Technology Innovations, Organisational Changes and Wages Inside the Firm in Italy

[2nda SESSIONE TEMATICA: L'EVOLUZIONE DELLE DISEGUAGLIANZE NEL MERCATO DEL LAVORO]

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Abstract: This paper uses longitudinal data for a sample of Italian firms to study the effects of possibly endogenous technological and organisational changes on wage levels and on wage differentials by skills and by occupations inside the firm. Fixed effect estimates reveal that both firm's innovations increase the wage of skilled and white collars, and also relative wages. IV estimates show that firms introducing organisational changes are negatively selected, while the opposite is true for those adopting new technologies. Thus, these two activities are more substitute than complement: the former used in restructuring periods, the latter during expansions.

JEL codes: J24, J31, L23, O33.
Keywords: Information technology; organisational change; wages; Italy.

1. Introduction

In recent years, many industrialised countries have experienced significant changes in the structure of production and work organization. On the one hand, the introduction of new technologies (ICT) have modified the traditional production paradigms used by firms. On the other hand, augmented foreign and domestic competition, stimulated by increasing international economic integration and deregulation in product and labour markets, have often required innovative styles in the management of human resources, substituting centralised decisions' systems and rigid division of labour with the more flexible organisations.

Overall, these changes have been complemented by a higher level of employees' involvement and responsibility, as well as by a reduction of supervising positions and delegation of authority from top managers to middle occupations.

As it has been often argued, new technologies and/or new organisational schemes might have produced non neutral effects on the demand for skills and on the composition of the workforce by occupation. In particular, workplace innovations may have changed the optimal allocation of workers to jobs, as well as the channels used to evaluate and monitor employees' performances. As a result, both (internal) labour market conditions, and the structure of wages and wage differentials inside firms may be affected.

While the non neutral effect of new technologies on wages and employment conditions has received a lot of attention in the economic literature, only recently economists have started to analyse to what extent organisational changes, maybe interacted with new technologies, affected skills requirements and labour market outcomes. However, the scarcity of suitable data have confined the analysis of such issues to studies based on US and UK, and the evidence for continental Europe is rather limited.

In this paper we investigate the effect of both technological and organisational changes on the within firms structure of wages in Italy. We use a longitudinal data set which records information for a sample of Italian firms operating in the metal-machinery industry during the 1991-1995 period. Information on both wage levels and relative wages (by skill and by occupation) inside the firm is available, as well as on firm characteristics and industrial relations practices. Thus, we can control for many sources of firm's heterogeneity and for the effect of those institutions – especially unions and the structure of collective negotiations – which, in a regulated labour market such as the Italian one, may shape and constrain the design of optimal firms' pay policies.

In the analysis of wage differentials, a separate treatment of organisational and technological factors is important for at least three reasons: First, as argued by some authors, the two innovating activities may behave like strategic complements and empirical studies neglecting the role of organisational changes may suffer for the omission of a relevant variable that may bias upward estimates of returns to new technology on wages (Milgrom and Roberts, 1995). Similarly, others pointed out that workplace reorganisations often accompany technological innovations to fully capture the benefits of the latter (Bartel and Lichtenberger, 1987; Breshnan et al., 2002). Second, firm's reorganisations may be implemented independently of technological advances, for example as a consequence of openings of new markets or as a strategic response to increased competition. Third, since wage policies and wage differentials inside the firm are used as instruments to achieve higher levels of efficiency, as well as to select and motivate the workforce, changes aimed at increasing connections between tasks and functions modify not only the demand for skill, but also monitoring and supervising activities, so that (efficiency) wages are likely to respond to these changes. Thus, in general, the design of the internal structure of wage differentials by skills and by occupations may react to organisational changes not necessarily accompanied by contemporaneous technological advancements.

The paper contributes to the empirical literature on the effect new technologies and new work organisations on labour market outcomes in several aspects. First, we aim to expand the (rather limited) evidence on the wage effect of technological and organisational changes for Italy. In this respect, the longitudinal dimension of data enables us to control for unobservable firm (fixed) heterogeneity affecting both wages and the organisation structure. Furthermore, information on past technology and organisational changes allows us to analyse wage differentials by skill using an IV-GMM estimator where lagged innovation variables are used as instruments to control for the potential endogeneity of (or measurement errors in) workplace innovations. Finally, we complement the literature on wage differences in Italy, which is based for the most part on individual data.

The paper is organised as follows. Section 2 summarises main past contributions, both empirical and theoretical. Section 3 describes the data and Section 4 the econometric strategy. Section 5 presents the main results and Section 6 outlines some concluding remarks and policy implications.

2. Literature review

During the ‘80s and the first half of the ‘90s, the rapid increase in the demand for skills and the associated worsening of labour market perspective for unskilled workers - that translated into rising skilled/unskilled wage differential in competitive US and UK labour markets (see Katz and Murphy, 1992) and into increasing unemployment levels in more rigid continental Europe labour markets (OECD, 1996) -, has stimulated a large body of research, both at the theoretical and empirical level. In what follows, we review main contributions of both types.

2.1. Theoretical background

Several theories, characterised by both competitive and non competitive settings, offer useful insights to understand the relationship between innovations and wages inside the firm.

As regards wage levels, a number of theoretical findings suggest that new technologies and a more efficient firm’s organisation increase average firm’s wages.

First, if productivity gains due to workplace innovations are shared between employers and employees, the whole workforce may receive benefits in the form of higher wages. Moreover, since the process of technological and organisational renewal of production remarkably differs across enterprises and sectors, wage dispersion between sector and firms is also expected to vary. In principle, if firms and sectors increase their level of specialisation in the production, we could have a shift in sectoral composition such that the intensity of skills increases in high technology sectors, while traditional sectors deepen their use of low skilled workers (between sector component of wage inequality). However, there is evidence that the shift in the demand of qualified workers caused by new technologies has a strong within sector component, and that it has produced more wage inequality and higher levels of dispersion especially within sectors and even within firms (Katz and Author, 1999).

Second, also human capital effects could play a role. Workers’ effort in innovative organisations is different in nature and much more complex than in traditional systems. Workers are asked to actively participate in decision processes, to acquire knowledge about the whole cycle of production, to make proposals concerning the introduction of new technologies and, finally, to share information, experiences and ideas. On the whole,

the demand for interpersonal skills increases.[1] If skilled human capital is in short supply, and not entirely determined by formal education, firms, in an innovative effort may suffer rationing in skill supply and wages for skilled workers would increase.[2]

Third, firms undergoing restructuring processes may compensate risk-averse workers for higher job insecurity and preferences for more traditional and less demanding jobs.

Finally, and moving towards non competitive explanations[3], if delegation of authority and higher flexibility make monitoring techniques more costly, restructuring and innovating firms may be induced to pay efficiency wages in order to extract a less observable effort. As a result, we should observe higher wage levels within innovating firm and, to the extent that organisational changes affect only a part of the workforce, increasing wage inequality.

However, several considerations suggest that the positive linkage between workplace innovations and higher wages may not be stronge enough to generate higher wages.

For example, a less rigid division of work and a greater individualisation of competencies might reduce workers bargaining power, thus limiting the ability to extract rents in the form of higher wages. In addition, workers showing preferences for flexible tasks may be willing to substitute higher wages with higher levels of involvement and responsibility. Moreover, new technologies might improve the efficiency of monitoring techniques and reduce the use of efficiency wages to stimulate effort.

In addition to the effects on wage levels, new technologies and organisational changes could also alter skill requirements and the relative demand for occupations. As a result, the structure of relative wages and wage differentials could also be affected.

Acemoglu (1998) uses a model with heterogeneous firms (innovative and non innovative) and workers (skilled and unskilled) to show that, in response to the introduction of organisational changes, the workforce becomes more homogeneous within firm, and innovative firms substitute unskilled with skilled workers. The new labour market equilibrium is characterised by complete segregation: all the skilled are employed

[1] These changes are not only due to the increase in the demand for competencies strictly related to new technologies, but also to the growth in the request for those skills that, even if difficult to define, intuitively refer to the cooperation ability of individuals and to their versatility and adaptability on the workplace.
[2] However, if skills are firm specific, this would not be the case.
[3] There is established consensus on the terminology to classify, for example, efficiency wages model. We define as non competitive a setting in which the wage does not equal marginal productivity.

in the innovative firm and all the unskilled in the traditional firm. Thus, the main prediction of the model is that, as a consequence of organisational changes, inequality within firms should decrease, while inequality between firms should increase.

Caroli and Van Reenen (2001) highlight that under reasonable assumptions the adjustment towards the new equilibrium could be very lengthy and, in the meanwhile, if supply of skills is rigid and/or only a part of the workforce is affected by innovations inequality within firms is likely to increase.

Overall, a limitation shared by these theories is that, at least in their simplest version, they do not adequately take into account and do not properly model that in many European countries - including Italy – several institutional factors that, on the one hand, affect the firms' decisions to innovate, while, on the other hand, regulate the process of wage determination. For example, the union power, the level of employment protection and strictness of hiring/firing procedures often represent a constraint for innovating firms in the choice of the preferred composition of the workforce by skill. By converse, a cooperative system of industrial relations where "exit voice" unions, by reducing asymmetric information about the most efficient way to organise the workforce inside the firm, may favour the diffusion of organisational changes, but, at the same time, they may smooth their impact on relative wage.

As a result, and especially when the constraints created by labour market institutions are in place, the effects of workplace innovations on the wage structure inside the firm is an issue deserving empirical investigation.

