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Workers Cooperation Within The Firm: An Analysis Using Small And Medium Size Firms*

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Abstract

We investigate the determinants of teamwork and workers cooperation within the firm. Up to now the literature has almost exclusively focused on workers incentives as the main determinants for workers cooperation. We take a broader look at the firm's organizational design and analyze the impact that different aspects of it might have on cooperation. In particular, we consider the way in which the degree of decentralization of decisions and the use of complementary HRM practices (what we call the firm's vertical organizational design) can affect workers' collaboration with each other. We test the model's predictions on a unique dataset on Spanish small and medium size firms containing a rich set of variables that allows us to use sensible proxies for workers cooperation. We find that the decentralization of labor decisions (and to a less extent that of task planning) has a positive impact on workers cooperation. Likewise, cooperation is positively correlated to many of the HRM practices that seem to favor workers' interaction the most. We also confirm the previous finding that collaborative efforts respond positively to pay incentives, and particularly, to group or company incentives.

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1 Introduction

This paper concerns the horizontal relationships among workers within firms and, more precisely, the determinants that make workers collaborate with each other or the so-called teamwork. Following the multi-task models of Holmstron and Milgrom (1991) and others, we model workers' collaboration or cooperation[1] as the effort that a worker puts in helping co-workers as opposed to the effort she puts in her own individual task. Although the optimal mix of own and helping efforts is far from obvious and might vary across firms and corporate cultures,[2] there is recent evidence that relates teamwork with higher firm productivity. Based on a study of steel mills, Boning, Ichinowski and Shaw (2007) find that team-based work is associated with 6% higher firm productivity, especially in the case of complex products, and Gant, Ichinowski and Shaw (2002) argue that the productivity benefits of teamwork stem mainly from faster problem-solving because of tighter horizontal interactions between workers. Workers' cooperation might also affect firm productivity indirectly through activities such as innovation.[3] Thus, it seems important to know what drives workers to collaborate with each other, a question that has so far received little attention, especially in the empirical literature.

The existing theoretical literature has focused almost exclusively on two dimensions of workers' incentives, namely pay structure and promotions, as determinants of workers' cooperation with each other. Drago and Turnbull (1988) consider two extreme pay systems: individual piece rates that reward individual performance and group-based piece rates where the pay depends on own as well as other workers' output. They find that moving from an individual performance-based system to a group-based one fosters workers' cooperation. This prediction seems to be empirically confirmed in the works of Drago and Garvey (1998), Heywood et al (2005) and Encinosa et al (2007). In these works, by and large, cooperation is found to be positively correlated to the use of group-based pay incentives, such as profit-sharing, employee stock ownership or bonuses based on firm's performance, and discouraged by individual

[1]Throughout the paper we use the terms collaboration and cooperation interchangedbly.

[2]Itoh (1991) derives conditions under which teamwork, as opposed to a specialized task structure where each worker focuses on her own task and does not help others, is optimal. A sufficient condition for the optimality of teamwork is that workers' efforts be complementary. Even if they are sustitutes, teamwork can be optimal provided there are decreasing returns to own help so that helping efforts reduce the disutility of own effort. Drago and Turnbull (1988) also show that using incentive structures that foster cooperation might or might not lead to an optimal mix of own and helping effort, depending on workers' expectations on their co-workers behaviour. They use the examples of the U.S. and Japan to support this difference in corporate cultures.

[3]Batts and Mane (2010) find that innovation activity tends to be more prominent in firms where workers collaborate more.

performance pay systems.[4]

As for promotion systems, Drago and Turnbull (1991) obtain that competitive promotions schemes (or the so-called tournaments) where workers compete against each other for a higher position in the firm discourage cooperation. In Lazear (1989) tournaments might even lead to sabotage (i.e., negative helping effort). By contrast, non-competitive promotion systems (or quotas) as analyzed by Drago and Turnbull (1991) can encourage cooperation if workers think that their co-workers will reciprocate on helping efforts. The effect of tournaments on cooperation has been empirically tested in Drago and Garvey (1998) using as a proxy for the "promotion prize" the dispersion across workers in a firm of the wage residual once observable characteristics (schooling, occupation, job tenure and individual characteristics) are accounted for. They find a negative and statistically significant correlation between this variable and workers' cooperation.

With more or less success, the few empirical works available have explored the explanatory power of other variables as well. For example, Heywood et al (2005) investigate the impact of group-performance incentives (profit sharing schemes) on cooperation according to gender and hierarchical position. They find that women are less responsive to this type of incentives and that with profit-sharing schemes supervisors tend to decrease cooperative efforts, presumably because they then deviate effort from cooperation to monitoring subordinates. Drago and Garvey (1998) include task variety as a determinant of cooperation and find that it positively correlates with helping efforts.

Our paper contributes to the literature on workers' incentives and their impact on cooperation. However, we go beyond the existing literature by looking at work organization in a broader sense and considering variables other than direct incentive systems. In particular, we consider the impact on cooperation of the delegation of decisions within the firm and the use of several human resource management (HRM) practices, what we refer to as the vertical organizational design of the firm. The degree of decentralization of decisions is likely to be associated to workers' cooperation because as Bloom and Van Reenen (2010, p.43) suggest "when responsability is transferred downstream, it is most often delegated to teams of workers, generally involved in multi-tasking". Furthermore, more decentralized environments require higher knowledge of the different activities performed in the firm and higher coordination among workers. This in turn calls for higher interaction and collaboration among workers. Similarly,

[4] In an experiment based on cycler messengers in Switzerland and the U.S., Burks et al (2009) also obtain that the cyclists paid on commission (individual jobs) tend to be less cooperative than those paid per hour or a share of the group total revenues.

some of the HRM practices used by firms such as shared information systems (i.e., the use of intranet) facilitates workers cooperation making it easier, while practices such as problem solution teams or job turnover foster workers' interaction and a wider knowledge of others' tasks. Presumably these new explanatory variables considered here and workers' incentive structure are not disconnected elements in the firm's organizational design, but they're likely to be correlated. Thus, if HRM practices and the delegation of decisions are important determinants of workers' cooperation, the studies including only incentives as explanatory variables might fail to correctly identify the impact of incentives on cooperation.

Another important contribution of the paper is that, unlike previous works where the endogeneity of pay incentives is at the most acknowledged but not dealt with, we address the issue of endogeneity of pay incentive systems as well as that of delegation of decisions. Clearly these are variables that the firm's manager or owner chooses over. Thus, our theoretical model features a first stage, prior to the workers choosing their effort levels, where the manager chooses the pay structure and the firm's vertical organizational design. Consistent with that, in the empirical part we use suitable estimation methods to address the endogeneity of these variables.

Our results are easily summarized. As predicted by the theory, collaborative efforts respond positively to pay incentives, and particularly to group or company incentives. As for the firm's vertical organizational design, the decentralization of labor decisions (and to a less extent that of task planning) has a positive impact on workers cooperation, but not the decentralization of production decisions. Cooperation is also positively correlated to many of the HRM practices that seem to favor workers' interaction the most. Finally, among the other firm and workers' characteristics, we find the most robust results for firm size, which always appears positively correlated to cooperation, and gender that is negatively related to cooperation.

