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QUADERNI DEL DIPARTIMENTO
DI ECONOMIA POLITICA E STATISTICA

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Corporate Hierarchies and Labor Institutions

n. 827 – Aprile 2020

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This version: 27 April 2020.

Abstract

This paper analyzes whether labor institutions affect the design of firm hierarchies. We rationalize the role of workplace employee representation (ER) within an otherwise standard knowledge-based model of hierarchies as developed by Garicano (2000), where the firm's optimal choice of hierarchical layers depends on the trade-off between communication and knowledge acquisition costs. To explore the empirical validity of our framework, we rely on establishment-level data on a sample of more than 18000 private-sector workplaces in Europe. We uncover a set of novel descriptive facts regarding the structure and change in corporate hierarchies under the presence of employee representatives. In particular, ER is positively correlated with the depth of hierarchy (number of vertical layers), while there is no significant association between ER and delayering. These relationships appear to be mediated by firm size. We also document that delayering does not translate into greater worker empowerment, although the presence of ER reduces the probability of functional centralization among delayered establishments. Moreover, the presence of ER correlates with the frequency of staff meetings and the accumulation of noncodifiable productive knowledge through job training and skill development. The analysis of managers' perceptions suggests the higher frequency of meetings in firms with ER does not lead to more delays in the implementation of organizational changes. Taken together, our findings indicate that the effect of ER on the firm hierarchy is driven by a reduction in communication costs rather by an increase in knowledge acquisition costs, facilitating the flow of information to top decision makers possibly through skip-level reporting.

JEL Classification: J51, L23, M11

Keywords: Firm hierarchy, Delayering, Employee representation, European Company Survey

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1 Introduction

Since Ronald Coase's seminal article discussing the advantages of coordination via managerial command (Coase, 1937), economics and management scholars have deepened the analysis of the internal organization of firms and the nature and evolution of firm hierarchies. While earlier contributions focused primarily on issues related to worker supervision and employer-employees incentives alignment (e.g. Williamson, 1985; Milgrom and Roberts, 1992), more recent models stress the role of hierarchies in processing and communicating information (Garicano, 2000; Garicano and Wu, 2012).

The basic intuition behind the information processing role of hierarchies is the following. The firm is conceived as a collective group of workers who deal with problems and need to acquire the relevant knowledge to solve them. Whenever the match between problems and solutions is costly the firm is organized as a hierarchy, with those at the bottom dealing with routine problems and those at the top with more complex exceptions. The optimal choice of layers depends on the trade-off between communication and knowledge acquisition costs. The former capture the costs of evaluating and passing problems through the hierarchy and are increasing in the number of layers. The latter reflect the costs of acquiring knowledge to deal with problems at each layer of the hierarchy and are larger in flatter organizations. As pointed out by some organizational scholars, a detailed analytical consideration of hierarchies was somewhat missing from prominent approaches dealing with the development of organizational capabilities and routines (Gavetti, 2005). Therefore, by explicitly incorporating the role of hierarchies, the "cognitive view" has notably improved the understanding of the organization and mobilization of knowledge in production. At the same time, however, the line of study guided by this approach has suffered from an important limitation common to other dominant paradigms in the field of internal organization and corporate governance (Aguilera and Jackson, 2003; Aguilera et al., 2008; Van Essen et al., 2013): namely, inattention to the fact that the way in which organizations administer the cognitive and communication burden associated with the use of knowledge in production is critically influenced by their institutional embeddedness. Not surprisingly, empirical works focused on the knowledge-based functioning of hierarchies have mainly looked into the technological drivers of information and communication costs, such as resource planning software and intranet (Bloom et al., 2014). Given the fact that these technologies are widely accessible in advanced countries, residual (and yet significant) differences in the hierarchical organization of firms and their degree of decentralization remain puzzling. Few studies have analyzed the role of labor market institutions in explaining variation of management practices across firms and countries (Bloom and Van Reenen, 2010; Bloom et al., 2019). However, in the context of those studies labor institutions are predominantly conceptualized as distortions preventing the diffusion of "good" management practices.

This study is aimed at contributing to this literature by studying if and how the depth of firm hierarchies, i.e. the number of organizational layers a firm rely on to solve production problems, is affected by labor institutions. In particular, we analyze the role played by workplace employee representation (ER), i.e. a legally mandated channel for employee voice through which workers exert an influence on work organization and employment-related issues as exists in many European countries (e.g. unions, works councils, consultative committees). Since the hierarchical organization of production has direct implications for the distribution of decision power, we want to evaluate how it interacts with the institutional bodies aimed at keeping authority in check and fostering cooperation. Institutions of shop-floor ER transfer partial control rights to employees and preclude shareholders (and managers) from making unilateral decisions in relation to certain matters. While there is extensive evidence on the effects of ER on a wide range of worker and firm-level outcomes, little research has been conduced on its relationship with the design of firm hierarchies. Does ER affect firm's decisions to add (or cut) organizational layers? If so, what are the channels through which this effect takes place? Does this effect depends on firm size?

To answer these questions we develop a simple model using the knowledge-based approach first formalized by Garicano (2000) and then extended in more intuitive ways by Garicano and Wu (2012). We set aside incentive issues and focus on the organization of knowledge in production. Employee representatives are modelled as institutional bodies that impact on the cost structure of the firm. On the one hand, employee representatives have the rights to be informed or consulted on a given fraction of problems before they are passed to any layer above the shop-floor. This is the case, for instance, with problems whose solutions require decisions that may have a strong impact on the employment structure of the company, e.g. important investment decisions or substantial changes in the technology used in production. As a result, ER increases communication costs by delaying the process of problem evaluation. On the other hand, ER can perform "skip-level" reporting in organization that facilitates the flow of information to top decision makers. For example, an industrial council may provide a forum through which selected workers report directly to top managers on important issues related to production (Kaufman and Levine, 2000). In these cases, ER reduces communication costs by speeding up the passing of problems across layers of the organization. Depending on the relative size of these two effects, ER may induce the entrepreneur to select a higher or lower number of layers. In particular, as long as the reduction in communication costs due to skip-level reporting more than compensate the rise in costs due to delayed problem evaluation, ER will induce firms to select a higher number of layers. Such an effect, however, is weaker among large firms and may eventually reverse. Also, our framework allows to see that dropping a layer implies more worker autonomy only when delayering is associated to the movement of knowledge below in the firm hierarchy. When delayering is accompanied by

substantial layoffs instead, worker autonomy is unaffected.

We test the validity of these theoretical predictions using unique establishment-level data from the third wave of the European Company Survey (2013), covering more than 18000 private-sector workplaces located in 21 European countries and providing harmonized information on ER, firm hierarchies, and a wide range of management practices. Specifically, this survey contains a specific question about the number of hierarchical levels in the establishment as well as information about whether such number has increased, decreased or stayed the same over time. Moreover, the survey reports detailed information about the ER structure alongside a large set of other establishment-level characteristics, such as: team work, human resource management practices, working time arrangements, and employee involvement in decision-making. The availability of such a wealth of information allows us to control for several factors that may affect the design of firm hierarchies. Overall, the empirical analysis produces a number of stylized facts that are highly consistent with our theoretical model: (1) the presence of ER is positively correlated with the depth of hierarchy (number of vertical layers); (2) there is no significant relationship between ER and delayering decisions; (3) the number of layers is increasing in plant size but less so in establishment with ER; (4) delayering does not translate into greater worker empowerment (as measured by task autonomy), although the presence of ER reduces the probability of functional centralization among delayered establishments.