2.2. Empirical results

One of the leading explanations has been the so-called skill-biased technological change hypothesis, and many studies have investigated the effects of new technologies on the wage of skilled workers and on the wage premium they earn. Due to differences in data aggregation levels (industry, firm or individual data), sample coverage (representative national surveys; single industries; case studies), types of data (cross-section or panel) and estimation techniques, results are not easily comparable. Despite these difficulties, studies based on single cross-sections of US data have typically found a positive association between technology indicators (such as computer use, investment in R&D and ICT, introduction of innovative procedures) and the average wage of skilled workers both at the individual level (Krueger, 1993), at the sector level (for example Berman et al., 1994;

Autor et al, 1998; Dunne et al., 1997). By converse, studies based on longitudinal data find either that the premium does not exist or that it is simply due to unobservable individual characteristics (Di Nardo and Pischke 1997) or to the fact that innovating firms had above-the-average skills endowment both before and after the adoption of new technologies (Doms et al., 1997). For the UK, in one of the most influential studies Machin and Van Reenen (1996) use both industry and firm level longitudinal data and find a positive relationship between several indicators of the innovation activity and the use of skills. Mairesse et al (2001) find similar results for France.

For Italy, the empirical evidence is limited to the work of Casavola et al. (1996), who found that the labour markets effects of the adoption of new technologies are more on the quantity side (increase in the employment shares of the high skilled) than on the price side (the wage premium for white collars is do not display significant movements). However, they do not simultaneously control for the effect of labour market institutions on wage distributions. Thus, it is difficult to ascertain whether this result is due to the rigidity of wages caused or, for example, to the high elasticity of the supply of skilled workers.

Starting from the end of the ‘90s, a number theoretical contributions suggested that also organisational changes were important elements of the strategy of workplace innovation and potentially skill-biased as well.

On the one hand, organisational changes may act as complement to new technologies and allow to fully capture their productivity advantages (Aghion et al., 1999). On the other hand, firms reorganisations may be introduced for reasons independent of technology (for example, for openings to new markets) and, therefore, they may have a specific impact on wages (Thesmar and Thoenig, 2000). For the most part, it has been found that the probability to adopt organisational changes, especially in the form of the introduction of new work practices, is strongly and positively related to the adoption of ICT (see Osterman, 1994 for the US; Greenan and Mairesse, 1999 and Greenan, 2003 for France; Cristini et al., 2003a for Italy). Similarly, Bugamelli and Pagano (2001) claim that delays in the reorganization prevent to fully exploit advantages from the use of new technologies.

Still, also other factors matter: market factors - innovative organisations are more likely to be found when firms are globalised and operate in competitive markets (Osterman, 1994) -, institutional and financial factors - the probability to innovate the

organisation is higher if the firm is under restructuring[4] and if a powerful union and local bargaining are present (Machin and Wadhwani, 1991)[5].

Once identified its determinants, a second strand of literature investigated the effect of organisational change on wages. Looking at wage levels by skill and occupation, the impact of innovative (work) organisations is usually positive, at least using cross-sectional data. For example, Cappelli (1996) uses a sample of private establishments with more than twenty employees in the U.S. in 1994 matched with data on employees and finds that innovative workplace practices have a positive effect on wages of production workers and supervisors. However, the effect on wage inequality within firm is negative, suggesting that new technologies and innovative work practices may increase inequality within occupations, and, at the same time, reduce inequality within innovative establishments. An up-dated data set including also observations for 1997 has been used by Cappelli and Carter (2000) to show that computer use and teamwork are associated with higher wages, especially in the case of front-line workers, while the relationship is weaker for other occupations. Estimates based on cross-sectional data might be biased due to the correlation between wage levels, organisational changes and individual/firm fixed (unobservable) effects. Black and Lynch (2000) use a panel of U.S. establishments for 1993 and 1997 and shows that the relationship between a dummy indicating whether an establishment adopted flexible work organisation and wage levels is not significant using only the cross-section for 1996 but becomes significant after removing fixed effects by first-differencing. Osterman (2000) uses a sample of U.S. establishments in 1992 and 1997 to study the effects of the introduction of new work practices in 1992 on subsequent wage growth in 1996. He finds that the introduction of new work organisation has almost no effect on wage levels.

Black et al. (2003) use a panel of 700 manufacturing and non-manufacturing establishments in the U.S. in 1993 and 1996 to analyse the effects on wage differentials through skill reorganisation and find that the implementation of organisational changes is associated with higher within firm inequality.

[4] However, on this point the literature is mixed, with some authors suggesting that, as innovations are costly, only well-performing and high rents firms can afford complex reorganisations.

[5] Black and Lynch (2001), observe that the union power increases the probability that investments in technological and organizational innovations produce positive effects on productivity. However, this result is not shared by all the literature; some authors, like Ichinowsky (1990) and Kruse (1996), find that union presence prevent the diffusion of innovative work practices

In the few studies available for European countries, Caroli and Van Reenen (2001), using two representative panel data sets of British and French establishment, find that past organisational changes have a negative effect on wage growth for unskilled workers in both countries, while Bauer and Bender (2002), who use a matched employer-employee panel data for Germany, report that past organisational changes within firm wage inequality through a relative increase in the wages of the upper part of the wage distribution.

To our knowledge, the empirical evidence available for Italy is limited to the work of Piva and Vivarelli (2004) and Piva et al. (2005), who, by focussing on employment levels instead of on wages, performed an analysis which complements the one proposed here. Using the Mediocredito Centrale data set (around 500 firms in the Italian manufacturing sector), they estimate employment shares' equations by skill in long differences obtained from translog minimum labour expenditure by Shepard's lemma. They find that organisation innovations impact on the ratio between skilled and unskilled workers, especially through a negative effect on the share of the unskilled. On the contrary, changes in technology (measured by R&D expenditures) do not appear strongly correlated with skill upgrading. Moreover, they find evidence of strategic complementarity between new technologies adoption and firm reorganisations, which positively affect the demand for skilled labour when they are taken jointly.

Some of the above results are not free from severe methodological problems (Athey and Stern, 1998; Bauer, 2003). The main limitation of some studies lies in the cross-section nature of the information about organisational innovations and the introduction of new technologies, which leads to two problems: (i) the impossibility to control for correlations between practices and firm's fixed effect; (ii) endogeneity of the variables capturing workplace innovations in the form of new technologies and new organisation. Since these decisions might be seen as investment or production decisions, they depend on firm's performances and productivity, that, in turn, also affect wages.

The availability of panel data would mitigate or solve problem (i) above, while solution to problem (ii) relies on the availability of instrumental variables.[6] A more detailed discussion of endogeneity issues is contained in Section 5.

3. Data and descriptive statistics

This section has two purposes. The first is to describe the main characteristics of the dataset used in the empirical analysis, and to provide information on the main variables used in the study. The second is to describe how wages for different types of workers vary according to a number of observable firm characteristics, and which are the differences between firms innovating both technologies and the organisation, and the "traditional" ones.

3.1. Data and variables

The present paper uses a survey of firms in the Italian metalworking and engineering industry. Roughly 60,000 firms belong to this industry in Italy, which employs about one and a half million workers in year 2000. The sector accounts for 40 percent of value added and 50 per cent of exports of the overall manufacturing sector[7]. The data-set is the outcome of a survey conducted by the national employers' association of this industry (*Federmeccanica*) on a yearly basis. For this research, we use an unbalanced panel constructed using the 1995, 1993 and 1991 waves. Each cross section contains around 2,500 establishments, most of them (around 90%) were surveyed at least twice. The sample is representative of the composition of the metal-machinery sector in Italy, with the partial exception of small and Southern firms. The survey contains information both at the firm level and at the level of every establishment for multi plant firms. Wage and employment composition are available only at the firm level by category of workers and by wage components. Because wages are our dependent variable, information originally available for each establishments of multi-plant firms has been re-aggregated at the firm level. This implies that, even when more-disaggregated information was available for some key variables (as for technology innovations and organisational changes), we can only use averages at the firm level.

The initial sample contained 8,928 observations (5,225 firms). The unbalanced panel (at least two observations for each firm) used in this study - which is also used to compute summary statistics – is made of 6,241 observations (2,538 firms).[8] Despite its

[6] However, as pointed out by some authors (Nickell et al., 2001), in many circumstances using longitudinal data may not be enough to control for distortions in the estimates due to business cycles effects on the probability of adopting innovations, and to productivity effects

[7] Such sector accounts for the 16 percent of the Italian production and half of both the exports and the production of investments goods.

[8] Summary statistics for the whole sample do not significantly differ from what is reported in table 2.

limited sector coverage, this survey is unique for Italy, in the sense that it provides information on wage structure, workforce average characteristics (first of all its composition), firm's innovation activity, market characteristics as well as labour market institutions (in particular unions, bargaining arrangement at local level and industrial relations).

Table 1A contains a description of the main variables used in the empirical analysis. Workers fall into two main categories: blue collars (apprentices and manual workers) and white collars (the so-called special categories – mainly technicians -, clerks and executives). In addition they are further classified by occupational levels (eight broad job categories – "*livelli*" - characterised by different skill and responsibility requirements, as described in the national contract) for a total of 16 different categories. Wages include the amount set in the national contract plus additional payments settled at the firm level. Wage components are the average monthly wage for each category of workers and lump-sum pay schemes - like wage premium and other bonuses - paid once a year. Overtime or shift premiums and paid leaves are not included. Wage variables refer to annual gross earnings expressed in real terms (at 1989 prices). Average firm wages have been constructed by using information on average annual wages paid to each of the fifteen occupational classes – apprentices, manual, technical staff, clerks, executives and, within each group, each contractual level. To construct the firm average wage, wages have been weighted by the employment share of each group. A similar procedure has been used to construct the average wage for sub-samples of workers (blue collars, skilled, etc.). The wage variables (expressed in natural logs) used in the empirical analysis are:

1) *wage levels*: the firm (annual average wage), the wage of blue and white collars, the wage of skilled and unskilled workers
2) *relative wages:* the white collar/blue collar wage differential; the skilled/unskilled wage differential: the highest/lowest wage differential[9].

As already mentioned, the definition of skills for each occupation is given by the national contract and is based on the level of personal responsibility and the level of complexity of the task performed. we classify as "unskilled" those workers whose job doesn't require specific training and/or doesn't involve any responsibility[10].

