Flexible pay systems and labor productivity: Evidence from manufacturing firms in Emilia-Romagna

Abstract

Purpose: The aim of this paper is to analyze the link between flexible pay systems (FPS) and labor productivity, also looking at which factors drive firms to adopt such wage schemes.

Design/methodology/approach: The analysis is conducted on a sample of more than 500 manufacturing firms located in the Emilia-Romagna region of Italy. To address endogeneity a two-stage model is estimated.

Findings: Our results show that the adoption of a FPS is linked to organizational changes within firms and union involvement. The positive relationship between FPS and labor productivity concerns mainly a traditional typology of premium, targeted to individual employees and linked to "effort improvement and control" motives or to the firm's "ability to pay". We also find a positive relation between ex-ante, competence-based, FPS and labor productivity.

Originality/value: The paper provides new evidence on the returns of FPS in Italy. Results support the idea that a FPS is not simply a risk premium mechanism, but is part of a more complex strategy to increase workers' flexibility, autonomy and competences.

Keywords: performance-related pay, pay for participation, organizational innovation, industrial relations, labor productivity

1. Introduction

The rapid spread of information and communication technologies (ICT), and the increasing globalization of production have made international competition fiercer than ever. In a more dynamic, uncertain and risky world, a firm's performance depends more and more on intangible assets and non-technical aspects such as flexibility, recruitment, assessment, training, employee commitment schemes, and - last but not least - flexible pay systems (FPS) (Eurofound, 2011a,b). The adoption of FPS is generally seen as part of a broader set of human resource management (HRM) practices and one of the ways in which organizational change occurs at firm level.

It is generally assumed that the adoption of HRM practices is positively associated with a firm's performance, but a number of significant shortcomings have been identified in the recent empirical debate (Gritti and Leoni, 2012). For a start, many analyses lack external validity because they are based primarily on case studies and single industries. Second, a problem of endogeneity may arise if successful companies are more likely to introduce HRM practices than other firms. Third, there is the 'heterogeneity problem', when firms that adopt high-performance work practices are compared with those that do not.

Using an original dataset concerning manufacturing firms in Emilia Romagna, Italy, this paper investigates the impact on labor productivity of adopting different types of FPS. We stress the importance of changes in a firm's organization and work practices as a key driver behind the adoption of FPS (Marsden and Belfield, 2010)[1].

The analysis has two elements of novelty. First, we distinguish between a broad array of HRM practices in both production and labor management (like employee appraisal, the extension of employee autonomy and responsibility, hierarchy delayering and improvement of employees' multi-functionality), and we join them with union involvement as determinants of FPS adoption. While these variables are recognized to be relevant in the literature, especially on Italy, they have been investigated separately or using general indicators of work flexibility or presence of labor unions within the firm. Second, we consider different types of FPS (*ex-post*, *ex-ante*, individual, team-based and mixed) and we estimate their different relationship with labor productivity.

To mitigate self-selection into the adoption of FPS, we adopt a two-stage model, where the first-stage predicted values of FPS are used as regressors in the second-stage labor productivity equation.

The remainder of this paper is organized as follows: section 2 provides a literature review on what determines the adoption of FPS (2.1), and their effects on a firm's performance (2.2); section 3 describes our dataset (3.1), and empirical analytical strategy (3.2); in section 4 we discuss the results; and some concluding comments are given in section 5.

2. Related literature

Determinants of the adoption of a FPS

To see how a FPS can affect productivity, it is worth looking first at the factors driving its adoption. In fact, it may be that the best-performing firms or workers (Dohmen and Falk, 2011) self-selectively adopt HRM practices and financial incentive schemes. If this is the case, identifying the determinants of HRM practices may help mitigate the potential reverse causality effects on the relationship between FPS and productivity.

Since the seminal contributions from Holmström and Milgrom (1987), and Lazear (1995), the main economic reason for linking compensation to performance lies in agency theory, and the fact that it is impossible for managers to see how much effort employees put into their job. We should expect FPS to be more likely to exist where there is considerable employee discretion over work tasks; an empirical validation of this assumption comes from Barth *et al.* (2008). Variables like size might also affect agency costs: according to Eurofound (2011b), large firms may be more will to adopt FPS to reduce monitoring costs and the fixed costs related to the actual implementation of FPS schemes.

Other studies emphasize firm-level aspects such as foreign ownership, ability to pay, industrial specialization, high-low skill wage differential in the region where a firm operates (Caroli and Van Reenen, 2001; Dohmen and Falk, 2011; Eurofound, 2011a, b), and the state of technology and human capital (Barth *et al.*, 2008).

The literature on work organization and HRM identifies determinants on the management side. FPS are adopted to reinforce the communication of business goals, or to ensure that managements strive to monitor strategic goals, improve work efficiency, and increase employees' efforts and skill acquisition (Engellandt and Riphahn, 2010). FPS are also seen as being complementary to the adoption of other organizational practices, such as those relating to internal and functional flexibility, the use of flexible contracts, restructuring and team-working (Eurofound, 2011b).

