Workplace organisation and incentives

What changes in the age of Big Data and Globalisation?

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Abstract

How do employers re-organise their businesses and job descriptions in reaction to the digital revolution and the arrival of the platform economy? To examine the question of business and job readjustments, we use a unified theoretical framework developed by Chentouf and Ernst (2014) to understand the joint determination of job descriptions and business organisation. In particular, we consider a country's institutional and regulatory set-up regarding education, training, collective bargaining and social protection as important determinant for how firms combine tasks to jobs and jobs to organisations. Our conceptual framework considers that the organisation of tasks and jobs depends on the various signals that provide information to the employer regarding the quality of employee commitment and the level of employee effort. We consider that the external environment in which a firm operates and the technological tools to which it has access affects both the availability and quality of signals available for performance evaluation. We test these hypotheses using the cross section in the European Company Survey (2019). In particular, we conjecture that a higher use of IT capital for performance analysis is associated with a higher share of contracts that offer piece-rate wages and high-powered incentives such as employee participation or stock option remuneration. On the other hand, companies that pursue innovative strategies in uncertain markets are likely to offer low-powered incentives through higher work autonomy and company-related variable pay.

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Introduction

The world of work is undergoing significant changes thanks to digitization and shifts in the internationalization of production. This is not only changing the location of production but also the type of tasks workers are performing as well as the way work is organised within firms. Current discussion in this field argue that digital technologies change the technical content of work, building their empirical analysis on task code books, mainly available for the United States (Autor et al., 2003). According to this literature, as robotics and digitization allow to automatize specific routine manual and cognitive tasks, human work is being re-organised to focus on its comparative advantages, i.e. those tasks that so far cannot be replaced by machines. However, this literature takes no account of the impact these technological changes have on firm-internal re-organisation of work, nor on the restructuring of international production of work. In view of the impact of digitization not only on automation of production processes but also on the capacity of firms to access more and more detailed information for surveillance purposes, we argue in this paper that this is a short-coming of the existing literature in this area.

Our argument is based on previous work by Chentouf and Ernst (2014) and considers differences in workplace organisation related to the capacity of employers to entice effort from their workers. We argue that tasks are bundled to jobs and jobs to work organisations not only on the basis of technological characteristics (that we call production complementarities) but also on the basis of whether employers can provide incentive instruments more effectively (incentive complementarities) or whether the provision of training becomes more efficient when bundling certain tasks (training complementarities). Cross-country differences in workplace management practices then arise from a country's institutional setting and would explain how firms' approach differ in terms of their training policies, incentive systems and production methods.

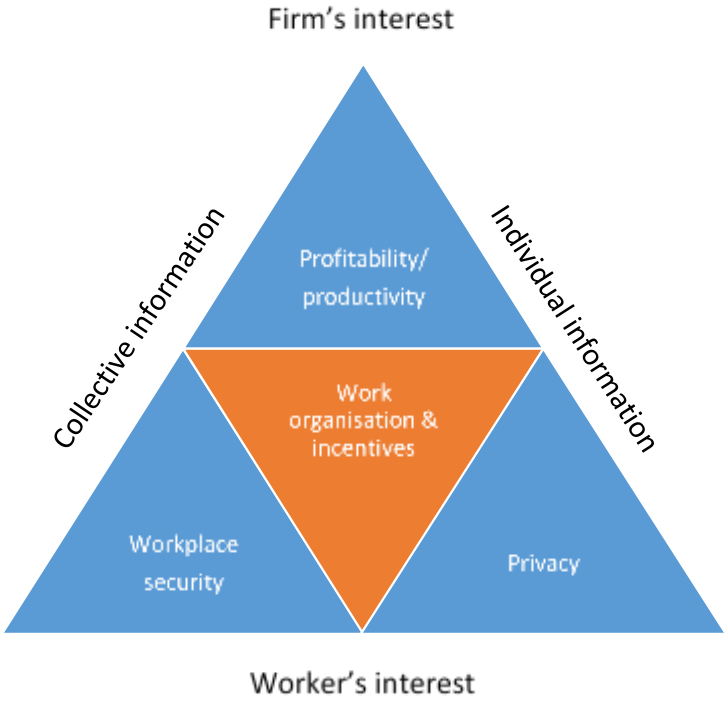
Chentouf and Ernst (2014) have argued that the way tasks are bundled to jobs and jobs are bundled to production units depend on a country's institutional set-up. The premise of their analysis was that workers enter a firm in a principal-agent relationship in which employers only imperfectly observe the effort level of a worker. In order to entice optimal effort by a worker, employers can use three different basic types of incentive mechanisms:

- **High-powered incentives** directly linked to (measurable) outcomes. These are called production incentives;
- **Medium-powered incentives** through measuring relative performance and comparison with peers. These are called tournament incentives;
- and **Low-powered incentives** through autonomy and self-determination with little direct control. These are called training incentives.

In technical terms, employers and workers invest in a relation-specific asset (the workplace) with bilateral investment (incentives/workplace organisation/safety by employers and effort/organisational learning by workers), the extent of which depends on the particular incentive mechanism chosen. We further argue that these incentive mechanisms can be mixed at different levels of a firm (for instance using production incentives at the level of individual jobs that are then combined with tournament incentives when it comes to comparing overall job performance across workers, as is done in the traditional Taylorist firm).

The organisation of the workplace, therefore, takes place at the interplay between the interest of firms and workers, using both individual and collective information (see figure 1).

Figure 1: Interests and information



As argued in a follow-up communication (Chentouf and Ernst, 2016), globalization and the use of digital platforms shifts workplace organisation in favour of a better availability of collective information, making outsourcing profitable at the expense of doing everything in-house. In such a situation, production incentives will become more important and will be sufficient to determine the optimal effort level of a worker (sub-contractor) at the expense of less investment of the firm in workplace security/safety. However, even though out-sourcing shifts the boundaries of the firm, not all tasks and jobs are susceptible to such a change, limiting the overall scope of changes in workplace organisation.

What had not been discussed in this previous work is the extent to which new technologies are giving access to additional individual information, previously not available to employers. Indeed, new supervisory technologies, such as video surveillance, calendar information and e-mail traffic text analysis, as well as the combined analysis of different sources of information through artificial intelligence allows more precise and individualised information on the performance of both the individual worker and the workplace organisation. In other words, workers do not only deliver effort signals but also allow employers to draw inferences about the organisational efficiency as a while through the way they deploy effort. Microsoft, for instance, uses calendar information regarding the timing and location of (internal) meetings to analyse and optimise meeting schedules and cubicle set-ups to minimize (physical) moving times between meetings. Jawbone (a fitness tracking company) is experimenting with linking individual health data to performances, thereby reaching deep into individual privacy rights. For the moment, this information is used at an experimental level only but there is scope for a large-scale implementation of these technologies.

Two issues arise in this regard that merit further analysis: To what extent will these new information technologies shift workplace organisation towards an increasing use of high-powered incentives (given the improved possibilities for monitoring individual performance)? And related: what opportunities do these technologies offer for enhanced autonomy (i.e. the use of more low-powered incentives) and self-organisation when properly regulated? Regulation thus understood does not try to limit the use of these new technologies but rather tries to strike a different balance between firm's and worker's interest in such a way that workers can gain increased autonomy and self-organisation (as is already the case through teleworking arrangements).

Literature review

Understanding the dynamics of tasks rather than jobs has become standard in economic analysis over the past years. In a series of articles, David Autor and his co-authors analyzed how changes in the earnings and employment distribution in the United States and other advanced economies are shaped by the interactions among worker skills, job tasks, evolving technologies, and shifting trading opportunities (Autor and Acemoglu, 2011; Autor and Handel, 2012; Autor, Levy and Murnane, 2003). Most of this work, however, looks at tasks from a purely technological point of view, defining them based on certain physical and cognitive characteristics that workers need to carry out. None of this work looks at the capacity of employers to effectively monitor and incentivize workers in carrying out their tasks. In the following, based on our previous, theoretical framework (Chentouf and Ernst, 2014) we propose a brief review of the literature regarding the relationship between the work organization and incentive policy and offer a more general view on how tasks are being allocated to jobs and jobs organized in work processes.

What is an economic organization?

Robbins (1990) states that "an organization is an economic coordination unit with identifiable boundaries and operating relatively continuously to achieve a goal or a set of goals shared by participating members". From this definition, we use three important elements for identifying the characteristics of the economic entity, such as a company: it is, first, a set of participants, second a formal coordination unit and finally it manifests an agreement among participants on some objectives.

Given a set of participants, the firm is responsible for defining individual actions and to organise their coordination within a collective framework. Theoretically, this requires two steps: First, setting up a principle of assigning tasks to individuals, second, organise individuals to form units of work. Mintzberg (1982) refers to three parameters involved in the design of individual workstations of an organization: the *specialization* of labour, *training and socialization*, and finally the *formalization* necessary for the performance of work behaviour.

The production process is divided into several stages as employees cannot carry out all of them at once. The employer assigns tasks to each employee depending on their type of specialization, specifying rights and obligations of each other in this work relationship. This establishes, in fact, the limits of the authority of the employer. This brings in the perspective of asymmetric information on the employment relationship by focusing specifically on opportunistic behaviour by both employees and employers. Hence, the extent to which the employer has all the rights on the allocation of tasks to employees impacts on the efficiency and productivity of the employment relationship.

To explain the emergence of the employment relationship, both Coase (1937) and Simon (1951) emphasized its simplicity and low cost compared to the conventional process of coordination on the

market. According to Coase, the employer is the one to choose freely the tasks to be performed by the employee "within limits". Simon speaks of a "zone of indifference" of the employee for the employer to choose the tasks at hand. This allows to achieve a flexibility in the employment relationship as the employee is required to perform, at any particular moment, a particular job based on data from the production process.

There are two cases of opportunism to which an employee might be exposed: the unilateral increase in the number or quality of tasks to be performed, for example by making them more painful and more difficult; and the exemption from certain tasks (e.g. replacing certain tasks by machines) making employment vulnerable to automation and redundancy. In theory, it would be possible to think of a detailed inventory of all the tasks that the employer can and has to ask the employee at the time of signing the employment contract. However, such a detailed description of all tasks would be very expensive, could lead to conflicts at work, and would remove all flexibility inherent in an employment relationship (Williamson, 1975).

In order to address the task assignment, Marsden (1999) sets up a series of principles to guide labour relations in order to limit the opportunism of the employer and generate adherence of employees to the employer's method of coordination. This involves setting up rules that define the type of tasks that an employer can ask an employee of a particular (job) category. These rules must meet constraints: the competence constraint and the contractual constraint. The first is to ensure a relationship between an employee's skills and technical requirements of the production process, i.e. the technical allocation of tasks. The second is to allow easy control of the obligations of each other in this relationship, i.e. to satisfy the incentive compatibility constraint. It is the latter that is typically forgotten in the current discussion on how tasks are allocated and grouped to jobs.

Firms have solved these rules to define the employment relationship differently. Focussing on the competence constraint, firms organise tasks according to the complementarity in the way they need to be carried out (the production approach, according to Lazear, 1995) or, alternatively, according to the skill level they require. The first principle refers to the fact that some tasks can be (physically) closer than others and, therefore, firms can minimize travel time by assigning them to the same employee.[1] The second, alternative principle portends that certain tasks may be complementary in terms of the training requirements they pose to the firm and firms might benefit from regrouping them according to their competence requirements rather than their production complementarities.

Neither of the two approaches tackles the incentive constraint, which can be seen as part of a wider problem of formal authority and organisational hierarchy (Mintzberg, 1982). Indeed, part of the incentive compatibility constraint are clear rules for allocation of positions of responsibility and decision-making power asymmetry between the group members in order to avoid conflicts. In this regard, employees are assigned to hierarchical ranks that are related to each other. Each rank has decision-making power and, therefore, a level of responsibility, with management to define the scope and limitations of each hierarchical rank and contributions.