The paper is organized as follows. Section 2 develops the theoretical model from which testable hypothesis concerning cooperation are derived. Section 3 deals with the empirical part: subsection 3.1 describes the data, we discuss the proxies used for workers' cooperation and the explanatory variables in subsection 3.2, while subsection 3.3 presents the empirical model and some results. Finally section 4 concludes.

2 The Theoretical Model

We propose a simple way to model worker interaction within a firm similar to that in Kretschmer and Puranam (2008). Suppose for simplicity that the owner and the manager of the firm are the same. Each worker has an exclusive task within the firm and produces a certain amount of output. Workers are heterogeneous in their abilities and, although tasks are exclusive, workers might be assisted by other workers who have different abilities. In this framework, it seems natural to assume that *incoming collaboration* is always beneficial and enhances workers' productivity. Further, we will consider that the manager can make a certain effort to foster worker collaboration.

Assuming the simplest possible organization with just two workers i and j and a manager, worker i's output is given by

$$\pi_i = x_i + zy_j + \gamma(x_i y_j), \tag{1}$$

where x_i is the effort worker i's exerts on his exclusive task. Incoming collaboration is given by $zy_j + \gamma(x_i y_j)$, where we can distinguish two different elements. The first element denotes the incoming collaborative effort y_j, which is magnified by the decentralization level of the firm, z, chosen by the manager. The second element captures the existing synergies between worker i's exclusive effort and the incoming collaborative effort y_j, where γ stands for the synergy intensity existing between the two efforts. The corresponding expression for worker j is identical to (1) after interchanging subscripts. In comparison with the model in Kretschmer and Puranam (2008), the output function in (1) endogenizes the differentiation between worker's collaborative and exclusive efforts. Thus, the manager can affect the relative productivity of exclusive and incoming collaborative effort by choosing z. In this way, there is an interaction between vertical relationships (manager-workers) and horizontal relationships (worker-worker) inside the firm.

Thus, as in Drago and Turnbull (1988) and others, employee i exerts two types of effort: the exclusive effort x_i, and the *outgoing collaborative* effort y_i to assist worker j. The cost of effort is assumed to be convex and, to generate determinate results, we model it in the standard quadratic form

$$\mu_i = x_i^2 + y_i^2, \tag{2}$$

We also assume that delegation entails some costs to the manager given by

$$\mu_z = z^2. \tag{3}$$

The manager can also create incentives to collaboration when designing workers' remuneration scheme. We assume that worker i's wage is given by

$$\omega_i = \alpha\pi_i + \beta\pi_j - \mu_i, \tag{4}$$

where ω_i is the wage perceived by worker i, and α and β represent the share of worker i's income related to his own production and to the other worker's production, respectively. Therefore, $\alpha\pi_i + \beta\pi_j$ is the income perceived by worker i. Denoting $\alpha + \beta = \kappa$, the constraint $\kappa < 1$ is implicit to this specification because workers cannot be paid more than total output. As in Kretschmer and Puranam (2008), we denote β as the collaborative incentive or *incentive breath,* and κ as the incentive intensity or *incentive depth.*

The total corporate output $\pi_i + \pi_j$ constitutes the surplus that remunerates the manager, after discounting workers's remuneration and her cost of effort, i.e.,

$$\pi_m = \pi_i + \pi_j - \underbrace{(\alpha\pi_i + \beta\pi_j)}_{i\text{'s income}} - \underbrace{(\alpha\pi_j + \beta\pi_i)}_{j\text{'s income}} - \mu_z. \tag{5}$$

We develop a two-stage game with the following timing. In the first stage, the manager decides the level of decentralization as well as the workers' pay scheme. In the second stage, given the inherited outcome from the first stage, workers decide simultaneously and independently their two types of efforts, i.e., their own and collaborative efforts. Following a standard backwards induction procedure, we solve for the (subgame perfect) equilibrium of the game.

2.1 Optimal workers' effort (second stage)

In the second stage of the game, given a certain remuneration scheme and the firm's decentralization level, a worker i chooses x_i and y_i to maximize (4), viewing x_j and y_j as parametric. Let us apply the identity $\alpha = \kappa - \beta$, so that any increase in β must come at the expense of α. After plugging (1) (and the corresponding expression for π_j) and (2) into (4) and maximizing, the first-order conditions are

$$\frac{\partial \omega_i}{\partial x_i} = (\kappa - \beta)(1 + \gamma y_j) - 2x_i = 0, \tag{6}$$

$$\frac{\partial \omega_i}{\partial y_i} = \beta(z + \gamma x_j) - 2y_i = 0. \tag{7}$$

As it can be seen, the second-order conditions hold, ensuring that (6) and (7) yield maxima. From the expression (6) above, it is easy to observe that an increase in x_i yields a gain $(\kappa - \beta)(1 + \gamma y_j)$ for worker i, which is composed by a direct reward from his exclusive effort and a synergy gain (that depends on the incoming collaborative effort), both qualified by the own-production share $\alpha = (\kappa - \beta)$. The expression (7) reflects that an increase in y_i produces a benefit of $\beta(z + \gamma x_j)$ for worker i, which is composed by the gain from the manager's effort in promoting collaboration and a synergy gain (that depends on worker j's exclusive effort), both qualified by the incentive breath β.

From (6), (7) and the analogous first-order conditions for x_j and y_j, the equilibrium is symmetric and equal to

$$x_i^* = x_j^* = (\kappa - \beta)\frac{2 + z\beta\gamma}{4 - (\kappa - \beta)\beta\gamma^2}, \tag{8}$$

$$y_i^* = y_j^* = \beta\frac{2z + (\kappa - \beta)\gamma}{4 - (\kappa - \beta)\beta\gamma^2}, \tag{9}$$

where superscript $*$ denotes equilibrium values, and $\gamma < \overline{\gamma} \equiv \left[\frac{4}{(\kappa-\beta)\beta}\right]^{1/2}$ is required to have positive equilibrium effort levels (remember that $\kappa > \beta$ is holds by construction).

To illustrate the properties of the equilibrium efforts, it is interesting to undertake a comparative-static analysis to assess the impact of the first-stage variables chosen by the manager (the decentralization level (z) and the remuneration scheme (κ and β)) on the worker's effort levels. The effect of changes in the incentive depth (κ) and in the decentralization level (z) on the equilibrium efforts are clear-cut, as it is captured in the proposition below.

Proposition 1 *Both exclusive and collaborative efforts are increasing with the incentive depth (κ) and with the firm decentralization level (z).*

The positive reaction of the optimal effort levels as κ rises is a natural outcome, since workers are willing to produce more (and thus to exert a higher effort) as the share of total output that is used to remunerate their work increases. A similar result is obtained in Kretschmer and Puranam (2008). More interestingly, both types of effort are also increasing with the firm's decentralization level, z, as it boosts firm productivity. The explanation is found in the presence of some synergies linking the exclusive and collaborative effort exerted by workers (as shown in (1)). In fact, in absence of synergies, i.e., $\gamma = 0$, we observe that $\partial y_i^*/\partial\kappa = 0$ because workers have no incentives in collaborating (see the appendix for the details).

