Imp}_{t-1}		0.098**		-0.008
		(0.049)		(0.016)
$\ln(TFP)_{t-1}$	0.108***	0.103***	0.025*	0.026*
	(0.020)	(0.020)	(0.013)	(0.013)
$Size^S$	0.023	0.034	0.084***	0.083**
	(0.046)	(0.045)	(0.032)	(0.032)
$Size^M$	-0.017	-0.016	0.056*	0.056*
	(0.039)	(0.039)	(0.032)	(0.032)
Obs	27736	27736	27727	27727
R^2	0.008	0.008	0.004	0.004

Notes: The dependent variables ΔSI and ΔWP are annual growth rates. D^{Exp} an D^{Imp} are dummies for the export and import activity, respectively. $Size^S$ denotes firms smaller than 50 employees and $Size^M$ those in the range between 50 and 250. All the regressions include sectoral, provincial and year dummies. Clustered robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In Table 7 we observe that all the trade status dummies are statistically significant for the skill intensity changes. This suggests that traders substitute faster the unskilled factor with the skilled one with respect to the firms that operate only in the domestic market. In addition, we observe from column 2 that by introducing the importer dummy the coefficient for exporters drops substantially, even below that for importers. It follows that much of the variation in skill composition, attributable to the export status in previous literature, may actually be linked to the import activity. In all regressions the TFP variable is statistically significant, suggesting that more productive firms are the ones that restructure faster the workforce toward more skilled labor. Looking at the wage premium growth rate, we observe that the trade dummies are not statistically significant. Productivity has limited explanatory power over the shifts in wage differentials within firms. More productive firms tend to shift wages toward more skilled labor, widening the wage gap. Among the regressors, size seems to be highly correlated with different dynamics in the wage premium.

The movements in wage premium seem to be mostly uncorrelated to the firms' trade activities which, however, discriminate over the shifts in the skill intensity. Although data limitation prevents us from capturing the effects of labor market characteristics on firms' employment structure, our findings may be driven by the peculiar feature of the Italian labor market distinguished by a wage bargaining system which inhibits any wage-productivity links. Indeed, the fact that size is the only variable that impacts consistently over the firm level wage gap reinforces this hypothesis as big firms have relatively more incentives to

renegotiate wage structure at the firm-level. Moreover, some scholars have argued that the enhanced flexibility has mostly concerned younger skilled workers entering the labor market. Despite a higher level of educational attainment, they have suffered a relative loss in entry wages compared with the preceding generations (Rosolia and Torrini, 2007).

We move forward in the analysis by assessing whether wage and skill structure changes are affected by the level of income pro capita of the trading partners. There are several reasons why the level of economic development may affect the skill and wage structure of an internationalized firm. Export quality requirements are found to be related to the level of income of the foreign markets. Therefore, we would expect firms exporting to rich countries to have a higher quality, and hence use more intensively the skilled labor input (Hallak and Sivadasan, 2009). In addition, importers may require complementary skilled factors to use imported inputs, especially when these imports are acquired abroad because of an higher quality and/or a more complex structure than those available domestically (Castellani et al., 2010). Those firms that import from richer countries necessitate relatively more skilled labor as a complementary inputs. Indeed, recent firm level analyses show that exporting firms charge higher prices in more distant markets and to high-income countries (Bustos, 2011; Manova and Zhang, 2012; Martin, 2012). Also, firms exporting to advanced economies are more likely to import more expensive inputs (Bastos et al., 2014).[21]

Therefore, we verify whether the level of income of trading countries can further discriminate over the wage and skill movements by running the following econometric model

$$\Delta Share^{y}_{i,t} = \alpha + \beta_1 D^{ExpD}_{i,t-1} + \beta_2 D^{ExpA}_{i,t-1} + \beta_3 D^{ImpD}_{i,t-1} + \beta_4 D^{ImpA}_{i,t-1} + \sigma \ln TFP_{i,t-1} + \omega Controls_{i,t} + \epsilon_{i,t} \tag{9}$$

where, as before, the dependent variable is a firm's annual growth rate of the skill intensity or of the relative annual wage of skilled workers, respectively. The dummy variables $D^{ExpD}_{i,t-1}$ and $D^{ImpD}_{i,t-1}$ denote the dummies for exporters and importers trading with developing countries, while $D^{ExpA}_{i,t-1}$ and $D^{ImpA}_{i,t-1}$ with high-medium-income countries.[22] As usual, we account for a firm's TFP and include a vector of controls with size dummies, sectoral, geographical, and year dummies. Thus, the βs coefficients captures the impact of being an exporter to different destinations and importer from different countries of origins with respect to the baseline category of non-internationalized firms.