In other words, the employment relation is a hierarchical relationship of a group of tasks between employer and employees that includes compensation arrangements (Menard, 1995). The employer must specify the nature of information that needs to be collected by a particular hierarchical level in

[1] See, for instance Piore (1968) who provides several examples explaining this approach in a study of organizational choices engineer's productions in the United States

order to improve the quality of decision-making (Menard, 1995). More precisely, an employment relationship consists of three elements: an allocation of tasks, a remuneration agreement in relation to the execution of the tasks by the employee, and a (hierarchical) organisation that generates information to monitor the execution of the task to an employee's effective remuneration (or his or her dismissal). In this view, incentives occupy a central point between an employee's behaviour and the type and amount of information available at the company level (Barnard, 1938).

Different organisational types can be distinguished, that allow for more or less autonomy at work. Martin (1994), for instance, notes the existence of three categories of communication networks and, therefore, coordination between different parts of the organization. *Hierarchical coordination, complex functional coordination and participatory coordination*. Coordination modes are, therefore, defined in terms of the organizational structure of the firm. The more hierarchical the coordination is the less autonomy workers have in the way they execute their tasks.

Organization and incentives

The preceding discussion suggests that work organisation and incentives cannot be separated from each other given that the way tasks are grouped to jobs and jobs to organisations influences the way incentives workers and employers face in providing match-specific investments (effort, training, etc.). Understanding the specific link between the incentives and the organizational, therefore, becomes crucial for maximizing the productivity and profitability of a company.

A company's incentive policy includes a set of factors supposed to drive (or convince) employees to join the organization and to serve its purpose. Hence, the question of the convergence of objectives of the various participants is at the heart of any organization's incentive policy.

As long as all actors in the firm share the same objectives, it becomes convenient to encourage employees to reveal their preferences and information they have. The literature has proposed two procedures in this direction: to make the resource allocation dependent on the information obtained from all participants (Croves 1974) or to share profits to improve the participation of all components of the organization (Bonin, 1976; Weitzman, 1974). In reality, however, heterogeneous preferences of workers and conflicting interests lead to heterogeneous motivations.

Indeed, preferences and motivations are generally defined in terms of employee characteristics (age, sex, education level, etc.). Take age, for instance. Younger employees tend to value training and career perspective besides the wage; older workers, however, might have a stronger preference for an immediate and sustained increase in their income. Both options may conflict with the goals of the firm, which might be to maximize short-term profits. Several aspects are of relevance in this respect: wages and benefits, training, flexibility, career perspectives ... etc.

This diversity of these factors raises questions about the relevance of their hierarchy within the firm. This will discern the priorities of the firm in managing its employees in connection with its objectives. The organizational structure of the firm seeks to identify, at least in part, these factors. Indeed, the two approaches to the design and allocation of work have different requirements in terms of incentives.

The training approach would focus investment on both sides in terms of training and skills. Thus, when the organization would require significant human capital, tasks will be allocated according to their training complementarities, and variable salary components will be linked to overall firm or team

performance rather than to individual output. At the same time, employers aim at encouraging their employees to improve their initial human capital, but also to keep them in the company, for instance by offering them greater autonomy in their work. In this regard, Aoki (1995) analysed how incentives are ordered within the Japanese firm in relation to its organizational logic.

Given these multiple aspects of any employment relationship, an obvious question arises: According to which principles should work incentives and organisation principles be defined? In our previous work, we related both to the institutional set-up of different countries. Specifically, we argued that depending on the presence and strength of trade unions, the way training is provided, or the necessity of dealing with frequent absenteeism (for instance due to family obligations) companies were led to pursue distinct approaches in setting up organisational and incentive structures (Chentouf and Ernst, 2014).

Theoretical considerations

In following, we extend the above considerations, looking at how information technology and access to task platforms ("gig work") affects the specific trade-offs involved in production, information and training externalities that we identified in our previous work. In particular, both access to new information technologies and the characteristics of the external environment affect the type of information that firms can have access to and the reliability with which a firm's management can assess individual performance, and hence incentivise workers directly (through high-powered incentives). Rather than considering either globalization and external market forces or technological innovation as mere external technical forces that shape task content and distribution as is common in the current literature[2], we try to look at it from an incentive point of view to detect the shift in both the employment relationship and the overall organisation of firms that these forces might bring.

Artificial intelligence and workplace change

A specific area where information technology has made a strong inroad in reshaping the employment relationship is regarding the use of artificial intelligence to run the platform economy. Demand and supply of specific services and micro tasks is increasingly being managed in an automated fashion through digital platforms. Whether taxi services, food delivery, business services (consultancy, document translation and treatment) or content management, service suppliers and customers can get connected by registering on specialised platforms that will aim at matching both sides of a market using sophisticated algorithms. The price of a particular service constitutes only one element among others in order to ensure high probabilities of successful matching. Past ratings that service providers achieve or delivery times and geographical proximity (as in the case of taxi services) are also taken into account. Algorithmic routines will then ensure that those with the highest probability for a match are actually being selected, reducing matching frictions. Moreover, as the user base of these platforms expand, the quality of the matches are said to improve, therefore ensuring higher user satisfaction rates and continuous use of the platform services.

So far, this platform economy seems to concentrate on particular sectors and markets.[3] However, the continuous rise in employment that is mediated through these platforms has triggered concerns that up to half of all employment might be come from platform work rather than through standard, open-

[2] Such as work by Autor et al. (2003).

[3] https://www.brookings.edu/research/tracking-the-gig-economy-new-numbers/

ended and full-time employment (McKinsey, 2016). The ensuing change in working conditions, and in particular the risk of a substantial erosion of workers' rights, in particular when services are provided internationally, has caused lively debate regarding the appropriate policy measures to address the challenges for services suppliers on these platforms (Berg et al., 2018).

What has been discussed much less is the impact of an increasing use of platform work on working conditions and, especially, on workplace organisation for those remaining in traditional forms of dependent employment relationships. Using a task-based model of work organisation as developed in Chentouf and Ernst (2014), in the following we argue that the rise of outsourcing through digital platforms is likely to change not only the stability of the employment relationship but also working conditions for those delivering labour services within companies. In particular, integrating a substantial part of outsourced services in the value chain of a company increases the likelihood of a return of Tayloristic work practices, with consequences for employee satisfaction and work density and autonomy.

In the original framework developed by Chentouf and Ernst (2014), individual tasks are characterised by the precision at which their outcomes can be measured (piecemeal tasks), the extent to which their performance can be assessed in comparison to competitors (incentive tasks) or the ease at which employees can be trained for them (training tasks). Tasks would then be bundled to jobs in order to exploit complementarities along these three dimensions. Similarly, jobs would be bundled to organisations ("firms") in order to exploit complementarities about tasks bundles ("jobs"). For instance, bundling piecemeal tasks to jobs and those jobs to organisations would result in exploiting production complementarities, following the logic of Taylor's scientific management (Taylor, 1911). The paper argues that significant cross-country differences in terms of enterprise organisation arise depending on institutional characteristics that, for instance, facilitate the exploitation of training complementarities, notably in countries with well-developed vocational training systems. Similarly, financial systems that allow for large cooperate conglomerates can facilitate the exploitation of incentive complementarities and rank-order competition among employees. In the following, we extend this framework to integrate the possibility for firms to outsource part of their work through platforms.

Hiring vs outsourcing

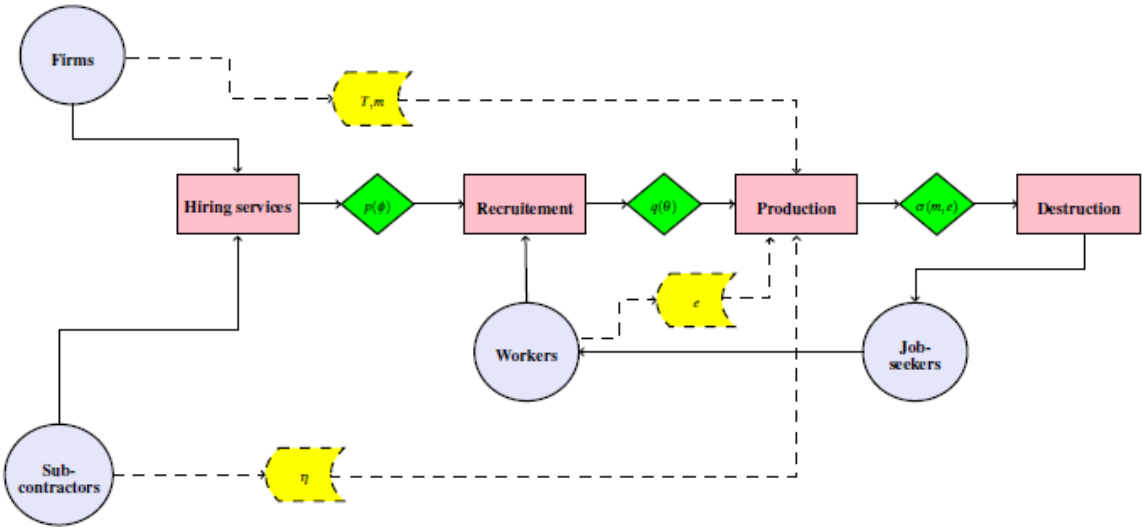
To understand the interaction between outsourcing and internal management practices, we use a multi-stage firm decision model where firms, workers and suppliers can make match-specific investments to improve the productivity of a match (see, also Haigu and Wright, 2018, who pursue a similar approach).

Our (representative) firm produces output, y, making use of outsourced services, η, and (effective) internal labour input, ξ. Effective internal input depends on a worker's effort, e , and the firm's training expenditures, T . Finally, given that the worker's effort level is non-contractual, the firm has to spend resources, m, in order to monitor its workers. Prior to starting the production process, the firm decides upon a minimum quality standard for outsourcing services, $\eta > \bar{\eta}$, depending on technological requirements, as well as a work organisation scheme, ξ(e, T) , to organise its stream of production: y=f(η , ξ (e, T)) which will stop with (endogenous) match-destruction probability: σ = σ (e, m). We have ξ := ξ (e, T) as the effective labour input arising from organising incentives, m, and setting up training programs, T , to stimulate workers' effort, e. We assume that $\xi(0, T)=0; \xi(e,0)>0$ and ξ_e , ξ_T, $\xi_{e,T}$ >0 . Moreover, we have $y_\eta > 0$, $y_{\eta,\xi} > 0$.