Finally, although the effect of changes in the incentive breath (β) on the equilibrium collaborative effort (y_i^*) is straightforward, the impact of changes in β on x_i^* is more interesting and depends crucially on the synergy-intensity level, as it is summarized in the following proposition.

Proposition 2 *Assuming $\kappa > 2\beta$ (i.e., $\alpha > \beta$), the equilibrium collaborative effort (y_i^*) increases in the incentive breath (β). However, the effect of an increase in β on the equilibrium exclusive effort (x_i^*) depends on the synergy intensity (γ) in the following way*
i) if $\gamma \in (0, \widehat{\gamma})$, then x_i^* rises for $z > \overline{z}$,

ii) if $\gamma \in (\widehat{\gamma}, \overline{\gamma})$, then x_i^* rises unambiguously.

These results can be ascertained in Fig. 1 below.

–Insert Fig. 1 here–

By increasing β, the manager gives more value to the other worker's output in the remuneration scheme. In this situation, workers increase their collaborative effort (y_i^*). In the same vein, the natural result in this situation would be to observe a lower exclusive effort (x_i^*), and this is what happens when $\gamma < \widehat{\gamma}$ and $z < \overline{z}$ (as it can be observed in the figure above). However, this is not a zero-sum game and workers can increase both efforts simultaneously either in high-synergy environments (i.e., $\gamma > \widehat{\gamma}$) or when decentralization is above a given threshold (i.e., $z > \overline{z}$). Since the model is symmetric and both workers are paid a share β of the other worker's output, a rise in β (which implies a lower α for a given κ) yields both a higher outgoing collaborative effort (y_i^*) and a higher incoming collaborative effort (y_j^*). In this situation, it may be a best-reply for worker i to either increase or decrease his exclusive effort (x_i^*), depending on the effect of y_i^* and y_j^* on his objective function (i.e., ω_i). More precisely, a worker will increase his exclusive effort if either z or γ are sufficiently high.[5]

By replacing x_i^* and y_j^* in (1), we can compute the equilibrium output corresponding to each worker, which is given by

$$\pi_i^* = \frac{8(\kappa - \beta) + 8\beta z^2 + z(\kappa - \beta)\beta\gamma\left[12 - (\kappa - \beta)\beta\gamma^2\right]}{\left[4 - (\kappa - \beta)\beta\gamma^2\right]^2}, \tag{10}$$

which is always positive for $\gamma < \overline{\gamma}$. Consistently with the result in Proposition 1, π_i^* is logically increasing both with the incentive depth (κ) and the firm's decentralization level (z).

2.2 Manager's effort and incentive scheme (first stage)

In the first stage, the manager anticipates and takes into account the workers' optimal choice of effort in the second stage of the game, and decides the optimal decentralization level and the pay scheme she will propose to both workers. Given the symmetry of the equilibrium efforts and using (3), the manager's profit (5) becomes

[5] Although this comparative-static analysis is not undertaken in Kretschmer and Puranam (2008), a result somewhat similar can be obtained, i.e., (i) for high γ then $\partial x_i^*/\partial\beta > 0$, and ($ii$) for lower values of γ, the sign of $\partial x_i^*/\partial\beta$ depends of the level of differentiation. The advantage of our setting is that this differentiation is endogenized since there is a manager that can affect workers' ability to collaborate.

$$\pi_m = 2\pi_i^* (1 - \kappa) - z^2. \quad (11)$$

After plugging (10) into (11), we can compute the manager's optimal choice for z, κ and β. From $\partial\pi_m(z, \beta, \kappa)/\partial z = 0$, we can compute the critical value of z. Assuming that the Hessian matrix is negative definite, it can be stated that $\pi_m(z, \beta, \kappa)$ is concave, and that z^* is the unique maximum, as summarized in the proposition below.

Proposition 3 *For $\gamma < \gamma_- < \overline{\gamma}$, then $\pi_m(z, \beta, \kappa)$ is a inverted U-shaped function, so that there exists a unique positive optimal value of decentralization z^*.*

The critical value of z is given by (see the details are in the Appendix)

$$z^* = \frac{\alpha\beta\gamma(1 - \alpha - \beta)\left(12 - \alpha\beta\gamma^2\right)}{16[1 - \beta(1 - \alpha - \beta)] - \alpha\beta\gamma^2(8 - \alpha\beta\gamma^2)}, \quad (12)$$

which is positive for $\gamma < \gamma_- < \overline{\gamma}$. Note that we use α in this expression for simplicity of the exposition, knowing that $\alpha = \kappa - \beta$. Looking at the second-order conditions, it can be checked that $\partial\pi_m^2(z, \beta, \kappa)/\partial z^2 < 0$.

Looking at (12), we can carry out a comparative statics analysis to explore the effect of the synergy intensity (γ) on the optimal decentralization level. Since z^* is a function of α and β, which are also chosen by the manager, we need to apply the envelope theorem and hold α and β at their optimal values. This result is encapsulated in the corollary below.

Corollary 1 *For $\gamma < \overline{\gamma}$, the optimal decentralization level (z^*) is increasing with the synergy intensity (γ).*

This result reinforces the idea that decentralization is more likely whenever this workers collaboration has a higher potential for profitability. In addition, in absence of synergies between workers, it can be checked that the manager would prefer no decentralization.

Corollary 2 *When $\gamma = 0$, the optimal decentralization level is $z^* = 0$ and workers do not collaborate ($y_i^* = y_j^* = 0$).*

Therefore, *complementarities* (or synergies) between workers is required by the manager to decide to delegate decisions down to her subordinates so that these complementarities can better be exploited. In an scenario without synergies, the second-stage equilibrium efforts exerted by workers in (8) and (9) are $x_i^* = x_j^* = \frac{(\kappa-\beta)}{2}$ and $y_i^* = y_j^* = 0$. Logically, this is the result that would have been obtained in a setting without worker interaction (i.e., independent workers) in which each worker only has an exclusive task, i.e., $\pi_i = x_i$, $\mu_i = x_i^2$ and thus $\omega_i = \alpha\pi_i - \mu_i = x_i(\alpha - x_i)$.[6]

Shifting attention to the manager's decision on the incentives breath, although the optimal value (β^*) cannot be computed because it involves non-tractable expressions, there are some insights that can be provided. By evaluating $\partial\pi_m(z, \beta, \kappa)/\partial\beta$ at $\beta = 0$ and applying the value for z^* in (12), we get

$$\left.\frac{\partial\pi_m(z^*, \beta, \kappa)}{\partial\beta}\right|_{\beta\to 0} = \frac{(1-\kappa) - (\kappa^2\gamma^2 - 2)}{2}. \tag{13}$$

From (13), it can be verified that $\left.\frac{\partial\pi_m(z,\beta,\kappa)}{\partial\beta}\right|_{\beta\to 0} > 0$ for $\gamma \in (\gamma', \overline{\gamma})$ with $\gamma' \equiv \left[\frac{2}{\kappa^2}\right]^{1/2}$. Therefore, in this case $\beta^* > 0$, i.e., the manager will design a payment scheme that will incorporate incentives by making each worker's remuneration contingent to the other worker's production. Further, it can also be checked that $\gamma = 0$ implies $\left.\frac{\partial\pi_m(z,\beta,\kappa)}{\partial\beta}\right|_{\beta\to 0} < 0$, so that $\beta^* = 0$, i.e. no incentives to collaboration are provided by the manager, given that there exist no synergies between workers. These results are summarized in the proposition that follows.

