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Does Incentive Pay Substitute for Monitoring? The Role of Managerial Skills and Span of Control

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Abstract

We model the conditions under which firm agency issues are tackled through incentive pay as opposed to monitoring. The model shows that a larger span of control makes labor surveillance less effective as an effort extraction mechanism, whereas managerial skills increase the opportunity cost of monitoring. As a result, the use of pay-for-performance schemes is more likely in firms with a lower staff-to-managers ratio and more skilled managers. An empirical analysis on firm-level Italian data produces results coherent with our theoretical predictions. Taken together, our results help to explain the highly heterogeneous use of incentive contracts among firms.

JEL Classification: L23, M52, C72, J33, J41

Keywords: Incentive pay, Managerial ability, Span of control

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1 Introduction

The design of mechanisms to elicit worker effort is a hallmark of standard agency theory – for a review, see Seth (2018). In presence of asymmetric information and conflicting interests between employers and employees, contracts are incomplete and residual claimants must undertake actions to prevent subordinates from shirking. Two are the typical strategies that employers can follow.

First, they can couple efficiency wages and labor surveillance, i.e. supervise worker activities under the threat of a sanction if caught shirking (Shapiro and Stiglitz, 1984; Bowles, 1985). Second, they can align the interests of all parties involved by offering compensation packages that let a part of the agents' remuneration depend on individual-, team-, or company-performance, hereafter incentive pay. While incentives based on relative performance trigger workers competition in tournament-like settings (for a review, see Connelly et al. (2014)), incentives based on absolute performance —either at the individual- (individual bonus), team- (team bonus) or firm-level (profit sharing)— tighten the link between compensation and productivity, and encourage more able workers to sort in skill-intensive occupations (Lemieux et al., 2009).

Whether incentive pay is effective in improving firm performance crucially depends on the workers' reaction to variable pay. By improving job satisfaction, it may indeed stimulate worker reciprocity, eliciting positive behavioral responses in the form of higher labor effort and reduced rates of absenteeism and quits. By contrast, it may increase job-related anxiety and create free-riding incentives in teams, particularly, when joint output is the only observable output measure. Manager's beliefs about these different reactions can play an additional role, since negative expectations on workers' behavior plausibly discourage the adoption of incentive pay. The available evidence is largely consistent with this behavioral heterogeneity, as it shows that while pay-for-performance schemes increase firm performance on average (Blasi et al., 2010), they fail to do so in a variety of settings (Robinson and Wilson, 2006). Unsurprisingly, the rate of incentive pay adoption is thus heterogeneous both within and across countries and sectors. In the comparative evidence discussed by Bryson et al. (2012), the share of firms' adopting this compensation schemes spans from around 10-15 percent in European countries and in the UK to over 40 percent in Scandinavian countries and in the US. The drivers of this variability are multiple, as can be deducted from other empirical regularities that systemically characterize the diffusion of incentive pay. As shown by Bryson et al. (2012), these schemes are more diffused in skill-intensive occupations (consistently with the worker sorting hypothesis), in non-family and medium-large firms (consistently with the managerial inclination hypothesis), in occupations characterized by strong degrees of task interdependence (where the free-riding problem is

mitigated by the technology of production), and in countries where product and capital markets are strongly regulated.

In this paper, we document the existence of two other sources of variability that, to the best of our knowledge, received no previous attention, i.e. the managers' span of control and the level of managerial skills. Descriptive evidence from a large representative sample of about 30.000 non-agricultural firms operating in Italy in 2010 and 2015 (more details on the data used are given below) shows that the rate of inventive pay adoption for non-managerial workers, while limited in absolute terms (around 6%), is higher in firms where the top manager is more educated or has a larger span of control. Figure 1 displays the share of firms using incentive pay for subordinate workers along the distribution of the managers' span of control. While the incidence of incentive pay is very limited (below 1%) for firms in the 1st quintile of the span of control distribution, it rises remarkably for firms in the 5th quintile, approaching 15%. Similarly, firms using some form of incentive pay have, on average, a lower staff-to-top-manager ratio, i.e. they are flatter. In Figure 2, we compare the "averaged" hierarchical structures of incentive pay-adopters and non-adopters, showing that the former are on average wider at the bottom of the hierarchy, having a number of white and blue collars that is at least as twice as that in fixed pay firms. Figure 3 compares the cross-sector incidence of incentive pay for subordinate workers in firms with and without tertiary educated head manager. In most cases, firms with better educated managers are significantly more likely to make use of incentive pay schemes compared to the others. In the paper, we show the robustness of these correlations in a number of regression exercises.

A question that naturally arises from this preliminary evidence is why the rate of incentive pay adoption should be positively correlated with the managers' education and span of control. The purpose of this paper is to answer this question. It does so by developing a simple principal-(multi-)agent model that studies an intuitive trade-off between supervision intensity and incentive pay. In the model, we consider the problem of a manager who chooses the size of the bonus she pays to her workers in case of good performance and also allocates her time between two activities: one (coordination) increases profitability by improving labor organization, the other (monitoring) by eliciting worker effort. In this framework, effort provision follows a mixture of efficiency wage logic and incentive pay logic.

The model hinges on two fundamental assumptions: the opportunity cost of monitoring is larger (i) the larger the manager's span of control (since labor surveillance becomes marginally less efficient the larger the staff-to-manager ratio) and (ii) the abler is the manager (since the marginal product of coordination increases with managerial ability). To reduce monitoring

intensity and dedicate more time to coordination, the manager can increase the size of the workers' bonus. This, however, may increase the labor share at the expenses of the manager's, constraining the feasibility of incentive pay as a worker discipline device. In equilibrium, the optimal ratio between the size of the workers' bonus and the level of monitoring intensity is increasing in the manager's skills and span of control, thus providing a possible rationale for the descriptive evidence reported above.

We complement the theoretical study with an empirical analysis conducted with granular data on a sample of about 30,000 Italian non-agricultural firms, observed between 2010 and 2015. The data provide a rich amount of information about compensation schemes, workforce structure, head manager characteristics, other ownership and industrial relations aspects together with information on location and sector of activity. Although without establishing causality, the econometric exploration of the data show that the correlation between incentive pay, span of control and managerial ability introduced above is robust to different empirical issues, including possible selectivity effects, imperfections in the measurement of managerial skills, heterogeneity in the type of incentive contracts and the incidence of teamwork.

Our paper contributes to the stream of research in personnel economics that studies the optimal combination of incentives in firms, and more precisely, to that analyzing the substitutability between incentive pay and efficiency-wages (MacLeod and JM, 1989; Yang, 2008; Coviello et al., 2022).[1] Extant studies in this sub-field focused on the role of workers', organizations' and markets' characteristics. Conversely, our theory emphasizes that of managers by modelling the opportunity cost of monitoring in terms of displacement of managerial resources. While previous works on the role of managerial talent in corporate hierarchies focused on how mangers' ability may explain the hierarchical organization and wage distribution in firms (see, for instance, Smeets et al. (2019) and Smeets and Warzynski (2008)), our contribution moves a first step in the direction of connecting the hardly communicating streams of literature on worker incentives and managerial ability.

Our study is also interesting if red in light of other stylized facts that have been recently discussed by personnel and labor economists. The first is the divergence in the managers' human capital across countries and firms, as shown by Bloom et al. (2014b) among others. If our theory is correct (and the empirical associations that motivate it robust enough) better-managed firms not only are more productive, but also more prone to adopt incentive pay, which may provide a further explanation to the mounting cross-firm and cross-country wage inequality described

[1] Others have focused on the relationship between incentive pay and career concerns in internal labor markets (Ortín-Ángel and Salas-fumás, 1998; Schöttner and Thiele, 2010) or on the how team and individual incentives should be combined, both in tournament (Danilov et al., 2019) and non-tournament settings (Bag and Wang, 2019).

by a number of recent studies —see Eeckhout (2021) for a discussion. The second is that firms are becoming flatter, i.e. have increased the number of employees directly reporting to the same top-manager (Caroli and Van Reenen, 2001; Acemoglu et al., 2007; Rajan and Wulf, 2006; Guadalupe and Wulf, 2010; Bloom et al., 2014a). Whether this tendency is leading to improved worker autonomy and greater delegation is still controversial. Without entering this issue explicitly, our study suggests that flexible remuneration schemes linking pay to performance may be better suited to support managerial activities in flatter firms.

The remainder of the paper is organized as follows. In section 2, we setup and solve our theoretical model. Section 3 and 4 expand on the descriptive evidence presented so far and show that the correlation between incentive pay, span of control and managerial ability is systematic in the data. Section 5 comments and concludes.

2 The Model

2.1 Setup and Assumptions

We analyze a partial equilibrium model where a firm employs a manager of ability $\alpha > 0$ to motivate a team of $l > 0$ identical workers. Both the manager and the workers are expected utility-maximizers assumed to be either risk-neutral or risk-averse.

We assume that the manager is given full residual rights over the team's output, and thus, is in a standard principal-(multi-)agent relationship with the l employees in her team. Nothing would change if we assumed that she has to split the surplus with the firm according to some bargaining rule.

The manager's span of control (defined as the staff-to-manager ratio) is measured by l, which is assumed to be fixed in the short-run. While the assumption is empirically motivated (what we wish to test is the firm-level correlation between pay-for-performance and span of control) it has nonetheless reasonable interpretations. In contexts where employment protection legislation is tight and redundancies are costly (such as Italy, the country we analyze empirically), downsizing for organizational reasons may be largely inefficient. Similarly, when recruiting and training is expensive and the use of flexible labor legally constrained or poorly productive (for instance, because non-standard workers have low incentives to invest in firm-specific human capital), hiring decisions should be understood as medium-to-long-term investments. In addition, managers rarely "start from scratch" in choosing how many workers to supervise, as they often take over already formed teams. The situation they inherit from their predecessors, in this case, further constraints their flexibility of action.

The manager is assumed to fulfil two functions in the organization: in an optimally chosen share $\tau \in [0,1]$ of her time, she monitors and controls her workers; in the remaining share $1-\tau$, she coordinates and organizes the labor process. Both activities are assumed to have a positive effect on productivity: the former, albeit unproductive *per se*, elicits labor effort; the latter improves labor organization by, for instance, fine-tuning the match between workers and tasks, facilitating communication and refining inter-task coordination. [2] While team-theorists dedicated thorough attention to each of these channels, we model the sum of these effects in a stylised way by assuming that the quality of labor organization $\omega > 0$ increases with the manager's (exogenous) ability α and decreases with the (endogenous) monitoring time τ. The intuition is that, ceteris paribus, more talented managers are more capable of shaping the organizational environment, and they are increasingly so the more time they dedicate to labor organization.[3] We wrap up these intuitions in the following Assumption:

Assumption 1–*The quality of labor organization,* $\omega = \omega(\tau;\alpha)$*, satisfies*:

(i) $\omega(1;\alpha) = \underline{\omega} > 0$ and $\omega(0;\alpha) = \overline{\omega} > \underline{\omega}$;

(ii) $\partial\omega/\partial\tau < 0$ and $\partial\omega/\partial\alpha > 0$;

(iii) $\partial^2\omega/\partial\alpha\partial\tau < 0$.

