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FEDERICA ORIGO, *Does modern organization rhyme with wage "equalization"? Some evidence on the effect of work organization and institutions on pay inequality within firms.*
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The empirical analysis on a cross section of Italian metalworking firms shows that internal wage inequality is influenced by both organizational and institutional factors.
In general, using the definition of "post-Tayloristic" firm prevailing in literature, these organizations seem to present lower wage inequality than other traditional ("Tayloristic") firms. The overall lower wage differentials that characterize modern organizations is mostly confined under the median wage, while in the upper part of the distribution a modern production organization is accompanied by wider wage dispersion.
The effect of employment composition by skill on wage inequality crucially depends on the definition of "skills" adopted: while wage differentials increase with the blue/white collars ratio, they decrease with the skilled/unskilled workers ratio.
Labor market institutions, in particular unions' power and local wage bargaining, generally compress wage differentials inside the firm. I also found that firm's size, which is in general positively correlated with internal wage inequality, doesn't seem to affect the lower part of the distribution.

Theme: Wage inequality and mobility
Key-words: internal wage inequality, work organization, labor market institutions.
JEL codes: J31, J51, L23, 030

Does modern organization rhyme with wage "equalization"?

Some evidence on the effect of work organization and institutions on pay inequality within firms[°].

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1. Introduction

The last decades have witnessed a significant transformation in production and management of most European and American corporations.

The traditional "Fordistic" or "Tayloristic" firm, characterized by mass production, high specialization of the workforce and centralization of decision making, was the predominant (and successful) model in the industrial economy of the past century. However, starting from the end of the eighties, its rigid vertical structure did no longer appear to be the best solution to operate in more competitive and customer-oriented markets and to fully exploit all the potential of new technologies (such as computers, more sophisticated tools, multi-task machines, etc.) requiring a more flexible and skilled workforce.

At the same time, the labor market experienced a significant increase in the average education and skills of the workforce accompanied by less rigid institutions, with an overall reduction of unions' power in wage bargaining and employment regulation (in terms of tightness of hiring and firing procedures).

In response to these changes, firms became progressively flatter and horizontally integrated, with less hierarchical levels and more connections between different tasks and functions. Individual specialized work was substituted by collective work through work teams, workers' involvement groups and quality circles, with a general increase in the demand of high skilled workers All these features led to a new model of organization: the so called "Post Tayloristic" firm[1].

Along with the composition of the workforce, wage structure and differentials, both within and between firms, were affected by all these changes.

The present work focuses its attention on wage dispersion inside the firm, with the aim of studying whether pay inequality among employees of the same company is determined by particular features of both work organization and institutional setting.

In particular, I shall try to address the following questions: does "post-Tayloristic" work organization reduce skills differentials inside the firm, compressing in this way internal wage differentials? What is the role of labor market institutions (such as unions, local wage bargaining, employment regulation, non wage costs) in determining within pay inequality? How do work organization and institutions interact in influencing internal pay inequality inside the firm?

In light of these objectives, the next section reviews previous empirical work, while section 3 discusses why internal wage differentials should change with work organization. In section 4, I present the results of the empirical analysis, paying particular attention to the specification of the empirical model (4.1), the features of the data set used, some selected descriptive statistics (4.2) and the resulting estimates (4.3). A few concluding remarks are then outlined in the last section.

[1] In literature, these new model is also called "decentralized" (Caroli, Greenan and Guellec, 1999) or "holistic" firm (Lindbeck and Snower, 1996)

2. Literature review

Economic research on firm organization is relatively recent and the results of empirical work is far from conclusive.

With the exception of some early case and psychological studies[2], the bulk of the analysis on this issue occured in the Nineties, when new Information Technologies and work practices (such as team work, Total Quality Management, quality circles, etc.) became progressively more popular among a higher number of firms.

Recent empirical work on firm organization (and organizational change) focuses its attention on three main aspects:

- the determinants of the use of new forms of work organization;
- the effect of new work organization on firms' performance, mainly on productivity-related measures;
- the effect on new work organization on employment structure, wage levels and labor costs.

The first group of studies showed that new work practices (such as team work, flexible job assignments, Total Quality Management, decentralization of responsibilities, etc.) are generally complementary (Osterman, 1994) and are usually adopted in clusters (Ichniowski and Shaw, 1995).

However, the effect of new work practices on firms' performance and labor productivity is unclear. While some researchers found positive effects of new work practices on labor productivity in the steel sector (Ichniowski et al. 1997[3]), on individual performance in public utilities firms (Cappelli and Rogowsky, 1998) and on sales of the call centers of a telecommunications company (Batt, 1999), others concluded that work practice *per se* has little effect on labor productivity at the establishment level, unless introduced in particular combinations with other work practices[4] (Black and Lynch, 1997). Furthermore, productivity improvements can be offset by increases in labor costs, so that the net result in terms of efficiency (a measure that combines labor productivity and labor costs) may be negligible (Cappelli and Neumark, 1999).

There is some evidence supporting a positive impact of new work practices on wage levels. Hunter and Lafkas (1998) used micro-level data on a sample of 300 US bank branches in 1994 and found that work practices enhancing individual discretionary effort are associated with significantly higher earnings. Using the 1994 and 1997 National Employer Survey matched with data on individual employees from the 1990 Census, Cappelli and Carter (2000) also showed that higher wages are associated with computer use and teamwork in the case of

[2] Trist (1981) presents some case studies, while Hackman and Oldham (1980) present psychological studies. For a more exhaustive review of past work see, for example, Caroli (1999) and Cappelli and Neumark (1999)

[3] Among new work practices, they included also teams and incentive pay schedules.

[4] For example, Total Quality Management seems to influence labor productivity only when a large proportion of employees is involved also in employee participation programs.

front-line workers (who are more likely the targets of most high performance work practice). This relationship is weaker for other occupations, particularly in the non-manufacturing sector. No relation between new work organization and pay gains was found by Osterman (2000), who studied a sample of almost 700 private firms with at least fifty employees in 1997. A positive relation seems instead to exist between new work practices, lay-off incidence and total employment levels: the adoption of these practices is then clearly linked to employment reorganization, in particular to a more limited use of both managers and contingent workers.

Organizational changes are likely to influence wage levels (and structure) through employment/skills reorganization: as showed by Bresnahan et al. (1999) in the American case, decentralization in workplace organization has a positive effect on firms' investment in human capital , also controlling for Information Technologies. Using two different panel data sets of British and French establishments, Caroli and Van Reenen (1999) found that organizational change reduced the demand for unskilled workers in both countries.