Market frictions, work organisation and production

In order to organise production, firms need to meet with subcontractors and hire workers, both of which can be described as matching processes with frictions. On the market for subcontractors, F firms randomly match with S subcontractors. From the point of view of the firm, the matching probability, p, depends on the liquidity of the subcontracting market ϕ = F/S with p=p(ϕ), p'<0 . On the labour market and abstracting from job-to-job transitions, firms post vacancies, V, to be filled by jobseekers, U. The matching probability with which firms can expect to fill their vacancies, q(θ), depends on the liquidity of the labour market, θ = V/U with q=q(θ), q'<0. The production process eventually breaks apart with probability σ, depending on the effort, e, deployed by the worker and the incentive structure, m , set up by the firm, σ = σ (e, m). Finally, prior to matching with subcontractors and going through the hiring process, firms first need to agree on a minimum sub-contracting quality, $\bar{\eta}$, set up its monitoring structure, m, and invest in training expenditures, T. The following flow diagram illustrates how the flow of production operates (see figure 2 below):

Figure 2: A stylized model of outsourcing



The value of a firm

In order to solve the model, we need to solve for the value of the firm, the subcontractor and the worker at each step of the production flow, i.e. at the entry stage when matching with subcontractors (stage '0'), at the stage when matching with subcontractors (stage '1'), at the production stage (stage '2') and when exiting (stage '3'). Matching with sub-contractors, the firm enters with flow probability p(ϕ) , moves to the production stage with flow probability q(θ) and exits with flow probability σ(m, e). Considering the firms need to spend entry costs c and leave no valuable assets after the break-up, i.e. F_3 =0, the value functions of the firm at the different production steps then write as:

$$\begin{aligned} r \cdot F_0 &= -c + p(\phi) \cdot (F_1 - F_0) + \dot{F}_0 \\ r \cdot F_1 &= -T - m + q(\theta) \cdot (F_2 - F_1) + \dot{F}_1 \\ r \cdot F_2 &= y(\bar{\eta}, \xi(e,T)) - w - \rho + \sigma(m,e) \cdot (F_3 - F_2) + \dot{F}_2 \\ F_3 &= 0 \end{aligned}$$

where F_0: value of the firm at market entry, F_1: value of the firm after having met with the subcontractor, F_2: value of the firm at the production stage and F_3: the exit value of the firm. At the production stage, firms pay a wage w to their workers and pay a fee ρ to their subcontractors. Training expenditures, T, and human resources management policies (e.g. incentives, monitoring, etc.) m are both being spent prior to matching a potential worker.

The value of subcontractors

Subcontractors need to make similar decisions regarding their entry into the market. Upon entry, subcontractors spend entry fees k and decide on service quality, η, before matching with a company. They will deliver their services at cost, γ , before receiving a payment stream, ρ, provided their quality matches the minimum quality standards, $\bar{\eta}$. Once the production process is dissolved, the remaining assets of the subcontractor are valued at zero, S_3=0.

$$\begin{aligned} r \cdot S_0 &= -k - \eta + \phi \cdot p(\phi) \cdot (S_1 - S_0) + \dot{S}_0 \\ r \cdot S_1 &= -\gamma + q(\theta) \cdot (S_2 - S_1) + \dot{S}_1 \\ r \cdot S_2 &= \rho(\eta \geq \bar{\eta}) + \sigma(m, e) \cdot (S_3 - S_2) + \dot{S}_2 \\ S_3 &= 0 \end{aligned}$$

Similar to the firm process, the subcontractor solves its entry and quality decisions by maximizing the asset values, S_0, S_1 and S_2.

The value of workers

Workers experience only two different stages in the production process: Either they work, W, or they are looking for job opportunities, U. Without loss of generality, we assume that workers cannot be subcontractors and vice-versa. Then, the two asset functions for periods of work and unemployment can be written as:

$$\begin{aligned} r \cdot W &= w - e + \sigma(m, e) \cdot (U - W) + \dot{W} \\ r \cdot U &= b + \theta \cdot q(\theta) \cdot (W - U) + \dot{U} \end{aligned}$$

where *e* denotes the cost of effort whereas *b* indicates the replacement income (e.g. from unemployment benefits) while the worker is searching around for alternative opportunities.

In equilibrium when the dynamics have played out, i.e. $\dot{W} = \dot{U} = 0$, we can derive the value of a job to workers as:

$$J^W \equiv W - U = \frac{w - e - b}{r + \theta \cdot q(\theta) + \sigma(m, e)}.$$

Match-specific investments

In order to determine the equilibrium conditions, we first need to solve for the match-specific investments that firms, subcontractors and workers are undertaking.

Firms' incentive investments and effort decision by workers

In order to determine the optimal incentive investment, *m**, a firm deploys, we need to solve for the worker's optimal effort decision. Let us assume that the match-destruction probability is additive

separable in incentive investment and effort: $\sigma(m,e) = \tilde{\sigma}_1(m) + \tilde{\sigma}_2(e)$ with $\tilde{\sigma}'_1 > 0, \tilde{\sigma}'_2 < 0$. Then the optimal monitoring by the firm solves:

$$m^* = \min\left\{ m \middle| W(e=1,m) \stackrel{!}{=} W(e=0,m) \right\}$$

which yields the optimal monitoring effort of:

$$m^* = \tilde{\sigma}_1^{-1}\left[\frac{r + \theta \cdot q(\theta) + \tilde{\sigma}_2(0)}{(w-b)(\tilde{\sigma}_2(0) - \tilde{\sigma}_2(1))}\right]$$

Incentive efforts will increase as the value of the outside option rises for workers, which is proportional to $\theta \cdot q(\theta)$. At the same time, the higher the wage premium of the current job, *w-b*, and the better effort deployed can maintain the match relationship, i.e. the higher $|\tilde{\sigma}_2(0) - \tilde{\sigma}_2(1)|$, the less incentive effort the firm has to spend.

Optimal sub-contracting quality

The subcontractor maximises:

$$\eta^* = \arg\max S_0$$

Given that entry costs rise in a linear manner with quality standards and that only a minimum quality is required, the subcontractor will optimally choose $\eta^* = \bar{\eta}$.

Optimal training expenditures

The firm selects training expenditure according to:

$$T^* = \arg\max(F_1 - F_0)$$

hence:

$$\frac{\partial \frac{q(\theta)\cdot\frac{y(\eta,\xi(e,T))-w-\rho}{r+\sigma(m,e)} - T - m}{r+q(\theta)}}{\partial T} = 0 \Rightarrow \frac{\partial y}{\partial T} = \frac{r+\sigma}{q(\theta)}$$

Therefore, the higher the interest rate and the break-up probability and the tighter the labour market – i.e. the higher θ – the lower will be match-specific investments in technology. This implies a trade-off between monitoring and training: The higher monitoring efforts and the higher the match-destruction probability, the lower the training investment the firm will deploy.

Equilibrium

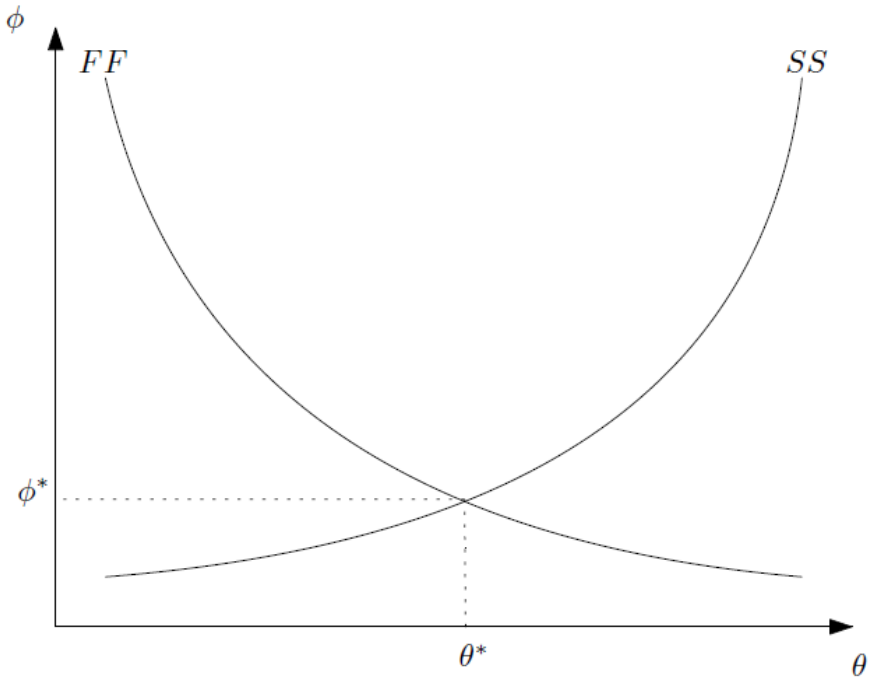
The equilibrium is attained when asset values do not change any more, i.e. $\dot{F}_i = \dot{S}_i = \dot{W} = \dot{U} = 0$, where i ∈ {0,1,2,3}. The above model can then be solved by considering the free-entry conditions for both firms and subcontractors: $F_0=0$, $S_0=0$. In the appendix A.1, we derive the equilibrium schedules for subcontracting and firm entry as:

$$SS: \frac{k+\eta^*}{\phi \cdot p(\phi)} = \frac{q(\theta) \cdot \frac{\rho}{r+\sigma(m,e)} - \gamma}{r+q(\theta)}$$

$$FF: \frac{c}{p(\phi)} = \frac{q(\theta) \cdot \frac{y(\eta,\xi(e,T))-w-\rho}{r+\sigma(m,e)} - T - m}{r+q(\theta)}$$

Simple inspection shows that the FF-schedule is downward-sloping in the (ϕ, θ)-quadrant whereas the SS-schedule is upward-sloping as depicted in the following chart (see Figure 3 below):

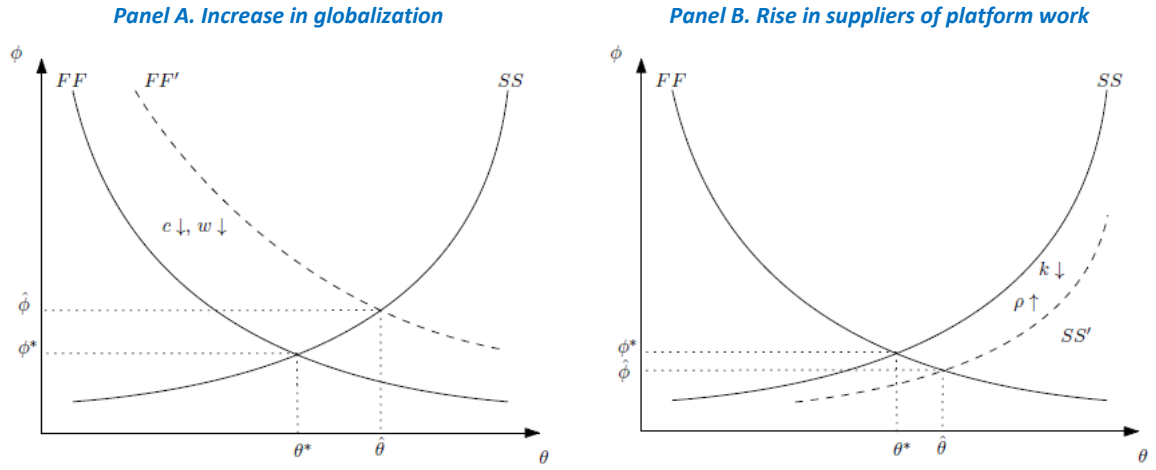
Figure 3: Equilibrium in the sub-contracting market



Comparative statics

The equilibrium in figure 3 is shifted by falling entry costs of firms, c, and the rise of suppliers of platform work, k. Panel A and B of Figure 4 below show important differences in the way platform work reacts to such changes that might result from a rise in either globalization or the number of platform workers. As firm entry costs, c, fall with globalization (Figure 4, panel A) both demand for platform work and dependent employment increase, leading to lower un-/under-employment for both types of services. In contrast, when the number of platform workers increase, for instance due to lower set-up cost for platforms, k, demand for dependent employment still increase but under-employment on platforms increase as total demand for their services does not increase in line with their rise in supply (Figure 4, panel B).

Figure 4: Globalization vs rise in platform work



In Chentouf and Ernst (2016) we argue that these changes in market composition between gig work and dependent employment do not only have an effect on the overall demand for these labour services. They will also affect the way, companies are organised and how tasks are bundled to jobs. In particular, they argue that platforms have lowered the sub-contracting costs, thereby increased sub-contracting and total labour demand, but at the cost of decreased incentives to invest in training of their employees (as external services can be hired more easily). Most importantly, the increase in the availability of gig work lowers the need for incentive pay and employee monitoring. This will push companies to resort more to bundling tasks according to production complementarities. In other words, companies will revert to a Tayloristic management approach with the increasing availability of gig work. On the other hand, in countries with well-developed vocational education systems where firms traditionally rely on training complementarities, they are likely to demand higher sub-contracting standards, which lowers the overall demand for sub-contracting.

