Performance related pay, productivity and wages in Italy: a quantile regression approach

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Abstract

The authors analyzed the role of Performance Related Pay (PRP) in a sample of Italian manufacturing and service firms and presented standard quantile estimates to investigate heterogeneity in pay-performance impacts on labor productivity and wages. In a second stage, the endogeneity of PRP was taken into account by using instrumental variable quantile regression techniques. They find considerable heterogeneity across the distribution of labor productivity and wages, with the highest role of PRP obtained at the lowest and highest quantiles. However, for all quantiles, the comparison of productivity and wage estimates suggests that PRP might not only be rent-sharing devices, but also incentive schemes that substantially lead to efficiency enhancements. These findings are confirmed for firms under union governance and suggest that well designed policies, that circumvent the limited implementation of PRP practices, would guarantee productivity improvement.

JEL Classification: D24, J31; J33; J51.

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Introduction

In the last few years, there has been a trend towards decentralization of wage setting, associated with the increasing use of variable pays to provide an important element of flexibility and closer links to individual or collective performance. However, this trend has shown great variability across EU economies and the number of contributions using nationally representative sample surveys to estimate the productivity effects of these agreements is still low. Furthermore, econometric studies have mainly focused only on the incentive effects of such schemes, whereas the question of whether employees benefit financially from performance related pay (PRP) has never been satisfactorily resolved.

Highlighting the incentive experience in Italy would be particularly worthwhile because prior works for this country have been restricted to large companies or selected sectors (Origo, 2009). In addition, not only has the efficiency performance been disappointing in the Italian economy, but also large drops have been recorded in the share of income accruing to salaried employees. We intend to analyze the drivers of this evidence and test whether the insufficient room given in decentralized bargaining to PRP has affected the efficiency and distributive patterns recorded in Italian enterprises.

We also focus on a relevant feature: the quality of industrial relations, represented by the presence of unions. The impact exerted by unions depends on their influence on promoting more efficient management, through their 'voice' function, but also on extracting union wage premiums, as predicted by monopoly union bargaining models. This seems relevant in a highly unionized economy, such as the Italian case, and particularly important because, up to now, international evidence shows contradictory findings and the effects of unions on pay settings and productivity are still ambiguous. These uncertain results require the attention of the researches aimed at verifying the role of workers' representation in the PRP experience.

We present OLS estimates but also address the question of the heterogeneity of firms with quantile regressions, whereas most studies have estimated PRP bonuses and union wage premiums focusing exclusively on conditional *mean* models. Thus, by adopting quantile regression techniques, we examine the heterogeneity of PRP effects over whole productivity and wage distributions. Finally, we consider the endogeneity of the firm's decision to adopt PRP, a choice that may depend in part on factors that influence productivity and wages, so that assuming exogeneity of PRP may give biased estimates. Therefore, to gain robustness, we have validated *quantile* results by instrumental variable estimates.

We use a unique dataset for the Italian economy obtained from the ISFOL Employer and Employee Surveys (2005, 2007, 2010) which collect information at firm level for both the manufacturing and services sectors and enterprises of all sizes. This rich dataset allows us to explore the relationship between PRP and labor productivity (and wages), but also to control for an ample set of covariates[1].

Related literature

One of the key characteristics of compensation systems concerns fixed or variable payments, i.e. payments linked to worker input or to worker performance (Lazear, 1995). The properties of these alternative options are still under debate since up to now neither of these payment types produces universally superior results (Belfield and Marsden 2003). We offer additional evidence by focussing on output- based pay, such as PRP, that may be individual or collective.

Pay settings that change from rewards based on input measures to payments related to output outcomes may induce dramatic improvements in production, which may be explained by two factors that have equal impacts. The first is that this policy attracts workers of greater ability (Lazear, 2000). The second is that contingent contracts are effective in contexts in which output (but not effort) is observable by the employer because such contracts encourage more effort and mitigate the agency problem (Prendergast, 1999).

However, controversial aspects arise from the possible trade-off between extrinsic and intrinsic motivations since contingent rewards may conflict with intrinsic motivation, thus impairing performance (Benabou and Tirole, 2003). For instance, Bandiera et al. (2010) examine the importance of social ties among workers and find positive spill-over effects where social ties exist, as a given worker’s productivity is significantly higher when that person works together with friends, especially those who are more able. In order to motivate workers, firms may, therefore, choose to exploit social incentives as an alternative to monetary incentives.

[1] The determinants of decentralized bargaining and of the bargaining covering PRP have been estimated on the basis of the ISFOL surveys for 2005 and 2007 by Damiani and Ricci (forthcoming).

Economic theory is also ambiguous as to the expected impact of PRP in the form of collective bonuses on productivity. These bonuses, such as profit sharing, favor better teamwork, greater workforce cooperation in facing new technology and organizational changes, and these collective incentive schemes are more likely to be offered when total output is the result of the efforts of many agents and individual contributions cannot easily be identified (Holmstrom, 1979; FitzRoy and Kraft, 1992). In such cases, the absence of group incentives may lead to inferior Nash equilibria, associated with low levels of productivity due to limited cooperation. By contrast, employees who participate in enterprise results "will become more committed to the goals of that enterprise, leading to improvements in individual and organizational performance. At a wider societal level, financial participation may be seen as a tool for redistribution of income and wealth, and may therefore serve as a broader instrument for social integration" (Pendleton et al. 2001, p.1).

However, collective bonuses may induce employees to free ride on the efforts of others and cut productivity. In such circumstances, group incentives may lead to decentralized monitoring due to peer pressure and shame norms (Kandel and Lazear, 1992), thus mitigating opportunistic behavior. Along these lines, Mas and Moretti (2009) find that workers whose efforts may be noticed by their fellows display more cooperative attitudes. Negative externalities (which are pervasive in workplaces) are thus internalized, not because of altruistic behavior but because peer pressure discourages free-riding, especially when workers expect that many future interactions with the same peers will occur.

The positive productivity effects of collective PRP have been tested in a number of recent studies (Gielen, Kerkhofs and Van Ours, 2009; Kruse, Freeman and Blasi, 2010; Kato, Lee and Ryu, 2012). What deserve closer attention are the main impacts of PRP on wage setting. In decentralized wage bargaining, workers, through PRP, can appropriate a large part of the rents generated by their firms. One interpretation of the positive wage premium negotiated in firm-level contracts is that of rent sharing. This phenomenon may be relevant when specific human capital is important and there is "a match-specific surplus (rent), created by the costs of finding new partners, and this surplus will have to be shared by bargaining" (Acemoglu and Piscke, 1999, p. F121). By using firm-level data some authors show a robust positive association between wages and profitability (see, among others, Abowd and Lemieux, 1993;

Blanchflower, Oswald, and Sanfey, 1996). This evidence has been confirmed by introducing controls for unobserved worker heterogeneities (Gurtzen, 2008; Martins, 2009).

However, how many of these wage effects are due to the presence of unions is still uncertain. It can be argued that trade unions have sufficient bargaining power to obtain high wage premiums with firm-level agreements even in the absence of PRP schemes (Booth and Frank, 1999). By contrast, it has been found that unionized plants are more likely to utilize incentive payments, also accompanied by joint decision-making, that lead to better results in terms of firm performance (Black and Lynch, 2001).

Finally, as signaled by the incentive contract literature, clusters of complementary human resource management (HRM) practices may exert significant effects on productivity. Also skill improvements and workers' skill competence, that result in more efficient production, can be obtained from specific high performance work practices, especially when adopted in a bundled form (see for the Italian case, Leoni, 2012). The set of HRM variables may include union relations, as tested in the representative study of Ichniowsky, Shaw and Prennushi (1997). Even in low unionized economies, such as the UK, there is new evidence that worker representatives are perceived by employers as institutions capable of improving firm performance (Bryson and Forth, 2010). This means that in unionized firms, constructive institutional responses overcome free rider problems of group incentives, increase workers' commitment and reduce voluntary labor turnover (Booth and Chatterji, 1998).

We will address these issues in the econometric section.

Data and descriptive statistics

Data

Our empirical analysis is based on information obtained by the Employer and Employee Surveys (RIL) that were conducted by ISFOL in 2005, 2007 and 2010 on a representative sample of partnerships and limited liability firms that operated in the private non-agricultural sector.