Other important aspects concern the social dialogue and industrial relations (Booth and Frank, 1999; Arrowsmith and Marginson, 2011; Eurofound, 2011b)[2]. Although unions may be against the adoption of PRP systems, employee involvement, representation and voice, and the existence of a social dialogue emerge as important predictors of a firm's willingness to use FPS (Arrowsmith and Marginson, 2011: Barth *et al.*, 2008; Nergaard *et al.*, 2009; Traxler *et al.*, 2008).

Pini (2001) provided a critical overview of the determinants of FPS in Italy in the 90s; and Cainelli *et al.* (2002) conducted a thorough empirical study on the use of FPS based on firm-level

agreements in a sample of firms in Emilia-Romagna. According to Damiani and Ricci (2009), FPS are adopted for different reasons, such as risk sharing, to improve productivity, and rent sharing. Casadio (2010) showed that PRP schemes are more common in the North of Italy than in the South, and in medium and large firms, but their effect on total remuneration was small.

There are also works that underscore the role of employees' skills in determining their wage profiles, and they develop the concept of "competence-based pay". This type of payment is awarded conditional to the employee acquiring and using skills to do a job, or for tasks that demand a particularly good performance on the part of individuals, teams and organizations (Brown and Armstrong, 1999). The main motives behind the adoption of a FPS are to broaden the employees' skill base and thus obtain a more flexible workforce, and this generates a higher level of commitment in the workforce and its participation in the decision-making process (Cainelli *et al.*, 2002; Leoni, 2014).

In this paper, we stress another reason for adopting FPS, which are the outcome of a broader and more complex knowledge management strategy that includes involving workers (and unions), and adopting new work practices. Specifically, we ask: (i) do union involvement and adoption of new work practices affect the probability to use FPS? (ii) If yes, which type of practices are more relevant?

The economic effects of adopting FPS

The recent empirical literature on the effects of organizational change suggests that firms adopting new work practices perform better in economic terms. In particular, productivity seems to be higher when firms adopt: (i) piece-rate pay instead of hourly wage schemes (Lazear, 2000); (ii) innovative work practices, such as incentive pay, flexible job assignments, employment security and training (Ichniowski *et al.*, 1997); (iii) HRM practices that promote shared decision-making and incentive-based compensation, and involvement of the unions (Black and Lynch, 2001); (iv) work practices that transfer power to employees (Cappelli and Newmark, 2001); practices for decentralizing authority, delayering managerial functions and increasing the use of multitasking (Caroli and Van Reenen, 2001).

Despite the great interest shown in FPS and firm performance after the July 1993 central tripartite agreement governing industrial relations, the empirical literature on the case of Italy remained scarce, probably because of a shortage of suitable microeconomic data. Some of the latest analyses provide some interesting insight, however [3]. Among others, Bazzana *et al.* (2005), and Cristini and Leoni (2007) stressed the trade unions' key role in deciding and negotiating wage premiums. Origo (2009) examined the effects of adopting PRP on productivity in a sample of

Italian machine-tool firms in 1989-1997. A year after introducing PRP productivity was up 10-15% and its effect persisted over time, but these results were only achieved by firms with a low union density. The positive effect on productivity of adopting collective PRP emerged in a more recent study by Lucifora and Origo (2015), but it depended on the specific characteristics of the PRP scheme. Damiani and Ricci (2011) found a positive impact of PRP on firm productivity too, but its effect varied across sectors. These results are in line with previous empirical studies on Italy (Biagioli and Curatolo, 1999; Amisano and Del Boca, 2004)[4].

In our view, the effect of FPS on productivity depends on the type of wage premium considered, which depends in turn on the firm's organizational strategy and the type of flexibility (innovative as opposed to numerical [5]) by means of which the firm aims to increase its productivity. In particular, individual and ex-post wage premiums should relate to the firm's ability to pay, the ex-ante definition of employees' goals and the adoption of performance assessment schemes. In line with the competence-based model (Spencer and Spencer, 1993; Leoni, 2014), ex-ante and team-based premiums should be more closely related to flatter organizational schemes, the existence of knowledge-sharing mechanisms within the firm, job or task rotation, skill training, competence development, and (no less important) union involvement.

Our main research questions are: (i) is adoption of FPS related to higher levels of labor productivity? (ii) If yes, which type of FPS does affect labor productivity more intensively?

3. Data and empirical analysis strategy

Data and variables

We analyze an original dataset extracted from a firm-level survey on manufacturing firms with at least 20 employees in the Emilia-Romagna (ER) region of Italy. In 2009, a company specializing in polls and surveys held interviews on factors and activities relating to the years 2006-2008, producing a set of Community Innovation Survey (CIS)-like details, plus additional in-depth information on the firms' organizational structure, industrial relations and other features. These data were merged with balance sheet information drawn from the AIDA database provided by the Bureau van Dijk, covering the years 2003-2011.

The survey concerns a representative sample of the population of manufacturing firms in ER, stratified by size, sector and geographical location (see Table A1 in the Appendix). The dataset contains information on many firm-level activities, the most important of which pertain to innovation, management attitudes and industrial relations, which we use to address the unobserved

heterogeneity typically affecting empirical analyses based on firm-level surveys (Antonioli *et al*. 2013).