Even if it is clear that "skill-biased" organizational change should influence not only wage levels, but also pay inequality both within and between firms, very few empirical work, mainly due to the lack of suitable data, has been done on this particular aspect. One of these examples in the recent empirical literature is Cappelli (1996), who used a sample of private establishments with more than twenty employees in 1994[5] to study the effect of work organization on wage levels of both production workers and supervisor and on the wage ratio of these two occupations. He found that for both occupations higher wages are associated with Total Quality Management programs, use of computer and capital intensity. However, the first factor, along with the use of computer by managers, has a negative effect on wage inequality within the firm, suggesting that the introduction of computers and new work practices may increase inequality within occupations in a certain sector, but reduce inequality within establishments where they were adopted. It is worth pointing out that these results are more tentative than conclusive, also given the broad (and unique) definition of wage inequality used.

Furthermore, it should be emphasized that the final effect of work organization on both wage levels and inequality strictly depends on the institutional characteristics of the country. In particular, labor market institutions such as unions, wage bargaining, employment regulation, non wage labor costs may either increase or offset the impact of organization change on wage inequality (Caroli, 1999).

Even if there is already some evidence of the role of these institutions (in particular, of the reduction in both workforce unionization and minimum wage level) in rising wage inequality – at least in the US and UK - over the last decades (Di Nardo et al., 1996; Fortin and Lemieux, 1997; Machin, 1997), much work has yet to be done to understand how labor

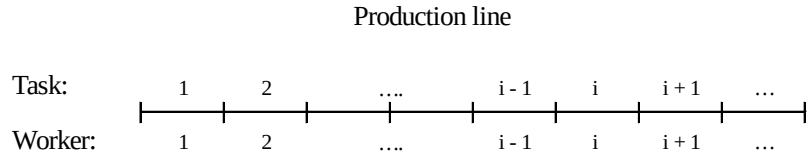
[5] The data is an earlier and less updated version of the same data set used in Cappelli and Carter (2000).

market institutions and work organization interact in influencing wage inequality within firms (or between occupations and educational levels).
In the next sections I shall try to address some of these still open questions.

3. The model

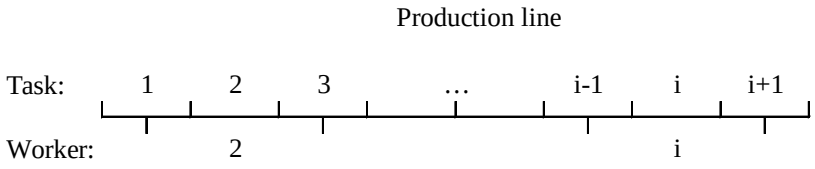
Let's consider work organization and division of tasks in a Tayloristic firm. Assume there are n workers and n tasks and production is organized such that each worker is assigned to a certain task and each task is independent from the others (see Figure 1). There is then a one-to-one relation between workers and tasks and the productivity of the i-th worker is exactly equal to the productivity of the i-th task.

Figure 1 - Work organization in a Tayloristic firm



Let p_i be the productivity of the i-th worker and assume p_i is normally distributed in the population with mean μ and variance σ^2.
The expected value of the average productivity of the firm is then equal to μ, with variance σ^2/n.
Now consider a firm (a "post-Tayloristic" firm) in which there is not a one-to-one relation between workers and tasks. Rather, due to either the technology or the production process used, the same worker is assigned to more than one task and, conversely, a certain task is performed by more than one worker. Assume, for example, that each i-th worker has to perform, other than the correspondent i-th task, part of the contiguous tasks (say, i-1 and i+1). Figure 2 sketches this relation between workers and tasks.

Figure 2 - Work organization in a post- Tayloristic firm



In this case, i-th worker's productivity can be defined as a weighted average of the productivity of this worker in performing three different contiguous tasks (i.e., i-1, i and i+1)[6]:

$$p_i = \alpha_1 p_{i,i-1} + \alpha_2 p_{i,i} + \alpha_3 p_{i,i+1} \quad \text{with } \sum_{j=1}^{3} \alpha_j = 1 \qquad [1]$$

Note that, if either $p_{i,i-1}$ or $p_{i,i+1}$ is zero, then the productivity of the i-th worker in the post-Tayloristic firm is lower than the productivity of the same worker in the Tayloristic firm. Post-Tayloristic firms are then prone to hire workers that are good at more than one task. This implies an increasing demand for high educated and skilled workers, who are usually more capable of performing different tasks and to deal with increasing level of uncertainty and responsibilities (Caroli and Van Reeenen, 1998).
Given the assumption on the αs made in [1] and assuming the same set of weights for all the workers[7], the expected value of the average productivity in the two types of firm is the same. However, the variance of the average productivity in the post-Tayloristic firm becomes:

$$\begin{aligned} \mathrm{Var}(\bar{p}_i) &= \mathrm{Var}\left[\frac{1}{n}\sum_{i=1}^{n}\left(\alpha_1 p_{i,i-1} + \alpha_2 p_{i,i} + \alpha_3 p_{i,i+1}\right)\right] \\ &= \alpha_1^2 \mathrm{Var}(\bar{p}_{i,i-1}) + \alpha_2^2 \mathrm{Var}(\bar{p}_{i,i}) + \alpha_3^2 \mathrm{Var}(\bar{p}_{i,i+1}) + 2\alpha_1\alpha_2 \mathrm{Cov}(\bar{p}_{i,i-1}, \bar{p}_{i,i}) \\ &\quad + 2\alpha_2\alpha_3 \mathrm{Cov}(\bar{p}_{i,i}, \bar{p}_{i,i+1}) + 2\alpha_1\alpha_3 \mathrm{Cov}(\bar{p}_{i,i-1}, \bar{p}_{i,i+1}) \end{aligned} \qquad [2]$$

If we assume that the productivity of each worker doesn't depend on the productivity of the others[8], but the productivity of the worker is positively correlated across tasks (for simplicity, assume that the positive covariance is constant across both tasks and workers and equal to ω), then equation [2] reduces to:

$$\mathrm{Var}(\bar{p}_i) = (\alpha_1^2 + \alpha_2^2 + \alpha_3^2)\frac{\sigma^2}{n} + 2(\alpha_1\alpha_2 + \alpha_2\alpha_3 + \alpha_1\alpha_3)\omega \qquad [3]$$

which is equal, after some algebraic transformations, to:

$$\mathrm{Var}(\bar{p}_i) = \frac{\sigma^2}{n} + 2(\alpha_1\alpha_2 + \alpha_2\alpha_3 + \alpha_1\alpha_3)(\omega - \frac{\sigma^2}{n}) \qquad [4]$$

---

[6] This expression for p_i assumes perfect separability of productivity across both tasks and workers, A more general formulation may be $p_i=f(p_{i,i}, p_{i,i-1}, p_{i,i+1}, p_{i-1,i-1}, p_{i-1,i}, p_{i+1,i}, p_{i+1,i+1})$.
[7] This is like saying that all the workers spend α_2 of their total working time in their central task (e.g, task i for the i-th worker), while the remaining time is split into the contiguous tasks in the same way for all workers.
[8] One possible extension is to assume non zero correlation in the productivity of workers assigned to the same task.