In the first three columns of Table 8 we observe that having export relation with richer countries is linked to a reallocation of the workforce towards more skilled labor. On the other hand, exporting to poorer countries is correlated to a relative greater use of unskilled workers. This is in line with our expectations: in order to be competitive on richer markets, firms have to provide higher quality products which demand a greater use of skilled inputs. However, the quality requirements for selling in poorer countries are smaller and thus the

[21] At the aggregate level Schott (2004) observes that the product export prices are positively correlated with exporters' income per capita and with a country's capital and skilled intensity. Similarly, Hallak and Schott (2011) finds that richer countries import relatively more from countries producing high-quality products.

[22] Advanced and developing countries are defined by the World Bank using the gross national income (GNI) per capita. Developing countries are those with a GNI per capita less than $1,045 or more than $1,045 but less than $12,746, respectively.

Table 8: Skill intensity and wage premium growth rate: exports by destination and imports by origin

	ΔSI			ΔWP		
	(1)	(2)	(3)	(4)	(5)	(6)
D^{ExpD}	-0.048*	-0.046*	-0.021	-0.029**	-0.024**	-0.012
	(0.028)	(0.027)	(0.026)	(0.012)	(0.011)	(0.010)
D^{ExpA}	0.144***	0.114**	0.138**	0.018	0.024	0.030*
	(0.047)	(0.047)	(0.056)	(0.014)	(0.015)	(0.016)
D^{ImpD}		-0.040*	-0.007		-0.014	0.004
		(0.025)	(0.031)		(0.013)	(0.015)
D^{ImpA}		0.115**	0.138***		-0.012	-0.006
		(0.048)	(0.052)		(0.015)	(0.016)
$D^{ImpAExpA}$			-0.053			-0.013
			(0.040)			(0.014)
$D^{ImpDExpD}$			-0.058*			-0.033*
			(0.032)			(0.017)
$\ln(TFP)_{t-1}$	0.100***	0.095***	0.099***	0.005	0.008	0.009
	(0.017)	(0.016)	(0.016)	(0.013)	(0.013)	(0.013)
Obs	27736	27736	27736	27727	27727	27727
R^2	0.004	0.004	0.012	0.002	0.002	0.002

Notes: The dependent variables ΔSI and ΔWP are annual growth rates. All dummies are lagged variables: D^{ExpA} and D^{ExpD} take value 1 for those firms that export to advanced and developing countries, respectively. D^{ImpA} and D^{ImpD} group those firms that import from advanced and developing countries, respectively. All the regressions include size, sectoral, provincial and year dummies. Clustered robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

level of exports to these destinations are correlated to a relative shift to unskilled labor. The results confirm that the most productive firms are also the ones that substitute faster unskilled with skilled workers.

Similarly, importing from advanced countries are positively correlated with a relative greater use of non-production workers. On the other hand, on average, being an importer to developing countries is linked to a relative reallocation of work toward unskilled labor. These results are consistent with the argument that imports are complementary inputs to the internal production. In other words, the introduction of skilled intensive imports within a firm supply chain requires skill-upgrading in the firm workforce.

To check for a possible interdependence between importing and exporting status from advanced or developing countries we include, in column 3, the interaction dummies. The explanatory power of being an exporter or an importer with developing countries falls as we introduce the interaction terms. Shifts towards more unskilled factor have on average occurred in those firms that are both importers and exporters with developing countries.

In columns 4-6 of Table 8 we can observe that the variables that are relevant for movements in the skill structure again do not play a crucial role in describing the wage changes. Indeed, those variables that impact on the quantity adjustments of the workforce are at most barely significant for the price shifts. Only the export activity seems to be marginally significant over the wage premium movements, with the export activity to developing countries

entering negatively while that with advanced ones entering positively. However, the relation is very weak as shown by the fall in significance with the introduction of the interaction terms. Only being both an exporter to and an importer from developing countries remains barely statistically significant, matching the negative adjustment on the quantity side.