While the workers' individual output is assumed to be ex-post observable and verifiable, their individual effort $e \geq 0$ can only be observed if the manager devotes some time to monitoring their work. As usual, employees dislike exerting effort, as measured by the cost function $c(e)$, where we naturally assume that $c'(e) > 0$ and $c(0) \geq 0$. Hence, the manager faces the usual moral-hazard problem studied in the principal-agent literature. More specifically, we assume that the effort of each individual worker is randomly observed by the manager according to a probability $\mu \in (0,1)$, which is increasing in the (endogenous) monitoring time τ and decreasing in the (exogenous) team size l. The idea that monitoring is less effective in larger team is intuitive, and it has been already put forward by Rebitzer and Taylor (1995) and Georgiadis (2013). The following Assumption specifies these ideas:

[2]The assumption that the manager improves labor organization when she is not monitoring her supervisees models the more general idea that high-level agents in corporate hierarchies face a trade-off between activities that have a direct effect on profitability and activities whose sole purpose is to maintain labor discipline. The chosen focus on labor organization is for the sake of readability only.

[3]Assuming that the effect of the manager's ability spreads over the entire work-team is consistent with the "scale of operation effect" studied in personnel economics and human resource management, according to which managerial talent has a larger effect on firm performance the larger is the manager's span of control —-see, for instance, Smeets et al. (2019). In our framework, when the manager improves labor organization, she raises the value of each worker's expected output, which implies that the overall effect is larger the larger her span of control.

Assumption 2–*The monitoring probability, $\mu = \mu(\tau; l)$, satisfies*:

(i) $\mu(0; l) = 0$;

(ii) $\partial\mu/\partial\tau > 0$ and $\partial\mu/\partial l < 0$;

(iii) $\partial^2\mu/\partial\tau\partial l < 0$.

Following Kräkel (2016), we assume that each individual worker produces a positive output $y > 0$ ("success") with probability $\pi(e) \in [0, 1]$ and zero output ("failure") with probability $1 - \pi(e)$, where we naturally assume that $\pi'(e) > 0$ and $\pi(0) = 0$. To keep things simple, we additionally assume that the only-labor-inputs production function that aggregates individual expected output πy in total expected output q has constant return to scale, so that $q = \pi y l$. While the assumption of binary output is both common and innocuous in the contract-theoretic literature (see also Kräkel, 2016), that of constant returns to scale greatly simplifies the analysis without altering any of our results qualitatively.

To build a connection between labor productivity and coordination, we assume that the value of the workers' individual output y (when realized) depends positively on the quality of labor organization ω. Moreover, since ω is assumed to depend on τ and α according to Assumption 2, the workers' productivity can be also specified as a function of these variables, and more precisely, as a decreasing function of τ and an increasing function of α. These intuitions lead to the following Assumption:

Assumption 3–*The worker's individual output, $y = y(\tau; \alpha)$, satisfies*:

(i) $\partial y/\partial\tau < 0$, and $\partial y/\partial\alpha > 0$;

(ii) $\partial^2 y/\partial\tau\partial\alpha < 0$,

The workers' compensation comprises a variable component $b \geq 0$ (i.e. incentive pay scheme) that is paid in case of positive output (which happens endogenously with probability π) and a fixed salary $F \geq 0$ that cannot fall short of a minimum wage set by the law, call it $w \geq 0$, which implies that $F \geq w$. To simplify the contract-theoretic problem studied in what follows, we restrict our attention to the case where the minimum wage is relatively high compared to the workers' outside option, so that it is sufficient to offer $F = w$ to induce workers to sign the labor contract. This allows us to disregard the situations where the workers' participation constraint is binding, in which case, the manager should leave workers an employment rent by raising the fixed wage —-see, for instance, Beckmann and Kräkel (2021).

To motivate workers, the manager optimally chooses whether to raise the monitoring time τ or to increase the bonus b that is paid in case of high output. In this framework, effort is elicited by a mix of efficiency wage and incentive pay logics. The two instruments can either complement or substitute each other, depending on the problem's specification. Following the usual efficiency-wage logic, we assume that workers who are caught shirking incur a penalty $\psi > 0$ that depends on the legal and economic environment where the firm operates. As the literature on efficiency wages, firing costs and judicial behavior has demonstrated (Gáldón-Sanchez and Güell, 2003), in fact the expected cost of a disciplinary dismissal depends on various economic and institutional features, such as, for instance, labor market conditions (Ichino et al., 2003) and judges' political bias (Berger and Neugart, 2011). When this cost is prohibitively high, firms may find it rational not to fire their caught shirkers and still may resort to other forms of endogenous sanctions relying on internal labor markets mechanisms or hierarchical social pressure. Hence, while efficiency wage models normally assume that caught shirkers are fired, we follow a more general approach and leave the parameter ψ willingly unspecified.

The parameters' interpretation is summarized in Table 1. As usual, we solve the game by backward induction, starting from the worker's effort decision at stage 2.

2.2 Stage 2, the workers' best-response

Given the above discussion, the problem of a representative worker is given by:

$$\max_{e \geq 0} U(e) = \frac{1}{1-r}\{\pi(e)(w+b)^{1-r} + (1-\pi(e))[\mu(\tau)(w-\psi)^{1-r} + (1-\mu(\tau))w^{1-r}]\} - c(e) \quad (1)$$

where $r \in [0,1)$ is the workers' (common) degree of risk-aversion (with $r = 0$ indicating risk-neutrality).[4] The solution to the worker's problem, when it exists, is uniquely identified by the following first-order condition (assuming that the second-order condition holds):

$$\pi'(e)\{(w+b)^{1-r} + \mu(\tau)[w^{1-r} - (w-\psi)^{1-r}] + w^{1-r}\} - (1-r)c'(e) = 0 \quad (2)$$

An interior solution to problem (1) exists when $\pi(e)$ is quasi-concave and $c(e)$ quasi-convex, at least one strictly so. When either of these conditions is met, the following Lemma characterizes the workers' effort decision:

[4] In many efficiency wage models, labor contracts are not renewed in t_2 when workers are caught shirking in t_1 —e.g., Rebitzer and Taylor (1995), Yang (2008) and Coviello et al. (2022). This implies that the discipline effect of raising the probability of being caught must be weighted for the rate at which workers discount the future. None of our results would be changed qualitatively if we followed this modelling strategy.

Lemma 1–*The workers' best-response to the manager's choice of b and τ, call it $e^* = e^*(b, \tau)$, is increasing in both b and τ, so that $\partial e^*/\partial b > 0$ and $\partial e^*/\partial \tau > 0$. In addition, the marginal increase in effort following an increase in monitoring intensity is decreasing in the manager's span of control, so that $\partial^2 e^*/\partial \tau \partial \alpha < 0$.*

Proof: see Appendix A.1.

Since the workers' best-response is increasing in both b and τ, the family of iso-effort curves in the b, τ space implicitly defined by equation (2) have negative slope, suggesting that incentive pay and monitoring intensity can be used as substitute to elicit worker effort. However, since monitoring is less efficient in larger teams, the effort reaction to an increase in monitoring intensity is less significant the larger the manager's span of control. This suggests that, ceteris paribus, managers with a larger span of control should rely more intensively to incentive pay. In addition, the choice of τ should also depend on managerial ability, since, by Assumption 2, the opportunity cost of monitoring is more substantial for high-ability managers. The next Section verifies these intuitions.

2.3 Stage 1, the manager's decision: incentive pay vs monitoring intensity

Given the assumptions laid out in Section 2.1. and the worker's best-response derived in Section 2.2, the manager's problem is given by:

$$\max_{b\geq 0, \tau \geq 0} V(b, \tau) = \frac{1}{1-m}\{\pi(e^*)[(y(\tau) - w - b)l]^{1-m} + (1 - \pi(e^*))(wl)^{1-m}\} \tag{3}$$

where $m \in [0, 1)$ is the manager's degree of risk-aversion (with $m = 0$ indicating risk-neutrality) and the selling price has been normalized to unity. Assuming that the second-order conditions hold, the incentive scheme chosen by the manager is uniquely identified by the following first-order conditions:

$$\frac{\pi'}{1-m}\{[(y - w - b)l]^{1-m} + (wl)^{1-m}\}\frac{\partial e^*}{\partial b} - \pi(e^*)(y - w - b)^{-m} l^{1-m} = 0 \tag{4}$$

$$\frac{\pi'}{1-m}\{[(y - w - b)l]^{1-m} + (wl)^{1-m}\}\frac{\partial e^*}{\partial \tau} + \pi(e^*)(y - w - b)^{-m} l^{1-m}\frac{\partial y}{\partial \tau} = 0 \tag{5}$$

Equations (4) and (5) identify the marginal benefits and costs of using the different types of incentives considered hitherto. Depending on the chosen functional forms, this may either

define an interior solution that characterizes how incentive pay and monitoring intensity should be optimally combined to elicit worker effort, or a couple of corner solutions that the manager may alternatively implement depending on the parameters' values. The following Proposition analyzes the first and more general of these scenarios:

Proposition 1−*When monitoring intensity and incentive pay complement each other, the optimal bonus/monitoring ratio:*

(i) *is increasing in the manager's ability*,

(ii) *is increasing in the manager's span of control*,

(iii) *is decreasing in the penalty incurred by shirkers.*

Proof: See Appendix A.1.

Point (i) of Proposition 1 directly follows from Assumption 1: since the opportunity cost of monitoring is increasing in managerial ability, high-ability managers find it rational to pay higher bonuses and reduce the level of monitoring intensity. Point (ii), in turn, follows from Assumption 2: since monitoring is ceteris paribus less efficient in larger teams, managers with a large span of control rely more intensively on incentive pay than on hierarchical control. Finally, point (iii) of Proposition 1 is intuitive: since monitoring is more efficient when ψ is large, a stricter penalty will ceteris paribus induces a downward adjustment in the bonus/monitoring ratio. In the particular case analyzed by standard efficiency wage theory where caught shirkers are fired, ψ would additionally depend on labor market conditions, being larger the higher the cost of losing one's job, and thus, the higher the unemployment rate. In this case, we should expect to observe less incentive pay (and more hierarchical control) where unemployment is higher.

To properly explore these theoretical propositions on an empirical ground, we should have information on the actual size of the bonuses paid, which, unfortunately, we do not have. Indeed, our observables include a dummy that is equal to one when the workers' contracts feature some type of incentive pay (bonus, profit sharing etc.) and zero otherwise. Given this limitation, empirically we can only check whether the managers' span of control correlates positively with the likelihood of using either of these incentives. In the next Section, we lay out a set additional assumptions and study a particular version of the model where monitoring intensity and incentive pay are perfect substitutes, so that the manager chooses to rely on either of these two instruments depending on the values of l, α, and ψ. While the theoretical insights

are all in line with those derived in Proposition 1, the discontinuous jump from one incentive scheme to the other triggered, in particular, by different values of l and α implies that managers of different abilities and with different spans of control may behave heterogeneously in their "yes or no" decision to use incentive pay as a worker discipline device, which is consistent with what we observe in our data.