In terms of identification, we are guided by legal analysis to find an instrumental variable that allows us to take into account the possible endogeneity of ER. In particular, we exploit firm coverage by sectoral or regional wage agreements as an exogenous factor that shifts the probability of establishing ER. According to cost-benefit theories of union determination (Schnabel, 2003) and previous empirical research (Scheuer, 2011), the benefits of unionization (as well as the propensity to organize) are affected by centralized collective bargaining taking place at a level higher than the firm. At the same time, comparative legal analysis clarifies that extension of collective agreements to third parties at the sectoral or regional level is mostly subject to regulatory institutions and labour laws, that are clearly exogenous in our study (Adams et al., 2016). On this ground, we consider firm coverage by sectoral or regional wage agreements as a viable instrument for the presence of ER. The results from the instrumental variable (IV) regressions reinforce our main findings.

We also investigate the underlying mechanisms that may explain our findings. Additional empirical regressions show a positive correlation between ER and different measures of on-the-job training and skill development, what may reflect that the effect of ER (if any) is to reduce knowledge acquisition costs. The presence of ER also correlates with reported changes in the way plants coordinate and allocate work to employees and the frequency of regular staff meetings, possibly enabling skip-level reporting and facilitating the flow of information to top decision makers. Interestingly, the investigation of man-

agers' perceptions suggests the higher frequency of staff meetings in establishments with ER does not seem to come at a cost in terms of delayed implementation of organizational changes.[1] Taken together, these empirical evidences suggest that the positive correlation between ER and the number of hierarchical layers may be driven by a reduction in communication costs rather by an increase in knowledge acquisition costs.

Our work is most closely related to four streams of literature. First, and at a more general level, our study adds to organization studies relying on comparative institutional analysis. While this literature has been mostly focused in accounting for variations in corporate governance (Aguilera and Jackson, 2003; Van Essen et al., 2013), we argue about the importance of considering the institutional context also in the realm of the internal organization of firms. Moreover, instead of adopting an aggregate approach and bundling several labor institutions with potentially very different impacts, we focus on a very specific institution (employee voice) which is more likely to affect the organization and circulation of knowledge within firms and, hence, the design of hierarchies. By focusing on a single institution, we depart from previous work on the effect of labor market institutions on management practices (Bloom and Van Reenen, 2010) and corporate governance (Van Essen et al., 2013) relying on composite institutional indicators.[2]

Secondly, the paper relates to theoretical and empirical works that study different aspects of firm organization, such as contract design (Qian, 1994; Aghion and Tirole, 1997; Rajan and Zingales, 2001), supervision (Rosen, 1982; Williamson, 1967; Calvo and Wellisz, 1978), and hierarchical organization (Garicano, 2000; Hart and Moore, 2005; Caliendo and Rossi-Hansberg, 2012; Garicano and Wu, 2012; Caliendo et al., 2015). In particular, the present paper integrates this literature with components that capture the functioning of employee representative bodies. A novel aspect of our approach is that we separate the effect of ER on communication and knowledge acquisition costs and study the impact of ER on each of them. The resulting model is then used to investigate the effect of the resulting cost structure on firm organization, as reflected into the optimal number of hierarchical layers. To the best of our knowledge, this is one of the first attempts to study the interplay between collective forms of employee voice and the design of corporate hierarchies.

Thirdly, this paper is related to the empirical literature on firm flattening. Several empirical works show that during the last decades firm hierarchies have indeed become flatter. Rajan and Wulf (2006), for instance, document that in major US corporations the number of managers reporting directly to the CEO has increased steadily in recent years,

[1]There is evidence showing that staff meetings may also provide workers with a structured opportunity to exchange knowledge and information with their peers (Sandvik et al., 2020). Therefore, by facilitating horizontal knowledge flows meetings may also contribute to reduce information acquisition costs in establishments with ER.

[2]The idea of unpacking aggregate effects has proved fruitful in explaining the distinct effects of information and communication technologies on the internal organization of firms within the knowledge-based hierarchies framework (Bloom et al., 2014).

reducing the number of layers in senior management hierarchies. Acemoglu et al. (2007) and Caroli and Van Reenen (2001) find similar trends in French and UK data. The causes of this organizational change have been related to two main factors: the growing intensity of market competition that requires firms to speed up and shorten the process through which decisions are taken (Guadalupe and Wulf, 2010); and the diffusion of technologies that make information access and processing cheaper at the plant-level (Bloom et al., 2014). Some works have also investigated the implications of firm flattening for the shift of decision power within the organization (Wulf, 2012). So far, however, little research has been conducted on the effect of firm-level institutional bodies, in particular employee representatives, on decisions concerning the optimal number of organizational layers. Our paper is expressly aimed at filling such gap.

Finally, our work integrates the voluminous literature on ER, considered both in its unionized and non-unionized version (e.g. shop-floor committees, works councils, unions). From a theoretical point of view, previous contributions investigate the role of ER in relation with several aspects of firms' activity such as wage bargaining (Booth and Chatterji, 1995), information provision (Freeman and Lazear, 1994), work engagement and employee voice (Bryson, 2004; Kwon and Farndale, 2020). On this ground, a relatively rich empirical literature has developed studying the effects of employee representation on firm performance, focusing in particular on productivity (Addison et al., 2004; FitzRoy and Kraft, 2005), investment (Addison et al., 2007; Jäger et al., 2019), employment (Addison and Teixeira, 2006; Jirjahn, 2010), innovation (Kraft et al., 2011; Addison et al., 2017; Belloc, 2019) and corporate market value (Gorton and Schmid, 2004). A relatively smaller literature has also investigated the effects of ER and more generally unions on non-wage aspects of labor, such as hours of work (Buchmueller et al., 2004), flexible-time arrangements (Burdin and Pérotin, 2019) and length of worker tenure (Bidwell, 2013). In this paper we extend this literature by studying the effect of ER on the hierarchical organization of the firm.

The remaining of the paper is organized as follows. In Section 2, we introduce our basic conceptual framework, of which the underpinnings are based on Garicano (2000). In Section 3, we describe the data and the key variables used in the empirical analysis, whose results are presented in Section 4. In Section 5, we discuss some possible alternative explanations of the empirical evidence. Section 6 concludes.

2 Conceptual framework

2.1 Knowledge, hierarchy and institutions

Much of the research in the field of organizational economics studies firm hierarchies through the lenses of agency theory (Alchian and Demsetz, 1972; Fama and Jensen, 1983;

Jensen, 1986). According to this view, firms are characterized by conflicting interests among agents placed at different layers of the organizational architecture (e.g. shareholders vs. managers or employer vs. employee) and the main purpose of organization is to design incentives to align their opportunistic conducts (Williamson, 1985; Milgrom and Roberts, 1992). While many important insights have been obtained from this approach, a shortcoming is that it overlooks the role of organizations as repositories of individual and collective knowledge. In fact, alongside the need to cope with individual opportunism, firms perform a key function in coordinating a set of differentiated skills and expertise, which are to be transformed into economically valuable products and services (Kogut and Zander, 1992; Grant, 1996; Conner and Prahalad, 1996). This objective is achieved through a system of organizational rules (both formal and informal) and operating procedures that shape social relations and behaviours, allowing individuals to follow structured decision-making processes that spare them excessive cognitive costs (Cyert and March, 1963). In the literature, such mechanisms have been broadly associated with the concepts of routines (Nelson and Winter, 1982), capabilities (Richardson, 1972; Chandler, 1992; Langlois, 1992; Teece, 1982) and dynamic capabilities (Teece and Pisano, 1994; Teece et al., 1997; Zollo and Winter, 2002). Despite some conceptual differences, these approaches share a common emphasis on the relevance of localized, socially constructed and embedded knowledge in understanding firm organization (Foss, 2003).