The ISFOL-RIL surveys collect a rich set of information about employment composition, personnel organization, industrial relations and other workplace characteristics. In particular, the RIL questionnaire provides information about the adoption of decentralized bargaining and PRP, as well as the presence of unions. Each RIL cross-section for the years 2005, 2007 and 2010 counts about 25,000 firms, whereas its longitudinal component over the period 2005-2007-2010 counts about 12,000 firms.

Each firm is asked whether or not a PRP scheme has been adopted. Therefore, our PRP-variable is a dummy variable indicating the existence or not of a PRP scheme of some kind.[2] As regards unions, the respondent firm is asked whether there is a form of employee representation of any kind in the firm. We thus analyze a sub-sample of unionized firms. Dummy variables are also inserted to take into account if firms are controlled by foreign companies, if they export, innovate, or have been involved in mergers or acquisitions in the three previous years (see the Appendix, Table A1, for detailed definitions of all variables).

In order to link information concerning workers' characteristics to indicators of firm performance and accounting variables, a sub-sample of the RIL dataset was merged with balance-sheet information from the AIDA archives. Then the longitudinal RIL-AIDA merged sample was restricted to those limited liability companies which operated in the Italian private sector over the period 2005-2010. Furthermore, we excluded firms with less than five employees to retain only those firms characterized by a minimum level of organizational structure. The final sample amounts to a no-balanced panel of about 9,000 firms during the period 2005-2010.

Descriptive statistics

Italy is characterized by a two-tiered bargaining regime, where the first-level wage contracts are linked to the target inflation rate and decentralized bargaining should distribute wage premiums linked to productivity or firm results. However, the implementation of decentralized bargaining has been modest. As shown by Table 1, in 2005, 2007 and 2010, only 15%, 12% and 14% of firms, respectively, had decentralized agreements that include payments by results, thus confirming the limited spread of these PRP schemes, and no significant changes over the observed period. From 2005 to 2010, the number of sample firms increased from 8064 to 10136 and, thus, some caution is necessary in interpreting summary statistics, although this time variability and the composition effects appear limited.

[2] Unfortunately, we do not know whether the different types of schemes are based on firm-, group- or individual- performance (this information is available only for 2010). Furthermore, the dataset does not provide statistics on how many workers in the firm receive PRP.

The merged RIL AIDA sample also reveals a rather slight increase in the two dependent variables (labor productivity and wages), and in the physical capital per employee between 2005 and 2010.

With respect to workforce composition, Table 1 shows that the share of blue-collar workers increased over time, from 46% in 2005 to 55% in 2010, while, symmetrically, the proportion of white collars decreased from 45% in 2005 to 39% in 2010. Concerning the percentage of women, workers with fixed-term contracts and immigrants (workers coming from other countries), a slight decrease over time was recorded, indicating a tendency, in our sampled period, towards the reduction of 'peripheral' employment. On average, the proportion of women decreased from 39% to 35% from 2005 to 2010; analogously, the stock of workers with fixed-term contracts over the total employment declined from 11% in 2005 to 10% in 2010, and the share of immigrants, on total employees, declined from 9% to 5%.

The overall weakness in productivity and wage growth of sample firms may be related to the decreasing share of innovative and exporting units. Firms that originated new products declined from 55% to 45%, whereas the proportion of exporters slumped from 41% to 31%, from 2005 to 2010.

It is worth noting that information on lagged sales volatility, used as instrument for PRP (1 when this volatility is higher than the median sample value and 0 otherwise), is available only for a restricted sub-sample of firms (about 3,000 observations per year). This means that by performing the instrumental variable regressions we made a double robustness check. First, we took into account endogeneity and second we performed estimates on a different, more restricted sample of firms.

According to expectations, small-size firms prevail and the largest share of firms is mainly located in Northern Italy. In particular, firms with less than 50 employees are more than 80% while those with more than 250 employees, in each year considered, are about 5% of the total sample. Finally the RIL-AIDA data indicate that firms were mainly specialized in manufacturing sectors and less present in services, with the exception of the trade sector. These differentials in sector and territorial localization of PRP Italian firms, as well as in various characteristics of workforce composition, show the importance of our unique data and of its wide coverage.

[Insert Table 1]

Finally, notice that PRP firms, that are not so numerous, exhibited better performances and paid higher wages; the Kernel density estimations, calculated on the pooled sample, show that there is higher probability to find PRP firms among those with higher values of labor productivity and wages. As shown by Figure 1, the distribution referring to PRP firms is slightly placed to the right of that concerning other firms. This difference is recorded in the whole sample and is confirmed in the restricted sample that includes only unionized firms. These first comparisons encouraged us to further explore the existence of possible relations between PRP schemes and enterprise performance.

[Insert Figure 1]

Econometric strategy

In this section we present the empirical strategy we used to estimate the effect of PRP on labor productivity and wages. In particular, the relationship between labor productivity and PRP may be formalized by a production function augmented by a dummy variable capturing the incidence of PRP and inserting a set of other controls for firm characteristics and workforce composition. The following equation was estimated:

$$(1)\ ln\left(\frac{P}{L}\right)_{i,t} = \alpha \cdot ln\left(\frac{K}{L}\right)_{i,t} + \beta \cdot PRP_{i,t} + \vartheta \cdot F_{i,t} + \mu_s + \gamma_j + \eta_t + \varepsilon_{i,t} \quad t{=}2005,2007,2010$$

where $\ln\left(\frac{P}{L}\right)_{i,t}$ is the (log of) valued added per employee, $\ln\left(\frac{K}{L}\right)_{it}$ is the (log of) physical capital per employee, PRP represents a dummy variable indicating the presence of PRP and the vector F_{it} denotes controls for characteristics at firm level and workforce composition. The parameter μ_s denotes sector specific fixed effects, γ_j regional (NUTS1_level) fixed effects for macro-areas, η_t represents year fixed effects and ε_{it} is the error term capturing the idiosyncratic component of labor productivity.

The wage equation parallels the productivity equation (1). Thus, we estimate the following equation:

$$(2)\ ln\left(\frac{W}{L}\right)_{i,t} = \alpha \cdot ln\left(\frac{K}{L}\right)_{i,t} + \beta \cdot PRP_{i,t} + \vartheta \cdot F_{i,t} + \mu_s + \gamma_j + \eta_t + \varepsilon_{i,t} \quad t{=}2005,2007,2010$$

where the dependent variable represents the (log of) the average annual wages (W) per employee (L), while the explanatory variables are the same included in equation (1).

We started with a pooled cross section analysis of equations (1) and (2), controlling for time fixed effects. We preferred a pooled sample because we had an unbalanced panel dataset, with a different number of observations for each year. In any case, a pooled OLS estimator does not allow us to take into account heterogeneity across firms. For this reason, besides OLS estimates, we performed a conditional quantile regression to study the effect of PRP along the labor productivity and wage distributions.

First of all, we started with the classical Koenker and Basset (1978) estimator:

$$(3) \qquad (\beta^{\tau}, \boldsymbol{\delta}^{\tau}) = argmin \sum \rho_{\tau} \cdot \left(ln\left(\frac{P}{L}\right)_{i,t} - \beta \cdot PRP_{i,t} - \boldsymbol{\delta} \cdot \boldsymbol{X}_{i,t} \right)$$

$$(4) \qquad (\beta^{\tau}, \boldsymbol{\delta}^{\tau}) = argmin \sum \rho_{\tau} \cdot \left(ln\left(\frac{W}{L}\right)_{i,t} - \beta \cdot PRP_{i,t} - \boldsymbol{\delta} \cdot \boldsymbol{X}_{i,t} \right)$$

where β is the coefficient of interest, $\boldsymbol{\delta}$ is a vector of coefficients for all control variables that now are included in the matrix $\boldsymbol{X}$, τ is the quantile 0.1; 0.5; 0.9, ρ_{τ} is the asymmetric loss function $\rho_{\tau}(u) = 1(u > 0) \cdot \tau|u| + 1(u \leq 0) \cdot (1 - \tau)|u|$.