Data and methodology

We make use of the European Company Survey, 2019 (ECS). Specifically, we make use of the information contained in the survey on firms' product market strategies – innovation, share of e-commerce, international sales – and their internal incentive and workplace management practices. At this stage, we do not make use of the employee representation information that could yield additional insights into the role of social dialogue and employee-employer negotiations.

Methods

We exploit the survey design of the ECS and perform stratified ordered logistic regressions, controlling for country and sector fixed effects. We also perform principal component analysis of incentive strategies, companies' pay structure and workplace organisation to detect commonalities across companies between different incentive structures and work organisation principles.

We run two sets of regressions, one to analyse the impact of a firm's external (competitive) environment on its incentive structure and workplace management, the other one to analyse the impact of a firm's internal technological set-up:

$$y_i = \alpha + \beta \cdot External_i + \gamma \cdot Control_i + D^{Sector} + D^{Country} + \varepsilon_i$$

$$y_i = \alpha + \beta \cdot Technology_i + \gamma \cdot Control_i + D^{Sector} + D^{Country} + \varepsilon_i$$

where y_i: incentive instruments/variable pay components/workplace practices; $External_i$: product market characteristics; $Technology_i$: Company use of robots/IT equipment; $Control_i$: Age/Firm size/Number of hierarchical levels/E-commerce/International sales; D^{Sector}: sector dummies; $D^{Country}$: country dummies.

Given the ordinal character of the responses, y_i, provided in the ECS regarding the use of different incentive instruments and workplace organisation principles, we use ordered logit regressions to estimate these equations.

Hypotheses

To bring our theoretical considerations to the data, we aim at answering the following questions:

1. Globalization, innovation, e-commerce and firm characteristics:
    a. How do market conditions determine firms' innovation strategies?
    b. How are firms' internal characteristics linked to their innovation strategies? Which forms of innovation are linked to what type of firm characteristics?
    c. What determines whether a company engages in e-commerce?
2. Firm characteristics and incentives:
    a. Which forms of incentive strategies are firms using? Are there factors common to all incentive strategies? What forms of high-, medium- and low-powered incentives are available to firms?
    b. What determines the use of these different incentive forms? How do firm internal characteristics and the external environment related to these different forms of incentives?
    c. How does the external environment such as market competitiveness and the use of information and communication technologies (ICT) influence different forms of variable pay?
    d. What type of training opportunities and group-level incentives are being used?
3. Autonomy and team work:
    a. Which forms of work organisation and autonomy do firms engage in?
    b. How does the external environment of a firm affect internal organisation principles?
    c. What role does ICT capital play in firms' organisational structure? In particular, is there are trade-off between managerial oversight and IT-based HR performance analysis?

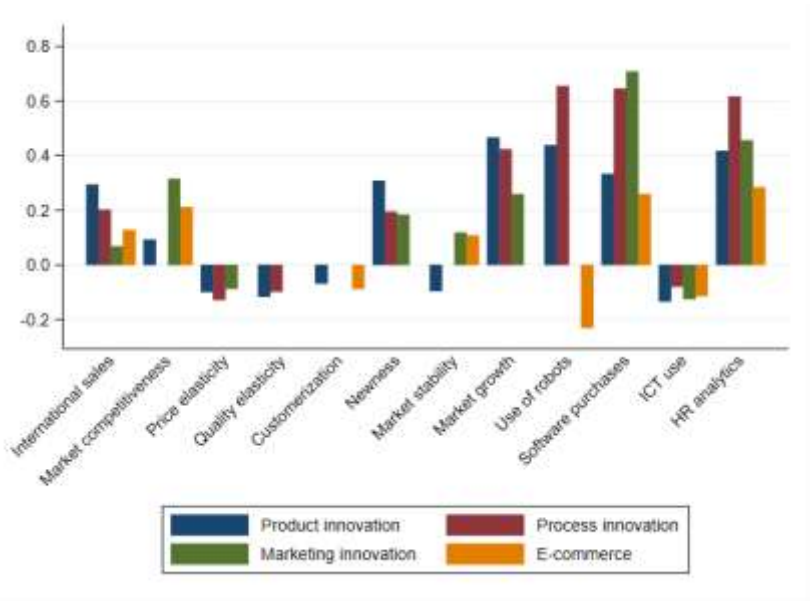
Results and interpretation

Firm characteristics

Before looking into specific incentive strategies, it is useful to get a better sense of companies' innovation strategies and their determinants in the survey. Using the survey information, we can distinguish for innovation strategies: Whether companies are pursuing innovations along the product, process or marketing dimension and whether companies are pursuing an e-commerce strategy or not. We match these four innovation strategies against a range of determinants covering the international exposure, market competitiveness, customer preferences, market growth and stability as well as the extent to which companies rely on ICT capital (see Figure 5). As we use ordered logit regressions coefficients are directly comparable in their strength across specifications. With the exception of the use of robots and market stability, all determinants go in the same direction across different

innovation strategies. Nevertheless, the impact of their strength varies significantly. Software purchases and HR analytics seem to be particularly relevant for process innovations while an international orientation and strong market growth is important for product innovations. In contrast, when markets are highly competitive and stable (i.e. saturated), marketing innovations and e-commerce strategies become important. In other words, firms' external and internal environments shape their innovation strategies and hence will have an impact on the type of incentive instruments that they are going to pursue. In the next sub-section, we take a closer look whether different patterns across incentive instruments emerge.

Figure 5: Determinants of firms' innovation strategies



Note: The chart shows the estimated probabilities for different innovation strategies depending on market characteristics and firms' use of IT capital. Estimates are derived from ordered logit regressions without country or sector dummies. Only significant coefficients are depicted.

Principal component analysis of firm's incentive structure and work organisation

The European Company survey offers a rich picture of different incentive instruments and work organisation principles that companies have at their disposal. We distinguish three different type of instruments and organisational types here and in the rest of the empirical work:

(i) Top-level instruments following our logic of high-/medium-/low-powered incentive instruments that we associate with monetary rewards, mission statement/challenging work and learning opportunities respectively;
(ii) Variable pay instruments and the link towards individual, team or company performance;
(iii) The degree of work autonomy and the organisation of work in teams.

In order to identify whether the different incentive and work organisations show systematic differences across companies, we run principal component analysis for all three categories (Figure 6-Figure 8). In all three cases, four distinct factors can be detected, where the fourth factor typically only represents less than 15% of the total variance. The different incentive instruments can be neatly associated with different levels of incentive strength moving up from individual level to team to company level incentives. In the case of top-level instruments (Figure 6) and variable pay (Figure 7) a common factor can be detected (label "incentive use" in Figure 6 and "common factor" in Figure 7)

that is associated with more than 50% of the variance of all four variables. Only in the case of work autonomy can one detect four distinct factors ranging from “machine pace” (i.e. no autonomy) to individual autonomy, working time autonomy and team autonomy (see Figure 8). This suggests that firms can be distinguished as to whether they use incentive instruments (or not at all) whereas organisational principles around autonomy at work has a much more discriminative power across companies. In the next sub-section, we will analyse the impact of firm characteristics on these different incentive instruments and organisational principles in more detail.