Proposition 4 *The manager will design a pay scheme that makes each worker's remuneration contingent to the other worker's production only when synergies between workers are sufficiently high (i.e., $\gamma \in (\gamma', \overline{\gamma})$). In absence of synergies ($\gamma = 0$) workers are independent and no incentives to collaboration are provided by the manager ($\beta^* = 0$). In this case, $z^* = 0$ and workers do not collaborate, i.e., $y_i^* = y_j^* = 0$.*

Looking at Propositions 3-4 and Corollaries 1-2, we perceive the importance of synergies to draw up an incentive-based remuneration scheme connecting both workers' output. In absence of complementarities, workers focus exclusively on their own task and do not make any effort in assisting another worker. In this framework, incentives are not useful and a rational manager would not waste any resource in promoting collaboration among workers and would remunerate each worker taking into account his individual output. In contrast, in presence of synergies, it is optimal for the manager to provide incentives and exert a positive effort to foster worker cooperation. In this framework, workers respond to these incentives by assisting each other and this set-up raises the global efficiency of the firm.

[6] Computations available from the autors on request.

3 The Empirical Model

The theoretical model in the previous section yields three clear testable hypothesis concerning workers cooperation:

1. Collaborative efforts (as well as exclusive efforts) increase with the variable component of a worker's salary or incentive depth $k = \alpha + \beta$.

2. Collaborative efforts are also increasing with the firm's level of decentralization z.

3. Given $\alpha > \beta$, an increase in group performance-based incentives, β, increases the collaborative effort, while an increase in individual-performance incentives, α, discourages cooperation.

We test these predictions on a dataset of small and medium Spanish firms that we describe in detail in the next subsection. Subsection 3.2 discusses the proxy we use for workers' cooperation and for the explanatory variables of interest, while the model and estimation results are presented in subsection 3.3.

3.1 Data Description

The data comes from a unique survey on small and medium firms conducted during 2005 and 2006 in the Spanish region of Catalonia.[7] The survey contains a rich set of questions and information that is not typically available in standard firm-level datasets.[8] The sample of firms changed from 2005 to 2006, so that information is available for only a pooled cross-section of firms. This unables us to use firm fixed effects, the major drawback of the dataset. However, we have a large list of controls to account for much of the firm-level unobserved heterogeneity. In total, we have information on about 500 firms, covering the main manufacturing and service sectors representative of the Catalan economy. Table 1 provides descriptive statistics for those firms.

–Insert Table 1 here–

It is worthwhile noticing that three quarters of the companies are *family firms* (i.e., firms for which the majority of capital is held by one family) and for an even higher percentage (about 85%) the owner and the manager are the same person. The owner of the firm provided

[7] Small and medium firms are defined as those with less than 250 employees.

[8] The survey design bears similarities with the British Workplace Employment Relations Survey (WERS), upon which it was based, containing additional questions not included in the WERS.

general information on the firm organization, its characteristics and performance. The firm-level information was completed by matching the survey to another dataset (SABI) based on the national registry of businesses.

In terms of workers, we have information on about 4900 workers, drawn from three different hierarchical levels: core employees, supervisors and managers. Workers in each firm were sampled randomly and, on average, about half of the workforce in a firm was interviewed (see Table 1). Their characteristics are summarized in Table 2.

–Insert Table 2 here–

Most of the workers are male, the average age is 38 years old, and have spent an average of 9 years working in the current firm. Vocational training is the most common educational credential they hold. Finally, only 11% are on a temporary contract, a percentage that is well below the overall Spanish rate.

3.2 Measuring Workers Cooperation and the Main Explanatory Variables

Finding good proxies for workers' cooperation is difficult. First of all, measuring cooperation is already a challenging task in itself, but even if we could agree on appropriate measures, most available datasets are likely to lack this kind of information. This is perhaps the main reason why empirical studies on workers' cooperation are so scarce, and the existing ones tend to use proxies that are clearly far from perfect. For example, based on survey data Heywood et al (2005) use the answer to the question "Do you get along with your colleagues?" as their proxy for cooperation, arguing that if workers get along they will tend to collaborate with each other. Drago and Garvey (1998) use a more direct measure, but still far from satisfactory: the answer to the question "To what extent do your fellow employees refuse to let others use their equipment, tools, or machinery?". Luckily our dataset include variables that seem more appropriate proxies. In the survey workers were asked several questions that can be related to cooperation or teamwork. In particular, they were asked it is in their job:

1. to persuade or influence others

2. to plan other people's activities

3. to delegate tasks and responsabilities

4. teamwork
5. to listen carefully to other co-workers
6. to train others.

The possible answers to these questions are categorical and can take five different values ranging from 1 ("not important at all") to 5 ("essential"). To a larger or lesser extent all the questions measure the degree of workers' interaction and some of them respond to workers' collaborative efforts. Question 4 asks specifically about the importance of teamwork, while questions 5 and 6 directly reflect collaboration of workers with each other. As we will explain in detail later, we use all six questions as our proxy for workers' cooperation in our baseline models, and tried using individual questions as well. An important point about these questions is whether the answers to them respond to workers' actual choice of collaboration or not. Although the wording of the questions could indicate they describe the nature of the job rather than the individual choice of cooperative effort, the relatively large variability in the answers found among workers of the same hierarchical level within each firm makes us confident that these variables reflect workers' collaborative choices.

The measures for our main explanatory variables, namely pay incentives and the firm's vertical organizational design, deserve some discussion as well. As for pay incentives, the survey provides information on whether workers' salary have a variable component and for those workers, it reports the percentage of their wage based on individual and company incentives respectively.

–Insert Table 3 here–

As summarized in Table 3, incentives are only used for 14% of the workers interviewed, and in those cases individual-performance incentives account on average for 21% of the worker's salary while company-based incentives only amount to 14%. Given that we are dealing with relatively small firms, many of them family-owned firms, this is not surprising. Econometrically, this might raise some identification issues, especially in the models using the intensity of incentives (individual and company) where the sample size gets considerably reduced. We discuss this potential problem later.

We use two dimensions of the firm's vertical organizational design: the degree of decentralization of decisions within the firm and the use of HRM practices. With regard to the decentralization of decisions, the survey provides information on the way decision rights are allocated within the firm, reporting for each firm the hierarchical category of the person (from basic employees to owner) deciding on 11 different issues. Using factor analysis, we grouped these issues into 3 types: 1) task planning decisions, 2) production related decisions (quality control, purchase of supplies, equipment and production technology, etc.) and 3) labor related decisions (job listing, hiring and training). This categorical variables can take value 1 (if the decision is made by core employees), 2 (if it is made by a working group), 3 (by a supervisor), 4 (by the manager) or 5 (by the owner). Thus a higher value of this variable indicates higher centralization (or lower delegation), and based on the theoretical predictions we expect a negative coefficient.