As known, the OLS estimator fits a linear model for the dependent variables $ln\left(\frac{P}{L}\right)$ and $ln\left(\frac{W}{L}\right)$ by minimizing the expected squared error. The quantile regression (QR) fits a linear model for the same dependent variables using the asymmetric loss function $\rho_{\tau}(u)$ and minimizing the least-absolute deviations. When $\tau = 0.5$, we have the conditional median, the loss function is symmetric and this expectation function minimizes the least absolute deviations. For $\tau \in (0,1)$ and $\tau \neq 0.5$, the loss function weights positive and negative terms, asymmetrically. This means, for example, that if $\tau = 0.9$ then much more weight is placed on prediction for observations $ln\left(\frac{P}{L}\right) \geq \beta_{0.9} PRP + \delta_{0.9} X$ than for observations $ln\left(\frac{P}{L}\right) < \beta_{0.9} PRP + \delta_{0.9} X$.

For labor productivity and wages we estimated three different quantile regressions simultaneously, with $\tau = 0.1; 0.5$ and 0.9. In addition, we addressed heteroskedasticity by means of bootstrap standard errors that assume independence over observations (Cameron and Trivedi, 2009). The QR approach is more robust to outliers and provides information about the relationships between PRP and the dependent variables at different points of their conditional distribution.

However, the Koenker and Basset (1978) estimator does not allow us to distinguish between casual effects *and* spurious correlation between PRP and productivity or wages, that will typically arise if more productive firms or firms that pay higher wages more likely adopt PRP schemes. Thus, if there are unobserved factors influencing the adoption of PRP, the estimated effect on productivity and wages will be biased. To avoid that these relationships remain obscured, the issue of endogeneity has to be taken into account. The binary nature of our key explanatory variable (PRP) led us to handle endogeneity within the context of the treatment effect techniques. As we will discuss below, in two out of the three instrumental variable quantile methods used in our estimates, we compared the performance of both treated firms (firms adopting PRP scheme) and the control group (firms that have not adopted PRP schemes), whose outcomes permit having a counterfactual analysis. The volatility of sales at the firm level, recorded in years before 2005 (over the period 2002-2004) [3] , may be a valid instrument because it is a proxy of uncertainty. This variable is expected to randomly affect the sample firms, but at the same time also influences the probability that firms introduce PRP schemes as an incentive device. Indeed, in the Italian two-tiered bargaining regime, firms may distribute PRP wage premiums linked to firm results, at the second level of bargaining. This wage component is *added* to the base wage, set in the first level, and could be zero when firms do not gain positive results. Thus, also risk-averse employees will be no reluctant to accept these agreements, because these variable pays add on in years of success, but do not cause any reduction in the (first level) base pay during unsuccessful years. Employees do not take any extra-risks, whereas firms, on their part, especially if they experienced a high degree of

[3] As explained in the previous section, the volatility of sales is not available for all firms, hence the robustness checks are performed on a restricted sample.

volatility in the past, would be more willing to adopt PRP schemes as a strategy to obtain higher employee performance and successful outcomes.

The literature dealing with the instrumental variable treatment effects of policy measures is increasing and different quantile regression estimators are available (see Bosio, 2009; Frölic and Melly, 2013a, for useful overviews). In our work, we use three different methods: i) the traditional Two-Stages Least Absolute Deviation Estimator (IVQR_2LAD), of Amemya (1982); ii) the Quantile Treatment Effect Estimator of Abadie, Angrist and Imbens (2002) (IVQR_AAI); iii) the IV estimator for Unconditional QR of Frölic and Melly (2013b) (IVQR_FFM). These estimators, that allow us to examine the impact of PRP throughout labor productivity and wage distribution by tackling endogeneity, present different characteristics.

First of all, the last two methods are based on a binary endogenous variable and a binary instrument. Thus, we transformed the past sales volatility of the firm into a dummy variable that is equal to 1 when the firm experienced a volatility higher than the median volatility recorded by the others, and 0 otherwise. The IVQR_2LAD estimator consists in using the fitted values, obtained from a first step, in a standard quantile regression, performed in a second step, where the instrumented key variable (PRP) is introduced as a covariate. In our case, the first step is a probit regression of PRP (our endogenous binary variable) on the binary instrument (sales volatility) at the firm level.

$$(5)\ P\left(PRP_{i,t} = 1 \middle| SV_{i,t}, \boldsymbol{X_{i,t}}\right) = \boldsymbol{\Phi}\left(\boldsymbol{\xi} \cdot SV_{i,t} + \boldsymbol{\delta} \cdot \boldsymbol{X}_{i,t}\right)$$

where SV is the binary instrument for volatility of sales, **X** the firm level controls mentioned above**.**

The fitted value of PRP was then inserted in the standard quantile regressions (4) and (5). In order to obtain consistent standard errors, we bootstrapped them in both the first stage and the second stage regressions (Arias, 2001; Bosio, 2009). Notice, however, that this approach relies on the symmetry of the composite error obtained in the second stage (see Wooldridge, 2010). Furthermore, Chernozhukov and Hansen (2005) show that this estimate is not consistent when the quantile treatment effect differs across quantiles and it is precisely in that case that the quantile regression method is interesting (see also Melly, 2004 and Bosio, 2009). For this reason we only keep the IVQR_2LAD estimator as a benchmark and turn to other methods that, although not completely free from other problems, reveal more robust.

The Abadie, Angrist and Imbens conditional quantile treatment effects estimator (IVQR_AAI) can be applied only if both endogenous variables and instruments are binary variables. Furthermore, the causal effect is identified only for the sub-population of compliers. In our case, the compliers are firms whose estimated probability to adopt a PRP scheme is correlated to the higher estimated probability of having experienced a past volatility of sales above the median. These compliers are, in our sample, about 72% of all firms adopting PRP[4].

Following Abadie, Angrist and Imbens (2002), the conditional quantile treatment effect for compliers can be estimated consistently by the following weighted quantile regressions:

$$(6) \qquad (\beta_{IV}^{\tau}, \boldsymbol{\delta}_{IV}^{\tau}) = argmin \sum W_{i,t}^{AAI} \cdot \rho_{\tau} \cdot \left(ln\left(\frac{P}{L}\right)_{i,t} - \beta \cdot PRP_{i,t} - \boldsymbol{\delta} \cdot \boldsymbol{X}_{i,t} \right)$$

$$(7) \qquad (\beta_{IV}^{\tau}, \boldsymbol{\delta}_{IV}^{\tau}) = argmin \sum W_{i,t}^{AAI} \cdot \rho_{\tau} \cdot \left(ln\left(\frac{W}{L}\right)_{i,t} - \beta \cdot PRP_{i,t} - \boldsymbol{\delta} \cdot \boldsymbol{X}_{i,t} \right)$$

$$(8) \qquad W_{i,t}^{AAI} = 1 - \frac{PRP_{i,t} \cdot (1 - SV_{i,t})}{1 - Pr(SV = 1 | \boldsymbol{X}_{i,t})} - \frac{(1 - PRP_{i,t}) \cdot SV_{i,t}}{Pr(SV = 1 | \boldsymbol{X}_{i,t})}$$

where the weights $W_{i,t}^{AAI}$ combine the endogenous variable and the instrument[5]. As stated above, the instrument is assumed to hit the sample firms randomly, and the conditional probability to have a volatility above the median, $Pr(SV = 1 | \boldsymbol{X}_{i,t})$ has been estimated by means of a non-parametric regression, by using the local logit estimation suggested by Frölich and Melly (2013b).

Finally, according to an unconditional instrumental variable quantile treatment effect, such as that of Firpo et al. (2011), all exogenous variables are estimated with the technique of Frölich and Melly (2010; 2013b). Unlike the conditional quantile regression methods explained above, in this case the inclusion of covariates independent from the treatment

[4] The remaining 28% are defiers, i.e. they are those firms with low volatility and that adopted PRP schemes.

[5] Actually, we estimated a modified version of $W_{i,t}^{AAI}$ that allows only positive weights, see Abadie, Angrist and Imbens (2002).

does not change the limit of the estimated quantile treatment effects; it means that the results do not change significantly when the set of covariates changes. Secondly, estimators for unconditional quantile treatment effects are entirely non-parametric and do not require restrictions such as linearity or other parametric features.