Empirical analysis strategy

Our empirical strategy is based on a two-stage approach. First, we estimate a "*FPS function*" in which we consider different types of FPS as dependent variable. From this equation, we extract a value for predicting the adoption of a FPS and we use this as a regressor in the productivity equation.

The first-stage equation (1) is modelled as follows:

[1] $Pr(FPS=1|X)_i = \Phi(Controls_i ; ORG\_CHANGE_i; TRAINING_i; WORKFORCE_i; PAST\_EC\_PERF_i; INDREL_i)$

where *i* is the firm, and FPS and the other covariates are measured over 2006-2008, while the past economic performance indicator refers to the years 2003-2005. The variables on the right-hand-side of equation (1) are fully described in the section 3.2.1 and in Appendix, Table A2.

We first estimate the relationship between FPS adoption and its determinants using a set of probit models, one for each type of FPS. The questionnaire enables us to identify the following PRP schemes: (1) ex-post premium based on performance assessments (FPS_POST); (2) ex-ante premium based on competence development (FPS_ANTE). For both kinds of scheme, we can distinguish whether the premium is assigned only to individual employees (FPS_IND), only to teams of employees (FPS_TEAM), or to both (FPS_BOTH). Table A2 shows each type of wage premium adopted in a given FPS. The most commonly used are the ex-post premiums, adopted by roughly one in two firms, while the ex-ante types are chosen by less than one in five firms. Among the three options (FPS_IND, FPS_TEAM and FPS_BOTH) there is a strong prevalence of the former, individual schemes [6].

After completing the first-stage regression estimates, we input the fitted FPS values (FPS_FITTED) in the economic performance equation (2). We also include a set of controls and a number of innovation-related variables (INNO), which might influence the firm's economic performance.

Equation (2) takes the following form:

(2) $LABPROD_{09-11} = a + b_0[Controls2]_{i,06-08} + b_1[FPS\_FITTED]_{i,06-08} + b_2[INNO]_{i,06-08} + v_i$

where LABPROD is a measure of labor productivity (i.e. the value added per employee), and 06-08 and 09-11 represent the time spans in which variables are measured. The standard errors are bootstrapped because we include the values predicted using equation (1).

The estimates obtained with equation (2) may suffer from a number of problems. First, the predicted values of the various FPS are highly correlated. To avoid collinearity, we introduce each of them separately in different specifications. Second, because of the cross-sectional nature of our data, we cannot fully control for reverse causality and omitted variables. To mitigate unobserved heterogeneity as much as possible, we saturate the model with controls, especially concerning management attitudes. To mitigate simultaneity, we adopt a two-stage approach. Since simultaneity may occur when the most efficient firms self-select into FPS adoption, we estimates a first-stage FPS adoption equation, in which we control for all its observable determinants. As an exclusion restriction, we use the labor unions involvement variable (Union_Inv), which is described in the section 3.2.1. Unions' involvement at firm level can be considered not only as a strategic management tool, but as the result of institutional specificities that foster cooperation among economic actors, which can be partly considered as exogenous to the firm. Our identification strategy is as follows: once controlled for the other covariates, unions' involvement does not directly relates to productivity, but only indirectly through the role it may have in promoting the adoption of FPS practices (e.g. the FPS adoption and specificities are frequently bargained with workers' representatives).

However, even with this approach we cannot identify clear causal relationships among variables; rather, we should consider our estimated coefficients as representing robust correlations in a multivariate context.

Variables included in equation (1)

FPS measures as dependent variables

As the dependent variable, we first use a general dummy to identify FPS adopters (FPS). Then, we distinguish between firms adopting FPS_ANTE (i.e. payment for competence development) or FPS_POST (i.e. wage premiums paid after reaching a certain productivity level). We also use a dummy for FPS concerning only single workers (FPS_INDIV), or teams (FPS_TEAM), or both (FPS_BOTH).

Controls #1

We include a set of dummies measuring: firm size (firms with 20-49, 50-99 or 100-249 employees); two-digit industrial sector [7]; location of the firm in the center of the region [8] (CentralReg); and foreign ownership (ForeignOwn).

Organizational change: production and work organization

Organizational change is measured by two sets of covariates. The first refers to changes in 'how production is organized'. It includes teamwork, quality circles, just-in-time methods, and total quality management. We compute an additive index, given by the sum of the number of practices adopted divided by the total number of practices listed in the questionnaire, i.e. four. The index (OrgProd_Index) informs on how many of such practices are adopted.

The second set of variables concerns organizational practices linked to jobs and tasks (see Appendix, Table A2), such as expanding employee responsibility and autonomy or reducing the hierarchical layers. The questionnaire provides information on the adoption of the eleven organizational practices listed in Table 1 below. Since firms simultaneously adopt many (collinear) organizational practices, we reduce their number by means of a principal component analysis. We extract four components (Table 1) using a polychoric correlation matrix (Kolenikov and Angeles, 2004) since we are dealing with binary variables. The resulting components are labeled according to the most relevant practices for each component. The first is mainly characterized by those practices that imply high level of autonomy and responsibility, or the extending of employee autonomy and responsibility (EmpAutResp). The second mainly synthesizes the presence of a system of employees appraisal and evaluation schemes (PerfManSyst). The third provides information on the reduction of hierarchical levels coupled with the usage of methods for managing information and knowledge exchanges (Delayer). The fourth concerns changes to improve employees' multi-tasking and poly-functionality (EmpPolif).