Figure 6: Factor loadings for incentive use

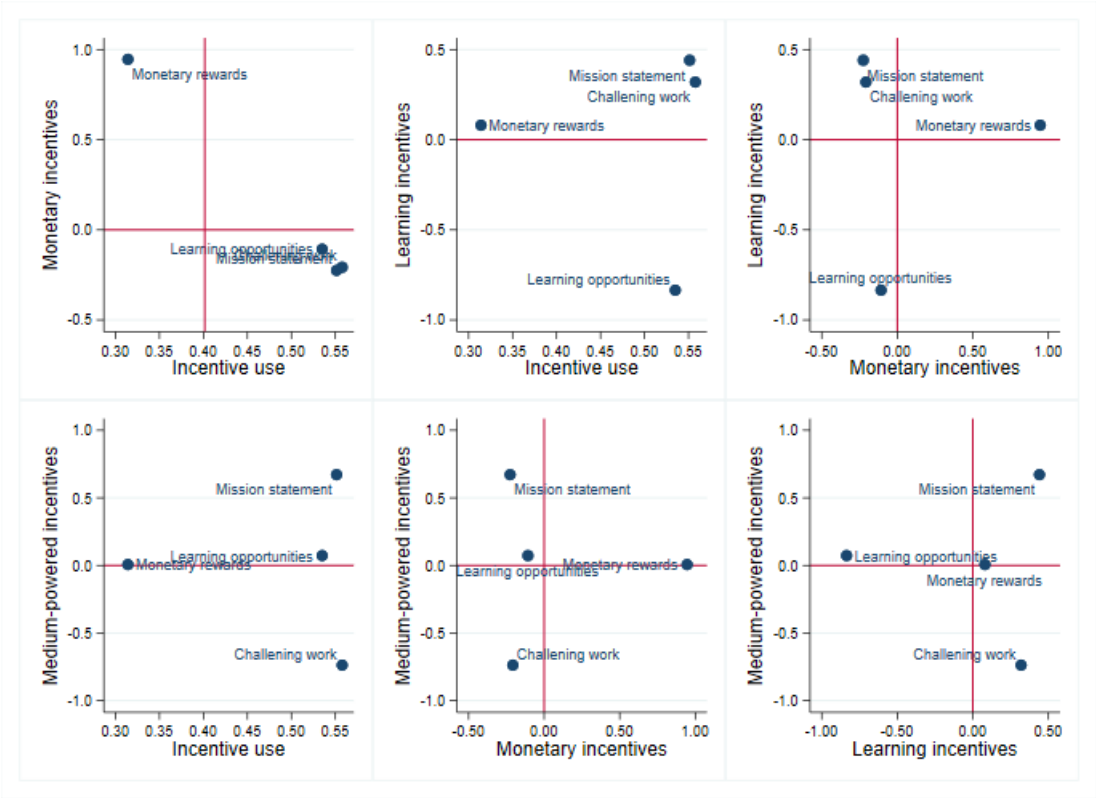


Figure 7: Factor loadings of variable pay indicators

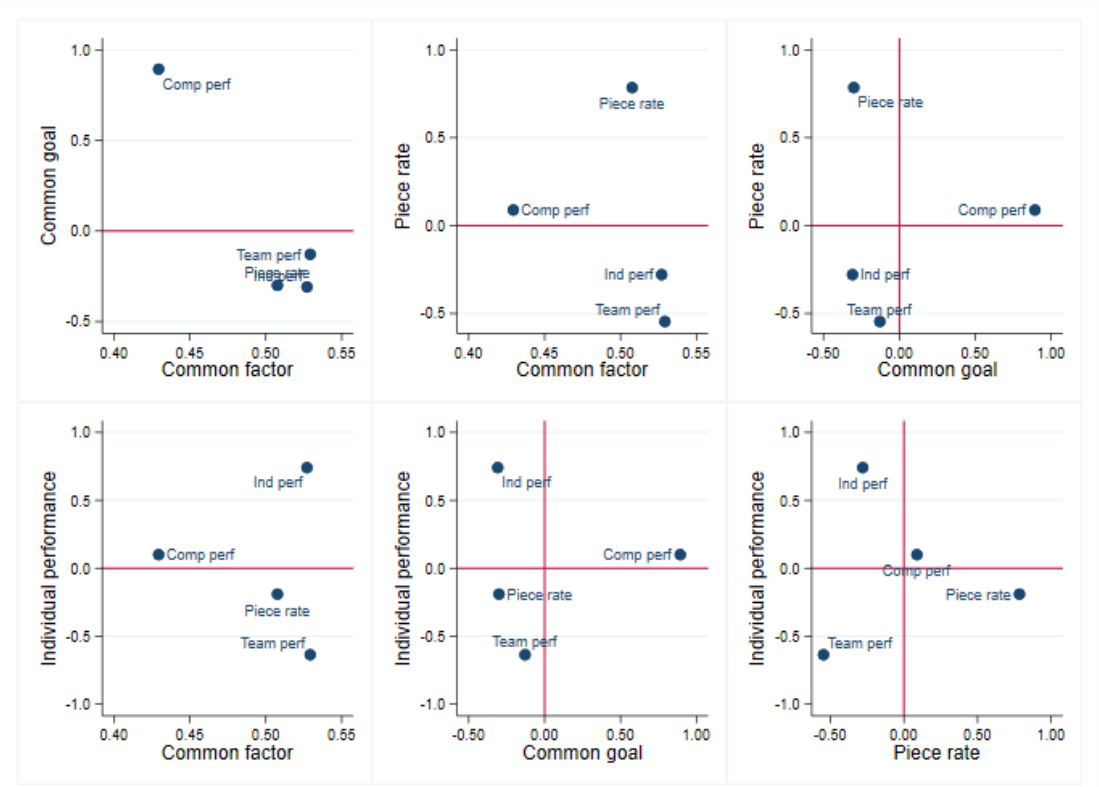
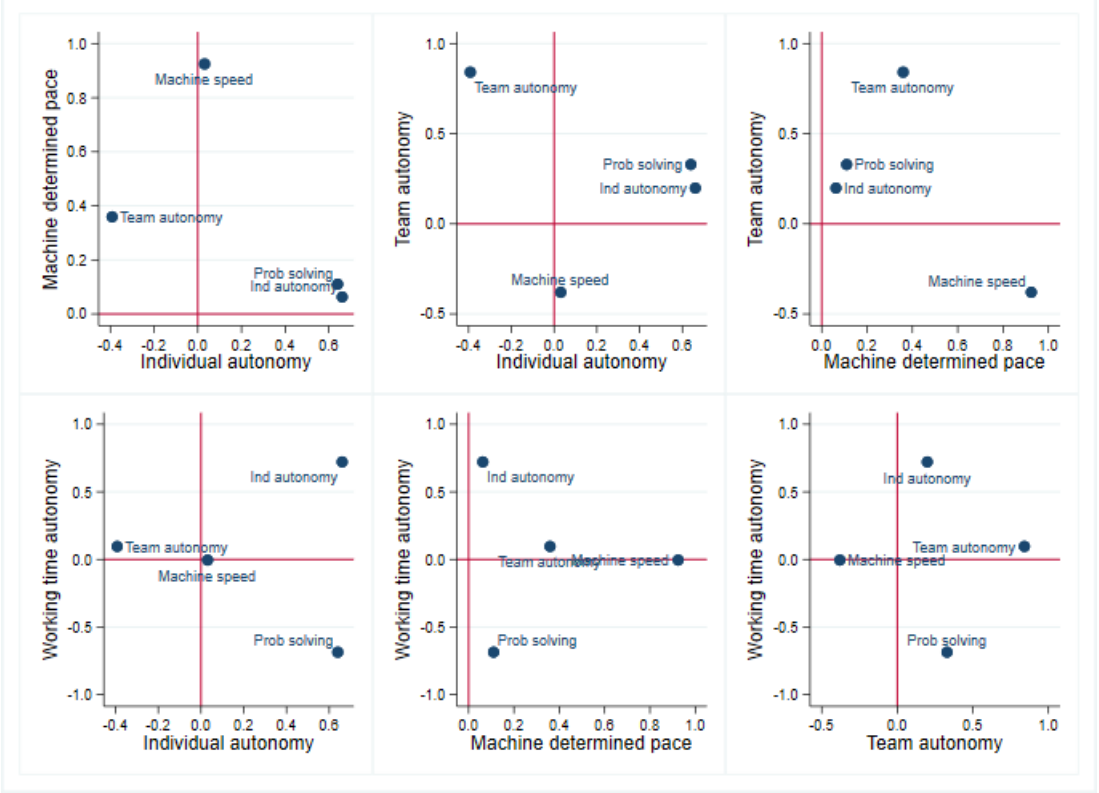


Figure 8: Factor loadings of work autonomy



What determines firm's use of incentives and work organisation?

Tables 2 to 7 in Annex A.4 summarize our findings for the use of different incentive instruments and work structures, including teamwork, autonomy at the work place and IT surveillance. Tables 2, 4 and 6 report the results regarding the impact of a firm's external environment on these different elements, whereas tables 3, 5 and 7 report a firm's internal structure, including the number of hierarchical levels, a firm's size and age and the use of robots and IT equipment to shape the workplace. Table 1 provides an overview of the variable coding for ease of interpretation of the empirical results. In the following, we discuss the main findings in relation to our theoretical considerations discussed in the first part of the paper.

Moving to an online presence or increasing a firm's international sales ("ecommerce") can be linked to a higher prevalence of monetary rewards but also to more problem-solving autonomy (columns (1) and (2) in table 2; columns (9) and (10) in table 6). The latter seems to be particularly important when firms need to customize their product or services or introduce innovations. In contrast, when focusing on price-sensitive of products and services – typically those with less unique features – problem-solving autonomy becomes less relevant. At the same time, a firm that focuses on innovative products and services is also more ready to use all forms of incentive instruments, especially through providing meaningful missions and a challenging work environment (columns (5) and (6) in table 2).

Product market volatility plays an important role in determining which type of incentive instruments a firm is using (table 2). In particular, more predictable demand leads to a higher prevalence of the use of any incentive instrument, as well as the use of variable pay based on individual and team performance (columns (3)-(6) in table 4). On the other hand, more predictable demand is only weakly related to machine-paced work (columns (1) and (2) in table 6), suggesting that firms do not necessarily translate the economic environment into specific workplace arrangements. Besides product market volatility, the degree of market competition is also a strong determinant of the use of incentives: More competitive markets increase the use of incentives across the board and strengthen the use of variable pay, in particular piece-rate pay (table 2 and columns (1) and (2) in table 4). In contrast to product market volatility, more competitive markets lead to a higher prevalence of machine-paced work, possibly because of the link between market competitiveness and the extent to which companies sell internationally (table 6).

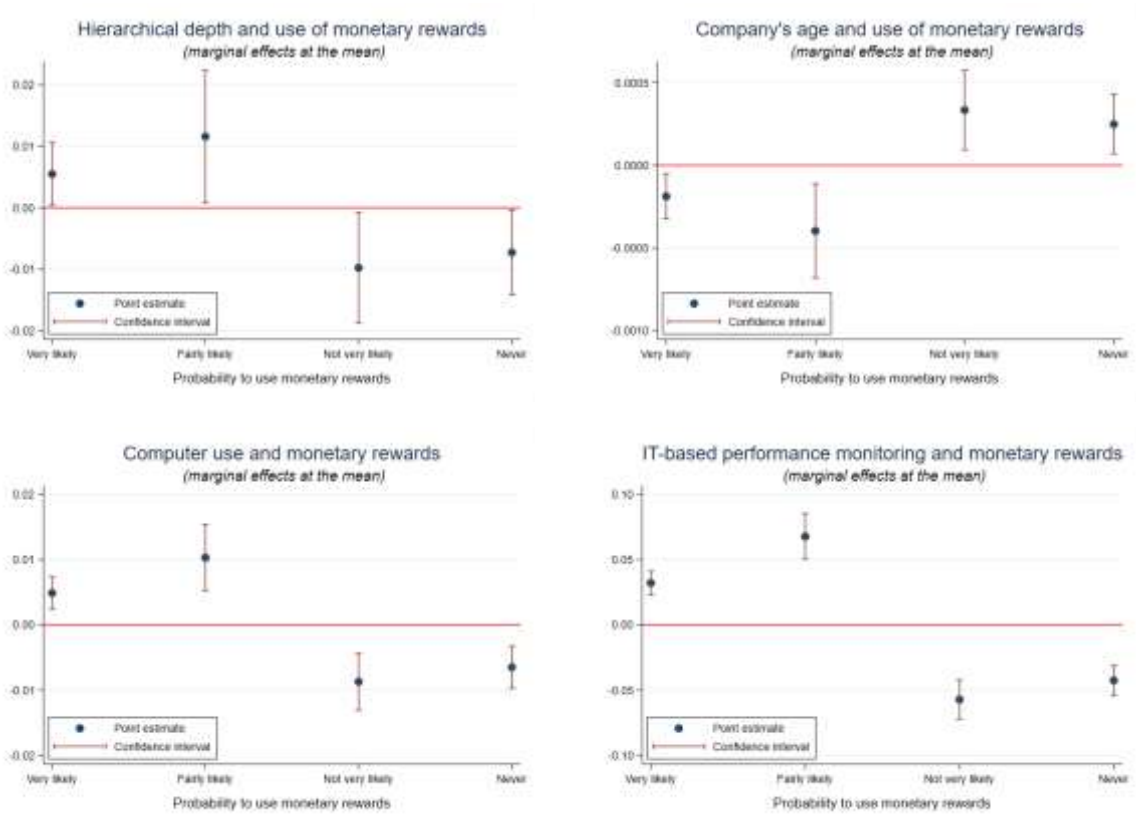
Regarding a firm's internal structure, the use of robots is directly linked to a higher prevalence of machine-paced work (table 7, columns (1) and (2)) but does not seem to have any impact on variable pay or the different use of motivational tools (tables 5 and 3 respectively). In contrast, when firms make more use of IT, for instance through the use of computers and specialised IT software, the prevalence of incentive tools increases as does the incidence of variable pay of any kind. This seems mostly linked to the fact that IT equipment is being used as a means to monitor more directly workers' performance through data analytics.

In this respect, increasing use of data analytics for HR performance management leads to a higher prevalence of team work and higher problem-solving autonomy but less team autonomy in organising their time and tasks. It also is negatively associated with the share of managers in a company (table 7 columns 11 and 12), suggesting that HR analytics are substituting – at least partially – for direct managerial oversight, in line with some discussions in the literature on artificial intelligence (Ernst et al., 2019).

Interpretation of results

Figure 9 provides a summary illustration of the key aspects of our results. First, it seems that a firm's characteristics such as its age and internal use of IT equipment determines the type of incentive tools being used across the board. In particular, the use of IT equipment – and specifically the deployment of data analytics for performance management – seems to be associated with more direct performance incentives and less autonomy. The only exception concerns problem solving autonomy, which might be linked to the more easily accessible way in assessing performance outcomes when data analytics can be used. This is also validated by the fact that managerial density is lower when more IT-related performance assessment is used, although from the data one cannot determine which type of managerial oversight (top vs middle management) is being reduced.

Figure 9: Firm's internal structure, use of IT and monetary rewards



Note: Marginal effects at the mean based on ordered logistic regression with country and sector fixed effects.

A second important insight from the data concerns a firm's external environment. While the competitiveness of a market in which a firm operates plays an important role, so does the complexity of the market environment. More export-oriented companies with a larger online presence allow for more work autonomy but also link a worker's pay more to companywide targets than piece-rates, thereby providing less-powered incentives. Whenever a market environment is highly predictable, more direct, high-powered incentives are being used. Similarly, for more competitive markets and those where price-elasticity is high, variable pay is more directly linked to individual performance and machines are pacing the rhythm of work rather than team decisions. On the other hand, in complex environments where companies focus on the introduction of new products and services, medium- and

low-powered incentives are being preferred while still introducing an element of variable pay but linked to companywide performance.