Since $\omega/(\sigma^2/n)$ - the correlation index – is never greater than one, the second term on the right hand side of the previous expression is non-positive.
This implies that the variance of labor productivity in a Tayloristic firm is greater or equal to the variance of labor productivity in a post-Tayloristic firm.
If workers' compensation depends on their productivity, then the same result should emerge also comparing wage dispersion in the two models: internal wage inequality should be lower in post-Tayloristic firms than in Tayloristic ones.

4. The empirical analysis

4.1. Econometric specification

The simple model presented in section 3 provides some testable predictions on the relation between work organization, composition of the workforce and wage inequality.
In a competitive environment, the relative price of input factors, along with changes in work organization inside the firm, influence the composition of the workforce and the latter determines the actual internal wage inequality.
If we split the workers into two broad categories according to their skill level (essentially, skilled and unskilled workers), the econometric model can be then specified with a system of two equations as follows:

$$\frac{n^s_{i,t}}{n^u_{i,t}} = f\left(\frac{w^s_{i,t}}{w^u_{i,t}}, O_{i,t}, X_{i,t}\right) + \varepsilon_{i,t} \qquad [1]$$

$$\frac{w^s_{i,t}}{w^u_{i,t}} = g\left(\frac{n^s_{i,t}}{n^u_{i,t}}, Z_{i,t}\right) + u_{i,t} \qquad [2]$$

where n^s/n^u is the skilled (s) to unskilled (u) workers ratio, w^s/w^u is the relative wage, O is a vector of variables related to work organization (such as the presence of team work, Total Quality Management, etc.), X and Z are vectors of covariates, ε and u are the usual error terms. The suffix (i,t) denotes the i-th firm in period t.
The exclusion of O from equation [2] guarantees identification of the parameters.
To obtain unbiased estimates of the above model, we have to deal with two main issues:

- in the first equation, work organization may be endogenous. This occurs if workforce composition and modern organizations are complementary (so that a certain firm's skill structure will increase the likelihood of shifting from a "Tayloristic" to a "post-Tayloristic" organization), or if both these factors simultaneously adjust to changes in a

third exogenous factor (for example, a negative demand shock may induce firms to simultaneously lay-off unskilled workers and re-organize the company);

- employment composition and wage levels are usually simultaneously determined, causing endogeneity of the first variable (i.e., n^s/n^u) in the second equation.

To avoid the second source of endogeneity, in the empirical literature the wage equation has been usually estimated in a reduced form, assuming work organization as exogenous and introducing directly the corresponding vector of variables (i.e., O) among the regressors (see, for example, Cappelli and Carter, 2000; Hunter and Lafkas, 1998).

To tackle the first source of endogeneity, different solutions have been proposed:

- estimating a recursive model, in which employment composition (or wage levels in the reduced form) depend on the lagged values of work organization (Caroli and Van Reenen, 1998);
- finding potential instruments for work organization (such as incidence of training expenses on total labor costs or characteristics of local labor markets) and testing – through alternative versions of the Hausman test - the null hypothesis of exogeneity (Cappelli and Carter, 2000).

It is worth noting that my current data set lacks of explicit information on organizational aspects such as teamwork, quality circles, etc. The estimation of a reduced form is then not feasible, at least for the entire sample of firms. On the other hand, as we'll see in the next section, the data set provides detailed information on the actual organization of the firms in terms of workforce, production and working time. Furthermore, additional information on the structure of the workforce, wage practices (mainly performance related pay schemes), working time and communication flows is available for the sub-sample of firms which introduced a (new) labor contract in the year of the survey[9].

In order to try to partly address all the above problems and data limitations, I estimated the proposed model following three different empirical strategies:

- estimating the structural model with 2SLS, trying to instrument the dependent variable in the first equation. The present data set allows to compute two alternative measures of skill structure: the non manual/manual workers ratio and the skill/unskilled workers ratio, where the definition of "skills" is given by the national contract for each job position according to the level of personal responsibility required and the complexity of the corresponding tasks[10]. Since it is extremely difficult to find good instruments that can shift

[9] The survey asks a series of additional questions on the elements bargained at the local level only for the firm which introduced a new labor contract in the year of the survey (in our case, 1995). Important information on organizational change can be derived from this section of the survey. A longitudinal data-set is then important also to better exploit this source of information for a larger number of firms.

[10] According to this definition, both manual and non manual workers are classified as "unskilled" if their job doesn't require specific training and/or doesn't involve any responsibilities. Using the job classification reported in the national contract of the metalworking sector, I then considered as unskilled workers all the employees classified in the first four occupational levels. All the remaining employees (starting from the fifth level upward) are classified as skilled workers.

the employment structure without being correlated with wages, I used as instruments the lagged values of skill structure. Unfortunately, this information is at the moment available only for the non manual/manual workers ratio. I then used a 2SLS estimator when this variable is used as a regressor in the wage equation, a OLS estimator when the alternative measure of skill structure is instead used[11].

- taken as given the results obtained in past empirical work and in the mainstream literature on this topic, I tried to define some "proxy" (indicator) variables of a modern organization on the basis of the actual organization of the firms. These proxies are then used as regressors in the reduced form. The variables derived in this way are dichotomous and, being proxy of unobserved (to the econometrician) variables, estimates may be affected by specification error. However, it's also true that most of the variables used in empirical research to describe firms' organization are also simple indicators (like use of work team, use of TQM, etc.). Furthermore, since they are often based on personal perception of the respondents to the survey, they may suffer from measurement error as well.
- restricting the sample to the firms which introduced a labor contract in 1995, I introduced additional variables on firms' organization, paying particular to the role played by more transparent communication flows and variable pay schemes, two basic features of flatter organizations (Caroli, 1999; Cappelli and Carter, 2000).