5. Conclusion

This paper aims at grasping the restructuring process occurred in Italy in the early 2000s. Italy underwent several external shocks in this period, the most significant being the international integration of markets matched with the process of European integration. These changes shared a common consequence: a strong and sharp increase in competitive pressure. As a consequence, the Italian manufacturing was subject to structural changes that should emerge from flows of skills and wages between or within sectors and firms. To investigate such flows we perform a decomposition analysis of the rise in the aggregate share of skilled workers in the wage bill by breaking it down into the changes in the skill utilization and changes in wage gap. In addition, our decomposition framework allows to distinguish whether the restructuring of the productive system results from shifts of workers between or within sectors, and within sector, between or within firms. The analysis reaches a number of interesting results.

In line with what have been observed for other OECD countries, most of the movements are registered within industries, and in particular within firms. These changes are mainly driven by a marked increase in the relative demand for skilled labor. Concerning the movements across sectors and firms, workers move towards more unskilled intensive sectors, but inside each sector, on average, they shift to more skilled intensive firms. The reallocation toward unskilled intensive sectors is consistent with the peculiar specialization of Italy in the production of traditional goods. At the same time the analysis reveals that the relative price of the skilled factor do not adjust positively as a consequence of the rise in the demand for skilled labor. On the contrary, the annual wage premium falls, which means that wage gap between skilled and unskilled labor narrows. Since the ongoing reforms in favor of labor flexibility may have changed the average number of hours worked by the two type of employees, we test whether the drop in the annual wage premium is driven by a reduction in the hourly wage premium or by a fall in the average number of hours worked by skilled workers. We observe that the fall in the hourly wage premium exceeds the annual one. This is driven by the fact that the number of hours worked by the average skilled employee rises with respect to those employed by the unskilled worker.

The picture provided by the decomposition analysis shapes our investigation of the factors behind changes in skill utilization and wage premium. The decomposition for different categories of firms, according to their level of commitment to exports and imports, suggests that both trade activities play a leading role in the reallocation process. At the same time, the regression framework confirms that there is evidence of a positive relationship between the internationalized status and a process of reallocation toward more skilled labor factor. Moreover, the analysis suggests that failing to account for the import activity results in an upward biased estimation of the export activity. This evidence is in line with those models that predicts that importers may necessitate complementary skilled factors to use imported inputs. This is especially true when these imports are acquired abroad because of an higher

quality and/or a more complex structure than those available domestically. To corroborate this thesis we test the role played by trade partners, distinguishing between advanced and developing markets as a proxy of the quality content of traded goods. Our results are in line with the broad intuitions behind the quality-related and the input-complementarity models. In particular, we observe that trade relations with advanced economies is associated to a faster substitution of workers toward skilled labor, both on import and export sides. On the other hand, firms that operate with developing countries tend to reallocate labor toward the unskilled factor. Those variables that are relevant in defining the changes in skill structure show small significance over the wage movements. The movements in wage premium seems to be mostly uncorrelated to those firms' characteristics that discriminate over the shifts in the skill intensity. This might be due to the peculiar characteristics of the Italian labour market.

Our research can be extended to tackle several additional important questions. First, it would be interesting to investigate wage and employment structure dynamics with respect to the changing labor market and their relationship to technology. More importantly, as suggested by the recent analysis of Bloom et al. (2011), rather than study trade and technology as competing explanations for changes in skill utilization and wage inequality, one should investigate how the two factors are interrelated. Indeed, theory models have been developed that show an important role for trade on technology and vice-versa (e.g. Grossman and Helpman, 1991, 1992; Acemoglu, 2008). Second, while the standard approach has been to look for broad evidence of the shifts in labor demand and supply, as suggested by Van Reenen (2011) the empirical analyses should move forward and analyze what are the micro-mechanisms through which trade and technological changes affect skill demand. However, because of data limitations, this has been traditionally the subject of management and organizational studies.

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Appendix

Appendix A: Custom data

In compliance with the common framework defined by the European Union (EU), there are different requirements in order for a cross-border transaction to be recorded, depending on whether the importing partner is an EU or NON-EU country, and on the value of the transaction.