However, also in the Frölich and Melly approach the causal effect is identified only for compliers, according to the following estimator:

$$(9) \qquad (\theta_{IV}^{\tau}, \beta_{IV}^{\tau}) = argmin \sum W_{i,t}^{FM} \cdot \rho_{\tau} \cdot \left(ln\left(\frac{P}{L}\right)_{i,t} - \theta - \beta \cdot PRP_{i,t} \right)$$

$$(10) \qquad (\theta_{IV}^{\tau}, \beta_{IV}^{\tau}) = argmin \sum W_{i,t}^{FM} \cdot \rho_{\tau} \cdot \left(ln\left(\frac{W}{L}\right)_{i,t} - \theta - \beta \cdot PRP_{i,t} \right)$$

$$(11) \qquad W_{i,t}^{FM} = \frac{PRP_{i,t} - Pr(SV=1|\boldsymbol{X}_{i,t})}{Pr(SV=1|\boldsymbol{X}_{i,t}) \cdot \left(1 - Pr(SV=1|\boldsymbol{X}_{i,t})\right)} \cdot \left(2PRP_{i,t} - 1\right)$$

where $W_{i,t}^{FM}$ are the weights suggested by Frölich and Melly (2010; 2013b). This regression corresponds to a bivariate quantile regression in which β_{IV}^{τ} is identified only for PRP=1 observations, and θ_{IV}^{τ} only for PRP=0 observations. In this case the covariates are inserted only in the weights $W_{i,t}^{FM}$, but not in the second stage equations (9) and (10). In addition, these weights simultaneously balance the distribution of the covariates between treated and non-treated compliers, whereas $W_{i,t}^{AAI}$ do not, because they refer to a conditional model. Lastly, also in this case the probability that a firm experienced a volatility of sales above the median $Pr(SV = 1|\boldsymbol{X}_{i,t})$, has been estimated by means of a non-parametric local logit approach.

Estimation results: OLS and standard Quantile estimates

In this section we present OLS (equations 1 and 2) and standard QR estimates (equations 3 and 4) for labor productivity and wages. These estimates are obtained by including time, sector and regional (NUTS) dummies to control for time- varying, sector-specific factors, as well as geographical disparities which likely influence the dependent variables and cannot be captured by other controls included in our analysis.

Due to multicollinearity problems, we cannot introduce the firm size as regressor. Notice, however, that we find a high correlation between export and innovation propensities, on the one hand, and firm size on the other, in line with results of other studies on Italian firms (see Hall *et al.* 2009). This evidence led us to consider export and innovation propensities as good proxies of the firm size[6].

[Insert Table 2]

[Insert Table 3]

The first columns of Table 2 and Table 3 report the labor productivity and wage estimates obtained for the whole sample of firms and the remaining columns those for unionized firms. OLS findings indicate that the coefficient of PRP is positive and significant and analogous results have been obtained by replicating our estimation strategy for unionized firms. This means that adopting PRP fosters, on average, both labor productivity and wages.

The standard QT estimates reported in Tables 2 and 3 confirm that our key explanatory variable shows a positive and significant effect (almost always at the 1% level of significance) at all quantiles. However, the differences in coefficients associated with PRP across the labor productivity and wage distributions signal that heterogeneity matters. The OLS and median regression coefficients (τ=0.5) for labor productivity are very similar (9.4% and 9.6%, respectively). Analogously, similar coefficients are found for wage estimates (11.8% and 10.9%, for OLS and median coefficients, respectively). However, these results change remarkably at the tails of the distribution. In particular, we obtain that PRP has a much greater positive impact at the lower conditional quantile (τ=0.1) of both labor productivity and wage distributions. These differences are confirmed also for the sample of unionized firms, highlighting that PRP schemes are particularly significant for enterprises facing difficulties in terms of efficiency, independently from the presence or not of unions.

From the specification adopted for OLS and standard QR, most of the control variables show the expected sign. First, we find the significant and positive role of the capital stock per capita in labor productivity and wage equations. Second, concerning workforce characteristics, we obtain the negative coefficient of fixed-term workers on labor productivity, accompanied by a parallel penalization of these precarious workers in terms of wages (see Table 3). The QR analysis reveals some evidence of heterogeneity also for this

[6] The results concerning these correlations, found in our sample, are available upon request.

variable, with negative and significant coefficients of fixed-term workers along the whole productivity and wage distributions, but with a magnitude, in absolute value, that decreases at higher conditional quantiles. The higher coefficient for the lower tail of the distribution suggests that, especially in low performer firms that use temporary contracts as a cost cut strategy, these forms of job instability reduces investment in training and workers' motivations and, in the end, deteriorate productivity prospects (Blanchard and Landier 2002). In best performer firms, on the contrary, temporary contracts may also represent a screening device to select new employees. Thus, these arrangements may induce motivation and effort from those workers who, after the probation period, are interested in obtaining permanent positions, with the result that this incentive effect partially counterbalances the negative impact due to uncertainty and job instability.

Other workers' characteristics, such as employment positions, play a role. The coefficient associated with white- and blue-collar workers, with respect to the omitted category, the executives, are negative and significant, mainly at the highest conditional quantile. A plausible interpretation is that managerial employees have a positive and significant influence on productivity, especially in better performing firms. Among other factors, this may be due to their providing better-designed pay schemes to induce optimal effort from their subordinates.

Another interesting finding is the strong negative coefficient associated with the percentage of women, across the whole productivity and wage distribution. A cautionary interpretation is necessary, since the percentage of women is very likely to be correlated with unobserved (or omitted) firm characteristics. In addition, the negative coefficients associated with the female component are likely to be related to the gender wage gap. Our wage estimates seem to confirm that lower productivity increases, obtained when the proportion of women is higher, is at least partially related to less generous remunerations offered to women. This is in line with other studies that find that female employees, on average, prefer activities that allow a larger flexibility between job and family, have lower interdependence with other workers, are less involved in participative work forms (Zwick, 2004), and appear less respondent to incentives.

For firm characteristics related to internationalization, our results indicate that the coefficients associated with the propensity to export are positive and significant, but lower at the highest quantiles and for the subsample of unionized firms. This provides evidence that productivity gains of exporters are more important for firms at the lower tail of the efficiency and wage distribution, probably because, under international competition, especially low performer firms are induced to catching up processes.

The control for multinational enterprises (MNEs), on the contrary, plays a significant role only at the 90th percentile, but is not significant across all quantiles in unionized firms. As discussed above, these international variables are highly correlated with the firm's size and thus, indirectly provide a control for the firms' size.

Estimation results: instrumental variable quantile regressions

The possible endogeneity of PRP deserves further attention. The exogeneity assumption of PRP might be violated if firms adopt this reward system on the basis of productivity performance. In other terms, enterprises with PRP might have already been more efficient (and may have offered higher rewards) than firms that do not have a scheme, before its adoption. This problem, due to the fact that better managed firms tend to adopt PRP, is taken into account by carrying out instrumental variable estimates.

As discussed above, in the section dedicated to the econometric strategy, we attempted to recover the random assignment of PRP (that is our treatment variable) by means of another binary variable such as past sales volatility. The volatility of sales at the firm level, recorded in the years before 2005 (2002-2004) is a proxy of uncertainty faced by firms, and it is not expected to be correlated with current values of labor productivity and wages, but correlated with the probability that firms introduce PRP schemes as incentive devices[7].

The results, obtained by using different estimators and using the past values of volatility of sales at firm level as instrument, are shown in Table 4. It must be recalled that this instrumental variable was not available for all the firms we considered in the standard QR (see

[7] Besides the reasons discussed in the previous section, it must be remarked that among the rationales behind the choice of our instrument, one may recall some results of the strategic management and sales management literatures. For instance, the use of an incentive plan is positively related to a dimension of organizational performance, such as sales volatility, as found by Menguc and Barkers (2003). Other arguments related to the correlation between variable pay and profit volatility are offered by Burke and Hsieh (2006).

Tables 2 and 3), hence the number of observations considerably reduces and performing estimates for a more restricted sample of firms represents an additional robustness check.

In order to make the comparison of different approaches readable, we report outcomes uniformed to IVQR_FM estimates that do not include control variables in the second stage. Thus, Table 4 reports only coefficients and standard errors for our variable of interest, PRP[8]. As done with previous estimates, for each dependent variable we ran two specifications, the first for the whole sample and the second for the unionized firms.