[9] The three measures of wage inequality are not entirely overlapping: corr(white/blue, skilled/unskilled) = 0.71; corr(white/blue, max/min) = 0.36; corr(skilled/unskilled, max/min) = 0.42.

[10] As a consequence, we considered unskilled all the employees belonging to the first four occupational levels. Note that production workers are classified in the first five occupational levels. Clerks can be found

For what concerns key explanatory variables, information on organisational and technological change is available only for 1991 and 1993. Respondents were asked if in the last current year and in the two years before (for example, the 1991 survey ask about changes in 1989, 1990 and 1991) the firm introduced the following innovations: (i) products innovations; (ii) process innovations; (iii) organisational changes. A related question asked if these product and/or process innovations required the introduction of micro electronic technology. On this basis, a dummy variable captures two-years changes in work organisation (organisational change), while another dummy control for technology innovations related to ICT (as separate from simple physical investment).

Measuring organisational change and technology improvements through simple binary variables has some advantages, but bears also some limitations. Advantages are that: (i) organisational change is clearly separated from technical change; (ii) when organisational change is measured by means of several different practices, severe multi-collinearity problems prevent to identify the single contribution of each practice. Main disadvantages from the use of binary indicators for technological and organisational change are: (i) they do not provide information on the number of individuals covered by these changes; (ii) they do not present a clear picture of what is included and what does really mean "organisational change". We are interested in organisational changes that increase the degree of flexibility in the use of work, promote information flows and organisations horizontally integrated as substituting traditional vertical channels. From the information available, we cannot say if respondents have in mind these type of organisational changes or other forms of restructuring, like simple down-sizing or outsourcing. However, it is difficult to think of organisational changes that don't imply also changes in the organisation of work and, especially, in the direction outlined above. Moreover, similar surveys conducted in other countries shows that, when managers are asked to explain in more detail what is meant by organisational change, work restructuring processes in the direction of less hierarchy and increased participation are often key ingredients (Caroli and Van Reenen, 1999; Bauer and Bender, 2002). As a consequence, though the measure of organisational change we will use in the empirical analysis is far from being perfectly adequate to fully capture the complex and multi-dimension

in all the occupational categories but the first and executives only in the highest. As a consequence, the two alternative classifications – blue/white collars and skilled/unskilled - are not overlapping. The first one has more to do with the type of the job performed; the second with the skill content of the job.

phenomena of within firms work reorganisation, it seems suited to broadly capture the flavour of features that are relevant from the theoretical perspective.

Another potential problem is that, since these dummy variables are based on personal perceptions of the respondent, they may contain a large amount of measurement error. However, if anything, we share these kind of limitations with the most part of literature on this issue.

In addition to firm innovation policies, the Federmeccanica Survey provides detailed information on several firm dimensions, which can be used to control for observable heterogeneity in the empirical analysis. Explanatory variables can be classified into three different groups: (i) *Average workforce characteristics and working conditions*, like the share of each skill group, the share of women, the presence of immigrants, a proxy for average tenure, non-standard work arrangements and working time; (ii) *characteristics of the production process and market/cycle factors*, like firm size, labour productivity, capital intensity, multi-plant, use of temporary lay-off, index of riskness of the firm, incidence of export and outsourcing, sector and geographic area, time dummies; (iii) *labour market institutions*, as the presence, the strength and the degree of coordination of union activity, the existence of firm-level contracts and regulations protecting workers from firing unless due to "unfair motivations" by the employer (which is a sort of employment protection regimes applied to firms with more than fifteen employees).[11]

3.2. Descriptive evidence

Table 2 presents the description of the main variables used in the empirical analysis and summary statistics (means and standard deviations) for the whole period and for single years.

As described in several studies, while at the aggregate level we can observe in Italy a widening of wage differentials from the end of the '80s (or the beginning of the '90s), at the plant level these patterns are not easily observed, and average wages and wages by occupation were substantially flat during the first part of the last decade in Italian manufacturing (see for example Ericksson and Ichino, 1995: Manacorda, 2000). The longitudinal sample of firms closely mirrors these features, and the (log of the) wage premium for white collars and skilled workers has decreased from 0.335 to 0.275, as well

as the dispersion of wages (as measured by the ratio between max and min wage). The traditional explanation for stable differentials over time emphasizes the role of labour market institutions in "equalizing differences" by reducing wage volatility and differences between different classes of workers (Dell'Aringa and Lucifora, 1994). On the other hand, after the 1993 reform, the overall wage structure has become less compressed, with a moderate increase in the real wage for white collars. This discrepancy between the general wage dynamic and the results for our sample may be accounted for by observing that in the last decade there has been also a change in the sectoral composition of the economy, with wages and employment shares of white collars increasing in the services and decreasing in manufacturing sector.[12]

We also notice that that workforce within firms has become more homogeneous: looking at Table 2, at the beginning of the '90s almost all firms employed workers in all occupations; at the end of the decade the picture is quite different and workers with different jobs are more likely to work in different firms (consistently with the existence of a segregated equilibrium). The result has important consequences for our empirical analysis: when we use wage differences between white and blue collars we loose a number of observations, because, as compared to the beginning of the period considered, many firms employ either only white collars or only blue collars.

Our sample broadly mirrors other general trends in the Italian economy during the '90s, like the increase in the participation of women and immigrants, the diffusion of non standard work contracts, the increase in productivity levels and in exports (after the lira crisis in 1992), the diffusion of local work contracts as a consequence of the 1993 reform in bargaining procedures, the decrease in union density and union coordination at the firm level.

Table 3 provides a more disaggregated picture, and shows how intra-firm wage variables differ across sub-samples based on firms' characteristics. Wages and wage differentials are higher in firms that introduced organisational or technological changes in

[11] Additional information on organisational changes in the form of flexible wage practices, communications flows and task requirements is available for those firms introducing a firm labour contract in the year of the survey.

[12] Therefore, aggregate figures for Italy are quite different from evidence for other countries like US and UK, where the widening of wage differential has been dramatic and with severe consequences for the well-being of a large part of the population. However, as suggested by some authors flat aggregate wage profile might hidden the effect of forces working in opposite directions (Manasse et al., 2004). It seems that technical progress has contributed to increase the relative demand for skills, whereas exports has reduced the demand for skills.

the period 1991-93, especially at the end of the period considered. Also the location of the firm matters: for example, both wages and wage inequality within firms are higher in the North than in the South and also differences in these variables exist across industries. Labour market institutions and unions compress internal wage differentials by increasing wages in the low part of the distribution, while the presence of additional local work contracts in addition to the national contract helps to widen the distribution of wages, thought it is associated to low levels of payments in every occupation.

To further investigate the differences between innovating and non innovating firms in terms of their characteristics, Table 4 shows that firms introducing changes in their organisation or in their technology are, on average, larger, with higher levels of work productivity and are more capital intensive. In addition, are more likely to be multi-plant, with higher percentages of outsourcing and export and with safer working conditions. On the industrial relations side, they are also relatively more unionised. Bargaining at the local level (captured by the existence of a firm local contract) is more diffused among traditional firms than among innovative firms, thus signalling a less cooperative industrial relations climate.

4. Econometric issues

In this section we, first, present the model of wage determination used in the empirical analysis, and estimation methods based on first differences, with special emphasis to identification assumptions. Finally, we describe the steps of our empirical strategy.

4.1. Model and estimation methods

In order to evaluate the effect of workplace innovations on the firm wage structure, several alternatives have been proposed in the literature. Caroli and Van Reenen (2001) derive translog cost functions from a problem of cost minimization with (variable) labour input and quasi-fixed physical and organisational capital. The empirical counterpart of the theoretical model is a function where the dependent variable is the wage bill (see also Doms et al., 1997). Using this specification, however, price effects cannot be distinguished from quantity effects. To overcome this problem, a second possibility would be to estimate a (structural) model in the form of a system of equations, the first measuring the impact of workplace innovations on relevant aspects of job characteristics or requirements as suggested by one of the theories of reference (see section 2), and the

second relating job changes to wages. As discussed by Cappelli and Carter (2000), while structural models allow to test separately the empirical relevance of the different theories relating workplace innovations to wage levels and wage inequality, their main disadvantage is that they are usually complex to estimate and conditions to ensure identification are problematic to be achieved. Due to these problems, existing studies typically estimate reduced form firm-level or establishment-level wage equations. As to say, they limit the analysis to the determinants of intra-firm wage structures, without being able to identify the role of each single theory in explaining the linkage between innovations and wages.

We follow a similar strategy and specify a model in which wages are a function of a vector of workforce characteristics, firm attributes (including industrial relations features), firm's organisation and technology:

$$y_{it} = f(X^{W}{}_{it}, X^{E}_{it}, ORG_{it}, TECH_{it}, \varphi_i, \varepsilon_{it}) \qquad (1)$$

where y_{it} is the wage variable of interest for the *i-th* establishment at time *t* (mean firm wage, mean wage by occupation, ratio between white and blue collar wage, ratio between skilled and unskilled employees), X^{W}_{it} is a vector of "average" worker characteristics in the firm (skills, tenure, gender, type of contract, training, etc.), X^{E}_{it} is a vector of employer characteristics (size, production process, market/competitive factors, institutional setting, etc.), $ORG_{it}, TECH_{it}$ define two types of (quasi-fixed) immaterial capital of the firm, organisational capital and technology capital, while ε_{it} represents a firm-specific and time-specific shock. φ_i is the fixed, unobservable firm heterogeneity. A simple linear representation of (1) is given by:

$$y_{it} = \alpha_t + \beta_1' X^{W}_{it} + \beta_2' X^{E}_{it} + \delta ORG_{it} + \gamma TECH_{it} + (\varphi_i + \varepsilon_{it}) \qquad \text{for } t=1,\ldots,T \qquad (2)$$