TABLE 1 HERE

Training

Training is crucial in determining the workforce's knowledge base (Antonelli *et al*., 2010). Broadening employees' knowledge base may enable firms to assign them more responsibility and autonomy, and this may prompt firms to adopt FPS to secure employees' commitment with a minimal amount of monitoring. We then use a dummy variable to capture the provision of training activities within the firm (Train).

Workforce composition

The composition of the workforce is also important in influencing any adoption of a FPS. We include a variable measuring the share of workers with a fixed-term contract (FixedTermEmp), as they are more likely to be excluded from wage premiums than workers with permanent contracts (Cainelli *et al.*, 2002). Alternatively, a FPS may be used by the management to motivate this second component of the labor force to work harder (Cristini and Leoni, 2007).

Past economic performance

A further element that may influence the adoption of a FPS is the firm's past economic performance. This element is important because it provides evidence of the each firm's potential "ability to pay": the better its past performance, the higher the likelihood for the firm of introducing FPS because of higher amounts of financial resources available. Past performance is captured by the employees' productivity (LABPROD0305) over the years 2003-2005, just before the period taken for reference in the survey (2006-2008).

Industrial relations

As suggested by Arrowsmith and Marginson (2011), the role of the unions and firm-level relations between unions and the management may influence the decision to adopt a FPS. We therefore include two measures of participative industrial relations: the first concerns the degree of union involvement (information, consultation or bargaining) over specific innovation strategies (Union_Inv); the second regards whether single employees are informed and consulted about several innovation strategies pursued by the management (Emp_Inv).

Table A3 in the Appendix shows the correlations among the continuous variables in equation (1): the low pairwise correlations should avoid the presence of multicollinearity among the covariates included in the specification in Table 2.

Variables included in equation (2)

Dependent variable: labor productivity

In the second stage of the model, we measure firms' economic performance in terms of labor productivity, given by the average of the log of the value added per employee (lnVAEMP0911) [9] over 2009-2011.

Controls #2

As controls we include openness to international markets by using the share of turnover due to exports (Export), belonging to a group (Group), the same set of size dummies as in equation (1), and the (log) average of physical capital per employee (KEmp0608) over the years 2006-2008, where we use the book value of technical assets as a proxy for physical capital.

Innovation strategies

Innovation and ICT are crucial factors influencing a firm's productivity (Giuri *et al.*, 2008; Antonioli *et al.*, 2010; Hall *et al.*, 2012), so in equation (2) we include product (ProdInno) and process (ProcInno) innovation, and the use of highly-specialized ICT such as Electronic Data Interchange (EDI) and Material Requirements Planning (MRP). We also add a dummy for environmental innovation (EcoInno) (see Appendix, Table A2 for a detailed description).

Predicted FPS

The main variables of interest are the fitted values of FPS adoption extracted from equation (1), namely: $\widehat{FPS}$, $\widehat{FPS_{INDIV}}$, $\widehat{FPS_{TEAM}}$, $\widehat{FPS_{BOTH}}$, $\widehat{FPS_{ANTE}}$ and $\widehat{FPS_{POST}}$. A positive and significant effect of such variables in equation (2) means that higher probabilities of FPS being adopted, after controlling for the first-stage covariates, correlate with higher labor productivity levels.

Appendix, Table A4, shows the correlations among the continuous variables in equation (2). Even in this case we can reasonably exclude any potential problem of collinearity in the estimated specification.

4. Results

Table 2 shows the first-stage probit results for FPS adoption, while Table 3 shows the second-stage OLS results for labor productivity.

TABLE 2 HERE

Focusing on the organizational variables, we find that (all else being equal) a significant correlation exists between FPS and Organizational Change variables: while innovation in the organization of production (OrgProd_Index) only affects FPS_BOTH, changes in work organization have an impact on all the types of FPS.

Both employee appraisal (PerfManSyst) and hierarchy reduction (Delayer) positively affect almost all the FPS. Changes made to make employees more multifunctional (EmpPolif) only affect FPS_ TEAM. The only component that has no influence on the probability of adopting a FPS is employee autonomy and responsibility (EmpAutResp).

Firms introducing work organization practices are also more likely to introduce FPS, and this holds for almost any kind of wage premium. In a sense, firms seem to be aware that the complementarity between new work organization practices and wages is important in making employees more competitive.

We also find that training never significantly relates to the probability of adopting any FPS, while past economic performance only influences the adoption of individual FPS. This latter aspect seems to represent a 'traditional' approach to wages, where the need to improve employees' effort is met through monetary incentives, particularly for workers with fixed-term contracts.

Interestingly, the estimated coefficient of Union_Inv is positive and highly significant in Column 1. Union involvement (through the presence of worker representatives like the *Rappresentanze Sindacali Unitarie*, RSU)[10] in decisions regarding innovation strategies significantly correlates with the probability of a firm to adopt FPS_BOTH and FPS_POST. With these results, we can confirm that unions involvement can be used as exclusion restriction for the adoption of FPS in general, and specifically for the adoption of ex-post and individual FPS, these being the most diffused types of FPS in our sample.