Although such knowledge-based theories represent fruitful ways to study firm organization, they suffer of three important limitations. The first one is that they do not pay sufficient attention to the role of hierarchies as structures that help to organize and process information. Within organization theory such role has been recognized in contributions that go as far back as the Carnegie school (Simon, 1976; March and Simon, 1958; March and Olsen, 1976). Simon (1981), in particular, argues that hierarchy is a general feature of complex systems emerging because of its evolutionary and problem-solving advantages. In this view, hierarchies represent efficient mechanisms to coordinate production systems that consist of multiple specialized units, such as a firm. Over time, however, organizational research has downplayed the analysis of hierarchies especially with formal models, while shifting the focus towards higher order conceptual constructs such as routines and capabilities. This trend, as argued by Gavetti (2005), has had a negative impact on the development of the theory's microfoundation. Recently, issues related to hierarchy have regained momentum in organization studies (e.g., Diefenbach and Sillince, 2011; Zhou, 2013; Dobrajska et al., 2015; Keum and See, 2017).

The second limitation of the knowledge-based approaches is that, even when they discuss organizational hierarchies, the latter are often assumed rather than derived from theory. Grant (1996), for instance, debates the role of hierarchies in favouring the process of knowledge integration, but he is more concerned with studying issues related to the shift of decision power within organizational layers than with the analysis of how the

organizational structure is derived in the first place. Similar weaknesses characterize other contributions in the knowledge-based tradition (e.g. Teece et al., 1997).[3] It follows that such theories have relatively little to say on the impact that factors affecting the acquisition and transmission of knowledge have on the design of organizational hierarchies. Based on these premises, Garicano (2000) develops one of the first formal model in which the structure of organizational layers is derived within a knowledge-based approach to production. The latter represents one of the most promising ways of complementing organizational research with formal analysis of hierarchies (see also Garicano and Rossi-Hansberg, 2004, 2006, 2012, 2015).

Finally, and this is a limit that characterizes also the contribution of Garicano (2000), most knowledge-based theories of organization adopt a relatively universalistic model of production that abstracts away from the institutional environment in which firms are embedded. Despite extensive research, both theoretical and empirical, shows that institutions matter as far as firm-level organization is concerned – e.g. they affect the adoption of corporate governance models (e.g. Hall and Soskice, 2001; Aguilera et al., 2008) as well as management practices (e.g. Bloom and Van Reenen, 2010; Bloom et al., 2019), similar issues have been seldom taken up by organizational research. Bloom et al. (2014) exploit Garicano's framework to study how changes in the costs associated with the acquisition and transmission of information affect organizational design but their analysis is limited to the role of technology. However, likewise technology, institutions may also affect the process of knowledge integration especially if their definition is stretched to include, not only formal and informal "rules of the game" (North, 1990), but also common resources (Hall and Thelen, 2009) and organizational bodies that foster cooperation among agents (Deeg and Jackson, 2007). For instance, the existence of labour institutions that support employee voice may affect the cost of knowledge acquisition and transmission within firms and this may in turn impact on the process of organizational design. Similarly, the degree of protection foreseen by employment contracts may create different incentives for workers to accumulate firm-specific knowledge, which may also impact on the firms' desirable level of hierarchical depth. Overall, a more explicit consideration of institutional embeddedness would allow a much better understanding of the extent to which the structure of organizational hierarchies change across time and space.

On this ground, the next section presents a formal model that make a first step in filling such gaps. The model is framed within a knowledge-based approach to production and it gives explicit account to the process through which firm hierarchies are derived. It embeds organizational design within a set of labour institutions related to workplace ER. The model, however, is general and simple enough to allow for future extensions that consider other types of institutions as well.

[3]The same limitation in the analysis of firm hierarchy characterizes most incentive-based approaches derived from agency theory (e.g., Qian, 1994; Calvo and Wellisz, 1978).

2.2 A simple model

To begin with, we follow Garicano (2000) and consider an organization without ER. The organization is composed by an entrepreneur and a number W of workers, who are organized in a hierarchical structure of L layers, with $L \geq 1$. Each layer l has a size s_l, in terms of the number of workers at layer l. The organization faces a flows of production problems over time. Problems may be of a different nature, from very standard (only requiring small adjustments at the shop floor) to very complex (involving, for example, the need to modify production schedules, to update some technologies used in the production line, or to enlarge or reduce an establishment's size). Problems of a different type arise with a different likelihood, with the more complex ones arising less likely. Let $F(n)$ be the probability density function of a problem n. Normalize this density so that problems are ordered from most to least common and assume that the density of problems $F(n)$ is nonincreasing. The number of problems that the organization receives in each time period t is $N_t > 1$. In t, the organization is concerned about solving all the N_t problems, with the average solved problem having value $v(N)$. Assume that $v(N)$ is continuous and twice differentiable, with $v'(N) < 0$ and $v''(N) > 0$, and that $\lim_{N\to\infty} v(N) = 0$. This means that the average value of a solved problem decreases with the number of problems solved (i.e. there are diseconomies of scale in problem solving). Various justifications may be provided for this assumption. One is based on the transaction costs economics argument that some organizational costs (not explicitly modeled here) increase with firm size because of contracts incompleteness, disagreements among employees, conflicts of interests and possibly hold-up (e.g., Williamson, 1967). Another is the possibility that problems are ordered from most to least valuable and that the firm starts dealing with the former; so, when problems are added to the firm's workload, the value of the average problem goes down. Finally, one may consider increasing opportunity costs for each unit of time spent in production by the firm that make the marginal problem less valuable than the preceding ones. Assume also that, in each time period t, one worker can solve one problem. Hence, under the assumption that the organization needs to solve all the N_t problems, we will have that $N_t = W_t$. To keep notation simple, hereafter we use N to denote both the number of problems and of workers; moreover, we omit the subscript t, but continue to consider all the variables as referred to a given time period t.

The firm can manipulate the number of layers over time. Suppose that, when the number of layers changes, the number of workers employed also changes. In particular, delayering implies firing a fraction $\beta > 0$ of the workers who were employed at the dropped layer, while adding a layer implies hiring new workers for covering a share β of the tasks at the newly added layer. Caliendo et al. (2015) report that firms adding/dropping a layer tend to grow/shrink in the periods around the change. Our data show a similar firm behaviour (see below, Figure 4). Changes in employment of both signs may be due

to inside workers being sticky in moving across layers. Denote with j the layer that is dropped or added, then the number of workers reduces or increases by βs_j. Consequently, also the number of problems N the firm is able to deal with changes by βs_j. Alternatively, one may assume that delayering implies some restructuring of the production process at the firm level, which induces a drop in the production capacity by βs_j, and that adding a new layer helps the firm dealing with some new problems.

Workers are identical in all the relevant characteristics, but the knowledge they acquire to solve problems. Suppose that each problem can be solved by applying a problem-specific knowledge and that the per-problem cost of knowledge is k_n, with $k_n = k \quad \forall n$ for simplicity. Problems may be of a same type (thereby having a same frequency) or different. Refer to the number of problem types the organization is concerned with as the "total problem variety". The "depth" of the knowledge of the worker, i.e. how many different problems he is able to solve (or the problem variety he is able to address), is denoted by d_i, with i denoting a generic worker. Workers of a same layer have the same depth of knowledge, so that $d_i = d_l \quad \forall i \in l$. Assume that knowledge is not overlapping across layers (i.e., workers at different layers are able to solve different problems), but workers of a same layer may be able to solve more than one problem.[4] The costs of making a worker at a layer l acquiring knowledge is $d_l^{1-e}k$, with e (normalized between 0 and 1) being the effort that the worker may exert to facilitate the development of problem-specific skills. Assume that effort is not contractible and that its cost is infinitely small.