With (2), we are assuming that, after controlling for workers' and firm's observable characteristics, the remaining unobserved heterogeneity is fixed over time. Observable firm characteristics include also region and sector dummies to capture demand conditions. Let us further assume the time-varying intercept to be the combination of a fixed intercept plus a set of shift dummies for each T-1 year. Hence, the equation to be estimated becomes:

$$y_{it} = \alpha_1 + \sum_{S=2}^{T} \alpha_S dS + \beta_1^{'} X_{it}^{W} + \beta_2^{'} X_{it}^{E} + \lambda_1 REGIO_i + \lambda_2 SECT_i + \delta ORG_{it} + \gamma TECH_{it} + (\varphi_i + \varepsilon_{it}) \quad (3)$$

where *dS* is a dummy for the *s-th* year. In order to get unbiased estimates of (3), a number of econometric problems arises. Standard OLS techniques produce inconsistent estimates in the presence of unobserved heterogeneity, endogeneity and measurement errors.
Omitted variable bias due to unobserved firm heterogeneity correlated with the covariates, and, especially, with organisational and technology choices is likely to bias the estimates. To solve this problem, a method based on first differences is available. In order to remove fixed effects, (3) can be rewritten in first (long) differences (to account for the quasi-fixed nature of organisational and technology capital and to have more variability in key covariates). In our case, T = 3, where t = 1991, 1993, 1995. Therefore, the model can be written as follows

$$\Delta y_{it} = \vartheta_0 + \vartheta_1 d95 + \beta_1^{'} \Delta X^{W}{}_{it} + \beta_2^{'} \Delta X_{it}^{E} + \delta \Delta ORG_{it} + \gamma \Delta TECH_{it} + \Delta \varepsilon_{it} \quad (4)$$

where Δ is the difference operator between time *t* and time *t-1*. The disadvantage is that, in principle, all time invariant attributes (as the industry or the geographical location of the firm) cancel out. However, we also perform robustness checks including (almost) time-invariant firm attributes as additional binary controls to proxy for different initial conditions between firms sharing similar changes (proxied by the long differences).

Further, in our case, changes in many variables and, especially, organizational and technology capital are not observed as continuous variables, but, rather as qualitative "shift" indicators. In fact, we assume that it is possible to observe only the sign and not the magnitude of ΔORG_{it} and $\Delta TECH_{it}$. For this purpose, let us define the following binary variables:

$$OC_{it} = \begin{cases} 1 & if \quad \Delta ORG_{it} > 0 \\ 0 & otherwise \end{cases}$$

$$TC_{it} = \begin{cases} 1 & if \quad \Delta TECH_{it} > 0 \\ 0 & otherwise \end{cases}$$

which are indicator functions for a latent (unobservable) behaviour. Once first differences have been taken, we are left with two cross-sections with variables differenced over time, with the two dummies for the technology and organisational changes:

$$\Delta y_{it} = \vartheta_0 + \vartheta_1 d95 + \beta_1^{'} \Delta X^{W}{}_{it} + \beta_2^{'} \Delta X_{it}^{E} + \delta OC_{it} + \gamma TC_{it} + \Delta \varepsilon_{it} \qquad (4a)$$

They can be consistently estimated by OLS on the pooled cross-sections, provided that OLS assumptions are satisfied. The most important is that the differenced error term is uncorrelated with the differenced covariates, or, stated differently, that the error term at each time is uncorrelated with the explanatory variables in all time periods (strict exogeneity).[13] However, as suggested by some authors, this is likely to be not true for *OC* and *TC* in (4a) (see Author et al., 1998). In what follows, we discuss how we tackle these issues in order to obtain our definitive empirical specification.

5.1.2. Endogeneity and measurement issues.

Three additional issues related to organizational changes and technology innovations need to be taken into account: (i) endogeneity, (ii) measurement errors, (iii) lag in the effect of the treatment. For what concern endogeneity and selection biases, because workplace innovations are not assigned at random, their relationship with wages may be spurious: the correlation may be positive, but not causal, if firms take the advantage of high productivity draws to improve efficiency through re-organisation and to share these rents with the workforce, or part of it, in the form of higher wages[14]; the correlation may be negative, but not causal, if firms decide to reorganize in bad times. In alternative, as suggested by Author et al. (1998), innovations may be introduced as a consequence of the positive shift in the supply of highly educated workers in the last two decades which has increased, for any given occupational level, the average schooling level of the workforce, and, to the extent which new technologies are complements of skills, the incentive to introduce innovations. Since for us the evolution of the average schooling levels within the firms is unobservable, we may suffer from reverse causality problems.

As discussed in length by Handel and Levine (2004), measurement errors arise for a number of reasons. First, our variables on organisational changes and technology innovations suffer from self-reporting and subjective evaluation. Moreover, innovations indicators do not report the number of workers involved in these practices, but only their usage. Assuming that the error in the interpretation of the question or in the reporting

[13] In addition, differenced error terms need to be uncorrelated over time. For this being true, the original idiosyncratic error terms have to follow a random walk. If the differenced error terms follow an AR(1), several FGLS techniques are available to perform valid inference and tests.

activity is idiosyncratic, results are biased towards zero. It is easy to show that using panel data the size of such distortion is even larger. Finally, there is the problem regarding the expected lag between the treatment and the outcome. Some authors argued that re-organisation of the firm and the implementation of new technologies are not instantaneous, but, instead, time consuming processes (Aghion et al., 1999). Thus, they might affect wages and wage inequality with some lag. In our case, the availability of longitudinal data allows to introduce non simultaneous effects, and to mitigate endogeneity problems by estimating a model with lagged values for organisational changes and technology innovations (for a similar approach, see Caroli and Van Reenen, 2001: Bauer and Bender, 2002; 2004).

Accordingly, our estimating version of a general wage equation on the pooled sample is the following:

$$\Delta y_{it} = \vartheta_0 + \vartheta_1 d95 + \beta_1^{'} \Delta X^{W}{}_{it} + \beta_2^{'} \Delta X_{it}^{E} + \delta OC_{it-1} + \gamma TC_{it-1} + \Delta \varepsilon_{it} \qquad (5)$$

It is estimated first by OLS[15]. However, standard OLS techniques to estimate (5) are likely to deliver inconsistent estimates if lagged values of *OC* and *TC* are correlated with the differenced error term: suppose for example that $E(ORG_{it}\varepsilon_{it}) \neq 0, \forall i,t$. Then:

$E[\Delta ORG_{it-1}\Delta\varepsilon_{it}] = E[(ORG_{it-1} - ORG_{it-2})(\varepsilon_{it} - \varepsilon_{it-1})] = -E[ORG_{it-1}\varepsilon_{it-1}] \neq 0$ and similarly for *TC*.

To tackle endogeneity and measurement error issues, we estimate the wage equations on the pooled data set and two linear reduced forms for *OC* and *TC* simultaneously using an IV-GMM estimator. The choice of the IV-GMM estimator in place of the more traditional IV is for convenience, since, with large cross sections, this procedure allows for heteroskedasticity and serial correlation in $\Delta\varepsilon_{it}$ of unknown form. To identify the model we need two exclusion restrictions. While local labour market variables and the incidence of training costs on total labour costs have been used to instrument organisational and technological change, their exclusion from wage equations is often questionable (Cappelli and Carter, 2000). In alternative, some authors advocated the use of longer lags of the endogenous variables as instruments for selection and simultaneity problems. However, they were not able to use this solution due to their

[14] As an alternative, demand shocks may induce firms to reorganize and to modify the workforce composition, thus affecting relative wages, or to postpone wage increases firms with high values of the error term may decide to.

shortness of panels (Caroli and Van Reenen, 2001). Fortunately, our data set provides information on long lags of organisational and technological changes, which can be used as instruments. More specifically, we use organizational and technological changes at time *t-2* (indicating a change between *t-2* and *t-3*, 1991 and 1989 respectively) as instrument for changes at time t-1 (indicating a change between *t-1* and *t-2*, 1993 and 1991 respectively). As main disadvantage, this approach reduces the sample available for the estimation to a single cross section.

To implement this identification strategy we need to assume that changes in the organization of work and in the level of technology between 1989 and 1991 don't affect the change in the wage structure between 1993 and 1995. This is equivalent to assuming that ORG_{it} and $TECH_{it}$ are only contemporaneously correlated with ε_{it}.[16] Since the model is exactly identified, we cannot test this assumption. For what concerns measurement errors, if they are purely random and not correlated over time[17], two-period lags are valid instruments for one-period lags to solve also this additional source of (toward zero) bias.

5.3. Empirical strategy

The methodological issues outlined above make the empirical analysis particularly challenging. In particular, a careful evaluation of the effects of modelling assumptions on results is crucial to validate our exercise. For this reason, in the next section, which is devoted to the econometric analysis, we estimate and compare several models and use a number of strategies to check the robustness of results. The outline of our empirical strategy is the following. First, we estimate equation (5) on wage levels for different categories of workers (whole workforce, white collars, blue collars, skilled, unskilled). For each dependent variable we estimate the model with OLS on the pooled first-differenced cross-sections. Then, we test the relevance of endogeneity issues (under the assumptions implied by our identification strategy) and estimate the model allowing for endogeneity of the innovation dummies. We then replicate the same exercise for wage differentials between white and blue collars, as well as between skilled and unskilled workers.

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[15] Note that in our case it is not possible to specify a dynamic model because the indicators for the innovation activity are simple binary indicators and not variables with a "true" time structure.

[16] In fact, suppose that $E(ORG_{it-1}\varepsilon_{it}) \neq 0$.

Then, $E[\Delta ORG_{it-2}\Delta\varepsilon_{it}] = E[(ORG_{it-2} - ORG_{it-3})(\varepsilon_{it} - \varepsilon_{it-1})] = -E[ORG_{it-2}\varepsilon_{it-1}] \neq 0$

6. Main Results

As shown in the previous section, there are significant differences in wage levels and wage inequality within firms by several characteristics related with workforce composition, innovation activity, production characteristics and market features. Simple averages, however, do not allow to analyse the role of firms' attributes on wages. For this purpose, to study wage determinants inside the firm, equation (5) has been estimated separately for wage levels and relative wages.