Finally, the fact that the estimated coefficient of Emp_Inv is never statistically significant means that the adoption of FPS is not stimulated by any direct involvement of the employees, but through a dialogue with their elected representatives.

We now turn to the second-stage results, as shown in Table 3.

TABLE 3 HERE

Once controlled for capital intensity, export and belonging to a group, we find that, among the innovation variables, labor productivity in 2009-11 is positively associated only with process innovation (ProcInno).

The relation between FPS and labor productivity, instead, depends on the type of scheme being adopted. Column 1 shows that, in general, firms adopting FPS benefit from a productivity premium. In particular, doubling the predicted probability of adopting FPS is associated with a 3.1% increase in the level of labor productivity, all else being equal. From Columns 2 to 4, we observe that this positive relationship only holds for FPS targeted on individual workers: doubling the probability of

introducing individual wage premiums is related to an average 5.4% increase in the level of productivity. Columns 5 and 6 show that both ex-post and ex-ante premiums are statistically significant, with a partial elasticity of 0.03. In this sense, an explanation based on agency costs, efficiency wages or competence development, does not seem to clearly emerge from data.

These results suggest that the strongest correlation between FPS and productivity pertains a 'traditional' type of wage premium (FPS_IND); from the first-stage estimates (Table 2), its adoption is more frequent when firms also adopt standard employee appraisal practices to merely induce employees to work harder (Green, 2004) and trade unions are not involved.

These results are different from those emerging from the recent literature where mixed types of incentives are found as more effective in stimulating employees' productivity on the job (Pendelton and Robinson, 2015). This does not mean that only traditional pay-for-performance schemes matter. Our results also identify a highly significant relationship between labor productivity and ex-ante pay-for-participation FPS, which are less traditional wage schemes and are based on employees' commitment to skill development. This can be seen as a win-win strategy because it benefits both the worker and the firms (Handle and Levine, 2004). The novelty of our results is also that the impact of FPS on productivity should carefully account for the underlying motivations of FPS adoption, and these motivations lie mainly in the organization of production and work.

5. Conclusions

This paper sheds some light on the whether the adoption of FPS relates to labor productivity. To account for self-selection into FPS, a two-stage approach was adopted to an original firm-level dataset on manufacturing firms in Emilia-Romagna, Italy.

Our results show that, in general, the adoption of FPS correlates with higher levels of labor productivity, but this result is low in magnitude and depends on the type of FPS. Individual wage premiums, traditionally used for extracting effort from employees (especially those on fixed-term contracts) through monetary incentives, are found the most effective. Instead, we do not find any significant relation between labor productivity and team or mixed FPS.

Ex-post and ex-ante FPS, which are related to adoption of new work organization practices and labor unions' involvement in strategic decisions, are also linked to higher productivity levels. The relevance of ex-ante premiums, in particular, is the sign that firms can increase their competitiveness not just through price-based incentives, but also through non-price mechanisms favoring employees' skill development. However, the picture for Emilia Romagna is that most of

the manufacturing firms adopt ex-post, individual FPS, and that these are also related to the highest productivity gains.

Our main findings have two important implications. With respect to the personnel economics literature, they stress the complementarity of different organizational practices and their role in making firms more competitive. They also attribute an additional role to FPS, which can be seen not just as a way to increase employees' effort, but also as the means through which the effects of organizational changes on labor productivity materialize. From the policy perspective, they show that firms' competitiveness is the outcome not only of a higher worker effort and lower labor costs, but also of the adoption of managerial and organizational innovations that promote skill development, learning and union involvement.

Future analyses should provide more robust counter-factual evidence of the relative gains and costs of adopting wage premiums that we could not investigate because of a lack of appropriate data.

Notes

[1] Marsden and Belfield (2010) stress the importance, too often neglected, of the institutional environment in influencing which types of pay system are adopted.

[2] An interesting study by Trevor and Brown (2014) shows that, even in the absence of unions and collective bargaining constraints, it can be extremely difficult for firms to adopt pay systems aligned with strategic goals. The authors call into question the relevance and actual feasibility of implementing pay systems to pursue strategic goals.

[3] Another interesting line of analysis concerns the relationship between FPS adoption, efficiency gains and wages. In a sample of firms in northern Italy, a study by Cristini and Leoni (2007) showed that the elasticity of wages with respect to efficiency gains due to the adoption of a FPS is relatively small.

[4] For a review of this generation of empirical analyses, see Pini (2001).

[5] According to Killich (1995), numerical flexibility is a strategy through which firms pursue price-competitiveness goals by reducing labor and welfare costs, whereas innovative flexibility is a non-price competitiveness strategy based on innovation, training, human capital development and the diffusion of social cohesion programs.

[6] Given the way the questions were posed, the decision to adopt a given type of wage premium did not necessarily exclude the adoption of other types of premium. Since the alternatives are not exclusive, and the error components among different specifications may be correlated, we also estimated equation (1) using a bivariate probit specification for FPS_POST and FPS_ANTE. We found that the bivariate and univariate probit models produced similar results. For simplicity, we use, and comment, only the univariate probit estimates.