As far as outside EU transactions are concerned, there is a good deal of homogeneity among member states as well as over time. In the Italian system the information is derived from the Single Administrative Document (SAD) which is compiled by operators for each individual transaction. From the introduction of the Euro, Italy has set a threshold at 620 euro (or 1000 Kg) for a transaction to be recorded. For all of these recorded extra-EU transactions, the COE data report complete about product category, destination, quantity and value.

Transactions within the EU are collected according to a different system (Intrastat). There the thresholds on the value of transactions qualifying for complete record are less homogeneous across EU member states, with direct consequences on the type of information reported in the data. In 2003 (the last year covered in the analysis), there are two cut-offs. If a firm has more than 200,000 euro of exports (based on previous year report), then she must fill the Intrastat document monthly. This implies that complete information about product types is also available. Instead, if previous year export value falls in between 40,000 and 200,000 euro, the quarterly Intrastat file has to be filled, implying that only the amount of export is recorded, while information on the product is not. Firms with previous year exports below 40,000 euro are not required to report any information on trade flows. According to ISTAT, although only one-third of the operators submitted monthly declarations, these firms cover about 98% of trade flows (http://www.coeweb.istat.it/default.htm). Thus, firms which do not appear in COE are either marginal exporters or do not export at all.

Appendix B: Checking the consistency of the balanced database

In this appendix we check whether we introduce any sample-selection bias when considering the balanced dataset. Table 2 shows the number of firms which are sampled each year and those that are active over two consecutive years. By using a balance panel the number of firms in the sample reduces from 66387 to 29173. In Table 9 we investigate whether the smaller sample, made of firms that are present in both 2003 and 2004, is representative of the whole number of firms operating in 2003.[23] One expects that those firms active on a continuous basis are on average larger, this is because the probability of being sampled for a firm with less than 100 employees is smaller and also because larger firms are more likely to survive (Geroski, 1995; Sutton, 1997). Indeed, the average value of sales, exports and imports is marginally bigger in firms that produce in both 2003 and 2004. However, the shares of skilled workers in employment as well as the ratios of the wage rate of skilled workers over the average wage are similar between the two samples. Thus, since our analysis will focus on the wage and skill structure of firms, we should not incur in any large selection bias.

[23] We report here 2003-2004 but figures are comparable in other years.

Table 9: Variables statistics for active and continuous firms

	Active firms			*Continuous firms*		
	Mean	Sd	Observations	Mean	Sd	Observations
$ln(Sales)$	9.31	1.36	11923	9.85	1.32	6683
$ln(Export)$	6.13	3.65	11923	7.07	3.52	6683
$ln(Import)$	5.30	3.38	11923	6.34	3.17	6683
$\frac{L_{sk}}{L}$	0.29	0.20	11923	0.31	0.21	6683
$\frac{W_{sk}}{W}$	1.43	1.47	11921	1.46	1.87	6683

Notes: The Table reports the statistics of some variables' distributions for active firms in 2003 and continuous firms between 2003 and 2004.

Appendix C: Hourly decomposition

The sectoral wage premium component ($Wtot_s$) of Equation 4 can be further disentangled into the quantity ($Htot_s$) and price ($HWtot_s$) movements, defined by summing up shifts in the hourly skill intensity and in the hourly wage premium at the firm level.

$$Wtot_s = \underbrace{\sum_{i \in s} \Delta \frac{h_{sk_i}}{h_s} \overline{\left(\frac{hw_{sk_i}}{hw_s}\right)\left(\frac{L_{sk_i}}{L_s}\right)}}_{Htot_s} + \underbrace{\sum_{i \in s} \Delta \frac{hw_{sk_i}}{hw_s} \overline{\left(\frac{h_{sk_i}}{h_s}\right)\left(\frac{L_{sk_i}}{L_s}\right)}}_{HWtot_s}. \tag{10}$$

Proceeding as before, we aim at separating the *between* changes resulting from compositional effects from those occurring *within* firms. Thus, in equation 11 and 12 we calculate between and within effects for the two components of the wage premium we derived above, namely the hourly skill intensity and the hourly wage premium.