6.1. Workplace innovations and wages

Table 5a presents OLS estimates of the model in first differences, pooling the available two cross-section (1995 and 1993) over time. The dependent variables are the natural log of the average overall wage level in the firm, the average wage for white collars, blue collars, skilled and unskilled workers[18]. Results in the first column show that past (lagged one period) organisational changes and the introduction of new technologies have usually a positive and significant effect on (two-years changes in) firm average wage.[19] In particular, it seems that the effect of technology innovations is larger than the effect of workplace reorganisation. In first approximation, this evidence is consistent with the idea that productivity gains guaranteed by new technologies and work reorganisations are shared with workers. For what concerns workforce characteristics, changes in the number of employees are negatively related with wage changes, even controlling for the change in the share of part-timers on workers with fixed term contract. Thus it may be that hiring firms attract new entrants, without experience and, therefore, with lower wages than comparable tenured workers. Also the effect of changes in the share of women is negative. As we control for part-time and non-standard forms of work, we interpret the evidence that increasing shares of women have a negative effect on wage a signal of wage

[17] And if measurement errors are not systematically related to the outcome or to the level of organizational capital.

[18] As already mentioned, we use two alternative measures of the workforce composition by skills: the traditional classification based on white and blue collar and another one based on skilled and unskilled workers, where the notion of skill is related to the description of the skill requirement to perform the job. For concreteness, according to the first classification a firm with many generic secretaries and few generic manual workers is classified as more "skill" intensive than a firm with few specialized clerks and many specialized manuals. The opposite is true according to the second measure.

[19] Results from a model in levels show that the effect is negligible for organisational changes and positive but somehow insignificant for technological change. Overall, it seems that the "transmission mechanism" is more rapid for technology innovations.

discrimination or occupational segregation based on gender. Our proxy for tenure is positively associated with wages, although, due to the bias toward zero induced by measurement error, the coefficient is probably underestimated.

Of course, since we have available only average workforce characteristics, our model cannot capture and explain the substantial part of variance in wages due to individual worker characteristics, such as the education level, age, and so on.[20] For what concerns production characteristics, none is significant. Possible reasons are (i) lack of enough variation in regressors and (ii) variables related to productivity and capital intensity are proxy variables embedding a lot of measurement error which bias the estimates toward zero. Industry dummies regional dummies might capture important aspects of the technology and production techniques used by firms, but disappear using first differences.[21] As expected, labour market institutions matter in the change of wages. The existence of a firm local contract increase the wage over and above the level settled at a national level and the presence of a union has a similar effect. Union coordination does not seem to play a role in the explanation of wage dynamics. The negative coefficient for strikes might simply reflect simultaneity effects: workers strike more where the wage decreases[22].

The other columns of Table 5a replicate the estimates by different skill categories. Though the results are quite similar, the specification which delivers the more precise estimates is the one which splits the workforce between skilled and unskilled workers. Overall, as predicted by the human capital theory, firm's innovations raise the wage for those skilled workers (or white collars) who appear complementary to re- organisations and new technologies. For what concerns unskilled workers and blue collars, there is some evidence that new technologies have a positive but insignificant effect on wages for these categories, while organisational change appears negatively related to the wage of manual workers, and therefore associated to higher levels of skill. The wage of employees in the lower part of the distribution seems to be positively determined only by factors as tenure

[20] While a matched employer-employee data set would be surely more informative, still a data set with these characteristics at the moment is easily not available for Italy. Moreover, using information at the firm level only, we do not incur in the problems created by different aggregation levels.

[21] Following Caroli and Van Reenen (2001), we also run robustness checks including sector, size and geographic time invariant dummies. Results show that controlling for these fixed and structural differences between firms helps to improve the performance of the model in terms of explained variation of the wage or relative wage changes. However, they do not alter the estimated coefficients of the variables in tables 5, and in particular the values for organisational and technological changes.

[22] An alternative specification with lagged values for the strike variable has been also estimated. The coefficient for strikes is positive but only marginally significant. estimates

and union density. Moreover, the fact that the R-squared is quite low suggests that firm characteristics don't explain much of the blue collars' wage, which, probably, is essentially explained by individual characteristics (age, education, ect.) and/or technology.[23] In other words, since return to firm characteristics play a role for the wage of white collars but not for that of blue collars, it seems that only the former receive a firm-specific payoff which adds to the one due to human capital characteristics. In a sense, white collars are less substitutable with others from outside the firms, and they may be important to the extent which returns to firm characteristics signal talent, motivation, attitudes to collaborate, and so forth.

For what concerns white collars and skilled workers, the union presence in the firm guarantees higher wages, while union power, as represented by union density, tend to compress differences in pay by decreasing the wage in the upper part of the distribution. Local contracts seem to act in the opposite direction. These results are consistent to the findings of previous studies for Italy (see Dell'Aringa and Lucifora, 1994). It is worth to note that the time dummy for 1995 is negative and significant in all the specifications, witnessing the decrease in real wages after the 1993 reform in bargaining procedures which abolished the automatic indexation of wages to real inflation.

As discussed in section 4, the presence of autocorrelation in the error terms casts doubts on the validity of the estimates. Using estimated residuals, an AR(1) model has been estimated. Indeed, results show that there is significant autocorrelation in the residuals. In this case, a correction for autocorrelation based on FGLS (Prais-Winsten transformation) might be desirable, but, since the coefficient is negative, OLS statistics may not be heavily affected.

Table 5b deals with endogeneity and measurement error issues, estimating (5) and auxiliary regressions for organisational and technological changes with IV-GMM techniques on a single cross-section for 1995, by using 2 periods lags in organisational changes and technology innovations to instrument one period lags in the same variables. The results for the reduced form equations of the two selection processes are reported in Table A1. The instruments appear to be strongly correlated with the endogenous variables. The key result is that, under our identification assumptions, depending on the variable considered, self selection operates in opposite directions: negative for organisational changes and positive for technology innovations. As a result, OLS underestimate the true

[23] Using an alternative specification, industry dummies are jointly significant (see below).

effect of organisational innovations on wage changes and overestimate the coefficient associated to technology. In other words, it seems that firms tend to introduce innovations depending on their economic situation, being more likely to reorganise especially in periods of decline, while the adoption of more advanced technologies happens during periods of high productivity. Although the validity of our identification strategy cannot be directly tested, we note that our results are broadly consistent with a number of recent studies for other European Countries. The fact that firms are more likely to introduce new technologies when they are in periods of goods profits and enjoy high productivity levels may be explained by the evidence that in good periods the cost of capital is lower and maybe the cash flow to finance new investments is higher. In addition, the adoption of technological innovations encounter low workers' opposition, and it can be carried out by the management especially in periods of business expansions, when productivity improvements due to new technologies produce additional extra rents which can be shared with employees. Concerning the negative selection in the decision to reorganise, Wolf and Zwick (2002) and Zwick (2004) using a sample of German establishments for the period 1996-2000 find that neglecting the role of unobserved heterogeneity leads to an underestimation of the productivity consequences of organisational changes, because they are introduced especially by especially firms facing productivity problems. A similar result is reported by Nickell et al. (2001). In their sample of UK establishments they find evidence that organisational changes are more likely to be introduced by firms facing productivity slowdowns to improve their competitive level. Both the theoretical and the empirical evidence has proposed a number of explanations for the fact that firms introducing organisational changes are negatively selected. The baseline arguments is that firms reorganisation are usually opposed by employees. This happens because organisational changes are often accompanied by a strategy of cost reductions which may increase the risk of unemployment. Thus, the pay-off of the investment (increased productivity through restructuring processes) is uncertain and risk averse workers may dislike it.[24] Moreover, organisational changes usually involve a rationalisation strategy, which may increase the pressure on employees because of higher effort levels and supervision possibilities (Zwick, 2002). For all of these reasons, it is clear that the liability

[24] Cappellari et al. (2004) exploring job satisfaction issues using data for an Italian public utility company find evidence of employees resistance against innovations and substantial dissatisfaction of workers towards reorganisations of production carried out in such company.

of reorganisational changes is higher when productivity is low and employment opportunities are endangered by the risk of bankruptcy (Nickell et al., 2001).

Moving to the analysis of the other wages' determinants, again the model seems to better explain wages for skilled workers. In addition, the model estimated by GMM reports significant (but small) coefficients for plant characteristics: as one might expect, an increase in capital per employee is complement of skilled work and substitute of unskilled work. Labour productivity is a positive determinant of mean firm wage and increases especially remuneration of skilled workers. Institutional features are similar as before, but now the effect of union density on mean wage is estimated more precisely and negative (but the coefficient is small).

6.2. Workplace innovations and wage inequality

Table 6a and 6b present the estimate of (5) applied to measures of wage differentials. More specifically, these tables report results for the relative wage of both white collars and skilled workers, as well as the ratio between the maximum and minimum average wage within the firm. According to Table 6a, results from OLS show that work reorganisations and the adoption of new technologies have positive effects on all the proposed measures of wage inequality within firm. In other words, there is evidence that also in Italy, and controlling for the effect of institutional factors, organisational changes and technological changes have been skill-biased, i.e. they have caused an increase in the relative wage of highly qualified workers. While this result not necessarily holds outside the available sample of firms operating in the metal machinery industry, and, therefore, not easily extendable either to whole manufacturing or to the economy as a whole, still it suggest that recent innovations have increased wage dispersion within firms. Union density tends to compress wage differentials by skill and job, still overall wage inequality, measured by the ratio between highest and lowest average wage in the firm seems to depend positively on different wage profiles, as proxied by tenure and, especially, negatively on policy reforms and cycle factors (external factors) captured by the dummy for 1995. When (5) is estimated using IV-GMM to address endogeneity issues, interesting results emerge. First of all, when the differential between white and blue collars is considered, the effect of technology innovations vanishes, and the effect of organisational changes seems to drive the results. However, the preferred specification (on the basis of explained variance) is the one which estimates the skilled/unskilled differential. In this case, the two variables

considered have positive effects, but, somehow surprisingly, the size of the coefficient is higher for firm changing their organisation. In addition, when coefficients for the additional controls are considered, collars and skilled workers are more likely to share productivity gains and capital deepening in the form of higher wages. For what concerns overall wage inequality within the firm, the last column shows that the introduction of more flexible work organisations, characterised by multitasking, individualization of jobs and horizontally-integrated organisations produce a significant increase in the dispersion of wages. Technology innovations act in the same direction, but the overall effect is smaller.