4.2. Data source and descriptive statistics

The empirical analysis is based on a sample of 2684 Italian metalworking firms in 1995. The data set is the output of the survey yearly conducted by the national employers' association of this industry (Federmeccanica), mainly for wage bargaining purposes. The present sample is representative of the composition of the metalworking sector in Italy, with the partial exception of small and Southern firms[12].

The data set provides information on wage levels, firm organization and labor market institutions. Wage levels and composition are available by skill (blue/white collars) and occupation (the so called "*livelli d'inquadramento*", which are eight broad job descriptions – differentiated by the quality of skills and the level of responsibility required– reported in the national labor contract of this sector). Wages are defined on both a monthly and annual basis and pay schemes that are not paid every month (like profit and gain sharing schemes) are reported separately from monthly wage. Overtime or shift premiums and paid leaves are not included.

Table 1 presents the mean and the standard deviation of the main variables used in the

[11] Since the two measures of skill structure are uncorrelated, the use of the lagged of the first as instrument for the second gives estimates that are more biased than OLS (Staiger and Stock, 1997).

[12] The comparison with the relevant data of the Intermediate Census of the Italian Industry in 1996 reveals that these two groups are both under-represented in the present sample. In fact, 78% of the sampled firms has less then 100 employees and 10% are located in the Center-South of Italy, while the corresponding percentages in the Census are 96% and 17%.

empirical analysis.

Table 1
Descriptive statistics

	Mean	Standard deviation
Alternative measures of wage inequality within firms:		
ln(wage white collars/wage blue collars)	0.273	0.161
ln(wage max/ wage min)	0.775	0.321
ln(wage at 90th percentile /wage at 10th percentile)*	0.443	0.219
ln(wage at 90th percentile /median wage)*	0.285	0.186
ln(median wage/wage at 10th percentile)*	0.159	0.118
Independent variables:		
Ia) Workforce organization		
ln(# employees)	3.762	1.321
white collars/blue collars	1.355	12.159
skilled workers/unskilled workers**	5.200	9.552
% workers with atypical contracts	7.208	12.237
% females	19.938	17.393
Ib) Production organization		
Capital/Labor (proxy; 1000$ per worker)***	8.909	30.152
% production made by contract manufacturers (outsourcing)	12.528	20.165
% sales exported	24.601	20.018
Ic) Working time organization		
% shift workers	10.499	20.895
Use of flexible working time (1=yes)	0.074	0.261
Overtime hours per worker	95.629	78.238
II) Labor market institutions		
% unionized workers	26.452	25.406
Presence of a firm labor contract (1=yes)	0.475	0.499
Firm's size greater than 15 employees (1=yes)	0.806	0.396
Firm located in the Center-North of Italy (1=yes)	0.969	0.166
FIRMS WHICH SIGNED A LABOR CONTRACT IN THE YEAR OF THE SURVEY (1995)		
Local bargaining on (1=yes):		
- Job ad task requirements	0.2259	0.4188
- Working time	0.1977	0.3989
- Communication rights	0.2571	0.4376
- Profit and gain sharing schemes	0.7147	0.4522

* weighted for the number of employees in each wage level/occupation
** definition of "skills" based on job descriptions reported in the metalworking national contract
*** new investment in capital per employee

I used, as dependent variables, five alternative measures of wage inequality, either referred to the overall wage distribution (wage differential between blue and white collars, highest and lowest wage and 90th and 10th percentile) or to specific part of it (above and below the median

wage). As expected, wage inequality above the median (0.285) is higher than below it (0.159). Dependent variables were classified into two main groups: those referred to organizational factors and those referred to labor market institutions. As already mentioned, I used two alternative measures capturing the organization of the workforce by skill: the traditional white/blue collar ratio and the skilled/unskilled workers ratio based on the job description reported in the national contract of the metalworking sector. It is worth noting that, according to the first measure, a firm with many generic secretaries and few generic manual workers is considered more "skill-intensive" than a firm with few professionals and many highly specialized workers. The opposite is true using the second measure. In fact these two variables are uncorrelated and are characterized by different means: in this sample, the number of white collars is slightly higher than that of blue ones (1.35) but the number of skilled workers is five times the number of unskilled ones[13]. Concerning labor market institutions, detailed information is available on unions' power (measured in terms of unionized workers in the total workforce) and bargaining setting at the local level (captured by the eventual existence of a firm labor contract)[14]. Even if the data set doesn't contain direct information on employment protection and labor cost regulation, some indirect evidence can be obtained classifying firms by their size (below and above 15 employees) and location (roughly, Center-North and South). Hiring and firing procedures are in fact quite different between small and large firms, while reduction of social security contributions ("*fiscalizzazione degli oneri sociali*") was in 1995 still used in the South to compensate the productivity gap with Northern regions, given the low responsiveness of wages to local labor market conditions.

The data set provides some additional information on firms which introduced a firm labor contract in the year of the survey (i.e., 1995), representing about 13% of the firms in the total sample. In particular, it gives detailed information on the object of bargaining at the local level, reporting whether the new contract contains new clauses related to job requirements, working time, communication flows and performance related pay schemes. Since this second bargaining level can introduce only more flexible conditions with respect to what already stated in the national contract, it's possible to use these variables as a direct measure of organizational change. In our case, more than 70% of the firms signing a labor contract in 1995 introduced some kind of flexible compensation, more than one quarter of them bargained over workers' communication rights and around one out of five introduced new clauses related to either job requirements or working time. Only 28 firms (7% of the sub-sample) bargained over all the four organizational aspects mentioned.

[13] For the definition of "skill" used, see footnote 6.

[14] In Italy collective bargaining can take place at two levels: industry and firm/local level. While the first is mandatory for all the firms belonging to a certain industry, the second is optional. An additional contract is usually bargained in large or unionized firms.

To see if there is any relation between the alternative measures of wage inequality used as dependent variables in the econometric analysis, in table 2 I reported the relative pair-wise correlation coefficients. The correlation is particularly high among the three variables measuring wage inequality in the overall distribution. They are also all correlated with the variable capturing wage inequality above the median. On the contrary, there is no correlation between the latter and the corresponding measure of the bottom part of the wage distribution.