[7] The classification follows the NACE Rev 1.1 classification of economic activities. We also aggregated some of the two-digit sectors to obtain a lower number of sectors. See Table A2 for details.

[8] This variable captures a distinctive feature of Emilia-Romagna's industrial scene, i.e. a concentration of districts and firms in the central provinces (Parma, Modena, Reggio Emilia and Bologna). We include this control because district-based firms introduced wage premiums earlier than other firms.

[9] The problem of missing values in calculating the value added was solved by interpolating the missing information on the basis of the following characteristics of firms for which no information was missing: size, sector, geographical location (9 provinces) and belonging to a business group.

[10] RSU are representative bodies elected by the workers at a given firm. There were RSU at 75% of the firms sampled.

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TABLES

Table 1 - Principal components: scoring coefficients for orthogonal varimax rotation - sum of squares (column loading) = 1

	Comp. 1 EmpAutResp	Comp. 2 PerfManSyst	Comp. 3 Delayer	Comp. 4 EmpPolif
1 Task rotation and/or job rotation (with tasks unchanged)	-0.1773	0.0996	-0.0990	**0.8512**
2 Broadening of tasks and/or assignments	0.2935	-0.1079	0.1029	**0.4655**
3 Greater autonomy in performing tasks and assignments	**0.6202**	-0.0194	-0.1127	-0.0953
4 Broadening of competences	**0.4424**	-0.0126	0.0686	0.1855
5 Training associated with organizational needs	0.2024	**0.2715**	0.1214	-0.0227
6 Greater autonomy in problem solving	**0.4698**	0.1128	-0.0366	-0.0230
7 Structured discussion/exchange of views on labor organization and process/product quality	0. 1536	**0.3268**	0.1097	0.0152
8 Definition of goals for employees	-0.0170	**0.5839**	-0.0629	-0.0271
9 Employee performance assessment systems	-0.1071	**0.6218**	-0.0494	0.0194
10 Reduction of hierarchical layers within the same business department	0.0066	-0.1360	**0.7347**	0.0827
11 Methods for managing information, knowledge and competency exchanges	-0.0701	0.1965	**0.6228**	-0.0777
Variance	2.749	2.661	1.763	1.408
Difference	0.087	0.897	0.355	/
Proportion	0.249	0.242	0.160	0.128
Cumulative	0.249	0.491	0.652	0.780

Table 2 – First-stage probit estimates

Controls	(1) FPS Included	(2) FPS_IND Included	(3) FPS_TEAM Included	(4) FPS_BOTH Included	(5) FPS_POST Included	(6) FPS_ANTE Included
ORG_CHANGE						
OrgProd_Index	0.016	-0.031	-0.021	0.101**	0.023	0.003
	(0.057)	(0.062)	(0.034)	(0.049)	(0.057)	(0.048)
PerfManSyst	0.220***	0.212***	0.006	0.059**	0.223***	0.122***
	(0.027)	(0.030)	(0.017)	(0.025)	(0.027)	(0.026)
EmpAutResp	0.029	0.054	0.016	-0.023	0.019	0.026
	(0.029)	(0.034)	(0.018)	(0.025)	(0.030)	(0.025)
Delayer	0.170***	0.062	0.040**	0.060**	0.164***	0.146***
	(0.035)	(0.038)	(0.019)	(0.028)	(0.035)	(0.025)
EmpPolif	-0.023	-0.025	0.034*	-0.038	-0.033	-0.018
	(0.034)	(0.037)	(0.020)	(0.029)	(0.034)	(0.028)
WORKFORCE						
FixedTermEmp	0.189	0.264**	-0.021	-0.035	0.217	0.009
	(0.140)	(0.133)	(0.081)	(0.104)	(0.141)	(0.104)
TRAINING						
Train_d	-0.008	-0.047	0.021	0.064	0.003	0.004
	(0.047)	(0.054)	(0.029)	(0.049)	(0.048)	(0.042)
PAST_EC_PERF						
VAEMP0305	0.116	0.135*	-0.016	-0.029	0.099	0.079
	(0.071)	(0.081)	(0.031)	(0.059)	(0.072)	(0.054)
INDREL						
Emp_Inv	0.025	-0.003	-0.015	0.016	0.024	-0.045*
	(0.034)	(0.034)	(0.017)	(0.028)	(0.034)	(0.027)
Union_Inv	0.073***	-0.022	0.008	0.073***	0.077***	-0.017
	(0.023)	(0.023)	(0.012)	(0.016)	(0.023)	(0.017)
N	555	555	555	555	555	555
Pseudo R^2	0.270	0.129	0.118	0.193	0.268	0.197
Chi2 (d.f.=21)	165.937	86.328	564.456	83.874	164.990	98.432
Chi2 p-value	0.000	0.000	0.000	0.000	0.000	0.000

*; **; *** significant at 10%, 5%, 1%, respectively; robust standard errors in brackets; dummy variable reference groups: Textiles (sector); 250 employees or more (size); marginal effects reported. Controls: sector dummies; size dummies; geographical dummy, foreign ownership.