The most standard production problems are solved at the shop floor layer, while more complex and rarer issues require the involvement of workers at some higher layer in the hierarchy. Specifically, when workers of layer l do not know how to solve a problem, they pass the problem to workers of a higher layer $l+1$, and this process continues until the workers of a higher layer are able to solve the problem. The process of a worker passing a problem across two layers cost $c_l = c \quad \forall l$, with $c < k$.[5] The cost c is incurred by who receives the problem and is identical for those who know the solution and those who not. Alternatively, all the workers at any layer are aware of the problems arisen in t, but for a problem being solved the workers of the relevant layer need to collect some information from the layers below in the hierarchy, with the cost of transferring information across layers being c for each problem-layer pair.

[4]We make the assumption of no-overlapping knowledge in order to avoid confusion in the text, but it is irrelevant for the comparative statics in the propositions here.

[5]The assumption that $c < k$ is used because it seems more reasonable from an empirical point of view. Also, this assumption rules out the unrealistic situation of the most cost efficient organizational structure being that with only one layer, with all the workers able to solve any type of problem.

The net output per-worker is

$$y = v(N) - \underbrace{\sum_{l=1}^{L} s_l {d_l}^{1-e} \frac{k}{N}}_{\substack{\text{Knowledge} \\ \text{costs}}} - \underbrace{\left((L-1) \sum_{l=1}^{L} s_l - \sum_{l=1}^{L-1} s_l (L-l) \right) \frac{c}{N}}_{\substack{\text{Communication} \\ \text{costs}}} \tag{1}$$

where the communication costs component reflects the sum of the costs of each unsolved problem moving across layers until it is solved.[6] Clearly, as both communication costs and knowledge costs enter Equation (1) negatively, the net output per-worker is reduced when they increase. However, as in Garicano (2000), while an increase in communication costs pushes a profit maximizing firm to reduce L in order to minimize over the cost of transmitting information across layers, an increase in knowledge acquisition costs induces an increase in L, because in doing so the firm minimizes redundancies in knowledge formation.

Next, consider an organization where an ER body is established. The ER body has the right to be informed or consulted on an exogenously given fraction p (with $0 \leq p \leq 1$) of the problems that are unsolved at the shop floor, which amount to $N - s_1$. Information and consultation take place thorough meetings, that have both a positive and a negative effect on the ease of communication within the firm. First, meetings allow ER to make skip-level reporting, i.e. to collect information about a fraction of unsolved problems and to supply them directly at the layer where they can be solved. In doing so, meetings with ER allow the firm to save some costs of communication across layers, because workers at different layers are not required anymore to communicate directly to each other about $p(N - s_1)$ problems. Second, meetings require ER itself to discuss about a fraction p of problems with the workers and this slows communication down. The unit cost of delay (which includes the cost of transmitting a problem to ER, discussing it in a meeting and transmitting it back to the correct layer) is z. At the layers higher than the shop floor, the fraction of problems $1 - p$ can be addressed by workers without involving the ER body, and therefore imply communication costs as when ER is absent. If ER bodies are not established, then $p = 0$. To keep things simple, assume without loss of generality that an ER does not reduce the workload of workers at any layer, regardless of whether it is composed by one or more workers of lower or higher layers. Figure 1 shows a graphical representation of within-firm communication both with and without ER.

[insert Figure 1 about here]

ER may also influence knowledge acquisition costs (this is not crucial for our argu-

[6] A simple example to grasp the intuition of how we obtained the communication costs component of Equation (1) is provided in Appendix A.1.

ment). Assume that (both with and without ER) workers are paid

$$w = \overline{w} + \tau y \tag{2}$$

where $\overline{w}$ is an exogenously given (fixed) component and $\tau = \tau(p)$ is the share of the unit net output that goes to workers. The share $\tau(p)$ is monotonically increasing in p, i.e. τ rises with the share p of problems the ER body is consulted about, which proxies the bargaining strength of workers (this is a standard result of industrial bargaining models; see Freeman and Lazear, 1994), with $\tau(0) = 0$. Therefore, if $p = 0$ (or the ER is absent), workers are paid only a fixed wage $w = \overline{w}$. On the other side, the payoff of the entrepreneur is

$$\pi = (1 - \tau)y - \overline{w} \tag{3}$$

The workers can raise their payoff, by increasing y as a result of improved effort. Hence, when p increases, thereby increasing the worker share $\tau(p)$ of total rent, the workers will also improve effort to benefit from a larger payoff. That is, effort e also depends on p. Given that both e and p range from 0 to 1, assume that $e(p) = p$ for simplicity.

Now, the net output per-worker is

$$y = v(N) - \underbrace{\sum_{l=1}^{L} s_l {d_l}^{1-p} \frac{k}{N}}_{\substack{\text{Knowledge} \\ \text{costs}}} - \underbrace{\left[\left((L-1) \sum_{l=1}^{L} s_l - \sum_{l=1}^{L-1} s_l (L-l) \right) \frac{c}{N} (1-p) + (p(N - s_1)z) \frac{1}{N} \right]}_{\substack{\text{Communication} \\ \text{costs}}} \tag{4}$$

To improve clarity, exploiting that $\sum_{l=1}^{L} s_l = N$ and that $e = 0$ when $p = 0$, the net output per-worker with and without ER can be simplified as

$$y = \begin{cases} v(N) - \sum\limits_{l=1}^{L} \frac{s_l d_l}{N} k - \left((L-1) - \frac{\sum\limits_{l=1}^{L-1} s_l (L-l)}{N} \right) c, & \text{w/out ER} \\ v(N) - \sum\limits_{l=1}^{L} \frac{s_l {d_l}^{1-p}}{N} k - \left((L-1) - \frac{\sum\limits_{l=1}^{L-1} s_l (L-l)}{N} \right) c(1-p) - \frac{p(N-s_1)z}{N}, & \text{w ER} \end{cases} \tag{5}$$

The problem of the entrepreneur is to decide the number of layers L so as to maximize (5). Each time period t can be thought of as composed by three sub-periods. In t_0, the firm observes N and the types of the problems it is required to deal with, sets the number of workers and decides the number of layers L, k and c being given. In t_1, an ER body can be established at the firm (this is an exogenous event). If the ER body is

established, in t_2 the firm can change the number of layers.

Looking at Equation (5), we can advance some testable predictions.

Prediction 1: *When an ER is present, a profit maximizing firm may optimally choose to have a higher number of layers than a firm without ER.* It is so when the communication costs component in Equation (5) is reduced enough by the introduction of ER, i.e. when the reduction in the communication costs component is larger than the reduction in the knowledge acquisition costs component.

Prediction 2: *The positive effect of ER on hierarchical depth decreases with firm size and eventually becomes negative, i.e. large firms with ER may select a lower number of layers than otherwise identical smaller counterparts.* Due to diseconomies of scale, the average value of a solved problem is lower for larger firms. Hence, large firms are less able to accommodate the layer-increasing effect of ER.

Notice that Equation (5) does not have direct implications about the link between ER and the likelihood of a firm's delayering. When a negative shock hits the firm, requiring it to shrink in size (i.e. to reduce N), the cost components of Equation (5) are affected in the same way, with and without ER. Hence, ER should not influence the optimal reduction of the number of layers of the firm.

Our simple framework also allows to see that delayering implies some worker empowerment (as proxied by increased worker autonomy) only when it is associated to the movement of knowledge below in the firm hierarchy. When delayering is accompanied by substantial layoffs instead, worker autonomy is unaffected. This is described in the following remark.