Table 2
Correlation between the alternative measures of wage inequality within the firm

	ln(wage white /blue collars)	**ln(wage max/ wage min)**	**ln(wage at $90^{th}/10^{th}$ perc.)**	**ln(wage at 90^{th} perc./median)**
ln(wage max/ wage min)	0.644*			
ln(wage at $90^{th}/10^{th}$ perc.)	0.517*	0.543*		
ln(wage at 90^{th} perc./median)	0.554*	0.478*	0.841*	
ln(median wage/10^{th} perc.)	0.075*	0.252*	0.528*	-0.016

* Statistically significant at 5%

Table 3 summarizes how wage inequality changes with particular characteristics of firms' organization and labor market institutions. To control for differences among firms due to technology or sector's characteristics, firms are classified according to their relative position with respect to the average of the corresponding economic sub-sector[15]. From the first rows of the table it is clear how wage differentials change with the measure of skill structure considered. Wage inequality, regardless how it is measured, increases with the relative blue/white collar ratio, while the opposite is true when the skilled/unskilled workers ratio is considered, mainly in the bottom part of the wage distribution.

When firms are classified according to the other organizational variables (like capital intensity, incidence of outsourcing and exports, overtime hours per workers), wage inequality is higher in firms characterized by values of these variables above the average. Only the incidence of shift work exhibits a negative relation with internal wage inequality, in particular below the median wage.

Among labor market institutions, the presence of unions increases wage differentials in the upper part of the wage distribution and decreases it below the median wage.

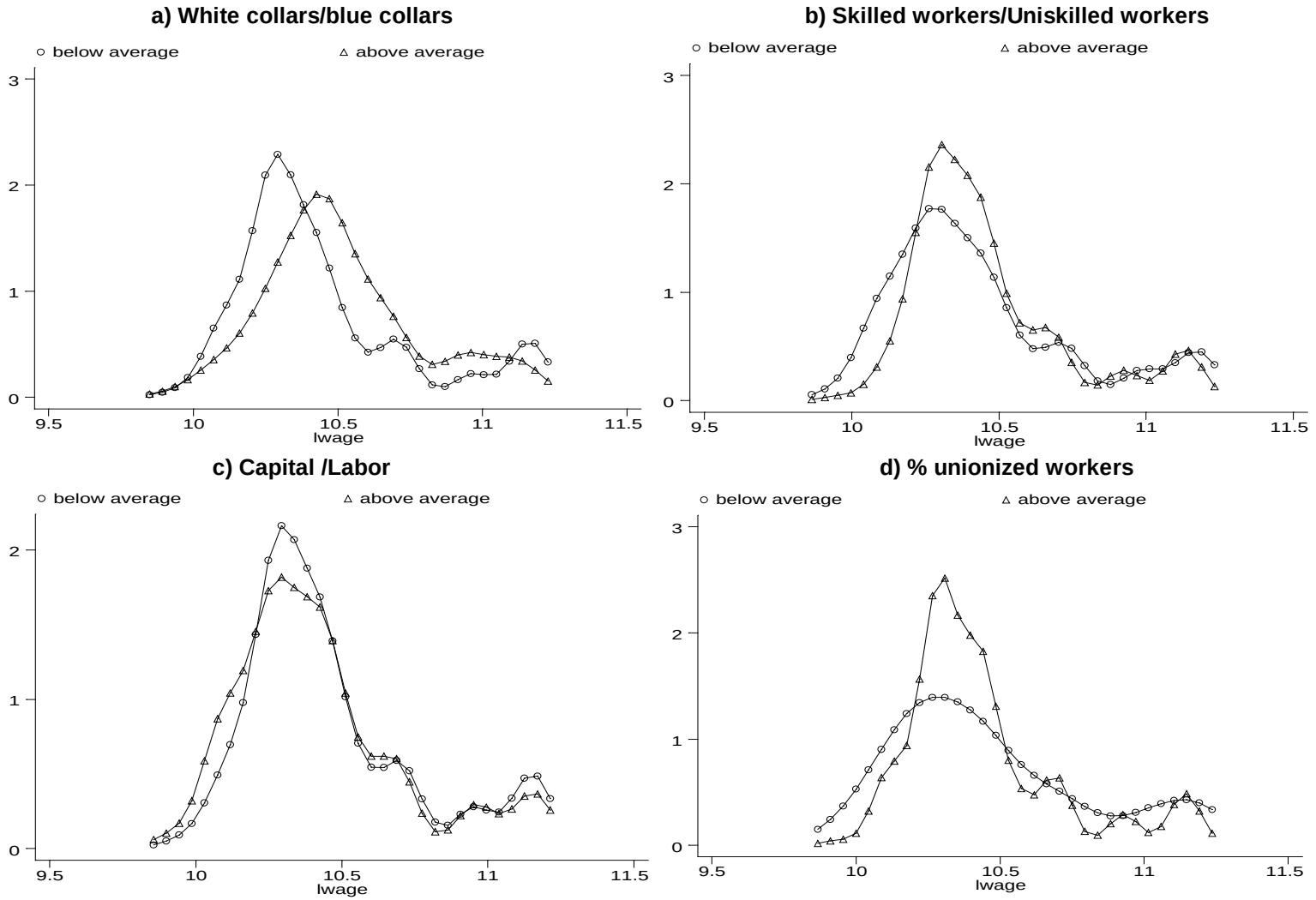
[15] I computed the average for the 75 economic sub-sectors available and each firm was compared with the average of the corresponding one.

Table 3
Alternative measures of wage inequality by firm organization and labor market institutions

	ln(wage white collars/wage blue collars)	ln(wage max/ wage min)	ln(wage at 90th/wage at 10th percentile)	ln(wage at 90th percentile /median wage)	ln(median wage/wage at 10th percentile)
Blue/white collars:					
- below average	0.268	0.771	0.409	0.262	0.147
- above average	0.284	0.782	0.520	0.335	0.185
Skilled/unskilled workers:					
- below average	0.262	0.798	0.470	0.292	0.178
- above average	0.292	0.734	0.396	0.271	0.124
% atypical workers:					
- below average	0.271	0.758	0.435	0.283	0.152
- above average	0.274	0.808	0.459	0.287	0.172
Capital/labor:					
- below average	0.264	0.746	0.437	0.279	0.158
- above average	0.295	0.855	0.459	0.299	0.160
% outsourcing:					
- below average	0.267	0.752	0.432	0.276	0.155
- above average	0.284	0.824	0.467	0.302	0.165
% export:					
- below average	0.256	0.709	0.429	0.268	0.161
- above average	0.298	0.879	0.465	0.310	0.155
% shift workers:					
- below average	0.257	0.737	0.450	0.284	0.166
- above average	0.315	0.881	0.423	0.286	0.137
Overtime per worker:					
- below average	0.263	0.732	0.438	0.286	0.152
- above average	0.284	0.826	0.449	0.283	0.167
Flexible working time:					
No	0.272	0.769	0.442	0.284	0.158
Yes	0.281	0.836	0.458	0.297	0.162
Unions:					
No	0.230	0.620	0.443	0.268	0.175
Yes	0.289	0.841	0.443	0.292	0.151
Firm contract:					
No	0.256	0.693	0.450	0.278	0.172
Yes	0.290	0.861	0.435	0.292	0.143
Size >15 employees:					
No	0.194	0.477	0.406	0.237	0.169
Yes	0.289	0.847	0.452	0.296	0.156
Center-North:					
No	0.259	0.689	0.342	0.250	0.091
Yes	0.273	0.777	0.446	0.286	0.161

Note: continuous independent variables were transformed as deviation of each firm level from the mean of the relevant economic sub-sector. Firms are classified into 75 sub-sectors. “Below” and “Above” average is then referred to the relative position of each firm with respect to the mean of its sector.