HRM practices can form part of the firm's vertical organizational design because many of them accompany or are complementary to delegation of decisions. For example, the use of problem solution teams or semi-autonomous teams go hand in hand with the delegation of decisions down to the workers, while the use of shared information systems and suggestions practices facilitate delegation. In addition to the HRM practices just mentioned, we also have information on whether the firm uses or not job turnover, job redesign, quality circles and Total Quality Management. Although not all these practices are equally relevant, we include them all in our baseline estimations. Generally, as many of these practices are complementary to decentralization and imply a higher degree of workers' interaction we expect positive coefficients on these variables.

3.3 Estimation

As explained, we use the answers to the six questions in subsection 3.2, to which we will refer as collaborative effort e (with $e = 1..6$), as our measure for cooperative effort. Similar to what Colombo and Delmastro (2004) do for different firm strategic decisions, we stack the data according to the six collaborative efforts and create a pseudo-panel.[9] The optimal choice of worker i in firm j regarding cooperative effort e is denoted C^*_{ije} and is given by

$$C^*_{ije} = \theta_1 Incentives_{ij} + \theta_2 V_j + \delta' X_j + \lambda' Z_i + \epsilon_{ije} \tag{14}$$

where $Incentives_{ij}$ refer to the workers' retribution scheme, V_j is the firm's vertical organizational design (in particular, the degree of decentralization and the use of HRM practices), X_j is a matrix of firm specific characteristics, Z_i is a matrix of worker's characteristics and ϵ_{ije} is the disturbance term. Among the firm controls we include variables such as age, size,

[9] One benefit of doing that is to increase the sample size, although not all observations are independent. The observations corresponding to each worker share the same value of the regressors. To deal with this correlation, we use collaborative-specific dummies.

variables related to ownership structure, the degree of intensity of competition in the market and sector dummies, while the set of workers characteristics includes gender, age, nationality and the type of contract held (permanent vs. temporary).

We do not observe C^*_{ije} but a latent variable C_{ije} that relates to the optimal cooperative effort as follows

$$
\begin{array}{ll}
C_{ije} = 1 \text{ (minimum cooperative effort)} & \text{if } C^*_{ije} \leq \mu_1 \\
C_{ije} = 2 & \text{if } \mu_1 < C^*_{ije} \leq \mu_2 \\
C_{ije} = 3 & \text{if } \mu_2 < C^*_{ije} \leq \mu_3 \\
C_{ije} = 4 & \text{if } \mu_3 < C^*_{ije} \leq \mu_4 \\
C_{ije} = 5 \text{ (maximum cooperative effort)} & \text{if } C^*_{ije} \geq \mu_5
\end{array}
$$

where μ_l $(l = 1...4)$ are the thresholds that separate the five different discrete categories of collaborative efforts. Given the categorical ordered nature of the dependent variable we estimate an ordered probit model.

The estimation of (14) poses a number of econometric challenges that need to be addressed. First, as we said above, workers' retribution schemes and the firm's vertical organizational design are potentially endogenous. Moreover, given that the owner or manager do presumably decide on both retribution schemes and the other organizational issues based on the same unobserved factors, these variables are expected to be correlated. Second, in the models including the intensity of incentives (individual and group-based) we face a clear problem of sample selection as those schemes are not used for all workers. Given the categorical nature of our dependent variable, the conventional methods to deal with endogeneity and sample selection based on linear models such as the two-stage least square procedure and the Heckman correction deliver inconsistent estimators. Instead, methods such as maximum likelihood estimation should be used.[10] Third, there is also a potential problem of multicollinearity, especially among HRM practices as firms using some of those practices are more likely to use others too.

–Insert Table 4 here–

We start with the estimation of the baseline ordered probit models where no attempt is made to address the potential endogeneity problem. Results are reported in Tables 4, 6 and 7. In all regressions the dependent variable is the collaborative effort described in 3.2. In column (1) on Table 4 we estimate the model on the whole sample, while in column (2) we restrict our attention to firms in the manufacturing sectors -see Table 2 for the list of sectors included– that

[10] See for example Train (2009) for a detailed discussion of these issues.

are more homogeneous and for which we have information on additional variables. In these models, pay incentives are captured by a dummy variable that reflects whether the worker's salary has a variable component or not. Recall from section (2) that a higher incentive depth (k) leads to higher cooperation. In the regressions on Table 4 we just test the differential impact of workers' pay having or not a variable component. Given that we estimate probit models, it is important to note that only the signs of the coefficients are informative, but not the magnitude. To have an idea of the magnitude of the effects, marginal effects should be calculated which we have not done yet. As observed in both columns (1) and (2), those workers whose salary has a variable component tend to report higher levels of cooperation with each other. As for the delegation of decisions from the top of the hierarchy, when all sectors are considered the decentralization of task and labor decisions seems to be correlated to higher cooperation.[11] However, as far as production related decisions are concerned having them centralized would foster cooperation, and in this case the estimated coefficient is significant in both the whole sample and for just manufacturing. As expected, most of the HRM practices have a positive and significant coefficient indicating that they encourage workers' interaction and collaboration. Regarding the additional firm controls, firm size has a positive and significant effect on collaboration, while being a family-owned firm is negatively correlated to cooperation. Cooperation seem to be lower among women and those holding a temporary contract. The last result makes sense as workers in a fixed-term contract might not be as engaged in the firm and motivated to then collaborate. As for the negative coefficient on female workers, as Heywood et al (2007) argue this might be due to the fact that women tend to avoid jobs where cooperation and teamwork are important and prefer, instead, more individualistic jobs that give them greater flexibility to attend their family lives. Finally, managers and supervisors tend to collaborate more than core employees –the omitted reference dummy in the regressions.

–Insert Table 5 here–

As discussed above, the pay incentives as well as the centralization of decisions are endogenous because the manager does actually choose them. We deal first with the endogeneity of pay incentives, i.e., the dummy on whether the salary has a variable component or not.[12] To that purpose we simultaneously estimate the main equation and an auxiliary equation for the

[11] Notice that the way the variable is coded, it reflects centralization (lower delegation of decisions) instead of decentralization.

[12] Although we acknowlege the degree of decentralization/centralization is also endogenous, as it might be HRM practices, we leave this issue to be dealt with in future versions of the paper.

endogenous dummy variable by maximum likelihood.[13] We exclude some of the explanatory variables assumed to affect pay incentives, such as firm age and variables related to the firm's ownership structure, from the main equation. Results are presented in Table 5. As can be observed in column (1), when we account for the possible endogeneity of pay incentives, these are no longer significant (and have the opposite expected sign). However, the estimated correlation of the error terms of the two equations (main and auxiliary) is only 0.107, and moreover, according to the likelihood ratio test it is not significantly different from zero. This indicates that pay incentives are not really endogenous, which undoubtedly constitutes a puzzling result.