2.4 The case of perfect substitutes

In this Section, we lay out the particular case where the tangency condition for an interior optimum implied by Equations (4) and (5) is violated, and the manager chooses a corner solution depending on her given ability and span of control. To do so, a number of specific assumptions must be put forward. First, we assume that both the manger and her workers are risk-neutral ($r = m = 0$). Second, we assume that $\pi(e) = e$ and $c(e) = e^2/2$. Third, to model Assumption 2, we assume that $\omega(\tau;\alpha) = \omega_0 + \alpha(1-\tau)$, where ω_0 is a positive constant and $\alpha(1-\tau)$ models the effect of managerial ability on the quality of labor organization, weighted for the fraction of time $1-\tau$ that the manager devotes to labor organization. This functionalization implies that $\partial^2\omega/\partial\tau\partial\alpha < 0$, as stated in point (iii) of Assumption 1. Fourth, to model Assumption 2, we assume that $\mu(\tau;l) = \tau/l$, which implies that $\partial^2\mu/\partial\tau\partial l < 0$, as stated in point (iii) of Assumption 2. Fifth, to model Assumptions 3, we assume $y(\omega(\tau;\alpha)) = [\omega(\tau;\alpha) = \omega_0 + \alpha(1-\tau)]$. Under these additional assumptions, the following Proposition holds:

Proposition 2–*Define* $\overline{\alpha} = \psi/sl$. *Iff* $\alpha > \overline{\alpha}$, *the manager will rely on pay-for-performance, so that* $\{b^*, \tau^*\} = \{\frac{1}{2}(\omega_0 + \alpha), 0\}$. *Conversely, iff* $\alpha < \overline{\alpha}$, *the manager will rely on hierarchical control, so that* $\{b^*, \tau^*\} = \{0, \frac{1}{2\alpha}(\omega_0 + \alpha)\}$.

Proof: see Appendix A.1.

The results in Proposition 2, as anticipated, mirror those already derived in Proposition 1, as they show that an incentive pay equilibrium is more likely: (i) the abler is the manager —Point (i) of Proposition 1; (ii) the higher her span of control —$\partial\overline{\alpha}/\partial l < 0$, Point (ii) of Proposition 1; and the lower the penalty incurred by caught shirkers in the hierarchical control equilibrium —$\partial\overline{\alpha}/\partial\psi > 0$, Point (iii) of Proposition 1. The relationships implied by Points (i) and (ii) are particularly relevant for our empirical analysis, and lead to the following hypotheses:

Hp 1–*The probability to use incentive pay is positively correlated with the managers' ability.*

Hp 2–*The probability to use incentive pay is positively correlated with the managers' span of control.*

The next Section verifies whether these hypothesis are confirmed the data. Before proceeding, a number of limitations must be acknowledged, both at the theoretical and empirical level.

Theoretically, our model assumes that the team-size is fixed in the short run. As anticipated, the assumption is empirically motivated: what we wish to test is whether the probability to use some type of incentive pay correlates positively with the managers' span of control. However, little would change if we allowed the manager to adjust l as well. According to point (ii) of Assumption 2, an increase in monitoring time τ increases the probability μ of detecting shirkers, and it does less importantly the larger the manager's span of control l. Hence, when both l and τ are endogenous, they are strategic substitutes, which implies that a manager choosing a larger span of control would also find it rational to dedicate little time to monitoring and thus, by extension, pay larger bonuses to elicit labor effort. Even in this case thus, we should observe a positive correlation between the use of incentive pay and the span of control.

As to the passage from theory to data, we have to acknowledge some limitations too. To account for managerial ability we can only rely on the education level of the top manager, that admittedly provides but a reasonable proxy for the true value of managerial talent in the organization. This aspect should be taken into account when interpreting the results. Moreover, we do not have information about what mangers actually do in organizations. Taking our theory to the letter would require knowing how managers split their time between monitoring and coordination. But this information is nearly impossible to obtain. Hence, the best we can do is to check how the manager's ability and their span of control is related to the probability of using some type of incentive pay and to investigate, through a set of empirical exercises, whether the empirical evidence is broadly consistent with our hypothesized theoretical mechanisms.

3 Empirical analysis

3.1 Data

Performance-related pay for subordinate workers is widely used worldwide, to different extents across countries and firms. A broad range of different variable schemes based on sales, production

or hierarchical subjective evaluation can be observed, with certain types of contracts emerging more likely than others depending on the institutional context (Bryson et al., 2012). The Italian case is well-suited to look at the use of these contracts given the availability of granular data on their adoption. In addition, Italian firms rarely use other forms of variable compensations based on financial rather than productive performance (such as stock options and stock ownership), which are often hard to measure and may likely substitute for the productivity-based instruments we analyze in this paper, thereby making it difficult to document how this latter type of arrangements correlates with the hierarchical governance of the firm.

We analyze the correlations suggested by our theoretical model and by the raw figures presented in the Introduction by using data from the 2010 and the 2015 wave of the "Rilevazione Imprese e Lavoro" (RIL), conducted by the Italian National Institute for Public Policy Analysis (INAPP). These data cover a representative sample of non-agricultural private firms operating in Italy. Quite importantly for our purposes (see below), no minimum size is foreseen for firms to be included in the surveyed sample, which implies that the reference population include also small and micro firms (which are very common in Italy). After data cleaning, the pooled sample amounts to about 55,000 firm-year observations. For each firm, a rich array of variables is available, including information about compensation schemes (whether the wage is entirely fixed or it includes an incentive pay component), workforce structure (i.e. the size of each of the firm's hierarchical layers), head manager characteristics (sex, age, education and whether the head manager is hired from outside the firm), ownership type (family ownership), industrial relations (unionization and share of open-end contracts), regional location and sector of activity, plus information on other firm characteristics (membership in a group and in employer associations and the exporting status).

In particular, the RIL-INAPP data provide granular information about the adoption of various types of incentive pay at each layer of the firm hierarchy, along with information about the number of workers at each of four layers: managers ("*dirigenti*"), middle-managers ("*quadri*"), white-collars ("*impiegati*"), and blue-collars ("*operai*"). When a firm adopts an incentive pay scheme, on top of the fixed wage, at any of its layers, we have information on whether this is based on individual performance, team performance and/or firm performance (i.e. profit sharing). Thus, to build our dependent variable we first divide the workforce in managerial- (top and middle managers) and non-managerial workers (blue and withe collars). Then, we measure whwteher incentive pay are used for subordinate workers with a single dummy variable equal to 1 if any among individual-based, team-based and firm-based (i.e. profit sharing) incentives is adopted at any of the non-managerial layers and 0 otherwise.

With reference to the possible drivers of incentive pay, we focus our attention on the managers' span of control as well as on their skills. The measure of span of control we rely upon is given by the ratio between the number of subordinate workers (both white and blue collars) and the number of managers (including middle-managers). Such ratio allows us to capture the average number of employees each manager is supposed to coordinate/supervise, which is strictly in line with parameter l in our model. For what concerns managerial abilities (i.e. parameter α), unfortunately, we do not have detailed information about the characteristics of all managers active in the firm, which prevents us from obtaining a comprehensive metrics of skills across all managerial layers. However, we do observe the education of the head manager, namely the manager at the top of the organization, who exerts direct control over the firm operations (in most instances it is the single entrepreneur). On this basis, we compute managerial skills through a dummy variable taking value equal to 1 if the head manager has a university degree and 0 otherwise. Although this variable allows us to measure skills only at the very top of the organization, we have to consider that in Italy most firms are of relatively small size (in our sample nearly 65% report less than 16 employees) and their managerial structure is rather thin. In our data, 74% of the surveyed firms report neither middle-managers nor additional managers besides the head in their organization. For these firms the head manager is indeed the only person with coordination and supervision responsibilities, and our proxy based on education captures his/her managerial skills rather well. Descriptive statistics are reported in Table 2.

3.2 Baseline results

We start by considering the following baseline model:

$$\text{Incentive pay}_{ij} = \beta_0 + \beta_1 \text{ Span of control}_{ij} + \beta_2 \text{ HM with higher education}_{ij} + \mathbf{d}\mathrm{X}_{ij} + \varepsilon_{ij} \quad (6)$$

where subscript i and j refers to the firm and industry respectively; the dependent variable is a dummy equal to 1 if firm i in industry j uses any type of incentive pay for subordinate workers (i.e. individual incentives, team incentives, and/or profit sharing); "Span of control" is the firm-level average number of subordinate workers per manager expressed in logarithm; "HM with higher education" is a dummy taking value equal to 1 if the head manager in firm i has a university degree; $\mathbf{X_{ij}}$ is the vector of controls; and ϵ_{ij} are the residuals. This model is estimated through a logistic regression run on the pooled 2010 and 2015 sample.

The estimated marginal effects are reported in Table 3. In column (1) we estimate a model in which alongside our focus regressors we control only for industry, region and year fixed effects. Both the span of control and the presence of a head manager with higher education

are positively associated with the probability of using incentive pay for subordinate workers. In columns (2)-(4) we add more controls sequentially to test the robustness of the results. In column (2), estimates control for firm-level characteristics through a battery of dummy variables identifying small (below 10 employees) and large firms (above 250 employees), firms belonging to a business group, firms that are family owned and firms that sell part of their output abroad. In column (3), we also account for differences in the system of industrial relations, including a dummy variable selecting those firms that are member of an employer association, the firm-level unionization rate and the fraction of workers with open-ended contract. Finally, in column (4) we control for some additional differences in head manager characteristics, such as whether the head manager is external (i.e. hired from outside the company/owning family), his/her gender as well as his/her age. In the most complete model a unit increase in the span of control is associated with 0.4 percentage point increase in the probability of using incentive pay for subordinate workers. Such effect rises to 3.3 percentage point increase if we consider the presence of a head manager with higher education.

With respect to the control variables we find results that are largely in line with our expectations and previous evidence. In particular, the use of incentive pay schemes for subordinate workers is more likely in firms that are larger, more oriented toward export and part of a group. These findings are consistent with the idea that in complex organizations incentive pay are relatively convenient effort extraction mechanisms as opposed to direct monitoring, and they are thus more frequently used. Similarly, variables that are partially correlated with the quality of management, such as the presence of a head manager selected from outside the firm and the absence of family ownership, are also positively associated with the use of incentive pays. This, likewise the result for our focus variable based on manager education, is coeherent with the theoretical intuition according to which the adoption of this type of incentives is more common in contexts where the opportunity costs of having managers spending their time monitoring instead of managing is higher. Finally, the use of incentive pay for subordinate workers is more likely in firms that are member of employer association as well as in firms that make larger use of standard employment contracts, which is partly a consequence of the industrial relation system on the basis of which such incentive schemes have to be agreed upon.

This baseline evidence may be biased in at least four ways that can be tackled with the data at hand. First, the correlation between incentive pay and span of control might be driven by the quality of management itself. Second, our span of control measure is given by the inverse ratio between managerial and non-managerial workers and thus, provides an imprecise proxy of the actual number of subordinates that each manager has to supervise. For the same reason,

our measure of managerial skills (top manager's education) may be biased as well, since we do not have information on the education of the other managerial workers in the organization. Third, the correlation between incentive pay, span of control and managerial skills may be heterogeneous across the different types of incentive scheme. Fourth, the positive association between the use of incentive pay and the span of control might be driven by the adoption of specific organizational practices in flatter firms, such as teamwork, which are not expressly controlled for in our estimates. The next Section addresses these empirical issues.

3.3 Robustness checks

3.3.1 Selectivity effects

First, the quality of the management may be an important determinant of the span of control. As showed by Smeets et al. (2019), among others, more talented managers are better able at supervising a larger number of workers, thereby implying that firms with more qualified managers have larger spans of control. On the other side, firms that have a larger span of control for exogenous (e.g. technological or sectoral) reasons may attract or select more educated managers. Such selectivity effects may drive the observed correlation between span of control, managerial quality and the adoption of incentive pay schemes. To tackle this problem, we use here a propensity score matching (PSM), originally introduced by Rosenbaum and Rubin (1983), and verify whether our correlations of interest remain statistically significant after controlling for possible selectivity.