$$\begin{aligned} Htot_s &= \sum_{i \in s} \Delta \frac{h_{sk_i}}{h_s} \overline{\left(\frac{hw_{sk_i}}{hw_s}\right)\left(\frac{L_{sk_i}}{L_s}\right)} = \\ &= \underbrace{\sum_{i \in s} \Delta \left(\frac{h_{sk_i}}{h_s}\right) \overline{\left(\frac{h_i}{h_s}\right)\left(\frac{hw_{sk_i}}{hw_s}\right)\left(\frac{L_{sk_i}}{L_s}\right)}}_{Hwit_s} + \underbrace{\sum_{i \in s} \Delta \left(\frac{h_i}{h_s}\right) \overline{\left(\frac{h_{sk_i}}{h_s}\right)\left(\frac{hw_{sk_i}}{hw_s}\right)\left(\frac{L_{sk_i}}{L_s}\right)}}_{Hbet_s} \end{aligned} \tag{11}$$

$$\begin{aligned} HWtot_s &= \sum_{i \in s} \Delta \frac{hw_{sk_i}}{hw_s} \overline{\left(\frac{h_{sk_i}}{h_s}\right)\left(\frac{L_{sk_i}}{L_s}\right)} = \\ &= \underbrace{\sum_{i \in s} \Delta \left(\frac{hw_{sk_i}}{hw_i}\right) \overline{\left(\frac{hw_i}{hw_s}\right)\left(\frac{h_{sk_i}}{h_s}\right)\left(\frac{L_{sk_i}}{L_s}\right)}}_{HWwit_s} + \underbrace{\sum_{i \in s} \Delta \left(\frac{hw_i}{hw_s}\right) \overline{\left(\frac{hw_{sk_i}}{hw_i}\right)\left(\frac{h_{sk_i}}{h_s}\right)\left(\frac{L_{sk_i}}{L_s}\right)}}_{HWbet_s}. \end{aligned} \tag{12}$$

Finally, we want to aggregate over all sectors s the between and within decompositions for the three components of the relative wage bill, employment, hours worked and hourly wage. We do this in a similar way to what done in equation 7. We indeed compute a weighted average, whose weights are the relative importance of each sector in terms of employment

and wage bill. Recalling equation 7, we see that we apply the same weights attributed to the $Wtot$ decompositions to the $Htot$ and $HWtot$ components. Equation 13 reports the weighted aggregation of all sectoral components, $Lwit_s$, $Lbet_s$, $Hwit_s$, $Hbet_s$,$HWwit_s$ and $HWbet_s$.

$$\begin{aligned}
&\underbrace{\left(\Delta\frac{WB_{sk}}{WB}\right)}_{WBtot^{wit}}^{within} = \sum_s \underbrace{\overline{\left(\frac{L_s}{L}\right)}Ltot_s}_{\overline{Ltot_s}} + \sum_s \underbrace{\overline{\left(\frac{WB_s}{WB}\right)}Htot_s}_{\overline{Htot_s}} + \sum_s \underbrace{\overline{\left(\frac{WB_s}{WB}\right)}HWtot_s}_{\overline{HWtot_s}} = \\
&= \sum_s \underbrace{\overline{\left(\frac{L_s}{L}\right)}Lwit_s}_{\overline{Lwit_s}} + \sum_s \underbrace{\overline{\left(\frac{L_s}{L}\right)}Lbet_s}_{\overline{Lbet_s}} + \sum_s \underbrace{\overline{\left(\frac{WB_s}{WB}\right)}Hwit_s}_{\overline{Hwit_s}} + \sum_s \underbrace{\overline{\left(\frac{WB_s}{WB}\right)}Hbet_s}_{\overline{Hbet_s}} + \\
&+ \sum_s \underbrace{\overline{\left(\frac{WB_s}{WB}\right)}HWwit_s}_{\overline{HWwit_s}} + \sum_s \underbrace{\overline{\left(\frac{WB_s}{WB}\right)}HWbet_s}_{\overline{HWbet_s}}.
\end{aligned} \tag{13}$$

Here, $WBtot^{wit}$ is the weighted average wage bill variation that has occurred within industries, which is within and between firms. As before, we denote the weighted decomposition components with a bar.