Conclusion

In conclusion, both a firm's internal structure and access to technology as well as its external environment play a significant role in the way incentives are being deployed and workers can benefit from relative autonomy. Given the cross-sectional approach we are pursuing in this paper, no attempt has been made to assess the extent to which country-specific institutions such as the access to training facilities, the strength of trade unions or different tax regimes play a role in the use of specific incentive instruments and workplace organisation methods. In particular, a more detailed analysis of the importance of country-specific institutional arrangements such as those suggested by Bloom et al. (2012) could help to better understand the particular relationship between a company's innovation strategy as discussed in figure 5, the institutional environment and the specific incentive structure and workplace management practices available to a company. We leave this to further research.

References

Anderson, E.; Couglhan, A. T. 2002. “A Channel management: structure, governance and relationship management”, in Handbook of Marketing, London, Sage publications, pp 224-247.

Aoki, M. 1995. “An evolving diversity of organizational mode and its implications for transitional economies”, Journal of the Japanese and international economies, N9, pp 330-353.

Aubert, B.A.; Rivard, S.; Patry, M. 2004. “A transaction cost model of IT oursourcing”. Information & Management, Vol. 41, No. 7, pp. 921-932.

Autor, D. H.; Acemoglu, D. 2011. “Skills, Tasks and Technologies: Implications for Employment and Earnings”, in Handbook of Labor Economics, Volume 4b, Chapter 12.

—; Handel, M. T. 2012. “Putting tasks to the test: Human capital, job tasks, and wages”, in Journal of Labor Economics, Vol. 31, No. 2, pp. S59-S96.

—; Levy, F.; Murnane, R. J. 2003. “The skill content of recent technological change: An empirical exploration”, in *Quarterly Journal of Economics*, Vol. 118, No. 4, pp. 1279–1333.

Barnard, C. 1938. “The Function of the Executive”, Reedition: Harvard University Press (1968).

Barney, J. 1991. “Firm Resources and Sustained Competitive Advantage”. Journal of Management, Vol. 17, No. 1, pp. 99-120.

Bloom, N. 2013. “Does management matter? Evidence from India”, in *The Quarterly Journal of Economics*, Vol. 128, No. 1, pp. 1-51.

—; et al. 2012. “Management practices across firms and countries”, in Academy of Management Perspectives, Vol. 2, No. 1, pp. 12-33.

Bonin, J.-P. 1976. “On the design of managerial incentives structures in decentralized planning environment”, American Economic Review, Vol 66, No. 4, pp. 687-700.

Boyer, K. K.; Lewis, M. W. 2002. “Competitive priorities: Investigating the need for tradeoffs in operations strategy”. Production and Operations Management 11 (1), 9-20.

Cappelli, P.; Keller, J. 2013. “Classifying work in the new economy”, in Academy of Management Review, Vol. 38, No. 4, pp. 575-586.

Capron, L.; Mitchell, W. 2004. "Where firms change: Internal Development Versus External Capability Sourcing in the Global Telecommunication Industry”, in European Management Review, Vol. 1, No. 2, 157-174.

Carr, N. G. 2004. “Does IT matter? Information Technology and the Corrosion of Competitive Advantage”, Boston: HBS Press.

Chamberland, D. 2003. “Is it core strategic? Outsourcing as a strategic management tool”. Ivey Business Journal Online (Jul/Aug), 1-5.

Chentouf, L.; Ernst, E. 2014. “Workplace organisation and incentives”. Global and Local Economies Review, Vol. 18/1, pp. 103-135.

—; —. 2016. *Workplace Organisation and Incentives in the New Industrial Revolution*. Communication given at the Society for the Advancement of Socio-Economics, San Francisco.

Chiles, T. H.; McMackin, J. F. 1996. “Integrating variable risk preferences, trust, and transaction cost economics”, in Academy of Management Review, Vol. 21, pp. 73-99.

Coase, R. 1937. “The nature of the firm”, in Economia, pp. 389-405.

Ernst, E.; Merola, R.; Samaan, D. 2019. The economics of artificial intelligence. Implications for the future of work. Journal of Labor Policy, Vol. 9, No. 1, pp. 7-72.

Espino-Rodriguez, T. F.; Padrón-Robaina, V. 2006. ”A review of outsourcing from the resource-based view of the firm”, International Journal of Management Reviews, Vol. 8, No. 1, pp. 49–70.

Ettlie, J.E.; Sethuraman, K. 2002. “Locus of supply and global manufacturing”. International Journal of Operations & Production Management, Vol. 22, No. 3, pp. 349-370.

Gottfredson, M.; Puryear, R.; Phillips, S. 2005. “Strategic Sourcing: From Periphery to the Core”. Harvard Business Review, Vol. 83, No. 2, pp. 132-139.

Hagiu, A.; Wright, J. 2018. “Controlling versus enabling”, in Management Science, Vol. 65, No. 2.

Heide, J.B; John, G. 1992. “Do norms matter in marketing relationships?” Journal of Marketing, Vol. 56, No. 2, pp. 32–44.

Holcomb, T.R.; Hitt, M. A. 2007. “Toward a model of strategic outsourcing”. Journal of Operations Management,, Vol. 25, No. 2, pp. 464-481.

Insinga, R. C.; Werle, M. J. 2000. “Linking outsourcing to business strategy”. The Academy of Management Executive, Vol. 14, No. 4, pp. 58-70.

Kakabadse, A.; Kakabadse, N. 2000a. “Sourcing: new face to economies of scale and the emergence of new organizational forms”. Knowledge and Process Management, Vol. 7, No. 2, pp. 107-118.

—;—. 2000b. “Critical review - outsourcing: A paradigm shift”, in The Journal of Management Development, Vol. 19, No. 8, pp. 670-728.

—;—. 2003. “Outsourcing best practice: transformational and transactional considerations”. Knowledge and Process Management, Vol. 10, No. 1, pp. 60- 71.

Kathuria, R. 2000. “Competitive priorities and managerial performance: A taxonomy of small manufacturers”, in Journal of Operations Management, Vol. 18, No. 6, pp. 627-641.

Kern, T.; Willcocks, L. 2002. “Exploring relationships in information technology outsourcing: The interaction approach”, in European Journal of Information Systems, Vol. 11, No. 1, pp. 3-19.

Kittur, A. et al. 2013. “The future of crowd work”, in Proceedings of the 2013 conference on Computer supported cooperative work, available at: https://www.researchgate.net/publication/255969848_The_Future_of_Crowd_Work

Lazear, E. 1995. *Personnel Economics*, (Cambridge, MA., MIT Press).

Macneil, I. R. 1980. *The New Social Contract: An Inquiry into Modern Contractual Relations*, (New Haven, Yale University Press).

Marsden, D. 1999. *A Theory of Employment Systems. Micro-Foundations of Societal Diversity*, Oxford University Press, Oxford

Martin, C. 1994. *Management global de l’entreprise et chois organisationnels*, Economica.

Menard, C. 1995. *L’économie des organisations*, La découverte.

Mintzberg, H. 1982. *Structure et dynamique des organisations*, Editions de l’organisation.

Niezen, C.; Weller, W. 2006. “Procurement as Strategy”. Harvard Business Review, Vol. 84, No. 9, pp. 22-25.

Nooteboom, B.; Berger, H.; Noorderhaven, N. G. 1997. “Effects of trust and governance on relational risk”, in *Academy of Management Journal*, Vol. 40, pp. 308-338.

Piore, M.-J. 1968. “The impact of the labor market on the design and selection of productive techniques within the manufacturing plant”, in *Quarterly Journal of Economics*, Vol. 82, Nr. 4, pp. 602-620

Robbins, S-P. 1990. *Organization theory* (Englewoodc Cliffs, NJ, Prentice Hall).

Schniederjans, M. J.; Schniederjans, A. M.; Schniederjans, D. G. 2005. “Outsourcing and Insourcing in an International Context” (1st ed.). M.E. Sharpe, Inc.: Armonk, NY.

Simon, H-A. 1951. “A formal theory of the employment relationship”, Econometrica, Vol. 19, No. 3, pp. 293-305

Slichter, S; Healy, J.; Livernash, E. 1960. “The impact of collective bargaining on management”, Brookings Institution.

Steensma, H.K.; Corley, K. G. 2000. “On the performance of technology-sourcing partnerships: The interaction between partner interdependence and technology attributes”, in *Academy of Management Journal*, Vol. 43, No. 6, pp. 1045-1067.

Strange, R. 2009. “The outsourcing of primary activities: Theoretical analysis and proposition”, Journal of Management and Governance, Vol. 15, No. 2, pp. 249-69.

Sue Greenberg, P; Greenberg R. H.; Antonucci, Y. L. 2008. “The Role of Trust in the Governance of Business Process Outsourcing Relationships: A Transaction Cost Economics Approach Business”, Process Management Journal, Vol. 14, No. 5, pp. 593-608.

Talluri, S.; Narasimhan, R. 2004. “A methodology for strategic sourcing”. European Journal of Operational Research, Vol. 154, No. 1, pp. 236-250.

van der Meer-Kooistra, J.; Vosselman, E. G. J. 2000. “Management control of inter-firm transactional relationships: The case of industrial renovation and maintenance”, in Accounting, Organizations and Society, Vol. 25, pp. 51-77

Vaxevanou, A.; Nikolaos, K. 2015. “Basic Principles the Philosophy of Outsourcing”, Procedia – Social and Behavioral Sciences Proceedings of the 3rd International Conference on Strategic Innovative Marketing (IC-SIM 2014), Vol. 175, pp. 567-571.

Venkatraman, N. V. 2004. “Offshoring without guilt”, in MIT Sloan Management Review, Vol 45, No. 3, pp. 14-16.

Weitzman, M.-L. 1974. “Prices vs. quality”, Review of Economic studies, pp. 50-65

Williamson, O.-E. 1975. *Markets and Hierarchies: analysis and antitrust implications*. (New York, Free Press).

Williamson, O.E. 1985. *The economic institutions of capitalism*. (New York, Free Press).

Zaheer, A; Venkatraman, N. 1995. “Relational governance as an interorganizational strategy: An empirical test of the role of trust in economic exchange”, in *Strategic Management Journal*, Vol. 16, Nr. 5, pp. 373-392.

Appendix

A.1 Equilibrium in the gig market

The equilibrium is attained when asset values do not change any more, i.e. $\dot{F}_i = \dot{S}_i = \dot{W} = \dot{U} = 0$ where $i \in \{0,1,2,3\}$. Hence, the above model can be solved by considering the free-entry conditions for both firms and subcontractors:

$$F_0 = 0,\ S_0 = 0$$

This can be used to calculate the (backward looking) asset values at the stage where firms match with workers:

$$\begin{aligned} S_0 = 0 \quad &\Leftrightarrow \quad S_1^b = \frac{k+\eta^*}{\phi \cdot p(\phi)} \\ F_0 = 0 \quad &\Leftrightarrow \quad F_1^b = \frac{c}{p(\phi)} \end{aligned}$$

Neither subcontractors nor firms leave assets behind, i.e. $F_3 = 0$ and $S_3 = 0$. This allows to asset values at the production stage 2 as:

$$r \cdot F_2 = y(\eta, \xi(e,T)) - w - \rho + \sigma(m,e) \cdot (F_3 - F_2) + \dot{F}_2 \Rightarrow F_2 = \frac{y(\eta, \xi(e,T)) - w - \rho}{r + \sigma(m,e)}$$

and

$$r \cdot S_2 = \rho + \sigma(m,e) \cdot (S_3 - S_2) + \dot{S}_2 \Rightarrow S_2 = \frac{\rho}{r + \sigma(m,e)}$$

Plugging these values into the asset equations at the recruitment stage yields:

$$F_1^f = \frac{q(\theta) \cdot \frac{y(\eta,\xi(e,T))-w-\rho}{r+\sigma(m,e)} - T - m}{r + q(\theta)}$$

and:

$$S_1^f = \frac{q(\theta) \cdot \frac{\rho}{r+\sigma(m,e)} - \gamma}{r + q(\theta)}$$