In this exercise, we need to disentangle two possible treatments, i.e. span of control and managerial quality. To make the analysis as clean as possible, we consider these two dimensions as reflected in two dummy variables. As for the span of control, we compute a dummy variable equal to 1 if the firm has a span of control which is above the median within its sector-year cell, with sectors classified at the 2-digit level, and equal to 0 otherwise. As for the quality of management, we still rely on the dummy variable for the HM with higher education. Then, we run two separate PSM analyzes, one for each treatment variable. In simple words, we estimate a propensity score, for firm i at time t, as the probability of being treated with a span of control above the median within the sector-year and with a HM with tertiary education, conditional to each other and to a number of other covariates (including the type of firm ownership, age and sex of the HM and whether the HM is hired from outside the firm). If treated and control firms have the same propensity score, the average treatment effect on the treated (ATT) can be attributed to the treatment itself. As usual, we verify that the common support condition is met, in order to rule out perfect predictability of the treatment. The matching procedure is

based on the Nearest Neighbour (NN). As a result, the PSM estimator for ATT is simply the mean difference in the adoption of incentive pay over the common support, weighted by the propensity score distribution of firms.

The results are presented in Table 4. Reassuringly, the results obtained with the PSM method are in line with those from our baseline analysis. Having a span of control above the median of the sector-year and a HM with tertiary education are associated with a higher probability of adopting incentive pay by 6.2% and 9.4% respectively.

3.3.2 Measurement of managerial skills

The measure of span of control we have been using so far is defined as the inverse ratio between managerial and non-managerial workers. Hence, it cannot but provide an imprecise measure of the actual number of workers each manager has to oversee. Beside, we do not have information on the level of education of middle managers, which makes our measure of managerial skills just as imprecise. While it is true that head managers generally exert a strong influence on labor organization and human resource management, it is not unlikely that other managerial workers (when present) are also involved in activities related to the monitoring and coordination of the workforce. As a consequence, our measure fails to adequately account for the trade-off involved in the time allocation between these two activities across all managerial layers, as suggested by our theoretical model.

To check whether this limitation affects our results we run a robustness check where we replicate the baseline analysis while restricting the reference sample only to firms that do not report any managerial position other than the head managers in their organization. This, obviously, leads us to loose some observations and to focus primarily on firms that are of relatively small size. However, as stated above, in the Italian industrial demography small firms are by far the majority. Moreover, the firms with only the head manager do not seem to belong systematically to any specific type of industry or region (see Figure A.2.1 in Appendix A.1). Together with the fact that we can correctly measure the skills of the single manager responsible for monitoring and coordination activities for these firms, this makes us confident that this analysis can provide a good refinement test of the correlations suggested by our theoretical model.

Table 5 reports the results of this exercise. In all the estimated models the empirical association between the managers' span of control and level of education, on the one hand, and the probability to use incentive pay, on the other, remains positive and significant. Compared to the baseline, we find that, while the magnitude of the span of control's coefficient increases,

the one related to the manager's education diminishes (in both cases we tested such differences through a Wald test and the p-value is < 0.001). In particular, in this sub-sample of firms a unit increase in the span of control is associated to 1.6 percentage point increase in the probability to use incentive pay (it was 0.4 in the baseline). Instead, the presence of a head manager with higher education is associated with only 0.7 percentage point increase in the adoption of incentive pay (compared to 3.3 in the baseline). One possible explanation for this difference consistent with out theory is that since the organization of work is relatively simple in small firms, the opportunity cost of devoting the manager's time to supervision instead of coordination is low. Thus, in these firms the presence of a manager with good skills in coordination activities exerts a lower incidence on the probability to use incentive pay as effort extraction mechanism compared to large firms. At the same time, since in firms with only the head manager there is only one subject with supervision responsibilities, a marginal increase in the number of subordinates may significantly undermine the effectiveness of his/her monitoring, thus tightening the empirical association between span of control on the use of incentive pay compared to firms with more structured managerial layers.

3.3.3 Heterogeneity of incentive pay schemes

A third potential limit of our analysis is that in the baseline estimates we do not differentiate among distinct types of incentive pay. In reality, firms can often choose among a variety of solutions depending on how incentives are designed. It is certainly possible that the empirical association between the use of incentives on the one hand and span of control and manager education on the other holds only for certain types of variable pay and not for others. Fortunately, the RIL-INAPP data contains information that allows us to partially deal with this issue. In particular, as stated above, in our data we do observe whether the incentive pay used by the firms is based on individual performance, team performance and/or firm performance (i.e. profit sharing). Although, incentive pay based on firm performance is by far the most commonly used, other types of incentive pay are used as well. At the descriptive level, the use of all types of incentives tends to be higher in firms with a larger span of control and a head manager with higher education (see Figure 4). However, we want to check whether this positive relation survives also in a multivariate setting.

To do so, we replicate our baseline analysis on all firms as well as on the sub-sample of firms that reports only the head manager by distinguishing the dependent variable depending on the type of incentive pay that is used. Results are reported in Table 6. When we consider all firms (columns 1-3), the managers' span of control turns out to be positively associated

with the use of individual incentive pay, but not with the use of profit sharing. Moreover, the relationship between span of control and the adoption of team incentives is positive but only weakly significant. Overall, this suggests that marginal increases in the number of workers that need to be monitored exert a relatively stronger influence on the introduction of incentive systems linked to individual performance as opposed to collective performance, possibly because they lower the risk of running into standard $1/n$ metering issues. Such difference, however, is not present when we consider small firms with only the head manager (columns 4-6), as in this case the effect of the span of control is always positive and significant. This may suggest that this type of firms are relatively less affected by $1/n$ metering problems.

With reference to managerial skills we find that in the extended sample of firms (columns 1-3) the presence of a head manager with higher education rises the probability of using all types of incentives. The magnitude of this effect is particularly large for profit sharing, which is, as we said, the most commonly used form of incentives. In the sub-sample of firms with only the head managers (columns 4-6), instead, the effect is more heterogeneous. While the coefficient of manager education is positive and significant for profit sharing, no statistically significant effect obtains for individual and team-based incentives. Once again, one possible explanation for this result rests on the specific type of firms that we are considering in this sub-sample. Since they are relatively small and with a "thin" managerial structure, they lack the organizational resources that are necessary to administer incentive schemes requiring the constant metering of individual and/or team performance. Thus, it is not surprising that the effect of managerial skills (and, if out theory is correct, the related opportunity cost of monitoring) is significant only for the incentive scheme which likely presents the lowest organizational costs, namely profit sharing.

3.3.4 Incidence of teamwork

An additional issue that could affect our estimates concerns the incidence of teamwork. An extended literature has indeed documented that team organization has become a common practice in modern firms (Laursen and Foss, 2013). When present, teamwork is often combined with flatter organizational structures as well as with a higher propensity to use incentive pay for subordinate workers on top of fixed wages (Burdin and Kato, 2022). Under these conditions, the positive association between the span of control and the use of incentive pay that we detect in our baseline estimates could simply be the consequence of the fact that flatter firms have a higher incidence of teamwork, which in turn rises the probability of using incentive pay.

A proper way of dealing with this issue would require introducing the firm-level incidence of

teamwork among the other controls included in our baseline estimates. Unfortunately, however, this information is not available in the RIL-INAPP survey. As an alternative strategy, we rely on information reported in the 2015 wave of the survey "Qualità del Lavoro" (QdL) conducted by INAPP. This survey (the Italian version of the EU's Working Condition Survey) reports rich worker-level information about the characteristics of individual jobs, including whether each job requires work to be performed in teams. On this ground, we build an industry-level measure capturing the incidence of teamwork across sectors (aggregated at 2 digits) and we then merge this information with the RIL-INAPP data. This allows us to carry out an empirical exercise where we clean the baseline estimates from potential spurious correlations due to teamwork by focusing on sectors in which the use of such organizational practice is relatively limited.

The results of this exercise are reported in Table 7. Column 1 shows the estimated coefficients for our main variables of interest when restricting the sample to sectors characterized by relatively high incidence of teamwork. Column 2, instead, considers only those sectors in which teamwork is relatively uncommon. In line with our expectations we find that where the incidence of teamwork is high the association between span of control and the use of incentive pay becomes weaker and statistically insignificant. This suggests that teamwork is a potentially relevant factor mediating the relationship between these two variables. At the same time, however, in sectors where the incidence of teamwork is low our baseline results are confirmed. The coefficients of span of control and managerial skills are both positive and significant, and their magnitude is slightly larger than in the baseline estimates. Overall, these results suggest that, although teamwork is indeed an important aspect to be taken into account in evaluating the association between the span of control and the use of incentive pay, there is some evidence that at least part of this association is not explained by teamwork alone. In our view, the unexplained part can be related to the trade-off that managers have to face when deciding how to allocate their time between supervision and coordination, which leads them to select incentive pay schemes to a greater extent in presence of larger span of control.

3.3.5 The role of the workers' outside option

To further test the empirical validity of our theoretical argument, in this sub-Section we explore the role of the workers' outside options. What we run here is not a robustness check of the econometric results strictly speaking, but an exercise to further verify whether the empirical evidence is consistent with the essential ingredients of our theoretical argument.

Our model, just as that of Coviello et al. (2022), assumes that worker effort can be elicited by a combination of incentive pay and efficiency wage. The second channel as is well-known,

rests on the possibility of sanctioning workers who are caught shirking. In our framework, the parameter ψ that measures this sanction is left willingly unspecified, as to allow for the possibility that low-effort workers may be punished in several ways, for instance, through hierarchical social pressure or internal labor market mechanisms. In standard efficiency-wage models, however, it is usually assumed that caught shirkers are fired, incurring in a cost that is increasing in the rate of unemployment of the local labor market. From the viewpoint of employers who must choose the optimal combination between monitoring intensity and incentive pay, a higher unemployment rate should therefore imply a downward adjustment in the bonus/monitoring ratio, as it improves the effectiveness of the efficiency wage instrument.

Hence, if this argument is correct, we should observe lower marginal effects of span of control and managerial skills on the probability of adopting bonus pay where the unemployment rate is higher. To test this point, we estimate the marginal effects of the span of control and HM education, as obtained in Equation (6), conditional to the region where the firm is located. Then, we plot these conditional effects across different regions, each with its own unemployment rate, in Figure 5. Graphical inspection of the resulting plots reveals that the effects of both the span of control and HM education are strongly reduced where the unemployment rate is higher, consistently with the theoretical argument whereby firms in thin local labor markets should find it optimal to rely less on incentive pay and more on monitoring to elicit labor effort.

4 Conclusions

The adoption of incentive pay is highly heterogeneous across firms. While previous works explained such heterogeneity by linking the use of bonus payments to imperfect monitoring, career concerns, internal labor-markets and productivity-related motivations, in this paper we provided an alternative arguments based on hierarchical structure and managerial skills. In particular, we proposed a simple model where managers face an opportunity cost of surveillance while allocating their time between coordination and monitoring. On the one side, a wider span of control makes monitoring more difficult, hence more costly. On the other, greater managerial skills make coordination relatively more valuable compared to monitoring. In both such cases incentive pay becomes a more convenient effort-extraction mechanism compared to monitoring. Thus, by modeling bonus pay as a mechanism that relaxes the trade-off between monitoring and coordination, we show that incentive contracts are more likely to be adopted by flatter firms as well as by firms with more skilled managers.