7. Conclusions

Differently from other countries, like the US and the UK, wages and wage differentials in Italy have increased only slightly during the past decade, and skill-biased technological change did not contribute to a dramatic widening of wage distributions at the aggregate level. However, this does not prevent workplace innovations such as the introduction of new technologies and more flexible work arrangements from having substantial effects on intra-firm wage dispersion. The aim of this study was to investigate how innovations in the organisation of work and adoption of new technologies affected wages inside the firm in Italy, paying also attention to the role of market factors and, especially, labour markets institutions. To empirically address these issues we have used longitudinal data for a sample of Italian firms in the metal mechanical sector during the 1991-95 period. Main results show that internal wage levels and wage inequality are affected both by firm innovation activity and institutional factors, while the effect of market factors and workforce characteristics is less clear-cut. For what concerns the former, workers benefit from the introduction of new technologies and new work arrangements in the form of higher wages. This result is consistent with the idea that such changes increase productivity and workers have enough power to gain parts of it.

From a policy perspective, our results deserve some discussion. First of all, the invoked introduction of higher degrees of flexibility in the organisation of work to increase efficiency and competitiveness, achieved through the creation of autonomous teams, more participation of workers and the diffusion of more individualized jobs, and the introduction of more sophisticated technologies is not without costs: if, on the one side, it seems that employers share productivity gains with workers, on the other side only

skilled workers seem to benefit from the introduction of such changes. In other words, these practices are skilled biased and increase wage variability even in presence of more homogeneous workforce within the firm. These findings raise the question of how risk-adverse workers respond to increases in the variability of wages and what can be done to ameliorate the situation of low skilled workers, who are in the worst position during a restructuring process with the characteristics of the one described above. Second, it is a diffused opinion that higher degrees of flexibility in the management of human resources are achievable only through a reform in labour market institutions and a reduction of union power inside the firm. Our results shows that, by some extent, union power counterbalance the negative effects of innovations on the wage of low skilled and on wage differentials. It is clear that the welfare cost from a reduction in the ability of unions to protect these categories of employees should be carefully evaluated.

For these reasons, it is clear that public intervention to promote investments in workplace reorganisations and to stimulate the introduction of more flexibility in the use of work should be accompanied by specific measures to upgrade the qualification of the workforce to mitigate their negative effects on the wage, and, thus, the welfare of less skilled workers.

Table 1 – Variables' description

Variable	Description
Wages within firms	
ln(average wage)#	Natural log of annual real average firm wage
ln(wage blue collars)#	Natural log of annual real average wage of blue collars
ln(wage white collars)#	Natural log of annual real average wage of white collars
ln(wage skilled)*	Natural log of annual real average wage of skilled workers
ln(wage unskilled)*	Natural log of annual real average wage of unskilled workers
ln(wage white collars/wage blue collars)#§	Natural log of the share between white collars and blue collars annual average wage
ln(wage skilled/wage unskilled)#*	Natural log of the share between skilled and unskilled annual average wage
ln(wage max/wage min)	Natural log of the share between max and min real annual wage within the firm
Average workforce characteristics	
ln(# of employees)	Natural log of the number of employees in the firm
Share Women	# women/total # of employees
Tenure (proxy)	Accumulated severance pay (TFR) per employee
Share fix-term workers	# of fixed-term workers/total # of employees
Share Part time	# of part-time workers/total # of employees
Share shift workers	# workers on shift/total# of employees
Flexible working time	Dummy for firm flexible working time arrangements over the year
Immigrants	Dummy for the employment of immigrant workers in the firm
Firm production characteristics	
Multiplant	Dummy for multiple plants in the firm
% outsourcing	% of sales from exported production
% export	% of production made by counter-manufacturers
Labour productivity (proxy)	Sales per employee
Capital/labour (proxy)	Total investments per employee
Riskness	INAIL index of production dangerousness
CIG	Dummy for temporary layoff (CIG=Cassa Integraz. Guadagni)
Institutional features within the firm	
Firm local contract	Dummy for additional local contract in the firm
Empl prot legislat	Dummy for applicability of national empl. protection law
Strikes	Dummy for strikes occurred during the year
Union presence	Dummy for the recognition of unions in the firm
Union density	# of unionized workers/total # of employees
Union coordination	Dummy for the Federation of Metal mechanical Workers
Firm innovations (for 1991-93)	
Organisational change	Dummy for organisat. change over the last two years
Technology innovations	Dummy for innovative technolog. over last two years

Dummies: 1 = yes. #: weighted means by occupation (weights are the number of employees by occupation level) *: definition of skilled based on job category as reported in the national metalworking contract. §: blue collars are apprentices and manual workers; white collars are technical staff, clerks and executives.

Table 2 – Summary Statistics (1991-95)

	Whole Sample			1991			1993			1995		
Variable	Obs	Mean	StDev	Obs	Mean	StDev	Obs	Mean	StDev	Obs	Mean	StDev
Wages within firms												
ln(average wage)	6825	10.136	0.146	2456	10.161	0.124	2426	10.172	0.135	1943	10.060	0.158
ln(wage blue collars)	6771	9.979	0.098	2456	9.984	0.094	2426	9.980	0.090	1889	9.970	0.112
ln(wage white collars)	6782	10.306	0.158	2456	10.323	0.126	2426	10.335	0.137	1900	10.247	0.199
ln(wage unskilled)	6697	9.875	0.082	2456	9.888	0.076	2426	9.877	0.072	1815	9.855	0.097
ln(wage skilled)	6819	10.235	0.142	2456	10.265	0.120	2426	10.273	0.133	1937	10.149	0.141
ln(wage white /blue coll.)	6728	0.327	0.156	2456	0.339	0.135	2426	0.355	0.147	1846	0.275	0.178
ln(wage skilled/unskilled)	6691	0.361	0.142	2456	0.377	0.136	2426	0.397	0.144	1809	0.291	0.123
ln(wage max/min)	6825	0.864	0.359	2456	1.049	0.202	2426	0.994	0.192	1943	0.468	0.365
Workforce character.												
ln(# of employees)	6825	3.799	1.332	2456	3.795	1.320	2426	3.749	1.344	1943	3.864	1.333
Share Women	6825	0.178	0.135	2456	0.176	0.121	2426	0.178	0.121	1943	0.180	0.166
Immigrants*	6825	0.219	0.414	2456	0.193	0.395	2426	0.210	0.407	1943	0.264	0.441
Tenure	5801	14.304	21.972	2040	11.173	5.239	2037	15.945	35.947	1724	16.070	6.911
Share fix-term workers	6825	0.017	0.071	2456	0.015	0.078	2426	0.009	0.037	1943	0.028	0.090
Share Part time	6825	0.022	0.056	2456	0.022	0.067	2426	0.021	0.047	1943	0.023	0.050
Share shift workers	6825	0.004	0.049	2456	0.006	0.058	2426	0.003	0.037	1943	0.005	0.051
Flexible working time*	6825	0.061	0.239	2456	0.058	0.233	2426	0.055	0.228	1943	0.072	0.258
Prod. characterist.												
Multiplant*	6825	0.048	0.215	2456	0.049	0.216	2426	0.047	0.211	1943	0.049	0.217
% outsourcing	6825	12.253	19.371	2456	12.518	18.935	2426	11.738	19.355	1943	12.559	19.926
% export	6825	24.073	28.288	2456	21.959	26.974	2426	24.676	28.812	1943	25.992	29.082
Labour productivity	6437	184.14	121.64	2336	177.86	124.54	2296	176.39	115.19	1805	202.13	124.02
Capital/labour	6824	7.312	104.67	2456	11.634	173.37	2426	3.987	14.170	1942	6.001	14.365
CIG	6825	0.236	0.424	2456	0.235	0.424	2426	0.354	0.478	1943	0.089	0.285
Riskness	6259	0.425	0.279	2265	0.438	0.303	2223	0.422	0.251	1771	0.413	0.279

Table 2 - continued

Institutions												
Empl prot legislat*	6825	0.808	0.394	2456	0.811	0.392	2426	0.796	0.403	1943	0.820	0.384
Firm local contract*	6825	0.540	0.498	2456	0.507	0.500	2426	0.520	0.500	1943	0.608	0.488
Strikes*	6816	0.365	0.482	2456	0.440	0.496	2426	0.478	0.500	1934	0.129	0.336
Union presence*	6825	0.719	0.450	2456	0.703	0.457	2426	0.718	0.450	1943	0.741	0.438
Union density	6825	29.445	26.562	2456	30.304	27.347	2426	29.309	26.661	1943	28.531	25.386
Union coordination*	6825	0.137	0.344	2456	0.153	0.360	2426	0.139	0.346	1943	0.115	0.319
Firm innovations (only for 1991-93)												
Organisational change*	4882	0.357	0.479	2456	0.342	0.474	2426	0.372	0.483			
Technology innovations*	4882	0.298	0.457	2456	0.292	0.455	2426	0.304	0.460			

Note: * = dummy variable.