[Insert Table 4]

Columns *a*, *b* and *c* of Table 4 show the results of the traditional IVQR_2LAD of Amemya (1982) and basically confirm a positive and significant impact of PRP along all distributions of both labor productivity and wages. As explained above, this estimator could not be consistent if the composite error is asymmetric (Wooldridge, 2010); in any case, it can be a useful benchmark because it allows the relationship between the instrument (volatility of sales) and the endogenous variable (PRP) to be observed directly in the first stage, as we formalized in equation 5. The results of the probit regression, shown in the appendix (Table A.2), highlight that high sales volatility (*SV=1*) positively influences the probability to adopt a PRP scheme, as we hypothesized above.

Columns *d*, *e* and *f* of Table 4 show the PRP coefficients estimated with the instrumental variable conditional quantile treatment effect of Abadie et al. (2002). These results confirm those of standard QR (Tables 2 and 3) in terms of positive and heterogeneous coefficients associated to PRP along productivity and wage distributions. It is worth noting that, like standard QR, the PRP scheme shows a greater impact on low performers (firms at the bottom of the productivity and wage distributions) in three out of four specifications (the only exception is labor productivity for all firms, reported in the first rows). According to the literature (Wooldridge, 2010; Frölich and Melly, 2010; 2013b), the IVQR_AAI estimator is much more reliable than the IVQR_2LAD one, even though the causal relationship between PRP and dependent variables is identified only for compliers, namely firms with high sale volatility (*SV=1*) that adopt PRP (about 72% of total firms adopting PRP, in our case). Probably the characteristics of this method, applied to more restricted sample, justify the

[8] For both IVQR_2LAD and IVQR_AAI estimations, the control variables maintained the same sign reported in tables 2 and 3, even though the significance level slightly reduces. These results are available upon request.

differences with respect to the standard QR results. Indeed in all IVQR_AAI estimates, we found a ‘U shaped’ relationship between PRP and dependent variables (the magnitude of coefficients decreases, moving from the lowest quantile to the median quantile, and increases again at the 90^{th} quantile).

The instrumental variable unconditional quantile regression of Frölich and Melly (2010; 2013b) is reported in the last 3 columns of Table 4. These results basically confirm those obtained with the IVQR_AAI approach, thus PRP coefficients are always positive and significant, but also show a “U shaped” behavior in moving from the bottom to the upper tail of both productivity and wage distributions. This means that PRP exerts greater positive influence for companies lagging behind in terms of productivity and wages. The different interpretation that unconditional quantile regression needs (Frölich and Melly, 2010, p.429), also in this case justifies the differences in the magnitude of coefficients.

On the whole, the results of Table 4 deserve further attention in terms of distributive implications. First, the comparison of the coefficients of PRP on labor productivity and wages unambiguously shows that the impacts on remunerations are lower than those recorded for labor productivity. Indeed, at least in our sample period, PRP schemes contributed to temperate unit labor costs because the workers did not fully appropriate productivity gains.

Second, the role of unions, far from reversing these general patterns, amplify the positive gap between labor efficiency and wages, since workers’ representatives do not exert their bargaining power to obtain additional premiums above-productivity gains. This finding is clearly observable in Figure 2, where the effects of PRP on labor productivity and wage distributions have been calculated with the instrumental variable unconditional quantile regression of Frölich and Melly (2010; 2013b) for all deciles (from 0.10 to 0.90). This result is a confirmation that in the years of progressive decline in trade union membership and diffusion of precarious working conditions, the objective function of unions has been more oriented to wage moderation to preserve job positions. Thus, employees’ representatives have exerted their bargaining power to moderate wage demands, as also shown for other country experiences (Dumont et al. 2005).

Finally, notice that all these estimates are obtained with specifications that control for firm characteristics (capital accumulation, firm innovation strategies, internationalization, merger policies), occupation characteristics (employment positions, typology of contracts, gender characteristics), macro-region and industry dummies.

Summing up, the quantile treatment effects estimates obtained with different estimators confirm and complement the previous findings reported in Tables 2 and 3.

Conclusions

The major finding of our study is that performance-related pay (PRP) may significantly stimulate efficiency gains and thus the limited implementation of these wage practices has played a role in explaining the disappointing Italian results. Concerning distributive aspects, we estimated the role of these agreements on wages to ascertain whether employees benefit financially from PRP, an issue that deserves attention because the existing empirical evidence is still insufficient to infer definite results. From the comparison of productivity and wage estimates, we obtained information indicating that PRP might not only be rent-sharing devices, but also incentive schemes that substantially lead to efficiency enhancements. These findings, obtained for a large sample of manufacturing and service firms in which we controlled for a complete set of covariates, provide useful insights for the Italian economy, whereas prior works for this country have been restricted to large companies, selected sectors or particular areas of the country.

We also considered another debated issue concerning the quality of industrial relations, represented by the presence of unions, whose importance, according to international evidence, is still ambiguous. In fact, their presence may minimize free-riding and promote collaborative attitudes, but their attitudes, in favor of (or adverse to) PRP schemes, remain ambiguous, and empirically there is no clear evidence whether unions increase or decrease incentive effects of PRP agreements, as reviewed in Hirsch (2007).

For Italian enterprises, we conclude that unions not only extract wage premiums for their workers, as predicted by monopoly union bargaining models, but through their 'voice' function, may counter-balance negative side-effects of collective PRP, such as free-riding. Overall, the estimates suggest that workers' organizations play a redistributive function that is not detrimental to an efficiency- enhancing role. All these findings were supported by a number of robustness checks, taking into account the heterogeneity of firms along the productivity and wage distributions by means of quantile regressions. We found significant differences and the highest incidence of PRP on productivity and wages at low and high quantiles of their distribution, also including corrections for biases due to endogeneity of PRP. Concerning policy implications, we suggest that the adoption of measures that circumvent the limited implementation of PRP practices should be implemented, since payments by results, rather than being only distributive devices, may substantially lead to efficiency enhancements, and the effectiveness of this strategy is not weakened under union governance.

Future research will allow us to more thoroughly explore firms' heterogeneity. Additional statistical information will permit us to explore the role of individual and collective variable payment schemes on the basis of an even more complete dataset and to thoroughly evaluate their different influence on efficiency gains and redistribution inside heterogeneous Italian firms.

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TABLES AND FIGURES

*Table 1***.** Descriptive statistics: RIL-AIDA

	Year 2005			Year 2007			Year 2010		
	N.	**Mean**	***Std. Dev.***	**N.**	**Mean**	***Std. Dev.***	**N.**	**Mean**	***Std. Dev.***
Performance Related Pay	8064	0.15	*0.35*	8362	0.12	*0.31*	10136	0.14	*0.33*
Accounting variables (constant prices, reference year 2005)									
ln (value added per capita)	5291	10.66	*0.77*	7512	10.73	*0.62*	9069	10.69	*0.61*
ln (wage per capita)	5241	9.93	*0.66*	7451	9.99	*0.42*	9060	10.01	*0.43*
ln (physical capital per capita)	5294	9.80	*1.60*	7507	9.85	*1.58*	9054	9.90	*1.76*
Workforce characteristics									
Executives	8064	0.09	*0.13*	8551	0.05	*0.1*	10136	0.05	*0.1*
White collar workers	8064	0.45	*0.32*	8551	0.38	*0.31*	10136	0.39	*0.31*
Blue-collar workers	8064	0.46	*0.32*	8551	0.57	*0.33*	10136	0.55	*0.33*
Women	8064	0.39	*0.28*	8580	0.34	*0.28*	10136	0.35	*0.28*
Fixed-term contracts	8064	0.11	*0.16*	8580	0.10	*0.17*	10136	0.10	*0.17*
Immigrant workers	8064	0.09	*0.18*	8301	0.06	*0.12*	9955	0.05	*0.11*
Firm characteristics (binary variables)									
Process Innovation	7775	0.47	*0.50*	8169	0.43	*0.50*	9920	0.39	*0.49*
Product Innovation	7820	0.55	*0.50*	8184	0.56	*0.50*	9926	0.45	*0.50*
Export	8064	0.41	*0.49*	8360	0.30	*0.39*	9944	0.31	*0.46*
MNEs	8429	0.03	*0.48*	8328	0.032	*0.18*	9955	0.039	*0.19*
M&As	8421	0.02	*0.14*	8348	0.016	*0.13*	9947	0.049	*0.22*
High Sales volatility_2002-2004	2887	0.50	*0.50*	3600	0.49	*0.50*	2416	0.51	*0.50*
Firm Size									
5 < n of employees<15	8064	0.38	*0.49*	8551	0.42	*0.50*	10136	0.43	*0.50*
15 ≦n employees < 50	8064	0.35	*0.48*	8551	0.34	*0.48*	10136	0.33	*0.47*
50 ≦ n employees < 250	8064	0.21	*0.41*	8551	0.19	*0.39*	10136	0.19	*0.39*
n of employees ≧250	8064	0.07	*0.22*	8551	0.05	*0.17*	10136	0.05	*0.18*
NUTS1_Macro-regions									
North- West	8064	0.35	*0.47*	8580	0.34	*0.47*	10136	0.33	*0.47*
North-East	8064	0.25	*0.43*	8580	0.26	*0.44*	10136	0.25	*0.43*
Centre	8064	0.2	*0.40*	8580	0.2	*0.40*	10136	0.21	*0.41*
South	8064	0.21	*0.41*	8580	0.21	*0.41*	10136	0.21	*0.41*
Sectors									
Textile, Wearing Apparel, Food Industry	8064	0.14	*0.34*	8580	0.14	*0.35*	10136	0.14	*0.33*
Other Manufacturing, Mining, Utilities	8064	0.28	*0.45*	8580	0.31	*0.46*	10136	0.31	*0.46*
Constructions	8064	0.11	*0.32*	8580	0.1	*0.31*	10136	0.1	*0.35*
Trade, hotels, restaurants	8064	0.13	*0.34*	8580	0.16	*0.36*	10136	0.16	*0.34*
Transportation and communication	8064	0.07	*0.26*	8580	0.05	*0.21*	10136	0.05	*0.26*
Intermediation and other business service	8064	0.14	*0.34*	8580	0.1	*0.30*	10136	0.1	*0.34*
Education, health and private social services	8064	0.12	*0.33*	8580	0.14	*0.35*	10136	0.14	*0.29*