We verify whether these theoretical propositions are empirically grounded by using granular data on a large sample of Italian non-agricultural firms. The empirical results are broadly

consistent with our theory. In most of the estimated models the use of incentive pay is positively correlated with both the span of control and the education of the manager. Such correlations survive in a wide arrays of robustness checks. Moreover, the positive association between, on the one hand, incentive pay and, on the other, span of control and managerial skills tends to be weaker in regional labor markets characterized by higher degree of unemployment. This result is consistent with the fact that where the value of the outside option is lower, monitoring becomes more effective as effort-extraction mechanism, thus weakening the link between the time allocation problem of the manager and the use of incentive pay.

With our paper we provide two main insights for research and the more general debate about the use of incentives in organizations. First, we suggest that alongside standard agency and monitoring issues, the decisions concerning the use of incentive pay are affected by a whole set of other coordination activities that managers need to carry out inside organizations. By failing to take these additional activities adequately into account, previous research has provided only a limited understanding of the reasons why incentive pay is more likely to used in some contexts as opposed to others. Our work contributes to fill, at least partially, this gap. Second, in our paper we provide an argument for the use of incentive contracts that shifts the debate about the drivers of such contracts away from standard worker and industry-level characteristics and it focuses instead on firm and manager structural features. On this basis, one contribution of our paper is to point out a set of previously neglected firm-level factors that can make the introduction of incentive pay relatively easier.

References

Acemoglu, D., Aghion, P., Lelarge, Claire Van Reenen, J., Zilibotti, F., 2007. Technology, information, and the decentralization of the firm. Quarterly Journal of Economics 122, 1759–1799.

Bag, P., Wang, P., 2019. Input, output or mixed monitoring in teams? Journal of Economic Behavior and Organization 166, 471–492.

Beckmann, M., Kräkel, M., 2021. Empowerment, Task Commitment, and Performance Pay. Journal of Labour Economics , forthcoming.

Berger, H., Neugart, M., 2011. Labour courts, nomination bias, and unemployment in Germany. European Journal of Political Economy 27, 659–673.

Blasi, J.R., Freeman, R.B., Mackin, C., Kruse, D.L., 2010. Creating a bigger pie? the effects of employee ownership, profit sharing, and stock options on workplace performance, in: Blasi, J.R., Freeman, R.B., Kruse, D.L. (Eds.), Shared Capitalism at Work. The University of Chicago Press.

Bloom, N., Garicano, L., Sadun, R., Van Reenen, J., 2014a. The distinct effects of information technology and communication technology on firm organization. Management Science 60, 2859–2885.

Bloom, N., Lemos, R., Sadun, R., Scur, D., Van Reenen, J., 2014b. The new empirical economics of management. Journal of the European Economic Association 12, 835–876.

Bowles, S., 1985. The production process in a competitive economy: Walrasian, neo-Hobbesian, and Marxian models. American Economic Review 75, 16–36.

Bryson, A., Freeman, R., Lucifora, C., Pellizzari, M., Perotin, V., 2012. Paying For Performance: Incentive Pay Schemes and Employees' Financial Participation. CEP Discussion Paper No 1112 .

Burdin, G., Kato, T., 2022. Complementarity in employee participation systems, in: Handbook of labor, human resources and population economics. Springer, pp. 1–29.

Caroli, E., Van Reenen, J., 2001. Skill-biased organizational change? Evidence from a panel of British and French establishments. Quarterly Journal of Economics 116, 1449–1492.

Connelly, B., Tihanyi, L., Crook, T., Gangloff, K., 2014. Tournament Theory: Thirty Years of Contests and Competitions. Journal of Management 40, 16–47.

Coviello, D., Deserrano, E., Persico, N., 2022. Minimum Wage and Individual Worker Productivity: Evidence from a Large US Retailer. Journal of Political Economy 130, 2315–2359.

Danilov, A., Harbring, C., Irlenbusch, B., 2019. Helping under a combination of team and tournament incentives. Journal of Economic Behavior and Organization 162, 120–135.

Eeckhout, J., 2021. The profit paradox. Princeton: Princeton University Press .

Georgiadis, A., 2013. Efficiency Wages and the Economic Effects of the Minimum Wage: Evidence from a Low Wage Labour Market. Oxford Bulletin of Economics and Statistics 75, 962–979.

Guadalupe, M., Wulf, J., 2010. The flattening firm and product market competition: the effect of trade liberalization on corporate hierarchies. American Economic Journal: Applied Economics 2, 105–27.

Gáldón-Sanchez, J., Güell, M., 2003. Dismissal Conflicts and Unemployment. European Economic Review 47, 323–335.

Ichino, A., Polo, M., Rettore, E., 2003. Are judges biased by labour market conditions? European Economic Review 47, 913–944.

Laursen, K., Foss, N.J., 2013. Human resource management practices and innovation, in: The Oxford Handbook of Innovation Management. Oxford University Press, pp. 505–529.

Lemieux, T., Macleod, B., Parent, D., 2009. Bonus pay can be used to induce sorting of high-ability workers. Performance Pay and Wage Inequality. The Quarterly Journal of Economics 124, 1–49.

MacLeod, W., JM, M., 1989. Implicit contracts, incentive compatibility, and involuntary unemployment. Econometrica 57, 447–480.

Ortín-Ángel, P., Salas-fumás, V., 1998. Agency-Theory and Internal-Labor-Market Explanations of Bonus Payments: Empirical Evidence from Spanish Firms. Journal of Economics and Management Strategy 7, 573–613.

Rajan, R.G., Wulf, J., 2006. The flattening firm: evidence from panel data on the changing nature of corporate hierarchies. Review of Economics and Statistics 88, 759–773.

Rebitzer, J., Taylor, L., 1995. The consequences of minimum wage laws: Some new theoretical ideas. Journal of Public Economics 56, 245–255.

Robinson, A.M., Wilson, N., 2006. Employee financial participation and productivity: An empirical reappraisal. British Journal of Industrial Relations 44, 31–50.

Rosenbaum, P.R., Rubin, D.B., 1983. The central role of the propensity score in observational studies for causal effects. Biometrika 70, 41–55.

Schöttner, A., Thiele, V., 2010. Promotion Tournaments and Individual Performance Pay. Journal Of Economics and Management Strategy 19, 699 –731.

Seth, A., 2018. Agency theory, in: Augier, M., Teece, D. (Eds.), The Palgrave Encyclopedia of Strategic Management. Palgrave MacMillan.

Shapiro, C., Stiglitz, J., 1984. Equilibrium unemployment as a worker discipline device. America Economic Review 74, 433–444.

Smeets, V., Warzynski, F., 2008. Too many theories, too few facts? What the data tell us about the link between span of control, compensation and career dynamics. Labour Economics 15, 688–704.

Smeets, V., Warzynski, F., Waldman, M., 2019. Performance, career dynamics, and span of control. Journal of Labor Economics 37, 1183–1213.

Yang, H., 2008. Efficiency wages and subjective performance pay. Economic Inquiry 46, 179–196.

Tables and Figures

Table 1: Parameters' interpretation (*choice variables).

Parameter	Interpretation
$\tau \in [0,1]$	Monitoring time*
$1-\tau$	Coordination time*
$e \geq 0$	Workers' effort*
$b \geq 0$	Incentive pay*
$w \geq 0$	Minimum wage
$F(=w)$	Fixed wage
$s > 0$	Workers' skills
$y > 0$	Individual output
$\pi(e) \in [0,1]$	Probability of positive output
$c(e) \geq 0$	Cost of effort
$\omega \in (\underline{\omega}, \overline{\omega})$	Quality of labour organization
$q > 0$	Total expected output
$l > 0$	Team-size=span of control
$\alpha > 0$	Managerial ability
$\mu \in [0,1]$	Monitoring probability
$\psi > 0$	Penalty for caught shirkers
$r \in [0,1)$	Workers' degree of risk aversion
$m \in [0,1)$	Manager's degree of risk aversion

Table 2: Descriptive statistics.

Variable	Mean	Std. Dev.
Incentive pay for subordinates (1 = adopted, 0 = not adopted)	0.058	0.235
Span of control (logarithm of the # of subordinates per manager)	1.923	1.252
Head manager with higher education (1 = yes, 0 = no)	0.273	0.445
External head manager (1 = yes, 0 = no)	0.045	0.208
Male head manager (1 = yes, 0 = no)	0.845	0.361
Head manager aged 60+ (1 = yes, 0 = no)	0.311	0.463
Small size (1 = yes, 0 = no)	0.521	0.499
Large size (1 = yes, 0 = no)	0.037	0.189
Group membership (1 = yes, 0 = no)	0.134	0.340
Family ownership (1 = yes, 0 = no)	0.481	0.499
Exporter (1 = yes, 0 = no)	0.227	0.418
Association membership (1 = yes, 0 = no)	0.526	0.499
Unionization (rate)	0.234	5.307
Open-end contracts (rate)	0.881	0.211

Table 3: Incentive pay, span of control and managerial skills.

	[1] The firm uses any incentive pay	[2] The firm uses any incentive pay	[3] The firm uses any incentive pay	[4] The firm uses any incentive pay
Span of control	0.028***	0.004***	0.004***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
HM with higher education	0.084***	0.034***	0.036***	0.033***
	(0.003)	(0.002)	(0.003)	(0.003)
Small size		-0.065***	-0.061***	-0.059***
		(0.002)	(0.002)	(0.002)
Large size		0.099***	0.107***	0.103***
		(0.006)	(0.006)	(0.006)
Group membership		0.048***	0.053***	0.049***
		(0.003)	(0.003)	(0.003)
Family ownership		-0.015***	-0.016***	-0.014***
		(0.002)	(0.002)	(0.002)
Exporter		0.016***	0.015***	0.015***
		(0.002)	(0.003)	(0.003)
Association membership			0.043***	0.043***
			(0.002)	(0.002)
Unionization			0.000	0.000
			(0.000)	(0.000)
Open-end contracts			0.060***	0.056***
			(0.009)	(0.008)
External HM				0.033***
				(0.004)
Male HM				0.008**
				(0.003)
HM aged 60+				0.007***
				(0.002)
Industry dummies	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
# of obs.	54,534	46,313	46,313	46,313

Notes: Estimates from logistic models with robust standard errors in parentheses. Marginal effects are displayed. The dependent variable is a variable indicating whether the firm uses any type of incentive pay (individual, team-based, profit sharing) for subordinate workers. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Robustness checks: PSM.

	[1] The firm adopts any incentive pay (ATT)	[2] The firm adopts any incentive pay (ATT)
Span of control above sector-year median	0.062***	
	(0.003)	
HM with higher education		0.094***
		(0.002)
# of treated obs.	13178	23167
# of control obs.	41378	39700
t	21.907	41.058
Common support	YES	YES
Balancing property	SATISFIED	SATISFIED
Matching ATT estimator	NN	NN

Significance level: *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Robustness checks: sub-sample with only HM.

	[1] The firm uses any incentive pay	[2] The firm uses any incentive pay	[3] The firm uses any incentive pay	[4] The firm uses any incentive pay
Span of control	0.014***	0.014***	0.016***	0.016***
	(0.001)	(0.001)	(0.001)	(0.001)
HM with higher education	0.007***	0.006***	0.007***	0.007***
	(0.002)	(0.002)	(0.002)	(0.002)
Industry dummies	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Firm-level characteristics	No	Yes	Yes	Yes
Industrial relations	No	No	Yes	Yes
HM characteristics	No	No	No	Yes
# of obs.	41,234	41,234	33,024	33,024

Notes: Estimates from logistic models with robust standard errors in parentheses. Marginal effects are displayed. The dependent variable is a variable indicating whether the firm uses any type of incentive pay (individual, team-based, profit sharing) for subordinate workers. Firm-level characteristics: small size, large size, group membership; family ownership; exporter. Industrial relations: association membership, unionization rate, fraction of open-end contracts. Head manager (HM) characteristics: external, male, aged 60+. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Robustness checks: span of control, managerial skills and types of incentive pay.