In equilibrium both backward and forward looking asset values need to equal, hence:

$$S_1^b = S_1^f \text{ and } F_1^b = F_1^f$$

This allows to derive the equilibrium schedule in the (ϕ, θ)- quandrant for both subcontractors and firms:

$$SS: \frac{k+\eta^*}{\phi \cdot p(\phi)} = \frac{q(\theta) \cdot \frac{\rho}{r+\sigma(m,e)} - \gamma}{r + q(\theta)}$$

$$FF: \frac{c}{p(\phi)} = \frac{q(\theta) \cdot \frac{y(\eta,\xi(e,T))-w-\rho}{r+\sigma(m,e)} - T - m}{r + q(\theta)}$$

A.2 Descriptive statistics

Country	Average age	Average firm size	Average number of hierarchies	Share of Ecommerce	Share of companies that export at least 25% of their sales
Austria	49.0	121.3	3.1	28.2	25.0
Belgium	39.5	65.8	3.0	19.3	21.6
Bulgaria	21.3	75.6	3.0	17.1	24.8
Croatia	28.4	92.9	3.1	19.7	29.6
Cyprus	27.3	46.2	3.2	25.6	12.3
Czech Republic	28.4	94.4	3.2	26.3	28.8
Denmark	48.8	93.2	2.8	35.7	17.2
Estonia	22.3	49.4	2.9	22.8	28.7
Finland	37.1	69.7	3.1	48.5	16.4
France	38.4	115.9	3.4	29.2	12.0
Germany	53.3	126.0	3.0	26.8	18.4
Greece	25.4	48.9	3.0	28.3	16.6
Hungary	22.1	48.9	3.1	41.4	20.5
Ireland	37.2	51.3	3.2	34.4	16.3
Italy	35.0	73.1	3.0	25.9	28.4
Latvia	19.8	48.7	2.8	21.5	27.0
Lithuania	23.0	80.0	3.0	27.6	28.8
Luxembourg	31.2	78.3	3.1	23.4	22.4
Malta	34.1	103.0	3.9	37.9	31.7
Netherlands	45.6	106.2	3.1	27.8	24.3
Poland	31.8	87.0	3.1	22.5	18.4
Portugal	29.1	57.9	3.1	28.4	28.7
Romania	18.7	94.4	3.1	27.6	20.4
Slovakia	23.5	53.3	3.0	27.9	21.1
Slovenia	28.0	72.4	3.0	20.5	36.7
Spain	30.4	72.2	3.3	29.6	24.0
Sweden	65.5	81.4	2.9	30.6	8.9
United Kingdom	40.9	102.1	3.4	37.5	13.2

A3. Variable coding

In order to facilitate the interpretation of the estimation results, in the following table an overview is provided of the way variables have been coded in the European Company Survey database

Table 1: Variable coding

Ecommerce	1 Yes 2 No

salesint - Since this establishment was set up, what percentage of this establishment's sales were to customers in other countries?

Salesint	1 We do not engage in export (0%) 2 1% to 24% 3 25% to 49% 4 50% or more

pmstratlp - Offering products or services at lower prices than the competition
pmstratbq - Offering products or services that are of better quality than those offered by the competition
pmstartcust - Customising products or services to meet specific customer requirements
pmstratnps - Regularly developing products, services or processes that are new to the market

1 most important 2 important 3 least important

competmark - How competitive would you say the market for the main products or s

competmark	1 Very competitive 2 Fairly competitive 3 Not very competitive 4 Not at all competitive

pdemstab - How predictable would you say that the demand for the main products or services of this establishment is?

Pdemstab	1 Very predictable 2 Fairly predictable 3 Not very predictable 4 Not at all predictable

prodvol - Since the beginning of 2016, how has the amount of goods or services produced by this establishment changed?

Prodvol	1 It has increased 2 It has stayed about the same 3 It has decreased

A4. Regression tables

A4.1 Incentive instruments use

Table 2: Use of incentives as a function of a firm's environment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Monetary rewards		Meaningful mission		Challenging work		Learning opportunities	
Does this establishment engage in e-commerce? [1]	0.119**	0.120*	0.0931*	0.0295	0.127**	0.0605	0.0373	0.00496
	(0.0581)	(0.0616)	(0.0554)	(0.0579)	(0.0589)	(0.0626)	(0.0581)	(0.0608)
Share of international sales (inverted)	-0.125***	-0.148***	0.0563**	0.00122	0.0114	-0.0824***	0.100***	0.0454
	(0.0253)	(0.0290)	(0.0257)	(0.0281)	(0.0257)	(0.0287)	(0.0254)	(0.0293)
Degree of market competitiveness[2]	0.202***	0.172***	0.258***	0.209***	0.181***	0.156***	0.235***	0.200***
	(0.0420)	(0.0435)	(0.0429)	(0.0431)	(0.0428)	(0.0448)	(0.0432)	(0.0447)
Importance of price elasticity of products/services/processes	0.0147	-0.0293	-0.178***	-0.144***	-0.267***	-0.204***	-0.219***	-0.178***
	(0.0256)	(0.0268)	(0.0260)	(0.0273)	(0.0269)	(0.0287)	(0.0269)	(0.0275)
Importance of quality improvement of products/services/processes	0.0182	0.0263	0.0137	0.0119	-0.0534*	-0.0522	0.00980	0.00558
	(0.0316)	(0.0325)	(0.0307)	(0.0316)	(0.0319)	(0.0330)	(0.0315)	(0.0320)
Importance of customising products/services/processes	0.00250	0.0213	0.00816	0.0350	0.0451	0.0465	0.0177	0.0328
	(0.0281)	(0.0288)	(0.0288)	(0.0298)	(0.0298)	(0.0311)	(0.0290)	(0.0295)
Importance of new products/services/processes	0.0918***	0.0818***	0.212***	0.224***	0.153***	0.180***	0.0676**	0.0936***
	(0.0265)	(0.0274)	(0.0254)	(0.0263)	(0.0272)	(0.0284)	(0.0272)	(0.0273)
Predictability of demand[3]	0.124***	0.121**	0.316***	0.260***	0.165***	0.108**	0.284***	0.226***
	(0.0470)	(0.0484)	(0.0487)	(0.0494)	(0.0437)	(0.0452)	(0.0465)	(0.0482)
Change in demand[4]	0.302***	0.308***	0.253***	0.278***	0.282***	0.290***	0.217***	0.225***
	(0.0403)	(0.0420)	(0.0437)	(0.0443)	(0.0406)	(0.0423)	(0.0428)	(0.0441)
Observations	17,803	17,803	17,776	17,776	17,773	17,773	17,813	17,813
Country dummies	No	Yes	No	Yes	No	Yes	No	Yes
Sector dummies	No	Yes	No	Yes	No	Yes	No	Yes

Notes: Ordered logistic regression. Cut-off values not reported. Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. [1] Variable coded as 1=e-commerce, 2=no e-commerce; [2] Variable coded in reverse order, higher values indicate less competitive environment; [3] Variable coded in reverse order, higher values refer to more predictable demand; [4] Variable coded in reverse order, higher values indicate decrease in amount produced.

Table 3: Use of incentives as a function of a firm's internal organisation and IT use

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Monetary rewards		Meaningful mission		Challenging work		Learning opportunities	
Does this establishment engage in e-commerce? [1]	0.107*	0.0876	0.0432	-0.00469	0.0680	0.0447	-0.138**	-0.145**
	(0.0559)	(0.0594)	(0.0547)	(0.0563)	(0.0565)	(0.0602)	(0.0570)	(0.0592)
Number of hierarchical levels	-0.0982***	-0.0750**	-0.151***	-0.0814**	-0.0501	-0.000908	-0.169***	-0.120***
	(0.0351)	(0.0359)	(0.0326)	(0.0339)	(0.0319)	(0.0329)	(0.0335)	(0.0344)
Number of employees	1.19e-05	-1.15e-05	-6.40e-06	-3.97e-05	-5.30e-05*	-8.01e-05***	-0.000671***	-0.000823***
	(2.96e-05)	(3.43e-05)	(1.95e-05)	(2.78e-05)	(2.80e-05)	(2.70e-05)	(0.000138)	(0.000163)
Age of the establishment	0.00415***	0.00255***	0.00217***	0.00262***	0.000980	0.00220**	-0.000813	-0.000327
	(0.000873)	(0.000931)	(0.000705)	(0.000764)	(0.000893)	(0.000951)	(0.000712)	(0.000770)
Use of robots	-0.0524	-0.0559	-0.138*	-0.0387	-0.00834	0.0866	-0.0950	0.0627
	(0.0757)	(0.0804)	(0.0754)	(0.0861)	(0.0830)	(0.0916)	(0.0834)	(0.0911)
Use of establishment-specific software	0.275***	0.331***	0.230***	0.264***	0.114**	0.167***	0.257***	0.292***
	(0.0538)	(0.0553)	(0.0531)	(0.0538)	(0.0532)	(0.0549)	(0.0537)	(0.0555)
Number of employees using computers	-0.0262*	-0.0658***	-0.113***	-0.105***	-0.194***	-0.146***	-0.180***	-0.147***
	(0.0136)	(0.0167)	(0.0136)	(0.0170)	(0.0137)	(0.0168)	(0.0139)	(0.0167)
Use of HR data analytics	0.479***	0.432***	0.400***	0.426***	0.201***	0.307***	0.411***	0.457***
	(0.0552)	(0.0584)	(0.0536)	(0.0546)	(0.0554)	(0.0573)	(0.0542)	(0.0557)
Observations	19,223	19,223	19,185	19,185	19,185	19,185	19,228	19,228
Country dummies	No	Yes	No	Yes	No	Yes	No	Yes
Sector dummies	No	Yes	No	Yes	No	Yes	No	Yes

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

A4.2 Determinants of variable pay

Table 4: Types of variable pay as a function of a firm's environment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Piece rate pay		Individual performance pay		Team performance pay		Company performance pay	
Does this establishment engage in e-commerce? [1]	-0.270***	-0.201***	-0.0820	-0.0929	-0.147**	-0.0842	-0.110*	-0.0665
	(0.0549)	(0.0582)	(0.0559)	(0.0595)	(0.0590)	(0.0619)	(0.0602)	(0.0640)
Share of international sales (inverted)	0.0806***	0.121***	0.102***	0.110***	0.0347	0.0906***	0.154***	0.197***
	(0.0248)	(0.0287)	(0.0241)	(0.0278)	(0.0262)	(0.0290)	(0.0260)	(0.0291)
Degree of market competitiveness	-0.202***	-0.194***	-0.163***	-0.180***	-0.204***	-0.183***	-0.0874**	-0.0936**
	(0.0409)	(0.0426)	(0.0412)	(0.0431)	(0.0424)	(0.0443)	(0.0435)	(0.0447)
Importance of price elasticity of products/services/processes	-0.0304	0.0237	-0.0264	0.0332	-0.0130	0.0271	0.0197	0.0327
	(0.0250)	(0.0263)	(0.0250)	(0.0265)	(0.0264)	(0.0282)	(0.0264)	(0.0283)
Importance of quality improvement of products/services/processes	0.0157	-0.0383	0.0273	-0.00150	0.0489	0.00681	0.0355	-0.00701
	(0.0286)	(0.0292)	(0.0290)	(0.0299)	(0.0304)	(0.0321)	(0.0306)	(0.0321)
Importance of customising products/services/processes	0.00387	-0.0264	-0.0453*	-0.0568**	0.0226	-0.0117	0.00821	0.0101
	(0.0274)	(0.0283)	(0.0272)	(0.0281)	(0.0289)	(0.0302)	(0.0286)	(0.0300)
Importance of new products/services/processes	-0.111***	-0.0943***	-0.119***	-0.102***	-0.164***	-0.150***	-0.0934***	-0.0988***
	(0.0255)	(0.0265)	(0.0256)	(0.0272)	(0.0267)	(0.0284)	(0.0275)	(0.0288)
Predictability of demand	-0.0660	-0.0521	-0.128***	-0.151***	-0.161***	-0.153***	-0.0638	-0.0682
	(0.0425)	(0.0431)	(0.0438)	(0.0450)	(0.0454)	(0.0478)	(0.0451)	(0.0469)
Change in demand	-0.163***	-0.172***	-0.192***	-0.195***	-0.241***	-0.250***	-0.156***	-0.155***
	(0.0407)	(0.0415)	(0.0417)	(0.0434)	(0.0435)	(0.0456)	(0.0424)	(0.0443)
Observations	17,519	17,519	17,311	17,311	17,257	17,257	17,165	17,165
Country dummies	No	Yes	No	Yes	No	Yes	No	Yes
Sector dummies	No	Yes	No	Yes	No	Yes	No	Yes

Notes: Ordered logistic regression. Cut-off values not reported. Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. [1] Variable coded as 1=e-commerce, 2=no e-commerce; [2] Variable coded in reverse order, higher values indicate less competitive environment; [3] Variable coded in reverse order, higher values refer to more predictable demand; [4] Variable coded in reverse order, higher values indicate decrease in amount produced.