Remark 1. Define the worker autonomy as the "relative depth" of knowledge of the workers at a layer l, i.e. $a_l \equiv d_l / \sum_{l=1}^{L} d_l$. In the special case in which $\beta = 1$ (i.e. when a layer j is dropped, all the workers employed at layer j are fired and both W and N reduce by s_j), delayering does not induce any change in a_l (with $l \neq j$).

The main intuition behind Remark 1 is straightforward. If a firm dropping a layer j of size s_j also fires s_j workers (or a number of workers close to it), then the firm itself looses the ability to solve s_j problems of the type dealt with at layer j. This implies that the firm is not required to reshuffle knowledge across layers and to increase the relative depth of knowledge of the workers at the remaining layers. Clearly, the presence of ER does not have any direct role in this, unless one assumes that β is significantly influenced by ER.[7] We do not develop this possibility here in formal terms, and leave it open to the empirical study presented next.

[7]Relying on the same data we use in our empirical study, Burdin and Pérotin (2019) show that ER does not have a significant effect on the probability of reducing employment.

3 Data and variables

3.1 The European Company Survey: overview

We test the basic predictions of the model using establishment-level data from the last wave of the European Company Survey (ECS 2013). ECS data cover a representative sample of non-agricultural European establishments employing at least 10 employees. A crucial advantage of this survey is that it provides harmonized cross-country information on employee representation, management practices and organizational design at the workplace level. The survey is conducted in two steps. The first step involves a telephone interview with a manager, who is asked about establishment characteristics, organizational practices (e.g. compensation policies, working-time arrangements, etc), and industrial relations, including the existence of employee representation structures. The second stage comprises an interview with an employee representative in those establishments in which an employee representation structure is present. As information obtained in the second stage is conditional on having an employee representation structure, our analysis is exclusively based on the information gathered in the management questionnaire.

A. Measure of shop-floor employee representation. We focus on institutionalized forms of employee representation, either through trade unions or works councils. Employee representation is a dummy variable identifying establishments with a trade union, works council or any other country-specific official structure of employee representation (e.g. joint consultative committees). This definition excludes health and safety representatives and ad-hoc forms of representation.

B. Measure of hierarchical layers and delayering. To characterize the hierarchical structure of establishments and the extent of delegation/decentralization, we rely on different measures. First, managers report the current number of hierarchical levels for each establishment. Second, they also report whether the number of layers has decreased (i.e. delayering), increased or remained constant since 2010. Therefore, we have information about both the current organization of the firm and organizational changes in the last three years. In Figure 2 and Figure 3, we show that these measures correlate well and in the expected way with average country-level scores on "Willingness to Delegate Authority" based on Executive Opinion Surveys and collected as part of the Global Competitiveness Index (World Economic Forum).

[insert Figure 2 about here]

[insert Figure 3 about here]

C. Worker autonomy. We also have information about the extent of task autonomy,

i.e. whether individual employees or teams (instead of supervisors) can decide on planning and execution of daily work tasks (see for instance Bresnahan et al., 2002). This allows to explore whether delayering is accompanied by greater employee empowerment and whether employee representation structures mediate that process.

D. Other control variables. Finally, managers report information on the use of information systems, changes in technology, firm organization and ownership, frequency of meetings between employees and managers, training activities, workforce composition, average tasks' complexity, plant size, subsidiary/headquarter status and a wide range of management practices. This rich set of information allows to test for specific mechanisms and control for conventional technological drivers of hierarchical structures previously studied in the literature.

We restrict the sample to private-sector establishments located in 21 EU countries. Variables description and descriptive statistics are reported in Table 1 and Table 2 respectively. On average, establishments have three layers of management in our sample. This compares well with previous studies using self-reported indicators of hierarchical structure.[8]

[insert Table 1 about here]

[insert Table 2 about here]

In Figure 4, we report changes in employment between 2010-2013 depending on whether the establishment decreased, increased or kept unchanged the number of layers over the same period. Roughly 70% of establishments that experienced delayering also reduced employment. By contrast, 63% of workplaces that increased the number of layers experienced employment growth during the same period. This suggests our measure of organizational change/reorganization is economically meaningful in the sense that it correlates with different patterns of firm growth. Then, in Figure 5, we do the same but instead of employment we consider reported changes in establishments' productivity. Approximately 45% of establishments that reduced the number of layers increased productivity over the same period, suggesting our measure of delayering does not merely reflect shrinking performance, but more complex processes of firm reorganization. Second, the fraction of establishments that increased productivity is the highest among establishments that added layers during the same period. The chances of adding/dropping a layer appear to be positively/negatively correlated with productivity in our sample. These two facts are broadly consistent with previous evidence on the anatomy of changes in production hierarchies (Caliendo et al., 2015) and further validate our survey-based measures of

[8]Using a French sample of manufacturing firms, the "Changements Organisationnels et Informatisation" (COI), Acemoglu et al. (2007) report a mean value of 3.2 layers of management.

hierarchical depth.

[insert Figure 4 about here]

[insert Figure 5 about here]

In Figure 6, we plot the histogram of the numbers of hierarchical layers for establishments with and without ER. The distribution appears to be skewed to the right for establishments in which ER is present, indicating deeper firm hierarchies in those establishments. This pattern holds for all industries (Figure 7). Moreover, a similar distribution is observed across countries belonging to different industrial relations regimes (Figure 8).[9] This suggests employee voice explains some of the variation in hierarchical depth independently of other labor institutions, reinforcing the case for unbundling institutions and investigating this specific arrangement separately. Observed differences may be partly explained by the fact that establishments with ER are larger and, hence, have more complex organizational structures. Indeed, the pattern is less clear when the comparison is restricted to large firms within industries (Figure 9), suggesting the importance of conducting multivariate analysis to account for different establishment-level characteristics.

[insert Figure 6 about here]

[insert Figure 7 about here]

[insert Figure 8 about here]

[insert Figure 9 about here]

[9]We group countries according to the classification of industrial relations regimes proposed by Visser (2009).

4 Results

4.1 Levels of hierarchical layers and delayering

We begin by considering the following baseline regression model:

$$\begin{aligned} \mathrm{Y}_i = \beta_0 + \beta_1\, \mathrm{ER}_i + \beta_2\, \text{Medium firm}_i + \beta_3\, \text{Large firm}_i + \\ \beta_4\, \mathrm{ER}_i \times \text{Medium firm}_i + \beta_5\, \mathrm{ER}_i \times \text{Large firm}_i + \mathbf{b}\mathbf{X}_i + \varepsilon_i \end{aligned} \tag{6}$$

where Y_i is alternatively the number of layers in 2013, a dummy variable equal to 1 if the firm has decreased the number of layers since 2010 (i.e. delayering), and a dummy variable equal to 1 if the firm has increased the number of layers since 2010; ER_i is a dummy variable for the presence of ER at the establishment level; Medium firm_i and Large firm_i are dummies for medium (50-249 employees) and large firms (250+ employees), the small firm category (10-49 employees) being the benchmark; $\mathbf{X}_i$ is the vector of controls (it also includes country and industry fixed effects); ε_i are the residuals.

We first analyze the correlation between ER and the number of hierarchical layers. Table 3 reports the results of a series of OLS estimates. In column 1, we estimate a parsimonious model in which we only include a dummy variable that takes value one for establishments in which there is a ER structure in place, three dummy variables to control for establishment size (small firms being the benchmark category) and interaction terms to capture the interplay between ER and plant size. Estimates reported in column 1 also control for industry and country fixed effects. The presence of ER is associated with 11% increase in the number of layers. As expected, larger establishments tend to have more layers (this is consistent with previous research; see, e.g. Delmastro, 2002; Colombo and Delmastro, 2004). Interestingly, the interaction between ER and size is significantly negative, suggesting the impact of ER on firm hierarchies is heterogeneous across the workplace size distribution.