Figure 3
The distribution of wage within the representative firm by some organizational and institutional features



Weighted Normal Kernel density
Ln(wage) levels for the representative firm of each group are weighted means of the corresponding wage levels by occupation.
(Weights are the number of employees by occupation level and firm)

Still considering this part of the wage distribution, wage inequality results much higher in firms located in the Center-North than in the South.
Figure 3 highlights how the entire wage distribution may vary with some firms' features, pointing out the importance of measuring wage inequality at different points of the wage distribution itself. Also in this case, the two alternative measures of the skill structure give a different picture of the internal wage distribution. The latter is in fact relatively more dispersed in firms with a blue/white collars ratio above the average of the relative sector (panel a), while it is relatively more concentrated in firms with a higher skilled/unskilled workers ratio (panel b). Differences in the wage distribution are less evident when firms are classified according to their relative capital intensity (panel c). A quite different behavior emerges if we consider labor market institutions, in particular the presence of unions: as already found in past empirical work (Fortin and Lemieux, 1997), the presence of a highly unionized workforce tends to compress internal wage differentials (panel d).

4.3. Main econometric results

Table 4a and 4b present the estimates of equation [2] obtained using the alternative measures of internal wage inequality. The two tables differ for the different measure of skill structure used among the regressors: the blue/white collars ratio (table 4a) and the skilled/unskilled workers ratio (table b) discussed in the previous paragraph. Given the availability of instruments only for the blue/white collar ratio, I used a 2SLS estimator in table 4a, OLS in table 4b. According to the results reported in table 4a, organizational variables have usually a positive effect on wage inequality, regardless of how and in which part of the wage distribution the latter is measured. In particular, internal wage inequality is higher if the firm is capital intensive and if its production is more dependent on external firms (in terms of percentage of production made by contract manufacturers) or external markets (in terms of percentage of sales exported). An extensive use of overtime increases wage inequality only in the lower part of the wage distribution (below the median), while it doesn't seem to affect the upper part (see the estimates relative to overtime in the last two columns of the table)[16]. The only organizational variable that has a negative effect on wage inequality is the incidence of shift work. Considering labor market institutions, I found the traditional result that the more unionized is the workforce, the more compressed are wage differentials inside the firm. Firms located in the Center-North present a more spread wage distribution: if this variable captures differences in non wage labor costs between areas, then a higher incidence of the latter is associated with higher wage inequality[17].

[16] As mentioned in the previous section, wages don't include overtime premiums and so the incidence of overtime should not be an endogenous variable in this model.
[17] Without other controls for location, this variable may also capture local differences due to factors that are not related to non wage labor costs.

Table 4a

	ln(wage blue/white coll.)	ln(wage max/ wage min)	ln(wage 90th/ 10th percentile)	ln(wage 90th /median wage)	ln(median wage/ 10th percentile)
Constant	8.28*	14.94*	24.15*	14.49*	9.67*
	(3.97)	(6.75)	(5.25)	(4.60)	(2.85)
Blue/White collars	0.06*	-0.001	0.16*	0.06	0.10*
	(0.03)	(0.06)	(0.04)	(0.04)	(0.02)
% atypical workers	-0.008	0.12*	0.005	-0.006	0.01
	(0.03)	(0.04)	(0.03)	(0.03)	(0.02)
Capital/Labor	0.04*	0.08*	0.04*	0.03	0.02
	(0.01)	(0.02)	(0.02)	(0.02)	(0.01)
% outsourcing	0.04*	0.07*	0.09*	0.07*	0.02
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)
% exports	0.02	0.08*	0.03*	0.03*	0.002
	(0.01)	(0.02)	(0.016)	(0.01)	(0.009)
% shift workers	0.04*	-0.03	-0.11*	-0.08*	-0.03*
	0.02	(0.03)	(0.02)	(0.02)	(0.01)
Overtime hours per	0.006	0.03*	0.01*	-0.005	0.02*
worker	(0.004)	(0.007)	(0.005)	(0.005)	(0.003)
Flexible time	-0.11	0.56	1.87	1.04	0.83
	(1.16)	(1.98)	(1.54)	(1.35)	(0.84)
% unionized	0.001	-0.05*	-0.11*	-0.06*	-0.05*
workers	(0.01)	(0.03)	(0.02)	(0.02)	(0.01)
Firm labor contract	-2.47*	-1.61	-2.28*	-1.13	-1.14*
	(0.77)	(1.31)	(1.02)	(0.89)	(0.56)
# employees > 15	3.91*	14.37*	1.30	1.87	-0.57
	(1.03)	(1.74)	(1.36)	(1.19)	(0.74)
Center-North	2.88	10.93*	7.37*	2.07	5.29*
	(1.86)	(3.16)	(2.46)	(2.15)	(1.34)
ln(size)	2.86*	10.01*	2.25*	2.33*	-0.07
	(0.38)	(0.65)	(0.50)	(0.44)	(0.27)
Sector					
(75 dummies)	yes	yes	yes	yes	yes
F test (87, 2418)	5.23	14.60	4.69	3.51	4.58
R^2 (adj.)	12.80	32.09	14.45	11.20	11.06
Root MSE	0.128	0.255	0.114	0.174	0.108
N. obs.	2506	2506	2506	2506	2506

Note: Second stage of 2SLS. Dependent variable of first stage: blue/white collar ratio (instrument: lagged value).
Estimates of first stage available upon request.
All coefficients and standard errors are multiplied by 100.
Standard errors in parenthesis.
* = statistically significant at 5%.