Notes: for binary variables and dummies the mean corresponds to the relative frequency.

Figure 1. Distributions of Wages, Labor Productivity and Total Factor Productivity

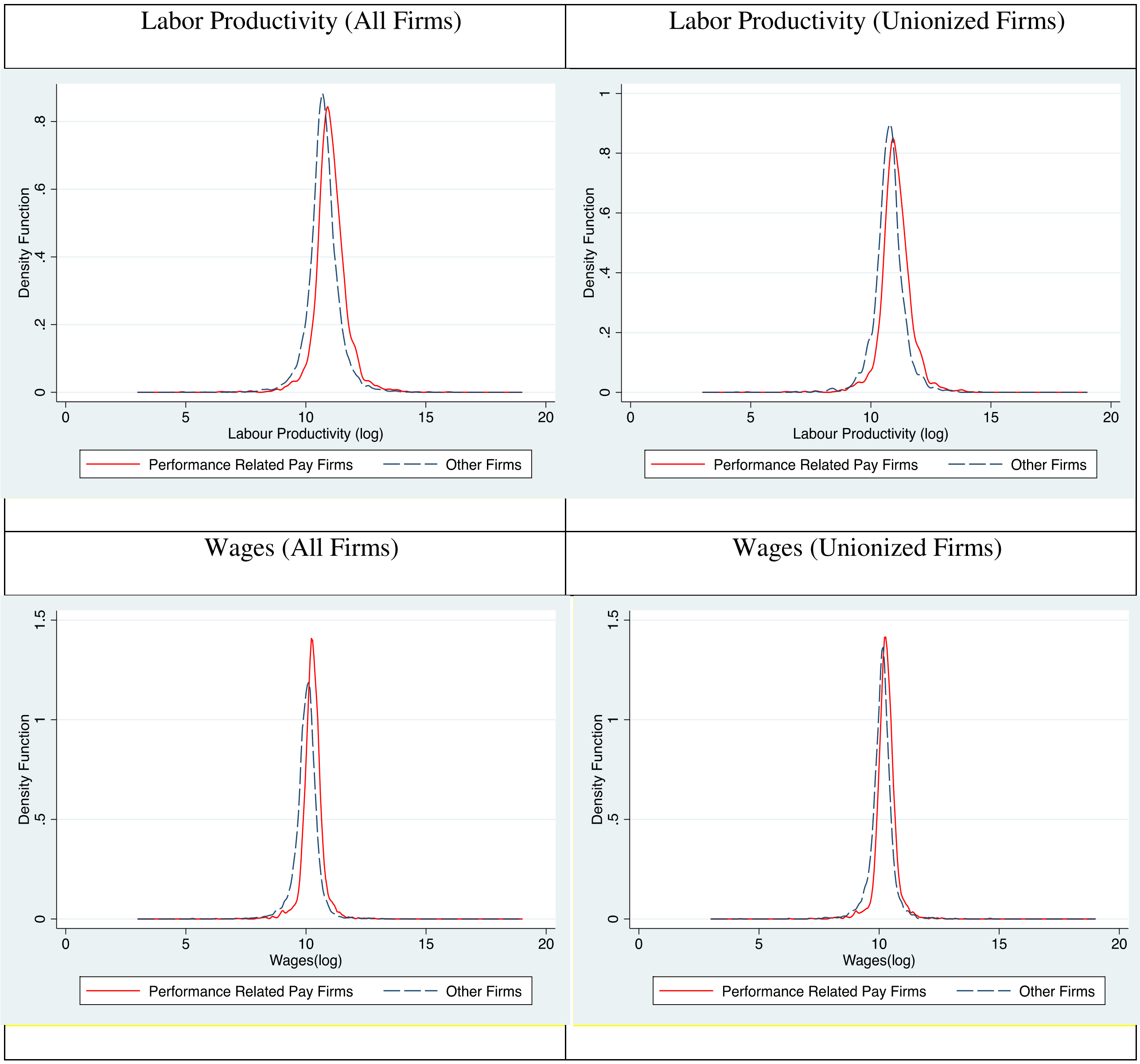


Table 2. OLS and Quantile Regressions: effects of PRP on Labor Productivity

	All Firms				Unionized Firms			
Dependent Variable	Ln(Value Added per capita)							
	OLS	Standard QR			OLS	Standard QR		
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*
Covariates		θ =.10	θ = 50	θ = 90		θ =.10	θ = 50	θ = 90
Performance Related Pay (PRP)	0.094***	0.136***	0.096***	0.044*	0.106***	0.183***	0.094***	0.088***
	(0.012)	(0.019)	(0.010)	(0.023)	(0.016)	(0.026)	(0.014)	(0.023)
ln (physical capital per capita)	0.140***	0.113***	0.115***	0.158***	0.125***	0.112***	0.100***	0.120***
	(0.003)	(0.005)	(0.003)	(0.005)	(0.006)	(0.011)	(0.005)	(0.007)
Fixed-term contracts_Share	-0.456***	-0.607***	-0.403***	-0.211***	-0.369***	-0.369***	-0.216***	-0.291***
	(0.030)	(0.052)	(0.025)	(0.042)	(0.076)	(0.102)	(0.062)	(0.100)
Executives_share	0.757***	-0.117	0.923***	1.791***	1.356***	0.487***	1.897***	2.477***
	(0.065)	(0.082)	(0.077)	(0.138)	(0.158)	(0.128)	(0.154)	(0.227)
White Collars_share	0.340***	0.272***	0.336***	0.493***	0.304***	0.145**	0.324***	0.476***
	(0.017)	(0.026)	(0.015)	(0.029)	(0.035)	(0.059)	(0.033)	(0.053)
Women_share	-0.395***	-0.502***	-0.426***	-0.301***	-0.463***	-0.399***	-0.505***	-0.449***
	(0.020)	(0.032)	(0.015)	(0.034)	(0.042)	(0.069)	(0.029)	(0.055)
Process Innovation	0.011	0.050***	0.015*	-0.019	0.01	0.044	0.019	-0.004
	(0.010)	(0.016)	(0.009)	(0.015)	(0.019)	(0.031)	(0.015)	(0.026)
Product Innovation	0.003	0.044***	0.007	-0.053***	0.005	0.009	-0.004	-0.016
	(0.010)	(0.015)	(0.009)	(0.016)	(0.020)	(0.033)	(0.014)	(0.028)
MNEs	0.055***	-0.037	0.033*	0.111***	0.014	-0.003	-0.005	0.011
	(0.019)	(0.035)	(0.017)	(0.029)	(0.029)	(0.064)	(0.031)	(0.041)
Exporters	0.065***	0.092***	0.064***	0.039**	0.050**	0.067*	0.034**	0.046*
	(0.010)	(0.018)	(0.008)	(0.016)	(0.021)	(0.039)	(0.015)	(0.026)
M&As	0.028	-0.007	0.011	0.035	0.064*	0.03	0.061**	0.208***
	(0.025)	(0.042)	(0.018)	(0.052)	(0.036)	(0.057)	(0.028)	(0.081)
Constant	9.228***	8.955***	9.525***	9.624***	9.372***	8.893***	9.702***	9.930***
	(0.039)	(0.064)	(0.033)	(0.062)	(0.078)	(0.144)	(0.062)	(0.088)
Time Dummies	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Sector Dummies	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
NUTS1_level Dummies	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
R_2/PseudoR_2	0.259	0.173	0.172	0.181	0.269	0.183	0.194	0.203
Obs.	19183		19183		4718		4718	

Notes: Robust (OLS) and bootstrap (Quantile Regression) standard errors in parentheses. .*** significant at .01 level; ** significant at .05 level; *significant at .10 level.