[insert Table 3 about here]

In columns 2-5, we sequentially add more controls to see the robustness of the results. In column 2, estimates control for differences in workforce composition (gender, age, skills, fraction of part-time and permanent contracts) and share of workers performing complex tasks, reported change in productivity and employment since 2010, and dummy variables identifying multi-site firms, subsidiary sites, recent changes in ownership and organizational changes. In column 3, we account for differences in the prevalence of outsourcing of production activities that may also affect the hierarchical structure of firms. In column 4, we control for the use of information systems oriented to minimize supplies or work-in-process (e.g. just-in-time, lean production systems). Finally, in column 5, we

add a series of "noise controls" on respondents' characteristics (gender, position and job tenure of the manager) in order to increase the precision of our estimates and reduce concerns about measurement error in the organizational variables. None of the described modifications alters the basic finding.

In line with Prediction 1, this suggests that on average the reduction in communication costs associated with the presence of ER is sufficiently large to offset any reduction in knowledge acquisition costs. This would also indicate that the net effect of ER on communication costs is negative, i.e. the skip-level reporting effect dominates the cost of delayed decisions resulting from the operation of employee representation (e.g. information and consultation process). The fact that the effect of ER is heterogeneous across establishment size categories suggests the trade off between communication costs and information acquisition costs may be size-contingent. This is consistent with the idea that firms of a different size deal with problems with different average value, thereby inducing ER to exert differential effects on the depth of hierarchy depending on firm size (our Prediction 2).

Having documented a positive correlation between ER and the number of hierarchical layers, we now turn to analyse whether ER presence affects the change in organizational hierarchies over time. Table 4 reports estimates from a series of Linear Probability Models (LPM) in which we analyze the correlation between ER and the probability that the establishment has reduced the number of hierarchical layers (delayering) since 2010.[10]

[insert Table 4 about here]

[insert Table 5 about here]

As in Table 3, we report estimates from five different specifications in which we successively consider additional sets of controls. In column 1, we find a positive correlation between ER and delayering, although the effect is not robust to the inclusion of further controls. Interestingly, large establishments with ER are more likely to delayer than large establishments in which ER is not present.[11] This is again consistent with our Prediction 2, when it says that large firms tend to accommodate the reduction in communication costs due to ER by adding layers to a lesser extent than smaller firms. Based on our framework, this may be driven by the fact that adding layers implies an increase in size and consequently a reduction in the average value of a solved problem. Hence, larger

[10]We obtain qualitatively similar estimates when average marginal effects are obtained from Probit models. Results are reported in Table A.2.1 in Appendix A.2.

[11]Table 5 reports symmetrical estimates in which the outcome is a dummy variable that takes the value one if the establishment has increased the number of layers since 2010. We find no significant correlation between ER and changes in layers. Large establishments with ER are less likely to increase the number of layers than large establishments in which ER is not present.

firms need to be more conservative after the introduction of ER, because they already deal with less valuable problems.

In addition, when looking at the relationship between size and (de)layering regardless of ER, Table 3 and Table 4 show that large firms are in general more stable than small firms (i.e. large firms are less likely to delayer but not more likely to add new layers).

4.2 Delayering, worker empowerment and functional centralization

We also have information on the extent of worker autonomy both at the individual and team level. We are interested in understanding whether delayering correlates with greater worker empowerment and how the presence of ER mediates this relationship. Results for both individual and team autonomy are reported in Table 6 and Table 7, respectively. Overall, we do not find any significant correlation between delayering and task autonomy. Most importantly, the presence of ER does not exert any differential effect. This may reflect the fact that delayering firms also restrict the problems variety they aim at dealing with, so that they do not need to improve the knowledge base of the remaining layers. If this is the case, when a layer is dropped, the firm should also be observed to shrink in terms of number of workers: this is in fact something that our data seem to confirm (see Figure 4).[12]

[insert Table 6 about here]

[insert Table 7 about here]

That delayering may be followed by a restriction in the total problem variety of the firm does not imply that delayering firms keep their functional organization unchanged. Related to this, some scholars have argued that the recent trend towards flatter business organizations does not necessarily entail greater worker empowerment and may be consistent with greater centralization of managerial authority (Rajan and Wulf, 2006; Foss and Klein, 2019; Guadalupe et al., 2014). For instance, Guadalupe et al. (2014) document, in the US context, an increase in "functional centralization", i.e. an increase in the number of functional managers directly reporting to the CEO. Hence, flatter corporate hierarchies

[12]It might also be the case that, once a layer is dropped and at least some workers are fired, knowledge moves up at the top of the hierarchy. This would also imply that worker autonomy at the shop floor does not improve; but, in our framework, it would require to allow for a top manager dealing with more than one problem. Our theoretical setting assumes that one worker (he/she being a blue collar or a manager) can solve only one problem and does not consider the possibility that managers gain the ability to solve more problems simultaneously after delayering. This is to keep the framework simple and not to exclude that top managers to some extent may centralize strategic knowledge after delayering.

may be indeed compatible with greater concentration of power in the hands of senior managers. In the words of our conceptual framework, after dropping an intermediate layer and firing some of its workers, the span of control of top managers is mechanically enlarged, because managers now get in touch directly with the larger layers operating below in the hierarchy; this may induce the firm to increase functional centralization without preserving its total problem variety.

The survey provides information on whether the establishment has departments based on functions (e.g. sales, production, administration, research etc). In Table 8, we report estimates of the correlation between delayering and the probability of having a functional department after controlling for the presence of ER and holding constant a wide range of workplace-level characteristics. Both delayering and the presence of ER correlate positively with the presence of functional departments, leading to greater centralization of core managerial decisions at the top. Interestingly, delayering is less likely to be conducive to functional centralization when ER is present.

[insert Table 8 about here]

Overall, the popular bossless workplace narrative receives little support in our data. Delayering does not correlate with task autonomy and appears to coexist with functional centralization. The evidence on the mediating effect of ER is mixed. On the one hand, there is no evidence that ER foster worker autonomy when firms becomes flatter. On the other hand, the presence of ER seems to counteract the tendency to concentrate decisions in functional departments among delayered establishments.

4.3 Endogeneity

Tables 3-8 present conditional correlations that are broadly consistent with the theory. In particular, our model suggests that in equilibrium the number of hierarchical layers should covary in systematic ways with the presence of ER and that the direction of such relationship is mediated by the size of the firm. This is what we observe in the data. Nevertheless, we are concerned about the potential endogeneity bias of our estimates. For example, there may be an unobservable variable that is correlated with the organizational outcome and our measure of ER.

In this subsection we consider an instrumental variable (IV) strategy for ER. We ground the identification of a viable instrument on the analysis of the institutional determinants of unionization.

According to standard cost-benefit analysis of union determination (e.g., Berkowitz, 1954; Hirsch and Addison, 1986; Pencavel, 1971), ER can be modeled as though it were an asset available to utility-maximizing workers that provides a flow of services. In this framework, the costs and benefits of unionization (as well as the propensity and the op-

portunity to organize) are affected by institutional variables such as the centralization of collective bargaining (Schnabel, 2003). Sectoral or regional coverage of collective agreements influences, in particular, the collective action costs needed to establish ER and the benefits that the workers can obtain from it. For instance, when employment conditions are determined by a collective agreement, workers have incentive to be active proponents of these conditions through union action. Setting up an employee representation structure at the workplace level may also require expert knowledge and operational support which is more likely to be available when there are higher level union confederations involved in collective bargaining (Devicienti et al., 2018). Depending on the labour legislation, it is also possible that sectoral collective agreements cannot be extended to workers if it is absent at the firm an ER body that acts as a signatory party of the agreement.