–Insert Table 6 here–

In Table 6 we estimate different variations of the baseline models on Table 4, but this time the dummy variables for pay incentives distinguish whether the variable component of the salary include individual- or company-based incentives. In the estimation for the whole sample -see column (1)– pay incentives are not significantly different from zero. However, individual- and company incentives appear to have a clearly different behavior according to hierarchical categories. When we only consider core employees –column (2)– company incentives have a positive and significant effect on cooperation, while individual incentives have a negative (although not significant) impact, just as expected. If we then restrict our attention to only manufacturing both coefficients are significant and keep the same expected signs. As for the rest of variables, by and large, we obtain the same results as the estimations on Table 4. The decentralization of task and labor decisions would exert a positive impact on cooperation (although the coefficients are not always significant) whereas the decentralization of production decisions would be detrimental to collaboration. Most HRM practices have a positive effect on cooperation, especially those that one would think foster workers' interaction the most. Finally, the signs on firm size (positive), family firm (negative) and being a female (negative) appear to be quite robust.

–Insert Table 7 here–

Table 7 focuses on the workers whose salary have a variable component and show the estimates of the effect of the intensity of individual and company incentives. In the model on Column (1) we estimate the model using as explanatory variables the percentages of a worker's salary that is based on individual and company performance. While the intensity of company incentives is not significantly different from zero, we confirm the negative effect for

[13] The estimation is performed using the "wrapper" program *ssm* for Stata. See Miranda and Rabe-Hesketh (2006) for details.

the intensity of individual incentives. The results on column (1) need to be taken with caution though. As only a (small) percentage of workers receive individual and company incentives, there is a clear problem of sample selection. Thus, as before, we jointly estimate the main equation and a selection equation for whether or not workers receive any type of incentives –see columns IIA and IIB. In this new estimation the coefficients on the intensity of individual and company incentives remain almost unchanged with individual incentives having a negative and significant impact on cooperation. However, the likelihood ratio test indicates that the correlation between the two equations errors are not significantly different from zero which, in turn, would suggest sample selection was not an issue in the model on Column (1). This new puzzling result, as well as the potential endogeneity of the vertical organizational design variables, deserves further examination.

4 Conclusions

Workers cooperation or teamwork can be an important factor to firm productivity and other related activities. In this paper we explore the determinants of cooperation within the firm by means of a theoretical model that we then test empirically. The main contributions of the paper are the following. First, unlike previous works that had almost exclusively focused on workers' incentives, we take a broader look at the firm's organizational design and analyze the impact that different aspects of it might have on cooperation. In effect, besides workers' pay structures, we consider the way in which the degree of decentralization of decisions and the use of complementary HRM practices (what we call the firm's vertical organizational design) can affect workers' collaboration with each other. Second, we test the model's predictions on a unique dataset containing a rich set of variables not available in most other datasets. More importantly, the data enables us to use sensible proxies for workers cooperation and the main explanatory variables, which represent a clear improvement with respect to previous empirical studies.

The estimation results obtained so far confirm the theoretical predictions that cooperation efforts respond positively to pay incentives, and particularly to group or company incentives. Also quite robust is the positive relationship between cooperation and decentralization of labor decisions (and to a less extent that of task planning) while the decentralization of production decisions seem to have a negative impact on cooperation. However, a word of caution is in order as we still need to account for the potential endogeneity of the decentralization variables. Cooperation is also positively correlated to many of the HRM practices that seem to favor workers' interaction the most. Finally, among the other firm and workers' characteristics, we find the most robust results for firm size, which always appears positively correlated to cooperation, and gender that is negatively related to cooperation.

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A Appendix:

Proof of Proposition 1.

The derivative of y_i^* with respect to κ is given by

$$\frac{\partial y_i^*}{\partial \kappa} = \frac{8z + 4\beta\gamma}{\left[4 - (\kappa - \beta)\beta\gamma^2\right]^2}, \tag{A1}$$

whose sign is always positive for $\gamma < \overline{\gamma}$.

The derivative of x_i^* with respect to κ is given by

$$\frac{\partial x_i^*}{\partial \kappa} = \frac{8 + z\gamma(\kappa - \beta)\left[8 - \beta\gamma^2(\kappa - \beta)\right]}{\left[4 - (\kappa - \beta)\beta\gamma^2\right]^2}, \tag{A2}$$

whose sign is positive for $\gamma < \left[\frac{8}{(\kappa-\beta)\beta}\right]^{1/2}$, which is always observed since $\overline{\gamma} \equiv \left[\frac{4}{(\kappa-\beta)\beta}\right]^{1/2} < \left[\frac{8}{(\kappa-\beta)\beta}\right]^{1/2}$.

The derivative of y_i^* with respect to z is given by

$$\frac{\partial y_i^*}{\partial z} = \frac{2(\kappa - \beta)}{4 - (\kappa - \beta)\beta\gamma^2} \text{ and } \frac{\partial x_i^*}{\partial z} = \frac{\gamma(\kappa - \beta)^2}{4 - (\kappa - \beta)\beta\gamma^2}, \tag{A3}$$

which are always positive for $\gamma \in (0, \overline{\gamma})$. Note that $\partial x_i^*/\partial z = 0$ for $\gamma = 0$. ■

Proof of Proposition 2 and Corollary 1.

The derivative of y_i^* with respect to β is given by

$$\frac{\partial y_i^*}{\partial \beta} = \frac{4\gamma(\kappa - 2\beta) - 2z\left[4 - \gamma^2(\kappa - \beta)^2\right]}{\left[4 - (\kappa - \beta)\beta\gamma^2\right]^2}, \tag{A4}$$

whose sign is positive when $4\gamma(\kappa - 2\beta) > 2z\left[4 - \gamma^2(\kappa - \beta)^2\right]$. The LHS of this expression is positive since $\kappa > 2\beta$ (or, equivalently, $\alpha > \beta$), and the RHS is positive for $\gamma < \widehat{\gamma} \equiv \left[\frac{4}{(\kappa-\beta)^2}\right]^{1/2}$, where $\widehat{\gamma} < \overline{\gamma}$. Therefore, when $\gamma \in (\widehat{\gamma}, \overline{\gamma})$, the RHS is negative and then $\frac{\partial y_i^*}{\partial \beta} > 0$. On the contrary, when $\gamma \in (0, \widehat{\gamma})$, the RHS is positive and $\frac{\partial y_i^*}{\partial \beta} > 0$ requires $z < \overline{z} \equiv \frac{4\gamma(\kappa-2\beta)}{2[4-\gamma^2(\kappa-\beta)^2]}$.

The derivative of x_i^* with respect to β is given by

$$\frac{\partial x_i^*}{\partial \beta} = \frac{(\kappa - \beta)\gamma\left\{2\gamma(\kappa - \beta) + z\left[\kappa\gamma^2(\kappa - \beta) - 8\right]\right\} - 8}{\left[4 - (\kappa - \beta)\beta\gamma^2\right]^2}, \tag{A5}$$

whose sign is positive when $2\gamma(\kappa-\beta) + z\left[\kappa\gamma^2(\kappa - \beta) - 8\right] > \frac{8}{(\kappa-\beta)\gamma}$ or, alternatively, $z\left[\kappa\gamma^2(\kappa - \beta) - 8\right] > \frac{8-2(\kappa-\beta)^2\gamma^2}{(\kappa-\beta)\gamma}$. The LHS of this expression is positive when $\gamma > \widetilde{\gamma} \equiv \left[\frac{8}{\kappa(\kappa-\beta)}\right]^{1/2}$, the RHS is positive for $\gamma < \widehat{\gamma} \equiv \left[\frac{4}{(\kappa-\beta)^2}\right]^{1/2}$, and it is easy to check that $0 < \widehat{\gamma} < \widetilde{\gamma} < \overline{\gamma} \equiv \left[\frac{4}{(\kappa-\beta)\beta}\right]^{1/2}$.