Table 3 – Second-stage OLS estimates: VAEMP0911 as dependent variable

	(1)	(2)	(3)	(4)	(5)	(6)
Controls	Included	Included	Included	Included	Included	Included
INNO						
ProcInno	0.058**	0.055*	0.063*	0.060*	0.058*	0.055
	(0.027)	(0.029)	(0.038)	(0.035)	(0.035)	(0.034)
ProdInno	-0.016	-0.019	-0.006	-0.012	-0.016	-0.017
	(0.030)	(0.037)	(0.030)	(0.040)	(0.027)	(0.030)
ICT	0.015	0.005	0.038	0.027	0.016	0.005
	(0.056)	(0.043)	(0.037)	(0.044)	(0.048)	(0.042)
EcoInno	-0.012	-0.014	-0.010	-0.009	-0.012	-0.015
	(0.031)	(0.032)	(0.039)	(0.040)	(0.037)	(0.035)
FPS (FITTED)						
$\widehat{lnFPS}$	0.031*					
	(0.018)					
$\widehat{lnFPS_{INDIV}}$		0.054***				
		(0.018)				
$\widehat{lnFPS_{TEAM}}$			-0.021			
			(0.017)			
$\widehat{lnFPS_{BOTH}}$				0.004		
				(0.015)		
$\widehat{lnFPS_{POST}}$					0.029*	
					(0.017)	
$\widehat{lnFPS_{ANTE}}$						0.032***
						(0.012)
Constant	3.622***	3.713***	3.132***	3.580***	3.618***	3.760***
	(0.076)	(0.080)	(0.377)	(0.075)	(0.071)	(0.103)
Size dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	555	555	555	555	555	555
Adjusted R^2	0.301	0.308	0.302	0.298	0.301	0.307
chi2(d.f.=17)	277.370	452.402	411.942	647.324	337.079	427.677
Chi2 p-value	0.000	0.000	0.000	0.000	0.000	0.000

*; **; *** significant at 10%, 5%, 1%, respectively; bootstrapped standard errors in brackets; Dummy variable reference groups: Textiles (sector); 250 employees or more (size); missing values in the accounting variables interpolated. Controls: sector dummies; size dummies; geographical dummy; group dummy; physical capital proxy; exports.

Appendix

Table A1 – Firms distribution by sector, size and geographical location

Total Population								
Sectors	**Freq.**	**Percent**	***Size***	**Freq.**	**Percent**	***Province****	**Freq.**	**Perc**
CokeChemical	130	3.2	20-49	2720	66.86	Out region	91	2.2
Food	382	9.39	50-99	726	17.85	BO	904	22.
Machinery	1,387	34.1	100-249	414	10.18	FC	346	8.5
Metallurgy	883	21.71	250+	208	5.11	FE	196	4.8
NonMetal	285	7.01				MO	891	21
PaperPrinting	197	4.84				PC	200	4.9
Shoes	236	5.8				PR	381	9.3
Textile	119	2.93				RA	229	5.6
WoodRubberPlasticOther	449	11.04				RE	667	16
						RN	163	4.0
Total	4,068	100		4,068	100		4,068	10
Sample								
Sectors	**Freq.**	**Percent**	***Size***	**Freq.**	**Percent**	***Province**^*	**Freq.**	**Perc**
CokeChemical	28	5.05	20-49	208	37.48	Out region	20	3.
Food	49	8.83	50-99	193	34.77	BO	115	20.
Machinery	232	41.8	100-249	96	17.30	FC	40	7.2
Metallurgy	94	16.94	250+	58	10.45	FE	30	5.4
NonMetal	42	7.57				MO	124	22.
PaperPrinting	19	3.42				PC	25	4.
Shoes	12	2.16				PR	49	8.8
Textile	23	4.14				RA	32	5.7
WoodRubberPlasticOther	56	10.09				RE	96	17
						RN	24	4.3
Total	555	100		555	100		555	10

Cochran Test

Margin of error θ

$$\theta = \sqrt{\frac{N}{(N-1)n} - \frac{1}{N-1}}$$

Interviewed firm

0.0

Margin of error θ "usually" tolerated: 0.05. Restrictive test for small populations: the smaller the value of N, the lesser the distance has to be between N and *n* to gene

Note: **Province* is a statistical geographical unit classified by EUROSTAT as level NUTS3