	All firms			Firms with head manager only		
	[1]	[2]	[3]	[4]	[5]	[6]
	The firm uses individual incentive pay	The firm uses team-based incentive pay	The firm uses profit sharing	The firm uses individual incentive pay	The firm uses team-based incentive pay	The firm uses profit sharing
Span of control	0.003***	0.001*	0.001	0.005***	0.003***	0.010***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
HM with higher education	0.007***	0.006***	0.025***	-0.000	0.001	0.007***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)
# of obs.	46,313	46,313	46,313	32,118	30,792	33,024
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes

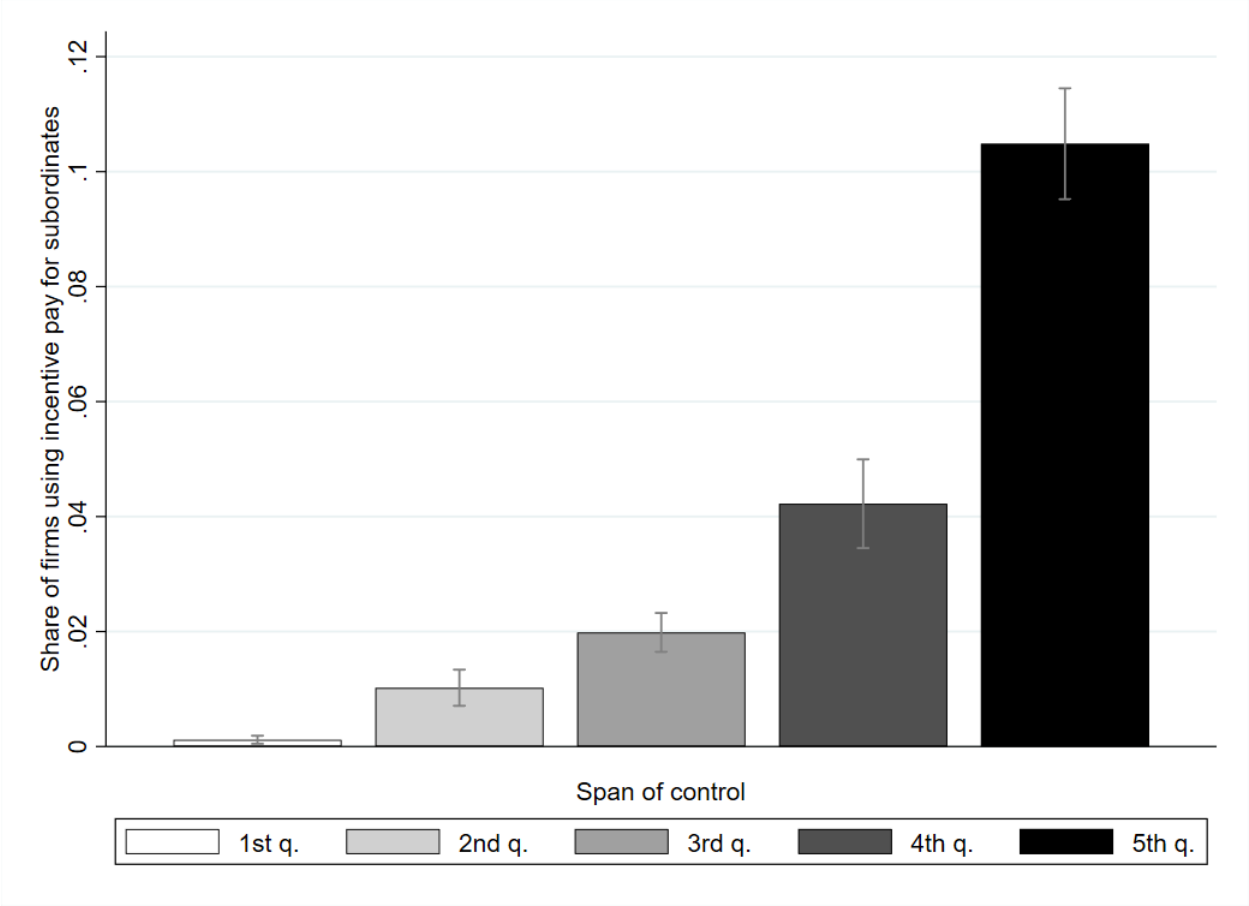
Notes: Estimates from logistic models with robust standard errors in parentheses. Marginal effects are displayed. In columns (1) and (4) the dependent variable is a variable indicating whether the firm uses individual incentive pay for subordinate workers. In columns (2) and (5) the dependent variable is a variable indicating whether the firm uses team-based incentive pay for subordinate workers. In columns (3) and (6) the dependent variable is a variable indicating whether the firm uses profit-sharing for subordinate workers. Sample split based on whether in the firm there are other managerial positions besides the head manager (HM). Firm-level characteristics: small size, large size, group membership; family ownership; exporter. Industrial relations: association membership, unionization rate, fraction of open-end contracts. Head manager (HM) characteristics: external, male, aged 60+. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Robustness checks: span of control, managerial skills and teamwork.

	High teamwork	Low teamwork
	[1]	[2]
	The firm uses any incentive pay	The firm uses any incentive pay
Span of control	0.001	0.013***
	(0.001)	(0.002)
HM with higher education	0.021***	0.051***
	(0.003)	(0.005)
# of obs.	28,167	17,703
Industry dummies	Yes	Yes
Region dummies	Yes	Yes
Year dummies	Yes	Yes

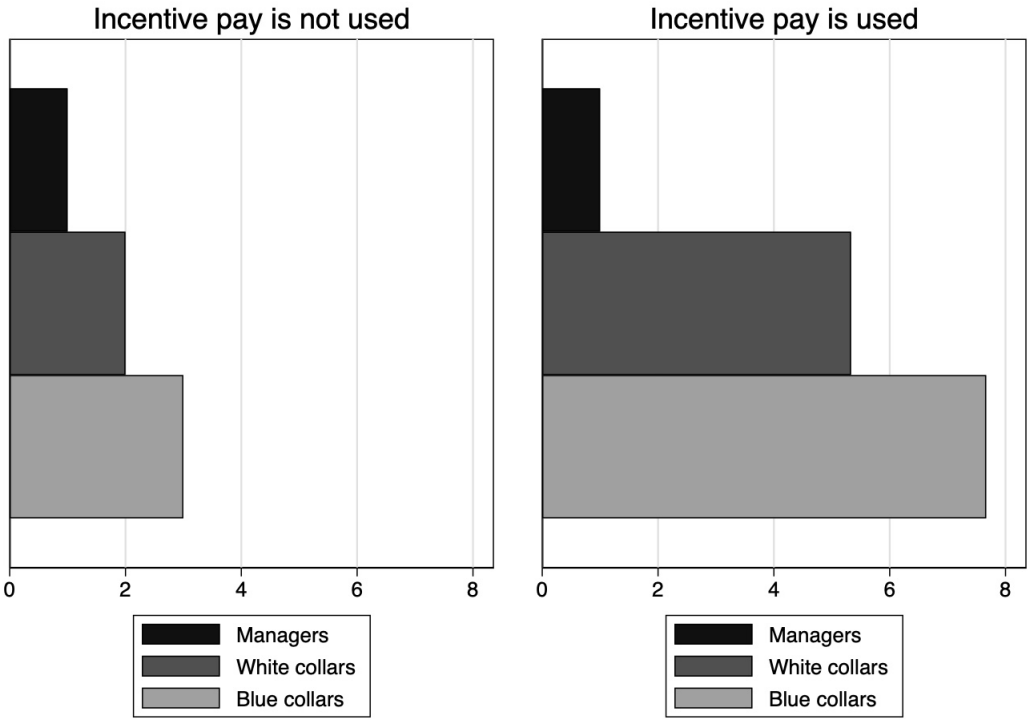
Notes: Estimates from logistic models with robust standard errors in parentheses. Marginal effects are displayed. In both columns the dependent variable is a variable indicating whether the firm uses any type of incentive pay (individual, team-based, profit sharing) for subordinate workers. In columns (1) the sample is restricted to firms belonging to industries with a high incidence of teamwork. In column (2) the sample is restricted to firms belonging to industries with a low incidence of teamwork. Sample split based on data retrieved from the INAPP's 2015 QDL survey, which reports worker-level information about the extent to which individual jobs requires working in team. Industries with a share of teamwork higher than the industry-level median (2 digits) are classified as "High teamwork". The other industries are classified as "Low teamwork". Firm-level characteristics: small size, large size, group membership; family ownership; exporter. Industrial relations: association membership, unionization rate, fraction of open-end contracts. Head manager (HM) characteristics: external, male, aged 60+. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

Figure 1: Use of incentive pay by quintiles of span of control.



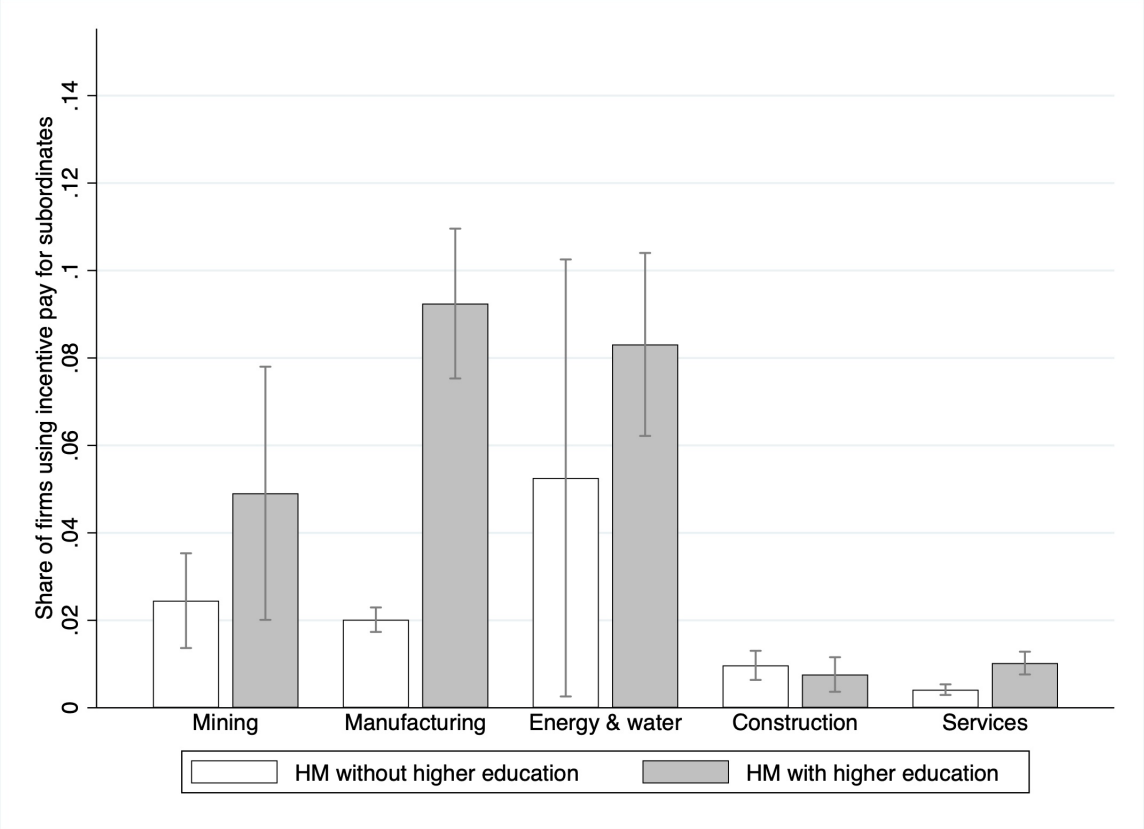
Notes: Pooled data from RIL-INAPP 2010 and 2015. Sample weights are used. The use of incentive pay for subordinates refer to any type of incentive pay, i.e. individual incentives, team incentives, and/or profit-sharing.