Therefore, when $\gamma \in (\widetilde{\gamma}, \overline{\gamma})$, the LHS is positive, the RHS is negative and then $\frac{\partial x_i^*}{\partial \beta} > 0$. When $\gamma \in (0, \widehat{\gamma})$, the LHS is negative, the RHS is positive and then $\frac{\partial x_i^*}{\partial \beta} < 0$. Finally, when $\gamma \in (\widehat{\gamma}, \widetilde{\gamma})$, both the LHS and the RHS are negative. In this case $\frac{\partial x_i^*}{\partial \beta} > 0$ when $z < \overline{\overline{z}} \equiv \frac{2\gamma^2(\kappa-\beta)^2-8}{(\kappa-\beta)\gamma[\kappa\gamma^2(\kappa-\beta)-8]}$.

■

Proof of Proposition 3.

For simplicity of the expressions, we use α in the reasoning that follows, knowing that $\alpha = \kappa - \beta$. The first-order condition of $\pi_m(z, \beta, \kappa)$ with respect to z is

$$\frac{\partial \pi_m(z, \beta, \kappa)}{\partial z} = (1-\kappa)\left\{2\alpha \frac{4\beta\gamma + \alpha\gamma(8-\beta^2\gamma^2) + 4z\left[4 + \alpha\gamma^2(\alpha-\beta)\right]}{\left[4-\alpha\beta\gamma^2\right]^2} - 2z\right\}, \tag{A6}$$

and, from this expression, it is easy to compute the critical value of z, which is given by (12). Looking at the expression for manager effort in (12), the numerator is positive for $\gamma < \left[\frac{4}{\alpha\beta} + \frac{8}{\beta^2}\right]^{1/2}$, which is always observed since $\overline{\gamma} \equiv \left[\frac{4}{\alpha\beta}\right]^{1/2} < \left[\frac{4}{\alpha\beta} + \frac{8}{\beta^2}\right]^{1/2}$. The denominator is positive for $[2\beta + \alpha(\alpha-\beta)]\, 4\alpha\gamma^2 - \alpha^2\beta^2\gamma^4 - 16\,(1-\alpha) < 0$, which is equivalent to $\gamma^2 \in (\underline{\gamma}^2, \gamma_+^2)$, where $\underline{\gamma}^2$ and γ_+^2 are the two roots that solve the equation, with $\underline{\gamma}^2 = 2\frac{-\sqrt{\alpha^4(\alpha-\beta)+4\beta}+\alpha\left[\kappa^2-3\kappa\beta+2\beta(1-\beta)\right]}{\alpha^2\beta^2}$ and $\gamma_+^2 = 2\frac{\sqrt{\alpha^4(\alpha-\beta)+4\beta}+\alpha\left[\kappa^2-3\kappa\beta+2\beta(1-\beta)\right]}{\alpha^2\beta^2}$. It can be easily shown that $\overline{\gamma} \equiv \left[\frac{4}{\alpha\beta}\right]^{1/2} < \gamma_+$. Therefore, assuming that the second-order conditions hold, an interior solution for the optimal manager effort $z^* > 0$, requires $\gamma \in (\max\{0, \underline{\gamma}\}, \overline{\gamma})$. Whenever $0 < \gamma < \underline{\gamma}$, the result for the optimal manager effort is degenerated. Further, it is easy to check that $\gamma = 0$ implies $z^* = 0$.

The second-order partial derivative of $\pi_m(z, \beta, \kappa)$ with respect to z is

$$\frac{\partial \pi_m^2(z, \beta, \kappa)}{\partial z^2} = (1-\kappa)\left\{8(\kappa-\beta)\frac{4 + (\kappa-2\beta)(\kappa-\beta)\gamma^2}{\left[4-(\kappa-\beta)\beta\gamma^2\right]^2} - 2\right\}, \tag{A7}$$

and $\frac{\partial \pi_m^2(z,\beta,\kappa)}{\partial z^2} < 0$ occurs when $[2\beta + \alpha(\alpha-\beta)]\, 4\alpha\gamma^2 - \alpha^2\beta^2\gamma^4 - 16\,(1-\alpha) < 0$, or equivalently, when $\gamma \in (\underline{\gamma}, \overline{\gamma})$. Thus, $\pi_m(z, \beta, \kappa)$ is concave with respect to z. At this point we need to assume that the Hessian matrix is negative definite to be able to state that $\pi_m(z, \beta, \kappa)$ is concave, and that z^* is the unique maximum. ■

Proof of Corollary 2.

Looking at the optimal effort exerted by the manager in (12), we observe that the denominator is decreasing in γ, whereas the effect on the numerator is unclear. However, a sufficient condition for the numerator to be increasing in γ is $\frac{\partial(\alpha^2\gamma(8-\beta^2\gamma^2))}{\partial\gamma} = \alpha^2(8 - 3\beta^2\gamma^2) > 0$ or, equivalently, $\gamma < \left[\frac{8}{3\beta^2}\right]^{1/2}$. This inequality will be always satisfied if $\overline{\gamma} \equiv \left[\frac{4}{(\kappa-\beta)\beta}\right]^{1/2} < \left[\frac{8}{3\beta^2}\right]^{1/2}$, which which is tantamount to $2\alpha > 3\beta$. As a consequence, $2\alpha^* > 3\beta^*$ is a sufficient condition for $\partial z^*(\alpha^*, \beta^*, \gamma)/\partial\gamma > 0$. ■

Proof of Proposition 4. Straightforward. ■

TABLE 1: FIRMS' CHARACTERISTICS

	Num observat	Mean	St. deviation
Size (num employees)	496	33	33.80
Of which sampled (%)		46.28	68.55
Age (years)	503	25.16	24.20
Family firm (%)	489	75.87	
Owner = manager (%)	488	84.63	
Sector:	465		
- Metal products (%)		21.51	
- Mechanical machinery & equip (%)		13.76	
- Food and beverages (%)		11.4	
- Rubber and plastics (%)		6.67	
- Furniture (%)		5.59	
- Electronic machinery & equipm (%)		12.48	
- IT sector (%)		10.11	
- Hospitals (%)		8.39	
- Hospitality sector (%)		6.24	
- Others (%)		3.9	

TABLE 2: WORKERS' CHARACTERISTICS

	Num observat	Mean	St. deviation
Age	4676	37.82	10.95
Seniority at firm (years)	4402	9.20	9.05
Female (%)	4676	31.33	
Foreign (%)	4596	4.96	
Occupational category:	4866		
- Core employees (%)		71.78	
- Supervisors (%)		14.43	
- Managers (%)		13.17	
Education:	4791		
- No formal studies (%)		12.31	
- Primary school (%)		23.29	
- Secondary school (%)		9.89	
- Vocational school (%)		32.25	
- College and more (%)		22.25	
Temporary contract (%)	4668	11.35	