Table 3 – Wage Structure by selected firm characteristics

		ln(av. wage)	ln(w blue)	ln(w white)	ln(w skil)	ln(w unski)	ln(w wh/bl)	ln(w sk/unsk)	ln(w max/min)
Org. Change									
No		10.135	9.969	10.296	10.236	9.863	0.327	0.375	0.846
	91	*10.167*	*9.973*	*10.321*	*10.274*	*9.875*	*0.348*	*0.399*	*1.046*
	93	*10.180*	*9.970*	*10.336*	*10.285*	*9.866*	*0.366*	*0.420*	*0.993*
	95	*10.041*	*9.963*	*10.215*	*10.129*	*9.843*	*0.249*	*0.283*	*0.415*
Yes		10.137	9.989	10.316	10.233	9.887	0.327	0.345	0.884
	91	*10.153*	*9.995*	*10.325*	*10.254*	*9.902*	*0.330*	*0.352*	*1.053*
	93	*10.163*	*9.990*	*10.334*	*10.261*	*9.888*	*0.343*	*0.373*	*0.995*
	95	*10.081*	*9.978*	*10.282*	*10.170*	*9.867*	*0.302*	*0.299*	*0.528*
Tech. Innov.									
No		10.134	9.970	10.299	10.235	9.866	0.328	0.370	0.854
	91	*10.166*	*9.976*	*10.323*	*10.272*	*9.879*	*0.346*	*0.392*	*1.050*
	93	*10.173*	*9.971*	*10.331*	*10.278*	*9.867*	*0.360*	*0.411*	*0.992*
	95	*10.046*	*9.962*	*10.229*	*10.136*	*9.845*	*0.264*	*0.288*	*0.441*
Yes		10.141	9.997	10.321	10.235	9.895	0.324	0.340	0.888
	91	*10.150*	*10.001*	*10.324*	*10.248*	*9.907*	*0.323*	*0.341*	*1.047*
	93	*10.168*	*9.999*	*10.343*	*10.263*	*9.896*	*0.343*	*0.367*	*0.999*
	95	*10.093*	*9.989*	*10.288*	*10.179*	*9.876*	*0.300*	*0.299*	*0.532*
Noth-west		10.144	9.981	10.313	10.244	9.876	0.333	0.370	0.854
North-east		10.130	9.982	10.306	10.228	9.875	0.323	0.354	0.907
Centre		10.115	9.957	10.269	10.203	9.864	0.310	0.336	0.819
South-islands		10.049	9.954	10.224	10.148	9.875	0.272	0.275	0.818
Metallurgy		10.131	9.991	10.322	10.229	9.889	0.331	0.341	0.874
Foundries		10.115	9.958	10.284	10.220	9.860	0.325	0.362	0.859
Metal tools		10.153	10.000	10.317	10.239	9.877	0.317	0.364	0.884
Machines		10.107	9.963	10.283	10.220	9.880	0.320	0.339	0.863
Precision Parts		10.183	9.986	10.321	10.269	9.872	0.335	0.398	0.868
Electronic Components		10.132	9.973	10.305	10.238	9.891	0.333	0.349	0.854

Table 3 - continued

Vehicles construction	10.121	9.991	10.310	10.220	9.905	0.319	0.313	0.851
Installation machines	10.125	9.941	10.287	10.233	9.832	0.345	0.398	0.870
Vehicles reparation	10.137	9.968	10.307	10.242	9.858	0.338	0.388	0.833
technical offices	10.237	10.000	10.343	10.318	9.879	0.371	0.443	0.815
Outsourcing								
no	10.136	9.971	10.301	10.236	9.866	0.329	0.370	0.842
yes	10.136	9.984	10.310	10.234	9.881	0.326	0.354	0.880
Export								
no	10.131	9.957	10.294	10.236	9.853	0.337	0.384	0.840
yes	10.139	9.991	10.313	10.234	9.887	0.321	0.348	0.878
Multiestabl.								
no	10.135	9.977	10.304	10.234	9.872	0.327	0.363	0.863
yes	10.158	10.020	10.346	10.238	9.927	0.324	0.310	0.885
Union								
no	10.123	9.935	10.281	10.242	9.836	0.347	0.409	0.852
yes	10.141	9.996	10.315	10.232	9.890	0.319	0.342	0.869
Union coord								
no	10.130	9.972	10.300	10.233	9.867	0.329	0.367	0.859
yes	10.172	10.023	10.342	10.247	9.922	0.318	0.324	0.900
Firm contract								
no	10.151	10.008	10.321	10.239	9.905	0.313	0.333	0.887
yes	10.123	9.953	10.293	10.231	9.848	0.339	0.385	0.845

Table 4 – Organisational change and Technology innovations (means)

	any organisational change		any technology innovation	
Variable	no	yes	no	yes
Workforce characteristics				
ln(# of employees)	3.367	4.283	3.493	4.485
Share Women	0.177	0.183	0.177	0.186
Immigrants	0.190	0.258	0.198	0.276
Tenure	14.233	14.302	14.258	14.283
Share fix-term workers	0.019	0.016	0.019	0.016
Share Part time	0.023	0.020	0.023	0.019
Share shift workers	0.001	0.008	0.002	0.010
Flexible working time	0.049	0.077	0.051	0.088
Production characterist.				
Multiplant	0.030	0.069	0.034	0.080
% outsourcing	10.487	14.179	11.158	14.617
% export	20.091	28.373	20.503	31.922
Labour productivity	177.435	194.540	183.118	190.691
Capital/labour	6.766	8.298	7.170	8.186
CIG	0.192	0.260	0.207	0.262
Riskness	0.444	0.399	0.450	0.362
Institutions within firm				
Empl prot legislat	0.731	0.899	0.759	0.925
Firm local contract	0.622	0.472	0.601	0.439
Strikes	0.255	0.453	0.289	0.481
Union presence	0.641	0.795	0.668	0.815
Union density	25.024	32.942	26.661	33.418
Union coordination	0.086	0.187	0.102	0.206
Firm innovations				
Organisational change			0.328	0.775
Technology innovations	0.125	0.502		

Table 5a – The determinants of wage levels: pooled OLS (1995-93) on first differences

Dep. Variable:	ln(av. wage)		ln(w. blue collar)		ln(w. white collar)		ln(w. unskilled)		ln(w. skilled)	
	Coef.	T	Coef.	T	Coef.	t	Coef.	t	Coef.	t
Year95	-0.128**	-15.54	-0.010**	-2.33	-0.104**	-10.46	-0.013**	-3.1	-0.138**	-16.38
Firm innovations										
Organisational change$_{t-1}$	0.017**	2.9	-0.004	-1.38	0.026**	3.52	-0.004	-1.57	0.023**	3.94
Technology Innovations$_{t-1}$	0.033**	6.14	0.004	1.08	0.031**	4.86	0.0002	0.06	0.033**	6.33
Workforce characteristics										
ln(# of employees)	-0.042**	-3.58	-0.001	-0.11	-0.013	-1.11	-0.003	-0.04	-0.029**	-2.57
Share Women	-0.315**	-6.89	-0.084**	-3.59	-0.359**	-6.2	0.010	0.5	-0.201**	-4.12
Immigrants*	0.011	1.26	0.003	0.57	0.010	0.86	0.008	1.59	0.010	1.16
Tenure§	0.01*	1.71	0.021**	4.33	0.022**	2.75	0.017**	4.06	0.003	0.27
Share fix-term workers	-0.098**	-1.81	-0.023	-1.06	-0.184**	-2.86	-0.030*	-1.66	-0.094*	-1.81
Share Part time	0.013	0.28	-0.005	-0.17	-0.041	-0.66	0.028	1.2	-0.003	-0.05
Share shift workers	0.018	0.53	-0.005	-0.25	0.041	1.37	0.009	0.39	0.038	1.18
Flex working time	0.005	0.39	0.003	0.43	0.009	0.59	-0.009*	-1.7	-0.002	-0.14
Production characteristics										
Multiplant	0.007	0.5	-0.005	-0.56	0.004	0.03	-0.022**	-2.38	-0.007	-0.64
% outsourcing§	-0.003	-0.15	-0.001	-0.12	0.001	-0.01	-0.012	-1.15	0.016	0.84
% export§	-0.034	-1.31	-0.025*	-1.75	-0.016	-0.56	-0.013	-1.13	-0.012	-0.48
Labour product.§	0.003	0.56	0.003	0.87	0.005	0.84	0.002	1.02	0.001	0.25
Capital/labour§	0.001	0.6	-0.001	-0.64	0.002	1.16	0.000	-0.18	0.003	1.39
CIG	-0.006	-0.99	-0.002	-0.75	-0.010	-1.3	-0.003	-1.11	-0.007	-1.19
Riskness	-0.006	-0.59	0.005	0.75	0.007	0.63	0.007	1.19	0.007	0.85

Table 5a - continued

	Institutions within the firm									
Empl prot legislat	-0.032*	-1.8	-0.003	-0.23	-0.045**	-2.18	-0.004	-0.47	-0.021	-1.23
Firm local contract	0.014**	2.15	0.001	0	0.022**	2.74	-0.507	-1.35	0.015**	2.14
Strikes	-0.026**	-4.04	-0.006*	-1.8	-0.015*	-1.76	-0.007**	-2.39	-0.023**	-3.49
Union presence	0.032*	1.77	0.005	0.42	0.033*	1.76	0.008	1.11	0.032**	2.01
Union density§	-0.037	-1.14	0.026*	1.74	-0.051*	-1.68	0.024*	1.88	-0.057**	-2.24
Union coordination§	0.002	0.16	0.001	0	-0.265	-0.23	0.494	1.04	-0.003	-0.27
residual AR(1) (ρ)°	-0.579	-9.1	-0.405	-7.72	-0.572	-9.81	-0.516	-7.97	-0.630	-11.08
Number of obs	2,374		2,374		2,374		2,374		2,374	
F(24, 1632)	17.76		2.41		9.79		2.71		18.77	
Prob > F	0		0.0002		0		0		0	
R-squared	0.211		0.0283		0.1239		0.0289		0.21	
clusters (id)		1633		1633		1633		1633		1633

Note: all the regressions include a constant. Model estimated using the Huber-White correction for heteroskedaticity. Standard errors clustered across observations for the same firm. Dependent variables are the two-year changes in wages between 1995 and 1993, and between 1993 and 1991. Organisational changes and technology innovations indicates changes occurred between 1993 and 1991, and between 1991 and 1989. Estimation with pooled OLS after taking two-years first differences for all the variables excluded organizational change and techonoly innovations (dummies for occurred changes). *= 10% significance level. **=5% significance levels. °= coefficient estimates from AR(1) model on residuals of the principal regression. §: coefficient multiplied by 100.