*Table 3***.** OLS and Quantile Regressions: effects of PRP on Wages

	All Firms				Unionized Firms			
Dependent Variable	Ln(Wage)							
	OLS	Standard QR			OLS	Standard QR		
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*
Covariates		τ =0.10	τ = 0.50	τ = 0.90		τ =0.10	τ = 0.50	τ = 0.90
Performance Related Pay (PRP)	0.118***	0.185***	0.109***	0.055***	0.073***	0.119***	0.067***	0.045***
	(0.008)	(0.012)	(0.006)	(0.011)	(0.011)	(0.019)	(0.008)	(0.014)
ln (physical capital per capita)	0.063***	0.065***	0.039***	0.046***	0.058***	0.062***	0.033***	0.035***
	(0.002)	(0.004)	(0.002)	(0.003)	(0.005)	(0.007)	(0.003)	(0.005)
Fixed-term contracts_Share	-0.486***	-0.676***	-0.423***	-0.133***	-0.447***	-0.488***	-0.318***	-0.184**
	(0.027)	(0.046)	(0.021)	(0.037)	(0.063)	(0.092)	(0.046)	(0.075)
Executives_share	0.630***	-0.291***	0.957***	1.656***	1.205***	0.610***	1.646***	2.006***
	(0.056)	(0.088)	(0.054)	(0.077)	(0.122)	(0.155)	(0.098)	(0.140)
White Collars_share	0.260***	0.301***	0.249***	0.293***	0.259***	0.253***	0.264***	0.335***
	(0.013)	(0.021)	(0.010)	(0.019)	(0.027)	(0.041)	(0.022)	(0.036)
Women_share	-0.374***	-0.453***	-0.392***	-0.338***	-0.376***	-0.462***	-0.421***	-0.357***
	(0.016)	(0.021)	(0.011)	(0.020)	(0.030)	(0.050)	(0.021)	(0.033)
Process Innovation	-0.01	0.004	-0.003	-0.032***	-0.024*	-0.022	-0.01	-0.045***
	(0.007)	(0.011)	(0.006)	(0.011)	(0.014)	(0.020)	(0.010)	(0.016)
Product Innovation	0.009	0.035***	0.004	-0.020*	0.005	0.028	0.000	-0.016
	(0.007)	(0.011)	(0.006)	(0.010)	(0.015)	(0.020)	(0.010)	(0.017)
MNEs	0.062***	0.009	0.039***	0.124***	0.000	0.077**	-0.002	-0.013
	(0.016)	(0.033)	(0.010)	(0.022)	(0.023)	(0.032)	(0.013)	(0.021)
Exporters	0.068***	0.082***	0.049***	0.033***	0.057***	0.053***	0.029***	0.025*
	(0.007)	(0.011)	(0.005)	(0.010)	(0.013)	(0.018)	(0.009)	(0.015)
M&As	0.047**	0.035	0.045***	0.013	0.055**	0.031	0.043***	0.043
	(0.019)	(0.028)	(0.010)	(0.027)	(0.026)	(0.029)	(0.013)	(0.029)
Constant	9.300***	8.825***	9.594***	9.894***	9.365***	8.831***	9.694***	10.029***
	(0.031)	(0.058)	(0.021)	(0.037)	(0.061)	(0.113)	(0.037)	(0.066)
Time Dummies	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Sector Dummies	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
NUTS1_level Dummies	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
R_2/PseudoR_2	0.237	0.204	0.17	0.17	0.274	0.249	0.208	0.205
Obs.	19217		19217		4699		4699	

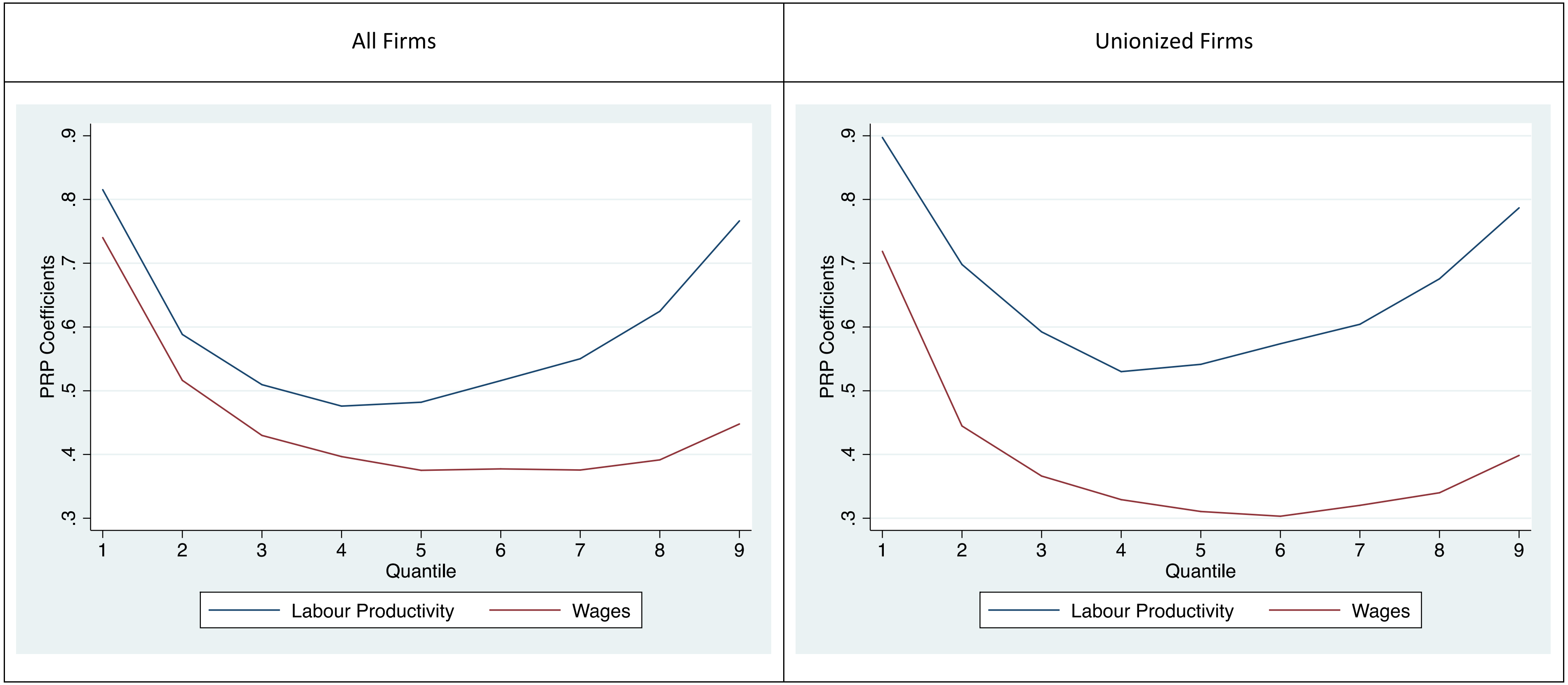
Note: Robust (OLS) and bootstrap (Quantile Regression) standard errors in parentheses. .*** significant at .01 level; ** significant at .05 level; *significant at .10 level.