Table 4b

	ln(wage blue/white coll.)	ln(wage max/ wage min)	ln(wage 90th/ 10th percentile)	ln(wage 90th /median wage)	ln(median wage/ 10th percentile)
Constant	6.57	19.05*	26.51*	14.79*	11.71*
	(4.04)	(6.93)	(5.39)	(4.71)	(2.91)
Skilled/Unskilled	0.04	-0.17*	-0.14*	-0.04	-0.10*
	(0.03)	(0.06)	(0.04)	(0.04)	(0.02)
% atypical workers	0.005	0.10*	-0.007	-0.004	-0.002
	(0.03)	(0.04)	(0.03)	(0.03)	(0.02)
Capital/Labor	0.04*	0.07*	0.05*	0.04*	0.01
	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)
% outsourcing	0.04*	0.06*	0.08*	0.06*	0.02
	(0.02)	(0.03)	(0.02)	(0.02)	(0.01)
% exports	0.02	0.08*	0.03	0.03*	-0.0009
	(0.01)	(0.02)	(0.02)	(0.01)	(0.009)
% shift workers	0.04*	-0.02	-0.10*	-0.07*	-0.04*
	0.02	(0.03)	(0.02)	(0.02)	(0.01)
Overtime hours per worker	0.007	0.03*	0.01*	-0.006	0.02*
	(0.004)	(0.007)	(0.005)	(0.005)	(0.003)
Flexible time	-0.07	0.15	1.52	0.86	0.66
	(1.17)	(2.0)	(1.55)	(1.36)	(0.84)
% unionized workers	-0.01	-0.04	-0.11*	-0.07*	-0.04*
	(0.02)	(0.03)	(0.02)	(0.02)	(0.01)
Firm labor contract	-2.42*	-1.19	-1.85	-0.96	-0.89
	(0.78)	(1.34)	(1.04)	(0.91)	(0.56)
# employees > 15	4.45*	13.93*	0.91	2.26*	-1.36
	(1.04)	(1.79)	(1.39)	(1.21)	(0.76)
Center-North	2.79	11.02*	7.47*	2.19	5.28*
	(1.86)	(3.19)	(2.48)	(2.17)	(1.35)
ln(size)	3.05*	9.93*	2.35*	2.29*	0.07
	(0.38)	(0.66)	(0.51)	(0.44)	(0.28)
Sector (75 dummies)	yes	yes	yes	yes	yes
F test (87, 2371)	5.56	13.71	4.43	3.40	4.62
R^2 (adj.)	16.95	31.02	10.82	7.82	11.35
Root MSE	0.149	0.255	0.199	0.173	0.108
N. obs.	2459	2459	2459	2459	2459

Note: OLS estimates.
All coefficients and standard errors are multiplied by 100.
Standard errors in parenthesis.
* = statistically significant at 5%.

Also employment regulation (captured by distinguishing firms with more than 15 employees, after controlling for firms' size) seems to increase wage inequality, mainly in the upper part of the distribution. Note also that firm's size, which is in general positively correlated with internal wage inequality, doesn't seem to affect the lower part of distribution.

Table 4b confirms most of the results previously discussed, but the alternative measure of the skill structure plays a quite different role in shaping wage inequality. In fact, the latter decreases as the skill/unskilled workers ratio increases and it's effect is particularly relevant in the lower part of the wage distribution. If this is the "correct" measure of job requirements (and given the results of past research in this area), modern work organization increases the demand for skilled workers (and of a more homogeneous workforce in terms of skill) and the latter reduces wage differentials within the firm, mainly among the less paid workers.

The comparison of the two tables also points out how crucial is the definition of "skills" in determining the results and how deceptive can be defining the skill structure of the firm using only the traditional distinction between manual and non manual workers.

In tables 5 and 6 I tried to test further the robustness of the previous results using two alternative sets of proxy variables of modern organization.

In table 5, I used the main findings of previous research to define a set of indicators identifying a modern organization. In fact, convergence of previous empirical results allows to draw a precise picture of a so called "post-Tayloristic" firm (Caroli, 1999), which can be defined as a more organic structure characterized by:

- a flatter hierarchy, with a relatively homogeneous and more skilled workforce (Caroli and Van Reeenen, 1998);
- a greater variety of tasks performed by workers, with a consequent limited use of atypical (contingent) workers (Osterman, 2000);
- more intensive communication;
- tighter links with other firms and clients;
- use of team working.

Given these features and the information on the actual organization of the firms provided by the data set used for the present work, I classified as "post-Tayloristic" firms those characterized by:

- a skilled/unskilled workers ratio above the average;
- incidence of atypical workers (with fixed-terms contracts) below the average;
- incidence of production made by contract manufacturers and exports above the average (as proxies of tighter links with firms or clients).

As in table 3, to control for differences between firms due to technology or sector's characteristics, all these variables are expressed as deviation from the average of the relative economic sub-sector.

The estimates obtained using this set of variables in the reduced form are reported in table 5. These results are consistent with those reported in the previous tables: wage differentials are

Table 5

	ln(wage blue/white coll.)	ln(wage max/ wage min)	ln(wage 90th/ 10th percentile)	ln(wage 90th /median wage)	ln(median wage/ 10th percentile)
Constant	11.34*	33.07*	32.96*	18.47*	14.49*
	(2.30)	(3.94)	(3.11)	(2.69)	(1.68)
Skilled/Unskilled workers above avg	1.86*	-5.02*	-3.66*	0.04	-3.70*
	(0.68)	(1.17)	(0.92)	(0.80)	(0.50)
% atypical workers below avg	-0.21	-1.13	-0.17	0.92	-1.11*
	(0.66)	(1.13)	(0.89)	(0.77)	(0.48)
% outsourcing above avg	0.79	2.17*	2.29*	1.46*	0.82
	(0.66)	(1.13)	(0.89)	(0.78)	(0.48)
% exports above avg	1.13	4.76*	2.29*	2.38*	-0.09
	(0.67)	(1.14)	(0.90)	(0.78)	(0.49)
Capital/Labor	0.05*	0.07*	0.03	0.03*	-0.0008
	(0.01)	(0.02)	(0.02)	(0.01)	(0.009)
% unionized workers	-0.03	-0.05*	-0.15*	-0.10*	-0.05*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)
Firm labor contract	-2.21*	-1.07	-1.69	-0.86	-0.84
	(0.77)	(1.32)	(1.04)	(0.90)	(0.56)
# employees > 15	4.07*	15.25*	1.54	1.96	-0.42
	(1.03)	(1.76)	(1.39)	(1.20)	(0.75)
Center-North	2.59	13.42*	9.21*	2.99	6.22*
	(1.81)	(3.09)	(2.44)	(2.11)	(1.32)
ln(size)	3.62*	9.69*	1.92*	2.25*	-0.32
	(0.34)	(0.58)	(0.46)	(0.40)	(0.25)
Sector (75 dummies)	no	no	no	no	no
F test (10, 2448)	32.49	101.88	16.42	12.02	20.52
R^2 (adj.)	11.36	29.10	5.90	4.29	7.36
Root MSE	0.151	0.259	0.204	0.177	0.110
N. obs.	2459	2459	2459	2459	2459

Note: OLS estimates.
All coefficients and standard errors are multiplied by 100.
Standard errors in parenthesis.
* = statistically significant at 5%
"Above" and "below avg" refer to the relative position of the firm with respect to the average of the corresponding economic sector. Firms are classified into 75 sectors.
Similar results are obtained if sector dummies are included.