Figure 2: Use of incentive pay and the hierarchical structures of firms.



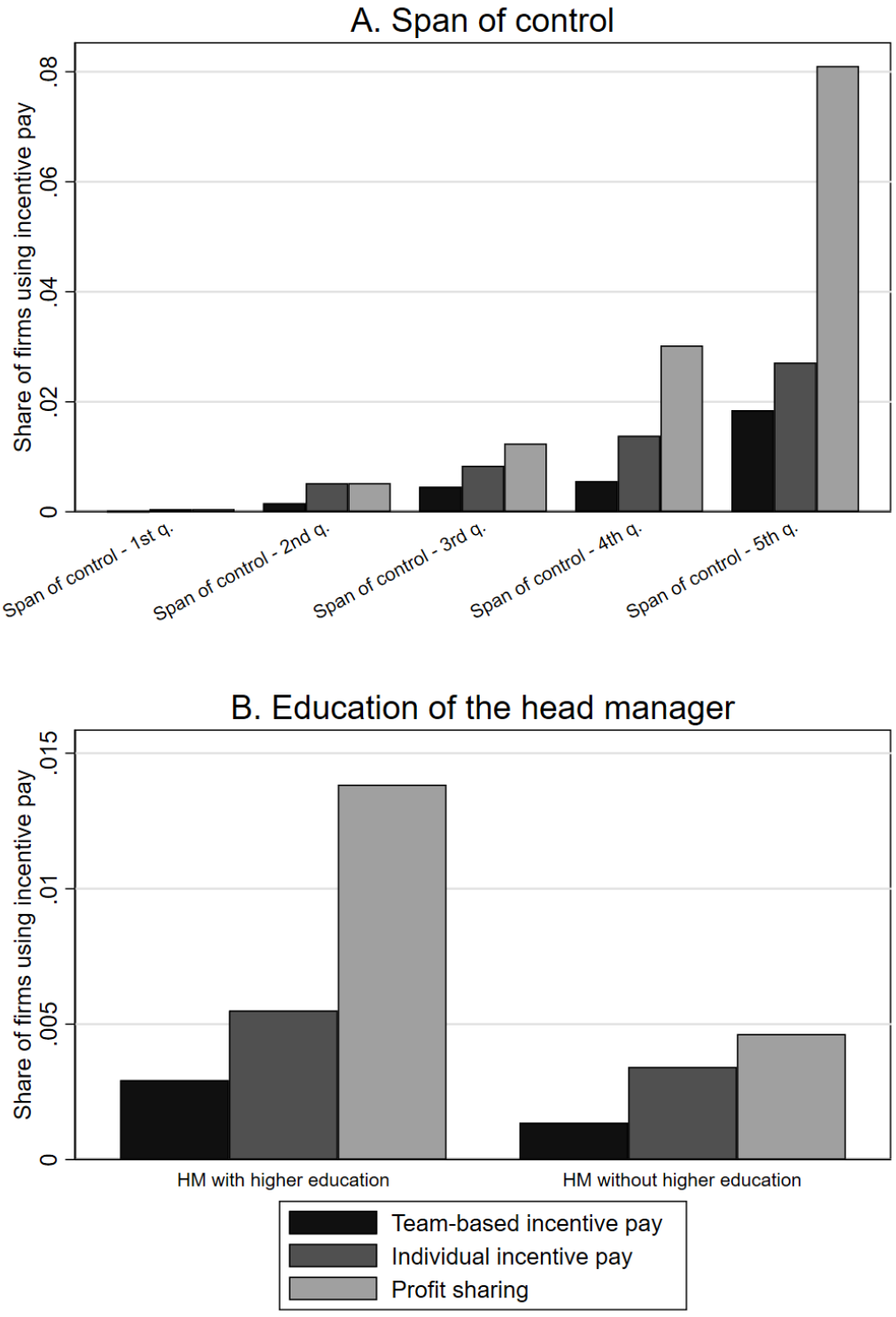
Notes: Pooled data from RIL-INAPP 2010 and 2015. Sample weights are used. The use of incentive pay for subordinates refer to any type of incentive pay, i.e. individual incentives, team incentives, and/or profit-sharing.

Figure 3: Use of incentive pay by head manager (HM) education status across sectors.



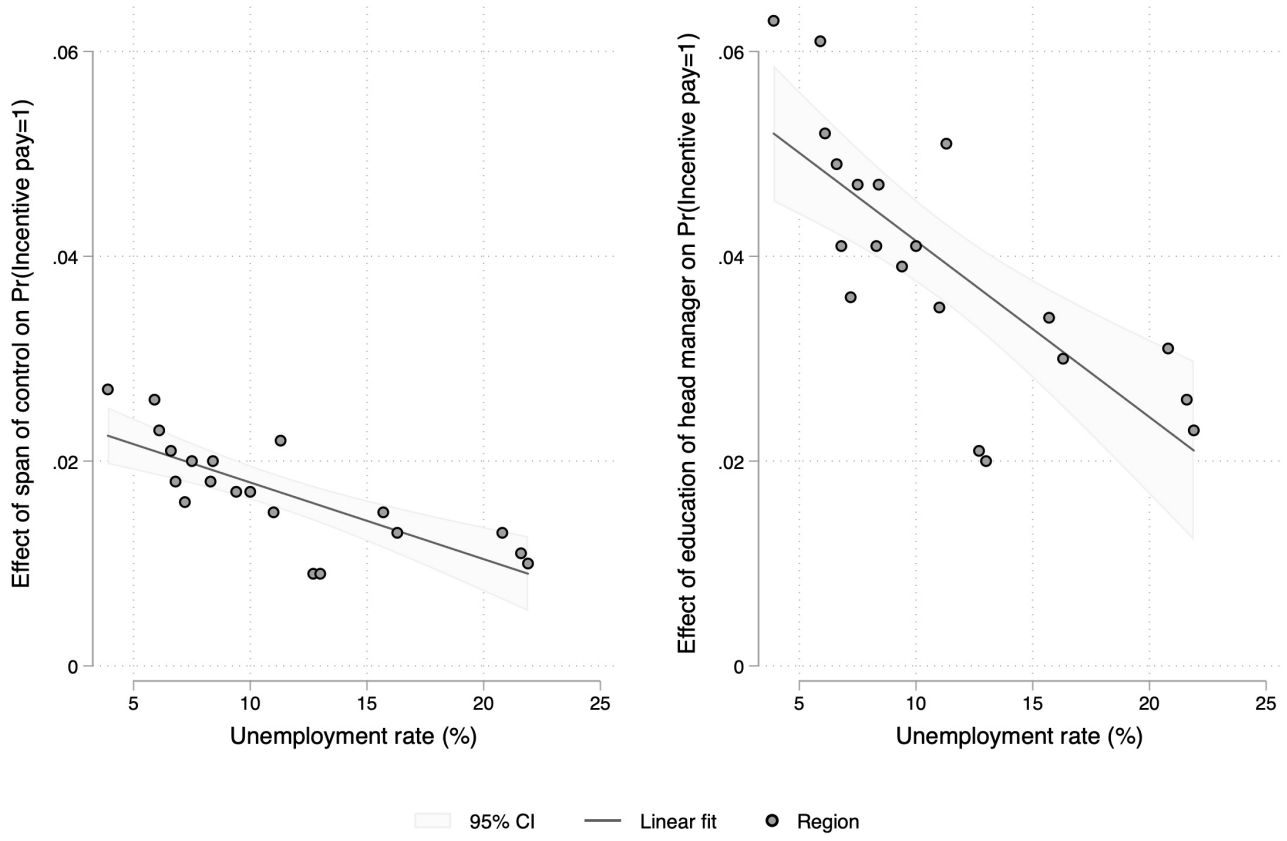
Notes: Pooled data from RIL-INAPP 2010 and 2015. Sample weights are used. The use of incentive pay for subordinates refer to any type of incentive pay, i.e. individual incentives, team incentives, and/or profit-sharing.

Figure 4: Span of control, education of the head manager and type of incentive pay.



Notes: Pooled data from RIL-INAPP 2010 and 2015. Sample weights are used. Team-based incentives pay refer to incentives linked to team performance. Individual incentive pay refers to incentives linked to individual performance. Profit sharing refers to incentives linked to firm performance. In panel A the x-axis refers to different quantiles of the span of control. In panel B the x-axis refers to head manager (HM) with and without higher education.

Figure 5: Marginal effects of span of control and HM education across regions with different unemployment rates.



Notes: Conditional marginal effects obtained from estimating Equation (6).

A.1 Theoretical Appendix

A.1.1 Proof of Lemma 1

The first-order condition (2) can be rearranged as follows:

$$\frac{c'(e)}{\pi'(e)} = v(b, \tau; l, \psi) \tag{A.1.1}$$

where we have defined:

$$\frac{(w+b)^{1-r} - w^{1-r} + [w^{1-r} - (w-\psi)^{1-r}]\mu(\tau; l)}{1-r} = v(b, \tau; l, \psi) > 0 \tag{A.1.2}$$

For future reference, it will be handy to derive:

$$\frac{\partial v}{\partial b} = (w+b)^{-r} \tag{A.1.3}$$

$$\frac{\partial v}{\partial \tau} = \frac{w^{1-r} - (w-\psi)^{1-r}}{1-r} \frac{\partial \mu}{\partial \tau} \tag{A.1.4}$$

By implicitly differentiating the first-order condition (A.1.1.) with respect to b and τ, we obtain the following comparative statics:

$$\frac{\partial e}{\partial b} = \frac{(\pi'(e))^2}{\pi'(e)c''(e) - \pi''(e)c'(e)} \frac{\partial v}{\partial b} \tag{A.1.5}$$

$$\frac{\partial e}{\partial \tau} = \frac{(\pi'(e))^2}{\pi'(e)c''(e) - \pi''(e)c'(e)} \frac{\partial v}{\partial \tau} \tag{A.1.6}$$

Recall that an interior solution to problem (1) exists when one of the following conditions is satisfied:

(i) $\pi''(e) = 0$ and $c''(e) > 0$;

(ii) $\pi''(e) < 0$ and $c''(e) = 0$;

(iii) $\pi''(e) < 0$ and $c''(e) > 0$;.

Hence, the numerator on the l.h.s. of equations (A.1.5) and (A.1.6) is positive. In addition, $\partial v/\partial b > 0$ according to equation (A.1.3) and $\partial v/\partial \tau > 0$ according to equation (A.1.4), since $\partial \mu/\partial \tau > 0$ according to Assumption 2. Hence, $\partial e/\partial b > 0$ and $\partial e/\partial \tau > 0$. This proves the first statement in Lemma 1.