Table 4. Effects of PRP on Labor Productivity, Wages and TFP, according to Instrumental Variable Quantile Regression methods

	All Firms _ Dependent Variable: Ln(Value Added per capita)								
	IVQR_2LAD			IVQR_AAI			IVQR_FM		
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*
	τ =0.10	τ = 0.50	τ = 0.90	τ =0.10	τ = 0.50	τ = 0.90	τ =0.10	τ = 0.50	τ = 0.90
PRP_Coefficient	0.235***	0.231***	0.279***	0.560***	0.386***	0.581***	0.815***	0.482***	0.766***
Standard Errors	(0.031)	(0.018)	(0.042)	(0.088)	(0.056)	(0.112)	(0.214)	(0.101)	(0.196)
Obs	*7600*	*7600*	*7600*	*7555*	*7555*	*7555*	*7555*	*7555*	*7555*
Pseudo_R_2	*0.144*	*0.155*	*0.199*						
	Unionized Firms _ Dependent Variable: Ln(Value Added per capita)								
	IVQR_2LAD			IVQR_AAI			IVQR_FM		
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*
	τ =0.10	τ = 0.50	τ = 0.90	τ =0.10	τ = 0.50	τ = 0.90	τ =0.10	τ = 0.50	τ = 0.90
PRP_Coefficient	0.309***	0.332***	0.279***	0.622***	0.389***	0.539***	0.897***	0.542***	0.787***
Standard Errors	(0.085)	(0.037)	(0.081)	(0.199)	(0.104)	(0.156)	(0.287)	(0.149)	(0.243)
Obs	*2698*	*2698*	*2698*	*2689*	*2689*	*2689*	*2689*	*2689*	*2689*
Pseudo_R_2	*0.173*	*0.182*	*0.192*						
	All Firms _ Dependent Variable: Ln(Wage)								
	IVQR_2LAD			IVQR_AAI			IVQR_FM		
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*
	τ =0.10	τ = 0.50	τ = 0.90	τ =0.10	τ = 0.50	τ = 0.90	τ =0.10	τ = 0.50	τ = 0.90
PRP_Coefficient	0.152***	0.132***	0.143***	0.421***	0.255***	0.306***	0.740***	0.375***	0.448***
Standard Errors	(0.022)	(0.011)	(0.022)	(0.087)	(0.040)	(0.079)	(0.187)	(0.075)	(0.132)
Obs	*7600*	*7600*	*7600*	*7547*	*7547*	*7547*	*7547*	*7547*	*7547*
Pseudo_R_2	*0.178*	*0.169*	*0.190*						
	Unionized Firms _ Dependent Variable: Ln(Wage)								
	IVQR_2LAD			IVQR_AAI			IVQR_FM		
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*
	τ =0.10	τ = 0.50	τ = 0.90	τ =0.10	τ = 0.50	τ = 0.90	τ =0.10	τ = 0.50	τ = 0.90
PRP_Coefficient	0.160***	0.172***	0.235***	0.386**	0.165***	0.193**	0.719***	0.311***	0.399***
Standard Errors	(0.052)	(0.024)	(0.048)	(0.152)	(0.059)	(0.086)	(0.322)	(0.105)	(0.162)
Obs	*2698*	*2698*	*2698*	*2677*	*2677*	*2677*	*2677*	*2677*	*2677*
Pseudo_R_2	*0.206*	*0.185*	*0.202*						

Note: IVQR_2LAD=Instrumental Variable Quantile Regression performed with a Two Stage Least Absolute Deviation Estimator (Amemya, 1982), in the first stage (see table A.2) the endogenous variable (PRP) is regressed on a dummy variable (instrument) controlling for high/low volatility of the firm sales over the period 2002-2004; IVQR_AAI= Conditional Quantile Treatment Effect with the Abadie, Angrist and Imbens (2002) estimator, the instrument is the dummy for firm sale volatility; IVQR_FM=Unconditional Quantile Treatment Effect according to the Frolich and Melly (2010) estimator, the instrument is the firm sale volatility. All regressions have been run with the same control variables that have been shown in tables 2 and 3.*** significant at .01 level; ** significant at .05 level; *significant at .10 level.

*Figure 2***.** Effects of Performance Related Pay on Labor Productivity and Wage distributions according to the Unconditional Quantile Treatment Effect Estimator for Endogenous Variables (Frolich and Melly, 2010)



Note: the plots of PRP coefficients refer to all deciles of labor productivity and wage distributions (from the 1th to the 9th). All these coefficients are significant at 1% or 5% level. More detailed information concerning these estimations are available upon request.

APPENDIX

Table A1. Variable definition

Variable	Definition
Performance Related Pay	Dummy variable that equals 1 if the firm adopts PRP payments of any kind, 0 otherwise.
ln (value added per capita)	Log of value-added per employee (source AIDA) deflated by the value added deflator (source ISTAT)
ln (wage per capita)	Log of wage bill per employee (source AIDA) deflated by the consumer price index for blue and white collar workers (source ISTAT)
ln (physical capital per capita)	Log of capital stock per employee (source AIDA) deflated by the investment deflator (source ISTAT)
Executives	Percentage of managers and supervisors
White collar workers	Percentage of white collar workers
Blue-collar workers	Percentage of manual workers
Women	Percentage of women among total workers
Fixed-term contracts	Percentage of fixed-term workers
Immigrant workers	Percentage of workers coming from other countries
Unions	Dummy variable that equals 1 if there is a worker representation of any kind in the firm, 0 otherwise
Age	Age of firms
Process Innovation	Dummy variable that equals 1 if the firm adopted process innovations in the 3 previous years, 0 otherwise
Product Innovation	Dummy variable that equals 1 if the firm originated new products in the 3 previous years, 0 otherwise
MNEs	Dummy variable that equals 1 if the firm is foreign owned, 0 otherwise
Exporters	Dummy variable that equals 1 if the firm exported in the last three years, 0 otherwise
M&As	Dummy variable that equals 1 if the firm experienced a merger or acquisition in the 3 previous years, 0 otherwise
High Sales Volatility	Dummy variable that equals 1 if the standard deviation of the 2002-2004 sales is higher than the median standard deviation of the sample, and 0 otherwise.
Firm Size	Logarithm of the number of employees at firm level
North- West	Dummy variable that equals 1 if the firm is localized in North-Western regions, 0 otherwise
North-East	Dummy variable that equals 1 if the firm is localized in North-Eastern regions, 0 otherwise
Centre	Dummy variable that equals 1 if the firm is localized in Central regions, 0 otherwise
South	Dummy variable that equals 1 if the firm is localized in Southern regions, 0 otherwise
Sectors	Dummy variable that equals 1 if the firm is localized in sector shown in table1, 0 otherwise

Source: RIL Survey, ISFOL

Table A2. Sales Volatility as determinant of PRP_First Stage Probit Regression of IVQR_2LAD Regression

Dependent Variable	**Performance Related Pay (PRP)**	
	All Firms	Unionized Firms
Covariates		
High Sales Volatility (1/0)	0.571***	0.429***
	(0.042)	(0.053)
ln (physical capital per capita)	0.023*	0.028
	(0.012)	(0.023)
Fixed-term contracts_Share	-0.287**	0.117
	(0.139)	(0.250)
Executives_share	0.458**	0.964**
	(0.193)	(0.382)
White Collars_share	-0.379***	-0.144
	(0.083)	(0.121)
Women_share	-0.623***	-0.680***
	(0.086)	(0.113)
Process Innovation	0.175***	0.144**
	(0.043)	(0.068)
Product Innovation	0.106**	0.180***
	(0.045)	(0.056)
MNEs	0.200***	0.099
	(0.068)	(0.077)
Exporters	0.171***	0.132
	(0.043)	(0.084)
M&As	0.099	0.027
	(0.110)	(0.122)
Constant	-1.357***	-0.813***
	(0.144)	(0.312)
Time Dummies	*yes*	*yes*
Sector Dummies	*yes*	*yes*
NUTS1_level Dummies	*yes*	*yes*
PseudoR_2	0.115	0.104
Obs.	7600	2698

Notes: The instrument of PRP is a binary variable indicating high sales volatility at the firm level. If standard deviation of the 2002-2004 sales is higher than the median standard deviation of the sample the binary variable equals 1, otherwise it is 0. Bootstrap standard errors in parentheses. *** significant at 1% level; ** significant at 5% level; *significant at 10% level.