Table 6

	ln(wage blue/white coll.)	ln(wage max/ wage min)	ln(wage 90th/ 10th percentile)	ln(wage 90th /median wage)	ln(median wage/ 10th percentile)
Constant	34.04*	60.16*	32.47*	25.29*	7.18
	(6.57)	(13.52)	(10.24)	(9.34)	(5.19)
Job and tasks	-1.42	-1.27	-3.08	-3.86°	0.78
requirements	(1.55)	(3.19)	(2.42)	(2.21)	(1.29)
Working time	-1.54	-4.99	1.01	2.31	-1.30
	(1.64)	(3.38)	(2.56)	(2.34)	(1.29)
Communication	2.33°	3.85	3.95°	3.12	0.82
rights	(1.47)	(3.04)	(2.31)	(2.10)	(1.17)
Profit & gain	-2.25°	2.43	2.72	1.07	1.65
sharing schemes	(1.39)	(2.85)	(2.16)	(1.97)	(1.09)
Capital/Labor	0.18*	0.30*	0.07	0.07	0.005
	(0.05)	(0.11)	(0.08)	(0.07)	(0.04)
% unionized	-0.07*	-0.14*	-0.24*	-0.17*	-0.07*
workers	(0.03)	(0.07)	(0.05)	(0.05)	(0.02)
# employees > 15	10.58	15.71	-11.85	-14.78	4.21
	(6.82)	(14.03)	(10.63)	(9.62)	(5.38)
Center-North	-4.36	6.28	20.57*	7.70	12.88*
	(5.55)	(11.42)	(8.65)	(7.89)	(4.38)
ln(size)	0.99°	5.97*	-0.25	0.64	-0.89*
	(0.58)	(1.35)	(0.91)	(0.82)	(0.46)
Sector					
(75 dummies)	no	no	no	no	no
F test (9, 344)	3.74	6.13	4.64	3.48	2.37
R^2 (adj.)	6.53	11.58	8.49	5.95	3.37
Root MSE	0.113	0.233	0.177	0.161	0.089
N. obs.	354	354	354	354	354

Note: OLS estimates. Sub-sample of firms which signed a firm labor contract in 1995 (year of the survey).
All coefficient and standard errors are multiplied by 100.
Standard errors in parenthesis
* = statistically significant at 5%
° = statistically significant at 10%

lower in firms where the workforce is more skilled and where the incidence of atypical workers is lower. On the contrary, organizational factors referred to the production process (like incidence of outsourcing, export and capital intensity) increase wage inequality. Note that the first group of factors reduces inequality only in the lower part of wage distribution, while the positive effect of the others is significant only in the upper part of it.

The overall lower wage differentials that characterize modern organizations is then mostly confined under the median wage, while in the upper part of the distribution a modern production organization is accompanied by wider wage dispersion.

Finally, I focused my analysis on the sub-sample of firms which signed a firm labor contract in 1995. For this group of firm the data set provides additional information on the object of local bargaining, which has to be different (and eventually more flexible) from what already stated in the national contract. As previously mentioned, you can know if the firm introduced profit sharing schemes, changes in some job requirements, a more flexible working time, more transparent communication flows. All these variables can be used as good proxies of change in the organization of the firm. Table 6 presents the estimates obtained for the reduced form. Given the smaller sample and the less variance of the covariates, the coefficients estimated for the organizational variables are less robust from a statistical point of view. Local bargaining on job requirements and working time are usually associated with lower wage inequality, while the opposite is true when bargaining is on communication rights and performance-related pay schemes. The coefficient estimated for the latter is negative and weakly significant only when wage inequality is measured as the blue/white collars wage ratio.

The coefficients estimated for the variables related to labor market institutions are generally coherent with the corresponding previous estimates: unions' presence reduces wage differentials, while employment regulation and location in the Center-North generally increase them. The magnitude of the last coefficient is particularly high when wage inequality is measured below the median.

In general, the comparison of the last two columns of the table points out again that the impact of most of the variables changes with the part of the wage distribution considered.

5. Concluding remarks

The aim of this paper was to study the relation between work organization and wage inequality inside the firm and how this relation is affected by labor market institutions, in particular unions' power.

The empirical analysis on a cross section of Italian metalworking firms showed that internal wage inequality is influenced by both organizational and institutional factors.

In general, using the definition of "post-Tayloristic" firm prevailing in literature, these organizations present lower wage inequality than other traditional ("Tayloristic") firms. The overall lower wage differentials that characterize modern organizations is mostly confined

under the median wage, while in the upper part of the distribution a modern production organization is accompanied by wider wage dispersion. It is then important to study the effect of firms' organization measuring wage inequality at different points of the wage distribution.

Among the organizational variables, I found that a more flexible workforce is generally associated with lower internal wage differentials, while a more capital intensity, export-oriented and flexible production seem to increase wage inequality.

The effect of employment composition by skill on wage inequality crucially depends on the definition of "skills" adopted: I found that wage differentials increase with the blue/white collars ratio, while they decrease with the skill/unskilled workers ratio. If the latter is the "correct" measure of job requirements (and given the results of past research in this area), modern work organization increases the demand for skilled workers (and of a more homogeneous workforce in terms of skill) and an higher incidence of the latter reduces wage differentials within the firm, mainly among the less paid workers.

Labor market institutions, in particular unions' power and local wage bargaining, generally compress wage differentials inside the firm. I also found that firm's size, which is in general positively correlated with internal wage inequality, doesn't seem to affect the lower part of the distribution.

From a policy perspective, it seems clear that public intervention can influence internal wage inequality through either the general design of labor market institutions or specific measures aimed at sustaining particular organizational structures. It is though not clear how eventual interventions on both sides has to be coordinated.

Further research is then necessary to better understand the relation between firms' organization and labor market institutions, looking for the existence of eventual complementarities between this two factors in influencing the wage distribution inside the firm.

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