To prove the second statement in Lemma 1, we further differentiate the comparative statics in equation $(A.1.6)$ w.r.t. to l, which gives:

$$\frac{\partial^2 e}{\partial \tau \partial l} = \frac{(\pi'(e))^2}{\pi'(e)c''(e) - \pi''(e)c'(e)} \frac{\partial^2 v}{\partial \tau \partial l} \tag{A.1.7}$$

Making use of equation $(A.1.4)$:

$$\frac{\partial^2 v}{\partial \tau \partial l} = \frac{w^{1-r} - (w-\psi)^{1-r}}{1-r} \frac{\partial^2 \mu}{\partial \tau \partial l} \tag{A.1.8}$$

Equation $(A.1.8)$ is negative according to point (iii) of Assumption 2 - $\partial^2 \mu / \partial \tau \partial l < 0$. Hence, $\partial^2 v / \partial \tau \partial l < 0$, which implies $\partial^2 e / \partial \tau \partial l < 0$. This proves the second statement in Lemma 1. ■

A.1.2 Proof of Proposition 1

Making use of equations (4) and (5), we derive the following tangency condition for an interior optimum:

$$\frac{\partial e}{\partial b} = -\frac{\partial e / \partial \tau}{\partial y / \partial \tau} \tag{A.1.9}$$

Equation $(A.1.9)$ defines the marginal rate of substitution between pay-for-performance and monitoring intensity. More specifically, it states that the optimal bonus/monitoring ratio is larger (smaller) the smaller (larger) the r.h.s. (l.h.s.) of equation $(A.1.9)$ with respect to its l.h.s. (r.h.s.). Recall that $\partial y / \partial \tau < 0$ according to Assumption 3. While $\partial e / \partial b$ and $\partial e / \partial \tau$ capture how workers optimally adjust their effort when b and τ increase, $-\partial e / \partial \tau$ quantifies the opportunity cost of monitoring measured in terms of coordination losses.

To prove point (i) of Proposition 1, we differentiate both sides of $(A.1.9)$ w.r.t. α. We already know that $\partial^2 e / \partial b \partial \alpha = 0$ – equation $(A.1.5)$ – $\partial^2 e / \partial \tau \partial \alpha = 0$ – equation $(A.1.6)$ – and $\partial^2 y / \partial \tau \partial \alpha < 0$ – point (ii) of Assumption 3. Given this, the exact expression of the derivative of the r.h.s. of equation $(A.1.9)$ w.r.t. α is given by $(\partial e / \partial \tau)(\partial^2 y / \partial \tau \partial \alpha)/(\partial y / \partial \tau)^2$, which is negative by Assumption 3. This implies that the l.h.s. (r.h.s.) of equation $(A.1.9)$ does not depend on (is decreasing in) α., and thus, that the optimal bonus/monitoring ratio is increasing in the manager's ability. This proves point (i) of Proposition 1.

To prove point (ii) of Proposition 1, we differentiate both sides of $(A.1.9)$ w.r.t. l. The assumption of constant returns to scale implies that q is linear in l, which can only possible if y does not depend on l in turn. Given this, the exact expression of the derivative of the r.h.s. of equation $(A.1.9)$ w.r.t. l is given by $-\partial^2 e / \partial \tau \partial l / \partial y / \partial \tau$ which is negative, since $\partial^2 e / \partial \tau \partial l$ has been proven to be negative in the Proof of Lemma 1. As to its l.h.s., we have to study the sign of:

$$\frac{\partial^2 e}{\partial b \partial l} = \frac{(\pi'(e))^2}{\pi'(e)c''(e) - \pi''(e)c'(e)} \frac{\partial^2 v}{\partial b \partial l} \tag{A.1.10}$$

and since $\partial^2 v/\partial b \partial l = 0$ according to equation $(A.1.3)$, $\partial^2 e/\partial b \partial l = 0$. Hence, the l.h.s. (r.h.s.) of equation $(A.1.9)$ does not depend on (is decreasing in) l, which implies that the optimal bonus/monitoring intensity ratio is increasing in the manager's span of control. This proves point (ii) of Proposition 1.

To prove point (iii) of Proposition 1, we need to differentiate both sides of equation $(A.1.9)$ w.r.t. ψ. According to equations $(A.1.3)$ and $(A.1.5)$, the l.h.s. of equation $(A.1.9)$ does not depend on ψ. To study the sign of its r.h.s., we need to say something about the relationship between y and ψ, which remained unspecified hitherto. In general, we see no reason to assume that the workers' output has something to do with the penalty incurred by caught shirkers. Hence, we put forward the following additional Assumption:

Assumption 4–*The workers' output, when realized, does not depend ψ, so that $\partial y/\partial \psi = 0$*

Given Assumption 4, the exact expression of the derivative of the r.h.s. equation $(A.1.9)$ w.r.t. ψ is given by $-\partial^2 e/\partial \tau \partial \psi / \partial y/\partial \tau$, which has the sign of:

$$\frac{\partial^2 e}{\partial \psi \partial \tau} = \frac{(\pi'(e))^2}{\pi'(e)c''(e) - \pi''(e)c'(e)} \frac{\partial^2 v}{\partial \tau \partial \psi} \tag{A.1.11}$$

Using equation $(A.1.4)$:

$$\frac{\partial^2 v}{\partial \tau \partial \psi} = \frac{1-r}{(w-\psi)^{-r}} \frac{\partial \mu}{\partial \tau} \tag{A.1.12}$$

which is positive provided that the penalty incurred by caught shirkers is relatively low compared to the minimum wage, which we assume throughout. Hence, the l.h.s. (r.h.s.) of equation $(A.1.9)$ does not depend on (is increasing in) in ψ, which implies that the optimal bonus/monitoring intensity ratio is decreasing in the penalty incurred by caught shirkers. This proves point (iv) of Proposition 1 ■

A.1.3 Proof of Proposition 2

Under the additional assumptions laid out in subsection 2.4, $e^*(b, \tau) = b + \tau\psi/l$, which implies that the tangency condition for an interior optimum derived in equation $(A.1.9)$ reduces to:

$$1 = \psi/l\alpha \tag{A.1.13}$$

Solving equation $(A.1.13)$ for α yields $\overline{\alpha}$. Since the marginal benefit/marginal cost ratios on both sides of equation $(A.1.13)$ do not depend on b and τ, the tangency condition for an interior

optimum is violated, which implies that pay-for-performance is marginally more (less) efficient than hierarchical control when the l.h.s. of equation (A.1.13) is greater (smaller) than its l.h.s, that is, when $\alpha > \overline{\alpha}$ ($\alpha < \overline{\alpha}$). When $\alpha > \overline{\alpha}$ ($\alpha < \overline{\alpha}$), the high-ability manager (low-ability manager) resorts to pay-for-performance only (hierarchical control only), offering workers a contract with $\tau^* = 0$ ($b^* = 0$). Plugging this in the manager's profit function estimated under the additional assumptions laid out in subsection 2.4 yields:

$$\max_{b>0} V(b) = b[(\omega_0 + \alpha) - b] - w \tag{A.1.14}$$

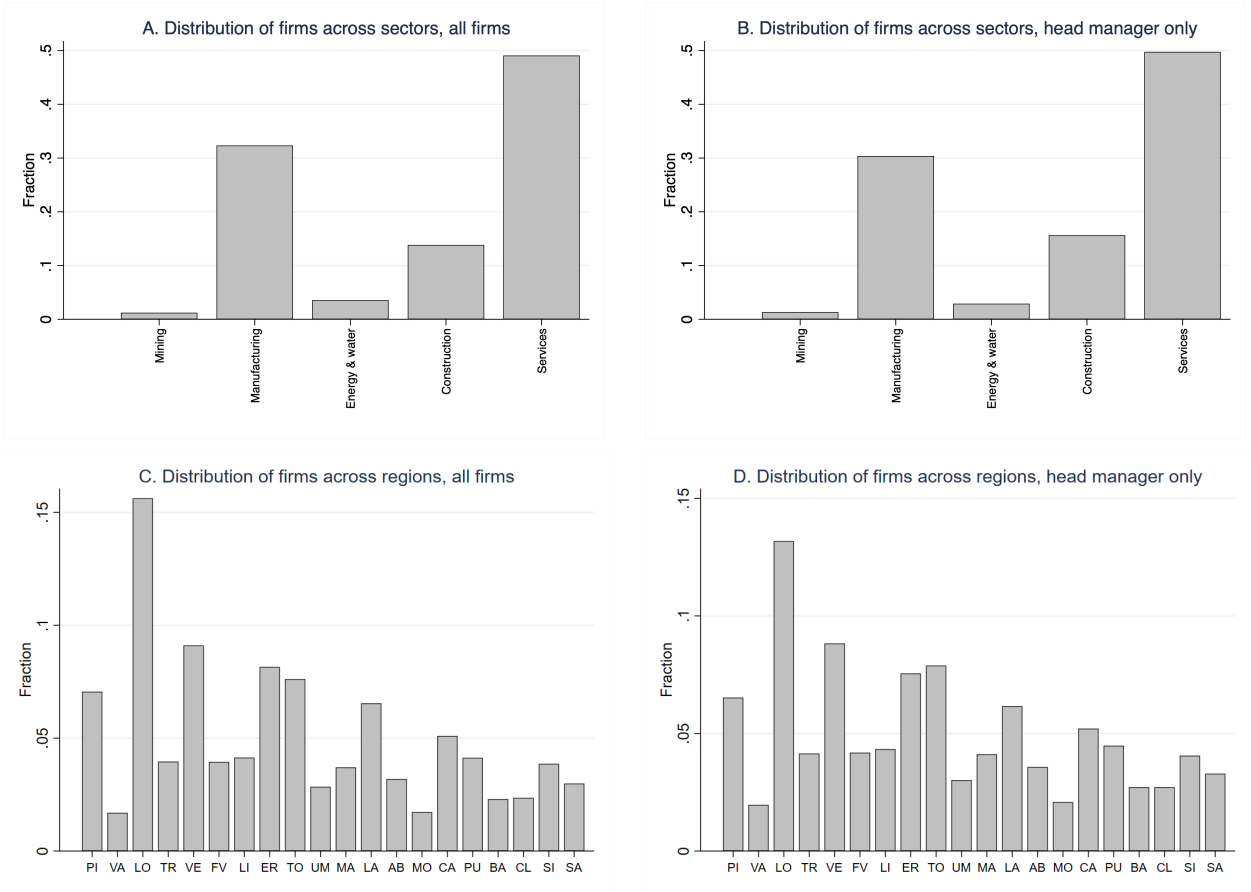
iff $\alpha > \overline{\alpha}$, and:

$$\max_{\tau>0} V(\tau) = \frac{\tau\psi}{l}[(\omega_0 + (1-\tau)\alpha] - w \tag{A.1.15}$$

iff $\alpha < \overline{\alpha}$. Maximizing equation $(A.1.14)$ w.r.t. b and equation $(A.1.15)$ w.r.t. τ yield the corner solutions put forward in Proposition 2 ■

A.2 Empirical Appendix

Figure A.2.1: Distribution of firms across sectors and industry by sample composition.



Notes: Labels of regions are as follows: "PI": Piemonte; "VA": Valle D'Aosta; "LO": Lombardia; "TR": Trentino; "VE": Veneto; "FV": Friuli Venezia Giulia; "LI"; Liguria; "ER": Emilia-Romagna; "TO": Toscana; "UM": Umbria; "MA": Marche; "LA": Lazio; "AB": Abruzzo; "MO": Molise; "CA": Campania; "PU": Puglia; "BA": Basilicata; "CL": Calabria; "SI": Sicilia; "SA": Sardegna.