Previous empirical research has showed that the coverage by centralized collective agreements is an important determinant of the degree to which unions can successfully pursue an individual service or insurance strategy. In line with this, Scheuer (2011) finds that coverage by a collective agreement actually triples the likelihood of union membership. Moreover, comparative legal analysis clarifies that extension of collective agreements to third parties at the sectoral or regional level is mostly subject to regulatory institutions and labour laws, that are clearly exogenous in our study (Adams et al., 2016).

Following these arguments we use information on whether the firm is covered by a collective wage agreement negotiated at the sectoral or regional level, i.e. a feature of institutional environment in which the establishments operate, as an exogenous factor that shifts the probability of establishing an ER at the establishment level.[13] Specifically, we build a dummy variable (Sectoral bargaining$_i$) coded 1 if the firm is covered by a sectoral wage agreement and 0 otherwise, and use it as an instrument for ER in Equation (6). Also the interaction terms capturing ER effects at different firm size classes are instrumented. The results are collected in Table 9. Consistent with our priors, the first-stage results show that coverage by sectoral or regional agreements is a strong predictor of ER presence at the firm level. Moreover, when entered in the depth of hierarchy regression, the coefficients of both the instrumented ER variable and interaction terms have sign and significance coherent with our baseline regressions. We find again that ER positively correlates with the number of hierarchical layers and that medium firms with ER tend to have a shorter

[13]We explore the possibility of using alternative instruments. In particular, we use the interaction between collective bargaining coverage and a dummy variable indicating whether the company takes part of any employers' organization that participates in collective bargaining. The rationale for using this interaction draws from the extensive literature on institutional complementarity between organized labor and capital (Aoki, 2001; Aguilera and Jackson, 2003; Belloc and Pagano, 2009; Van Essen et al., 2013; Landini and Pagano, 2020). Despite the fact we got similar results to those report in Table 9, we are less convinced about this alternative instrumental variable strategy. While setting wages according to collective bargaining agreements is clearly an exogenous institutional constraint for most firms, being a member of an employer organization is a choice variable. According to our reading of the literature on employers' associations (see, for instance, Martins, 2020), this choice is likely to be correlated with factors that may also affect the design of hierarchies. In this context, the exclusion restriction is unlikely to hold.

hierarchy with respect to smaller counterparts. In this case, large firms with ER do not behave significantly differently. Reassuringly, usual IV diagnostic tests for instrument relevance and exogeneity are passed.[14]

[insert Table 9 about here]

4.4 Mechanisms

There is a positive association between ER and the number of hierarchical layers. In this Section, we investigate several potential mechanisms that may account for our basic finding. First, we use training as a proxy of firm-specific activities related to the acquisition and accumulation of noncodifiable knowledge (Garicano and Wu, 2012). The survey contains extensive information on training activities at the workplace level, including the fraction of employees entitled to paid time off for training and information on the purpose of training activities. Results are reported in Columns 1-2 of Table 10.[15] The presence of ER positively correlates with our measures of training. Interestingly, ER is positively associated with the extent of training activities oriented not only to develop workers' skills at the current jobs but also with those aimed at enabling workers to take different job positions and rotate tasks with colleagues. This suggests that employees in ER-establishments are able to deal with and solve a wider variety of production problems. Hence, the effect of ER (if any) would be to reduce knowledge acquisition costs.

[insert Table 10 about here]

In the context of our model, this "skilling" effect of ER should contribute to push down the number of hierarchical layers. Therefore, our finding that ER is associated with a higher number of vertical layers should be driven by an even stronger reduction in communication costs in establishments under employee representation. In columns 3-5 of Table 10, we show that the presence of ER at the establishment level is associated with reported changes in coordination and allocation of work to employees and meetings between managers and employees. It is worth noting that the positive correlation between

[14]We also employed Propensity Score Matching techniques to deal with possible endogeneity of ER. The results are collected in Table A.2.2 in Appendix A.2. Propensity Score Matching allows dealing with selectivity issues, by estimating the firm's propensity to establish ER based on (pre-determined) observable characteristics of the firm. If a firm with ER (treated) and a firm without ER (control) have the same propensity score, any difference in the hierarchical structure between the treatment and control groups (i.e. the average treatment effect on the treated, or ATT) can be attributed to ER and not to differences in observable characteristics. In our exercise, we estimate propensity scores as the conditional probability of establishing ER given the sector of activity of the firm and whether the firm is a member of any employers' organisation which participates in collective bargaining. Doing so, we obtain qualitatively similar results to those obtained in our baseline analysis.

[15]The fraction of employees involved in training activities is a categorical variable: None at all, less than 20%, 20%-39%, 40%-59%, 60%-79%, 80%-99%, All employees. For this reason, Column 1 of Table 10 reports estimates from Ordered Probit Models.

ER and the frequency of staff meetings is an empirical fact that conflates both delay effects and skip-level reporting. Interestingly, according to estimates reported in column 6 of Table 10, managers in establishments with ER are not more likely than their counterparts in establishments without ER to agree with the statement that "employee involvement causes delays in the implementation of decisions". Our interpretation in light of the theoretical model is that arguably skip-level reporting dominates so the net effect of ER on communication costs is negative.

5 Alternative explanations

We analyse the effect of employee representation on the structure and change in corporate hierarchies through the lens of a model of knowledge-based hierarchies. However, our results may be consistent with alternative models. While we do not neglect the importance of alternative theoretical explanations, most of them suggest the effect of ER on hierarchical depth should be increasing in firm size, a pattern that we do not verify in our data.

For instance, models of hierarchy and delegation put significant emphasis on issues related to incentive design (Mookherjee, 2013). Dessein (2002) develops a model in which the principal must decide whether to fully delegate a task to a better informed agent or to keep authority on what to do after having consulted him. Although there is not explicit reference to hierarchical depth, the choice to delegate would induce an empowerment of the agent's knowledge and thus correspond to a flatter organization in our framework. On the contrary, authority brings with it disempowerment of the agent's knowledge and thus lead to a more hierarchical setup. The main result of the model is that delegation dominates authority as long as the agent's reporting bias, which is a proxy of the conflicting interest between him and the principal, is sufficiently small. When applied to our framework, the main prediction of the model would be that the effect of ER on the organization of corporate hierarchies depends on its effect of the reporting bias. If ER increases the reporting bias (i.e. it makes the interests of the principal and the agent more divergent), then we should expect an increase in hierarchical depth. In contrast, if ER reduces the reporting bias (i.e it makes the interests of the principal and the agent more convergent), then the hierarchical depth should reduce. The fact that we do not find ER to increase hierarchical depth more in large firms, where the conflict between ER-representatives and firm owners is (if anything) higher,[16] provides little support for this explanation.[17]

[16] A wide corporate governance literature (e.g. Mayer, 1997) finds that conflicts of interests between owners and employees tend to be milder in smaller firms, because in these firms ownership is more concentrated (this improves reputational mechanisms and within-firm long-term relationships) and owners are less diversified (this makes owners' interests in the firm longer and arguably closer to those of the employees).