Table A2 - Variables: descriptive statistics and description

Equation (1) variables:	Mean	Std. Dev.	Min	Max	Construction
Dependent variables					
FPS	0.55	0.5	0	1	1 if any type of FPS is adopted; 0 otherwise
FPS_IND	0.34	0.47	0	1	1 if only FPS for individual employees is adopted; 0 otherwise
FPS_TEAM	0.06	0.24	0	1	1 if only FPS for teams is adopted; 0 otherwise
FPS_BOTH	0.17	0.38	0	1	1 if FPS for both individual employees and teams is adopted; 0 otherwise
FPS_POST	0.53	0.5	0	1	1 if FPS based on performance is adopted; 0 otherwise
FPS_ANTE	0.17	0.38	0	1	1 if FPS based on competence development is adopted; 0 otherwise
Controls					
Size dummies: 20-49 emp.; 50-99 emp.; 100-249 emp.; >250 emp. (ref. category)	\	\	0	1	\
Sector dummies: Food, Machinery, WoodPaperOther, CokeChemicalsRubber, NomMetMineralProd, Metallurgy, TextileLeatherShoes (ref. category)	\	\	0	1	\
CentralReg	0.69	0.46	0	1	1 if the firm is located in one of the following central provinces of the region: Bologna, Modena, Reggio Emilia and Parma
ForeignOwn	0.12	0.32	0	1	1 for foreign ownership; 0 otherwise
Organizational Changes					
OrgProd_Index	0.48	0.33	0	1	Composite index: number of production organization practices adopted divided by total number of practices listed in the question (Quality circles, Team working, JIT, and Total Quality Management)
EmpAutResp	1.36	0.66	-0.17	2.18	Principal components capturing changes in work organization introduced by the firm (see section 3 for results of principal component analysis)
PerfManSyst	1.13	0.71	-0.16	2.19	
Delayer	0.36	0.52	-0.31	1.76	
EmpPolif	0.76	0.55	-0.21	1.58	
Training					
Train_d	0.8	0.4	0	1	1 if firm adopted training programs of any kind; 0 otherwise
Workforce composition					
FixedTermEmp	0.75	0.13	0	1	Percentage of employees with a fixed-term contract
Past Economic Performance					
VAEMP0305	4.07	0.28	2.76	5.43	Average value added in the years 2003-2005 (log values deflated by industry price index)
Industrial Relations					
Union_Inv	0.98	0.92	0	3	1 if unions are informed; 2 if they are consulted; 3 if they bargain with management on decisions concerning the adoption of innovations in: technology, organization, training, environment, ICT, internationalization; 0 otherwise
Emp_Inv	1.18	0.56	0	2	1 if single employees are informed; 2 if they are consulted on decisions concerning the adoption of innovations in: technology, organization, training, environment, ICT, internationalization; 0 otherwise
Equation (2) variables:					
Dependent variables VAEMP0911 (log values deflated by industry price index)	3.40e-10	0.33	-1.62	1.13	Average value added per capita for the years 2009-2011 by firm j

Controls					
Export	0.33	0.31	0	1	Percentage of turnover from exports
Group	0.3	0.46	0	1	1 if firm belongs to a group; 0 otherwise
KEmp0608	50.64	52.69	-4.63	600.31	Average capital stock per capita, years 2006-2008
Size dummies as in Equation (1)	\	\	0	1	\
Sector dummies as in Equation (1)	\	\	0	1	\
Fitted FPS variables					
$\widehat{lnFPS}$	-0.82	0.76	-3.46	0.00	Natural log of the fitted value (from first stage) of the probability of introducing a FPS
$\widehat{lnFPS_{IND}}$	-1.31	0.74	-3.82	-0.18	Natural log of the fitted value (from first stage) of the probability of introducing a FPS_IND
$\widehat{lnFPS_{TEAM}}$	-4.28	4.43	-26.50	-1.08	Natural log of the fitted value (from first stage) of the probability of introducing a FPS_TEAM
$\widehat{lnFPS_{BOTH}}$	-2.32	1.19	-6.36	-0.17	Natural log of the fitted value (from first stage) of the probability of introducing a FPS_BOTH
$\widehat{lnFPS_{POST}}$	-0.86	0.79	-3.66	0.00	Natural log of the fitted value (from first stage) of the probability of introducing a FPS_POST
$\widehat{lnFPS_{ANTE}}$	-2.40	1.37	-7.88	-0.28	Natural log of the fitted value (from first stage) of the probability of introducing a FPS_ANTE
Innovation					
ProcInno	0.68	0.47	0	1	1 if firm introduced process innovation; 0 otherwise
ProdInno	0.7	0.46	0	1	1 if firm introduced product innovation; 0 otherwise
ICT	0.29	0.28	0	1	Index as average number of practices (management information system, EDI, MRP, SCM, CRM, ERP) introduced by the firm. Rescaled on interval (0,1).
EcoInno	0.2	0.4	0	1	1 if firm introduced eco-innovations; 0 otherwise

Table A3 - Correlation matrix: main continuous covariates in equation (1)

		1	2	3	4	5	6	7
1	OrgProd_Index	1.00						
2	PerfManSyst	0.37	1.00					
3	EmpAutResp	0.30	0.43	1.00				
4	Delayer	0.28	0.30	0.27	1.00			
5	EmpPolif	0.11	0.29	0.35	0.13	1.00		
6	FixedTermEmp	0.00	0.04	0.03	0.01	-0.02	1.00	
7	VAEMP0305	0.09	0.15	0.00	0.01	-0.09	0.02	1.00

Table A4 - Correlation matrix: main continuous covariates in equation (2)

		1	2	3	4	5	6
1	$\widehat{lnFPS_{IND}}$	1.00					
2	$\widehat{lnFPS_{TEAM}}$	0.36	1.00				
3	$\widehat{lnFPS_{BOTH}}$	0.32	0.21	1.00			
4	$\widehat{lnFPS_{POST}}$	0.79	0.38	0.77	1.00		
5	$\widehat{lnFPS_{ANTE}}$	0.81	0.59	0.27	0.66	1.00	
6	KEmp0608	0.04	0.14	0.04	0.05	0.02	1.00