Table 5b – The determinants of wage levels: GMM (1995) on first differences

Dep. Variable:	ln(av. wage)		ln(w. unskilled)		ln(w. skilled)	
	Coef.	z-st	Coef.	z-st	Coef.	z-st
	Firm innovations					
Organisational change$_{t-1}$	0.092**	8.04	-0.01378	-1.18	0.09860**	8.63
Technology Innovations$_{t-1}$	0.019**	2.02	-0.00392	-0.42	0.01957**	2.11
	Workforce characteristics					
ln(# of employees)	-0.077**	-3.57	-0.016	-0.41	-0.025	-1.14
Share Women	-0.270**	-2.85	0.011	0.08	-0.171*	-1.8
Immigrants	0.012	0.93	0.016	0.95	0.009	0.67
Tenure§	0.018**	9.47	0.002**	2.31	0.014**	7.18
Share fix-term worker	-0.058	-0.36	-0.043	-0.26	-0.035	-0.22
Share Part time	-0.143	-0.14	-0.18	-0.13	-0.036	-0.03
Share shift workers	-0.003	-0.01	-0.004	-0.01	0.033	0.1
Flex working time	-0.006	-0.24	-0.025	-0.82	-0.016	-0.62
	Production characteristics					
Multiplant	0.034	0.77	-0.031	-0.55	0.010	0.22
% outsourcing§	0.024**	1.98	-0.021*	-1.79	0.035**	2.92
% export§	-0.037**	-5.12	-0.014	-1.32	-0.027**	-3.69
Labour product.§	0.005*	1.93	0.002	0.35	0.006**	2.11
Capital/labour §	0.006	0.86	-0.011**	-2.18	0.040**	6.01
CIG	-0.003	-0.56	0.006	0.09	-0.007	-1.37
Riskness	-0.013	-0.62	0.016	0.5	-0.010	-0.48
	Institutions within the firm					
Empl prot legislat	-0.070*	-1.78	-0.020	-0.37	-0.071*	-1.83
Firm local contract	0.018**	3.18	-0.003	-0.46	0.015**	2.74
Strikes	-0.035**	-6.61	-0.012**	-1.98	-0.030**	-5.57
Union presence	0.041	1.52	0.009	0.24	0.034	1.26
Union density§	-0.070**	-3.74	0.020	0.84	-0.090**	-4.86
Union coordination	-0.011	-0.46	-0.005	-0.18	-0.020	-0.89
Number of obs	935		751		935	
R-squared	0.12		0.06		0.10	

Note: see Table 5a

Table 6a – The determinants of wage inequality:

pooled OLS (1995-93) on first differences

Dep. variable:	ln(w. white/blue)		ln(w. skill/unskill)		ln(w. max/min)	
	Coef.	t	Coef.	t	Coef.	t
Year95	-0.093**	-8.96	-0.125**	-14.68	-0.467**	-29.77
			Firm innovations			
Org. change$_{t-1}$	0.030**	3.88	0.025**	4.2	0.024**	1.98
Tech. Innovations$_{t-1}$	0.028**	4.05	0.032**	6.11	0.042**	3.49
			Workforce characteristics			
ln(# of employees)	-0.012	-1.03	-0.027**	-2.76	0.047**	2.28
Share Women	-0.274**	-4.43	-0.202**	-4.36	0.054	0.41
Immigrants*	0.006	0.57	0.003	0.38	0.017	0.88
Tenure§	-0.001	-0.1	-0.013	-0.97	0.030**	2.68
Sh. fix-term worker	-0.162**	-2.2	-0.056	-0.97	0.022	0.27
Share Part time	-0.035	-0.48	-0.038	-0.64	-0.137	-1.48
Share shift workers	0.046*	1.65	0.028	1.12	0.025	0.42
Flex working time	0.006	0.38	0.008	0.68	0.014	0.55
			Production characteristics			
Multiplant	0.006	0.44	0.014	1.19	-0.011	-0.33
% outsourcing§	0.001	0.04	0.032*	1.65	0.001	1
% export§	0.009	0.3	0.001	0.05	0.001	-0.01
Labour productivity§	0.002	0.31	0.001	0.23	0.003	0.29
Capital/labour §	0.004	1.21	0.004	1.14	0.008	1.12
CIG	-0.007	-0.89	-0.003	-0.45	-0.006	-0.43
Riskness	0.001	0.13	-0.001	-0.01	0.011	0.44
			Institutions within the firm			
Empl prot legislat	-0.044*	-1.85	-0.013	-0.71	-0.001	-0.04
Firm local contr.	0.022**	2.62	0.019**	2.65	0.024*	1.74
Strikes	-0.010	-0.99	-0.011**	-2.37	-0.020	-1.35
Union presence	0.030	1.42	0.028*	1.71	0.029	1.09
Union density§	-0.076**	-2.46	-0.09**	-3.41	-0.019	-0.35
Union coordination§	-0.003	-0.2	-0.010	-1.19	-0.006	-0.31
residual AR(1) (ρ)°	-0.55	-10.08	-0.58	-10.71	-0.42	-7.48
Number of obs.	2374		2330		2374	
F(24, 1632)	6.33		15.6		56.13	
Prob > F	0		0		0	
R-squared	0.098		0.19		0.3762	
clusters (id)		1633		1633		1633

Note: see table 5.

Table 6b – The determinants of wage inequality: GMM (1995) on first differences

Dep. variable:	ln(w. white/blue)		ln(w. skill/unskill)		ln(w. max/min)	
	Coef.	t	Coef.	t	Coef.	t
			Firm innovations			
Org. change$_{t-1}$	0.120**	10.47	0.101**	8.46	0.187**	16.37
Tech. Innovations$_{t-1}$	0.001	0.13	0.024**	2.47	0.020**	2.13
			Workforce characteristics			
ln(# of employees)	0.018	0.85	0.006	0.27	0.154**	7.11
Share Women	-0.242**	-2.5	-0.181*	-1.63	-0.023	-0.24
Immigrants*	0.003	0.27	-0.006	-0.44	-0.024*	-1.84
Tenure§	0.007**	3.79	0.001	0.1	0.034**	17.62
Sh. fix-term worker	-0.099	-0.62	0.035	0.22	0.008	0.05
Share Part time	0.037	0.03	-0.143	-0.11	-0.116	-0.11
Share shift workers	0.067	0.2	0.034	0.1	-0.001	0
Flex working time	-0.022	-0.84	0.005	0.18	0.048*	1.81
			Production characteristics			
Multiplant	0.016	0.38	0.022	0.51	0.016	0.37
% outsourcing §	0.022*	1.65	0.069*	5.4	0.058**	4.77
% export §	-0.012*	-1.63	-0.010	-1.31	-0.064**	-8.82
Labour productivity §	0.007**	2.52	0.006*	1.87	0.018**	6.58
Capital/labour §	0.047**	7.08	0.057**	8.4	0.127**	19.08
CIG	-0.008	-1.61	-0.005	-0.92	-0.021**	-4.12
Riskness	-0.005	-0.23	-0.022	-1.02	0.010	0.5
			Institutions within the firm			
Empl prot legislat	-0.125**	-3.06	-0.053	-1.24	-0.004	-0.12
Firm local contr.	0.022**	4.0	0.015**	2.55	0.009	1.52
Strikes	-0.017**	-3.42	-0.016**	-3.06	-0.016**	-3.16
Union presence	0.046*	1.71	0.031	1.14	0.140**	5.24
Union density §	-0.106**	-5.5	-0.119**	-5.94	-0.225**	-12.08
Union coordination	-0.020	-0.9	-0.025	-1.1	-0.004	-0.16
Number of obs	2374		2330		2374	
R-squared	0.097		0.188		0.3762	

Table A1- First stage regressions for GMM estimations

	Org. Change		Tech. Innov	
	Coef.	t	Coef.	t
ln(# of employees)	-0.051	-1	-0.03929	-1.85
Share Women	-0.00309	-0.03	-0.03526	-0.72
Immigrants*	0.050432	1.25	-0.01044	-0.61
Tenure	6.21E-05	0.19	-4.07E-06	-0.03
Sh. fix-term worker	0.002577	0.02	-0.00607	-0.09
Share Part time	-0.61604	-1.56	0.035493	0.21
Share shift workers	-0.10916	-0.49	-0.05782	-0.62
Flex working time	-0.0159	-0.27	-0.00102	-0.04
Multiplant	-0.02176	-0.27	-0.01824	-0.55
% outsourcing	0.000666	0.77	-0.00062	-1.72
% export	-0.00043	-0.49	-0.00018	-0.5
Labour product.	0.000122	0.62	0.000103	1.24
Capital/labour	0.000252	0.41	4.25E-05	0.16
CIG	0.040325	1.59	0.005421	0.51
Riskness	-0.0483	-0.88	0.013541	0.58
Empl prot legislat	0.149549	2.04	-0.00437	-0.14
Firm local contr.	0.055146	2.07	0.020133	1.79
Strikes	-0.0425	-1.68	0.005457	0.51
Union presence	-0.01874	-0.3	-0.01573	-0.6
Union density	0.001669	1.57	-0.00011	-0.25
Union coordination	-0.05584	-0.99	-0.02413	-1.02
Org. change$_{t-2}$	0.544548	19.27	-0.00484	-0.41
Tech. Innov$_{t-2}$	0.165446	5.65	0.945486	76.54
_cons	0.117035	5.46	0.019801	2.19
N° obs.	935		935	
R-squared	0.4057		0.8893	
R-sq. Excl. Instr.	0.388		0.881	

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