Table 5: Types of variable pay as a function of a firm's internal organisation and IT use

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Piece rate pay		Individual performance pay		Team performance pay		Company performance pay	
Does this establishment engage in e-commerce? [1]	-0.304***	-0.218***	-0.0905*	-0.107*	-0.152***	-0.0937	-0.114*	-0.0701
	(0.0540)	(0.0571)	(0.0548)	(0.0579)	(0.0583)	(0.0610)	(0.0594)	(0.0635)
Number of hierarchical levels	0.174***	0.165***	0.217***	0.202***	0.156***	0.124***	0.120***	0.122***
	(0.0307)	(0.0316)	(0.0301)	(0.0310)	(0.0306)	(0.0329)	(0.0348)	(0.0364)
Number of employees	-5.28e-06	-5.63e-06	-5.99e-06	-5.15e-06	0.000117	0.000144	0.000227	0.000236
	(7.99e-06)	(7.98e-06)	(7.81e-06)	(7.93e-06)	(9.16e-05)	(0.000132)	(0.000282)	(0.000302)
Age of the establishment	-0.00510***	-0.00323***	-0.00449***	-0.00221**	-0.00369***	-0.00107	-0.00199**	-0.00213**
	(0.000877)	(0.000924)	(0.00101)	(0.000991)	(0.000936)	(0.000937)	(0.000860)	(0.000974)
Use of robots	0.133	0.170*	0.0649	0.115	0.0235	-0.0335	-0.00430	0.112
	(0.0829)	(0.0880)	(0.0774)	(0.0840)	(0.0867)	(0.0920)	(0.0841)	(0.0921)
Use of establishment-specific software	-0.133**	-0.204***	-0.156***	-0.232***	-0.211***	-0.278***	-0.166***	-0.229***
	(0.0526)	(0.0552)	(0.0528)	(0.0553)	(0.0560)	(0.0585)	(0.0575)	(0.0596)
Number of employees using computers	0.0537***	0.0990***	0.0629***	0.0990***	0.0535***	0.0783***	0.104***	0.108***
	(0.0135)	(0.0167)	(0.0135)	(0.0166)	(0.0142)	(0.0175)	(0.0141)	(0.0175)
Use of HR data analytics	-0.497***	-0.425***	-0.471***	-0.428***	-0.552***	-0.472***	-0.420***	-0.431***
	(0.0535)	(0.0555)	(0.0523)	(0.0546)	(0.0565)	(0.0593)	(0.0582)	(0.0608)
Observations	18,886	18,886	18,658	18,658	18,604	18,604	18,494	18,494
Country dummies	No	Yes	No	Yes	No	Yes	No	Yes
Sector dummies	No	Yes	No	Yes	No	Yes	No	Yes

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

A4.3 Work autonomy

Table 6: Work autonomy as a function of a firm's environment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Machine pace work		Team work		Team autonomy		Working time autonomy		Problem solving autonomy	
Does this establishment engage in e-commerce? [1]	0.0140	-0.107*	0.528***	0.507***	-0.00317	-0.0406	-0.0919*	-0.0224	-0.143***	-0.114**
	(0.0565)	(0.0590)	(0.0722)	(0.0747)	(0.0876)	(0.0937)	(0.0541)	(0.0569)	(0.0540)	(0.0576)
Share of international sales (inverted)	0.267***	0.122***	-0.0863***	-0.144***	0.0106	-0.0152	0.0332	0.146***	-0.000521	0.0778***
	(0.0234)	(0.0266)	(0.0306)	(0.0347)	(0.0396)	(0.0441)	(0.0240)	(0.0264)	(0.0240)	(0.0263)
Degree of market competitiveness	-0.121***	-0.118***	0.0888*	0.102**	-0.102*	-0.0629	0.0203	0.00830	-0.0510	-0.0726*
	(0.0387)	(0.0411)	(0.0481)	(0.0492)	(0.0584)	(0.0621)	(0.0405)	(0.0409)	(0.0399)	(0.0413)
Importance of price elasticity of products/services/processes	-0.0797***	-0.0339	-0.139***	-0.0961***	-0.131***	-0.0860**	0.162***	0.102***	0.132***	0.0734***
	(0.0248)	(0.0258)	(0.0302)	(0.0313)	(0.0409)	(0.0434)	(0.0244)	(0.0254)	(0.0243)	(0.0255)
Importance of quality improvement of products/services/processes	-0.0476*	-0.0118	-0.0234	-0.00341	-0.0130	-3.67e-05	0.0514*	0.0252	0.0782***	0.0758***
	(0.0282)	(0.0299)	(0.0357)	(0.0360)	(0.0452)	(0.0466)	(0.0277)	(0.0278)	(0.0279)	(0.0290)
Importance of customising products/services/processes	0.0460*	0.0324	0.0508	0.0528	0.0306	-0.00465	-0.107***	-0.0845***	-0.110***	-0.0845***
	(0.0279)	(0.0289)	(0.0333)	(0.0338)	(0.0466)	(0.0481)	(0.0264)	(0.0264)	(0.0275)	(0.0280)
Importance of new products/services/processes	-0.0919***	-0.0637**	0.0454	0.0460	0.0169	0.0396	-0.0427*	-0.0959***	-0.101***	-0.132***
	(0.0254)	(0.0266)	(0.0309)	(0.0321)	(0.0404)	(0.0419)	(0.0247)	(0.0251)	(0.0250)	(0.0259)
Predictability of demand	-0.0775*	-0.0822*	0.0851	0.0361	-0.0238	-0.0395	-0.0358	-0.00564	0.0342	0.0698
	(0.0434)	(0.0459)	(0.0537)	(0.0554)	(0.0691)	(0.0703)	(0.0441)	(0.0456)	(0.0419)	(0.0440)
Change in demand	-0.0418	-0.0330	0.201***	0.192***	0.0789	0.0779	-0.133***	-0.108***	-0.145***	-0.132***
	(0.0402)	(0.0408)	(0.0532)	(0.0549)	(0.0569)	(0.0589)	(0.0407)	(0.0412)	(0.0379)	(0.0397)
Observations	17,535	17,535	17,855	17,855	13,192	13,192	17,617	17,617	17,518	17,518
Country dummies	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Sector dummies	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes

Notes: Ordered logistic regression. Cut-off values not reported. Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. [1] Variable coded as 1=e-commerce, 2=no e-commerce; [2] Variable coded in reverse order, higher values indicate less competitive environment; [3] Variable coded in reverse order, higher values refer to more predictable demand; [4] Variable coded in reverse order, higher values indicate decrease in amount produced.

Table 7: Work autonomy as a function of a firm's internal organisation and IT use

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Machine pace work		Team work		Team autonomy		Working time autonomy		Problem solving autonomy		Share of managers	
Does this establishment engage in e-commerce? [1]	-0.0532	-0.0881	0.419***	0.451***	0.00977	-0.00553	0.0559	-0.0166	-0.0229	-0.0592	-0.178**	-0.183**
	(0.0547)	(0.0572)	(0.0736)	(0.0749)	(0.0867)	(0.0926)	(0.0528)	(0.0550)	(0.0538)	(0.0559)	(0.0706)	(0.0734)
Number of hierarchical levels	0.0685**	0.0497	-0.435***	-0.415***	0.436***	0.394***	-0.121***	-0.110***	-0.115***	-0.129***	0.241***	0.1557***
	(0.0302)	(0.0328)	(0.0447)	(0.0457)	(0.0501)	(0.0526)	(0.0297)	(0.0304)	(0.0311)	(0.0312)	(0.0376)	(0.0394)
Number of employees	3.86e-06**	3.08e-06	-0.00294***	-0.00287***	1.72e-05	5.14e-05	-1.03e-05***	-1.11e-05***	-9.63e-06***	-1.07e-05***	-9.51e-06*	-1.35e-05***
	(1.64e-06)	(2.87e-06)	(0.000653)	(0.000659)	(1.33e-05)	(0.000112)	(1.55e-06)	(2.05e-06)	(2.23e-06)	(2.48e-06)	(5.28e-06)	(4.87e-06)
Age of the establishment	-0.00157**	-0.000104	0.00148*	0.00104	-0.00243**	-0.000703	0.000291	-0.00166**	-0.00110	-0.00239***	-6.17e-05	-0.000166
	(0.000717)	(0.000760)	(0.000794)	(0.000886)	(0.00105)	(0.00114)	(0.000737)	(0.000782)	(0.000772)	(0.000794)	(0.000938)	(0.000969)
Use of robots[2]	-0.742***	-0.481***	-0.0318	0.0231	0.162	0.145	0.130	0.114	-0.0994	-0.130*	0.150	0.0658
	(0.0732)	(0.0799)	(0.119)	(0.132)	(0.136)	(0.145)	(0.0797)	(0.0866)	(0.0686)	(0.0761)	(0.102)	(0.113)
Use of establishment-specific software[2]	-0.164***	-0.232***	0.424***	0.466***	-0.127	-0.141	-0.0430	-0.0809	-0.140***	-0.184***	0.147**	-0.0255
	(0.0532)	(0.0559)	(0.0647)	(0.0662)	(0.0837)	(0.0863)	(0.0502)	(0.0512)	(0.0504)	(0.0515)	(0.0666)	(0.0679)
Number of employees using computers	-0.0246*	0.0359**	-0.176***	-0.135***	-0.0959***	-0.0499*	0.452***	0.373***	0.295***	0.253***	0.330***	0.297***
	(0.0143)	(0.0177)	(0.0171)	(0.0208)	(0.0217)	(0.0271)	(0.0156)	(0.0184)	(0.0145)	(0.0169)	(0.0177)	(0.0209)
Use of HR data analytics[2]	-0.397***	-0.277***	0.441***	0.468***	-0.300***	-0.207**	0.112**	-0.0382	-0.0941*	-0.192***	0.274***	0.163**
	(0.0557)	(0.0588)	(0.0742)	(0.0767)	(0.0862)	(0.0900)	(0.0530)	(0.0540)	(0.0523)	(0.0542)	(0.0703)	(0.0725)
Observations	18,911	18,911	19,270	19,270	14,395	14,395	19,022	19,022	18,902	18,902	19,294	19,294
Country dummies	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Sector dummies	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes

Notes: Ordered logistic regression. Cut-off values not reported. Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. [1] Variable coded as 1=e-commerce, 2=no e-commerce; [2] Variable coded in reverse order: (1) Yes, (2) No.