TABLE 3: PAY INCENTIVES

	Total	Managers	Supervisors	Core Employees
% of workers whose salary has a variable component	14.2	21.4	15.4	12.6

	Total	
For those workers, % of salary based on:	Mean	Standard Deviation
- individual incentives	21.0	20.5
- company incentives	14.4	13.6

TABLE 4: RESULST OF THE BASELINE ORDERED PROBIT MODEL I

	All sectors (I)	Only manufacturing (II)
Salary has variable component	0.041*	0.054**
Centralization of:		
- **task planning**	-0.035***	-0.010
- **production decisions**	0.032*	0.057**
- **labor decisions**	-0.028*	0.014
Human resource practices:		
- **Suggestion practices**	0.079***	0.060**
- **Shared info systems**	0.086***	0.034
- **Job turnover**	0.069***	0.049**
- **Job redesign**	0.040**	0.040*
- **Problem solution teams**	0.030*	-0.035
- **Semi-autonomous teams**	0.043**	0.112***
- **Quality circles**	0.002	-0.037
- **TQM**	0.015	0.128***
Firm size	0.089***	0.121***
Family firm	-0.047**	-0.009
Competitive environment	0.012	0.007
Product Complexity		0.022**
Number of managers		0.010*
Workers characteristics:		
- **Age**	-0.001	0.003***
- **Female**	-0.096***	-0.249***
- **Spanish**	-0.009	0.209***
- **Temporary contract**	-0.056**	-0.133***
Manager	0.781***	
Supervisor	0.830***	
Log-likelihood	-26531.6	-17724.0
LR X^2 statistic	6356.0	2628.1
Pseudo R^2	0.11	0.07
Number of observations	19280	12335

(***) significant at 1%, (**) significant at 5%, (*) significant at 10%. All regressions include sectoral dummies and collaboration specific dummies.

TABLE 5: ACCOUNTING FOR THE ENDOGENEITY OF THE VARIABLE SALARY COMPONENT

	Main equation (I)	Switch equation (II)
Salary has variable component	**-0.154**	
Centralization of:		
- **task planning**	-0.036***	
- **production decisions**	0.031*	
- **labor decisions**	-0.026*	
Human resource practices:		
- **Suggestion practices**	0.079***	
- **Shared info systems**	0.086***	
- **Job turnover**	0.069***	
- **Job redesign**	0.040**	
- **Problem solution teams**	0.030*	
- **Semi-autonomous teams**	0.043**	
- **Quality circles**	0.002	
- **TQM**	0.015	
Firm size	0.096***	0.160***
Family firm	-0.048**	
Competitive environment		-0.097***
Firm age		0.049***
Firm has foreign capital		-0.033
Firm is part of a group		0.008
Owner = manager		0.002
Workers characteristics:		
- **Age**	-0.001**	-0.006***
- **Female**	-0.100***	
- **Spanish**	-0.008	
- **Temporary contract**	-0.057**	
Manager	0.796**	0.363***
Supervisor	0.834***	0.158***
Log-likelihood	-36675.1	
LR X^2 statistic	6565.8	
Number of observations	27979	
Rho (correlation error)	**0.107 not sig**	

(***) significant at 1%, (**) significant at 5%, (*) significant at 10%. All regressions include sectoral dummies and collaboration specific dummies.

TABLE 6: RESULTS OF THE BASELINE ORDERED PROBIT II

	All sectors & workers (I)	Only core employees (II)	Core employees & manuf (III)
Individual incentives	0.038	-0.006	-0.061*
Company incentives	0.029	0.115**	0.110**
Centralization of:			
- **task planning**	-0.034***	-0.013	0.012
- **production decisions**	0.032*	0.083***	0.102***
- **labor decisions**	-0.029*	-0.037**	-0.004
Human resource practices:			
- **Suggestion practices**	0.081***	0.108***	0.108***
- **Shared info systems**	0.086***	0.066***	0.066***
- **Job turnover**	0.071***	0.105***	0.105***
- **Job redesign**	0.037**	0.025	0.025
- **Problem solution teams**	0.032*	0.032	0.032
- **Semi-autonomous teams**	0.042**	0.049**	0.049**
- **Quality circles**	0.002	0.002	0.002
- **TQM**	0.018	0.037	0.037
Firm size	0.089***	0.089***	0.111***
Family firm	-0.047**	-0.059***	-0.072**
Competitive environment	0.010	0.003	0.021
Product Complexity			0.033***
Number of managers			0.002
Workers characteristics:			
- **Age**	-0.001	-0.001	-0.001
- **Female**	-0.093***	-0.110***	-0.157***
- **Spanish**	-0.022	-0.018	0.073
- **Temporary contract**	-0.050*	-0.068**	-0.016
Manager	0.782***		
Supervisor	0.831***		
Log-likelihood	-26452.6	-19528.4	-12562.4
LR X^2 statistic	6225.2	4332.2	2642.2
Pseudo R^2	0.11	0.10	0.10
Number of observations	19232	13733	8823

(***) significant at 1%, (**) significant at 5%, (*) significant at 10%. All regressions include sectoral dummies and collaboration specific dummies.

TABLE 7: MODELS USING THE INTENSITY OF INCENTIVES

	All workers (I)	All workers (IIA)	Selection eq. (IIB)
% of salary based on:			
- Individual performance	-0.010***	-0.010***	
- Company performance	0.000	0.001	
Centralization of:			
- **task planning**	0.151	0.121	
- **production decisions**	0.241*	0.266**	
- **labor decisions**	-0.492***	-0.469***	
Human resource practices:			
- **Suggestion practices**	0.205	0.205	
- **Shared info systems**	0. 186***	0. 186***	
- **Job turnover**	0.289**	0.289**	
- **Job redesign**	-0.077	-0.077	
- **Problem solution teams**	0.227*	0.227*	
- **Semi-autonomous teams**	0.225*	0.225*	
- **Quality circles**	-0.612***	-0.612***	
- **TQM**	-0.207	-0.207	
Firm size	0.500***	0.517***	0.164***
Family firm	-0.088	-0.095	
Competitive environment			-0.100***
Firm age			0.044***
Firm has foreign capital			-0.068*
Firm is part of a group			0.022
Owner = manager			0.010
Workers characteristics:			
- **Age**	-0.014**	-0.015***	-0.006***
- **Female**	0.348**	0.346**	
- **Spanish**	-0.394*	-0.380*	
- **Temporary contract**	-0.347	-0.365*	
Manager	0.749***	0.819***	0.374***
Supervisor	0.788***	0.801***	0.165***
Log-likelihood	-724.2	-11005.7	
LR X^2 statistic	280.2	772.3	
Pseudo R^2 / rho	0.16	**0.34 not sign**	
Number of observations	600	29196	

(***) significant at 1%, (**) significant at 5%, (*) significant at 10%. All regressions include sectoral dummies and collaboration specific dummies.