[17] According to incentive-based explanations, one should expect different effects of ER on the number

An alternative line of reasoning rests on the literature that conceives the design of organizations as functional to resolve bargaining issues between workers and entrepreneur. Dow (1989), for instance, argues that workers employed to operate plants that present some degree of firm specificity may be able to capture quasi-rent by threatening to suppress knowledge acquired in the course of production activities. Difficulties in arranging ex ante payments that can completely offset the ex-post leakage of quasi-rent, make it attractive for the entrepreneur to create an information system that limits ex post worker bargaining power. Such system can take many forms such as: a hierarchical organization of tasks and information channels, a gradual "deskilling" of shop-floor workers (see also Braverman, 1974; Noble, 1977) as well as a greater propensity to invest in assets that are less relation-specific (Williamson, 1985). In relation to our work such an approach would imply that the depth of corporate hierarchies is mainly driven by the extent to which workers are able to capture ex-post quasi rents. As long as ER strengthen worker's ability to do so, because for instance it solves collective action problems among workers, the theory would predict a positive correlation between ER and number of organizational layers, which is consistent with our results. However, once again, it is plausible to assume that the size of such quasi-rent is greater in larger organizations, which are involved in more complex productions. As a consequence the positive effect of ER on hierarchical depth should increase with firm size, which is not what we find in the data.

A third group of works link the decision to delegate authority within organizations to the characteristics of the technology available both inside and outside the firm. Acemoglu et al. (2007), for example, argue that principal's choice to delegate authority to an agent depend on the knowledge he has about the technology used in production: as the available public information about it reduces, the trade-off shifts in favor of delegation. The reason is that in such cases the principal benefits the most from gaining access to the local knowledge available to the agent. The main predictions of the model are thus that delegation, i.e. low hierarchical depth, should be more likely in firms that operate closer to technological frontier (because they are dealing with new technologies about which the public information is limited) and in more heterogeneous environment (because principals can learn less from other firms operating within the same market). Bloom et al. (2014), using a theoretical framework very similar to ours, suggest that firm-level investments in different types of technologies can have differential impacts on the decentralization of decision-making. In particular, while information technology (via a reduction in knowledge acquisition costs) is a decentralizing force, communication tech-

of layers depending on the interest congruence between workers and owners-managers. We analyse the correlation between ER and the number of layers for establishments with and without with and without profit sharing schemes. The extent of conflict of interest between ER and management may be lower where pay is contingent on the performance of the enterprise, limiting the scope for rent-seeking activities(Freeman and Lazear, 1994). Interestingly, we find that ER is associated with more hierarchical layers in both establishments with and without profit sharing. These additional estimates are available upon request.

nology (via a reduction in communication costs) foster centralization. With respect to our analysis these contributions can be relevant as long as the establishment of ER is correlated with some of the above mentioned technological or firm-specific characteristics. For instance, ER structures may be more frequently organised in technologically mature and less competitive industries (where workers can share on noncompetitive rents) in which decentralization would be less common. This selection pattern could be driving the positive correlation between ER and the number of layers. However, the fact that our result holds even after controlling for industry fixed effects and the use of information systems at the workplace level suggests that the underlying theoretical argument remains valid.

Fourth, the differential negative effect of ER on the depth of hierarchy in large firms may be driven by the relationship between size, ER and complexity. Models based upon information processing (see, Radner, 1992; Bolton and Dewatripont, 1994) predict that the larger the number of items that need to be processed by an organization, the deeper the management hierarchy that minimizes total planning and implementation time. In particular, items complexity generates overload of information within the firm, thereby increasing the principal's marginal disutility of getting informed and so his/her incentives to delegate decision-making power to plant managers who enjoy an information advantage; that is, complexity requires a more stratified hierarchy. Hence, in these models, since larger firms deal with greater complexity, firm size should be observed to correlate with the depth of the organization positively. In the context of our framework, this positive correlation may be comparatively reduced where ER is present, if ER bodies reduce the complexity of the items the firm deals with (i.e. what we call the total problem variety). This may be due to risk aversion of the workers, who may prefer focusing on less uncertain activities in traditional productions, where problems are well-known and less diversified. Thus, where workers have a voice over strategic decisions and investments, as when ER is present, they may push the firm towards environments with lower complexity. As a result, the number of layers should positively correlate with firm size, but less so where ER is established. While this possible interpretation shares with ours the empirical prediction of deeper hierarchies in larger firms (which in fact finds verification in our estimates), it also requires that ER has an independent negative effect on the number of layers: this is something that instead we do not observe in the data. Also, the argument that ER reduces complexity does not fit well with the positive correlation between ER and training that we detected in our analysis.

Finally, there is also the possibility that corporate hierarchy emerges not as a result of conflicting interest between workers and owners, but as a consequence of colluding activities between workers and managers. The idea is that in presence of an imperfectly incentivized corporate system managers and workers may collude to further decisions that leave shareholders worse off. Together, they may try to transform cash flow into fixed assets rather than dividends, and engage in so-called empire-building (as in the agency

conflict mechanism in Jensen and Meckling, 1976). As long as ER makes such type of collusion easier, and under the assumption that hierarchical depth correlate positively with empire-building behaviour, we should expect firms with ER to be more hierarchical. However, this effect should hold independently of firm size, or eventually be larger in larger firms where management's prestige associated with empire-building is higher. This is not supported by our results.

6 Conclusions

Our study sheds light on the interplay between labor institutions and the internal organization of firms. Using establishment level data from 21 European countries, we analyzed the effect of shop-floor employee representation on the design and change in corporate hierarchies. We framed our empirical analysis on a model of knowledge-based hierarchies in which the optimal number of vertical layers depends on the trade-off between communication costs and knowledge acquisition costs.

We found that ER is positively associated with the number of vertical layers. In the absence of cleaner sources of exogenous variation in employee representation rights, we exploited features of the institutional environment and instrumented ER using firm coverage by sectoral or regional wage agreements. Ordinary Least Squares and Instrumental Variables estimates yielded consistent estimates. This positive association between ER and the number of layers seems to be driven by a reduction in communication costs, suggesting that skip-level reporting dominates the delay costs inherent to the information and consultation procedures involving managers and employee representatives. Phrased differently, ER may allow for a more efficient information transmission, by improving the match between unsolved issues and managers without such issues being required to move bottom-up through all the intermediate layers. Clearly, for this information improving effect to be effective, ER needs to be directly involved in the business decision making as in integral part of the corporate structure, and not to be relegated in a passive role where it is only informed without any substantive role. This is something that we did not elaborated in the paper, yet it is implicitly assumed in our conceptual framework.

Our results have important implications for the design of firm organizations and labour market institutions. The positive relationship between ER and hierarchical depth offers an alternative explanation for the growing evidence showing that firms are becoming flatter over time (Acemoglu et al., 2007; Caroli and Van Reenen, 2001). The previous literature explains such trend either as a result of rising market competition, which requires faster decision-making (Guadalupe and Wulf, 2010), or as the consequence of the spread of information and communication technologies, which reduces communication costs (Bloom et al., 2014). Our work suggests that a third possible explanation is deunionization, i.e. the shrinking proportion of workers covered by unions that has characterized the labour

market of most advanced countries during the last decades (Farber et al., 2018; Ebbinghaus and Visser, 1999). By reducing the share of firms with unionized forms of ER, and under the assumption that the latter have been only partially replaced by non-union types of ER, deunionization may have created incentives for many firms to design flatter organizations.

Our findings suggest that alongside well-known effects of ER on workers' bargaining power and wage composition, such bodies affect also the internal organization of corporate hierarchies. In particular, thanks to the improved information flows that follows the establishment of ER (i.e. skip-level reporting), firms with ER are induced to select a higher number of organizational layers compared to firms without ER. This insight contributes to extend the view of employee representatives beyond the approach that sees them mainly as tools to protect workers' interests. ER bodies impacts on the distribution of information and knowledge within hierarchies and managers need to take this effect into account while designing their organizations. Our results suggest that institutionalized forms of employee voice may enable firms to economize scarce cognitive resources through deeper hierarchies without retarding the accumulation of new shop-floor capabilities.

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Figures and Tables

Figure 1: ER and within-firm communication.

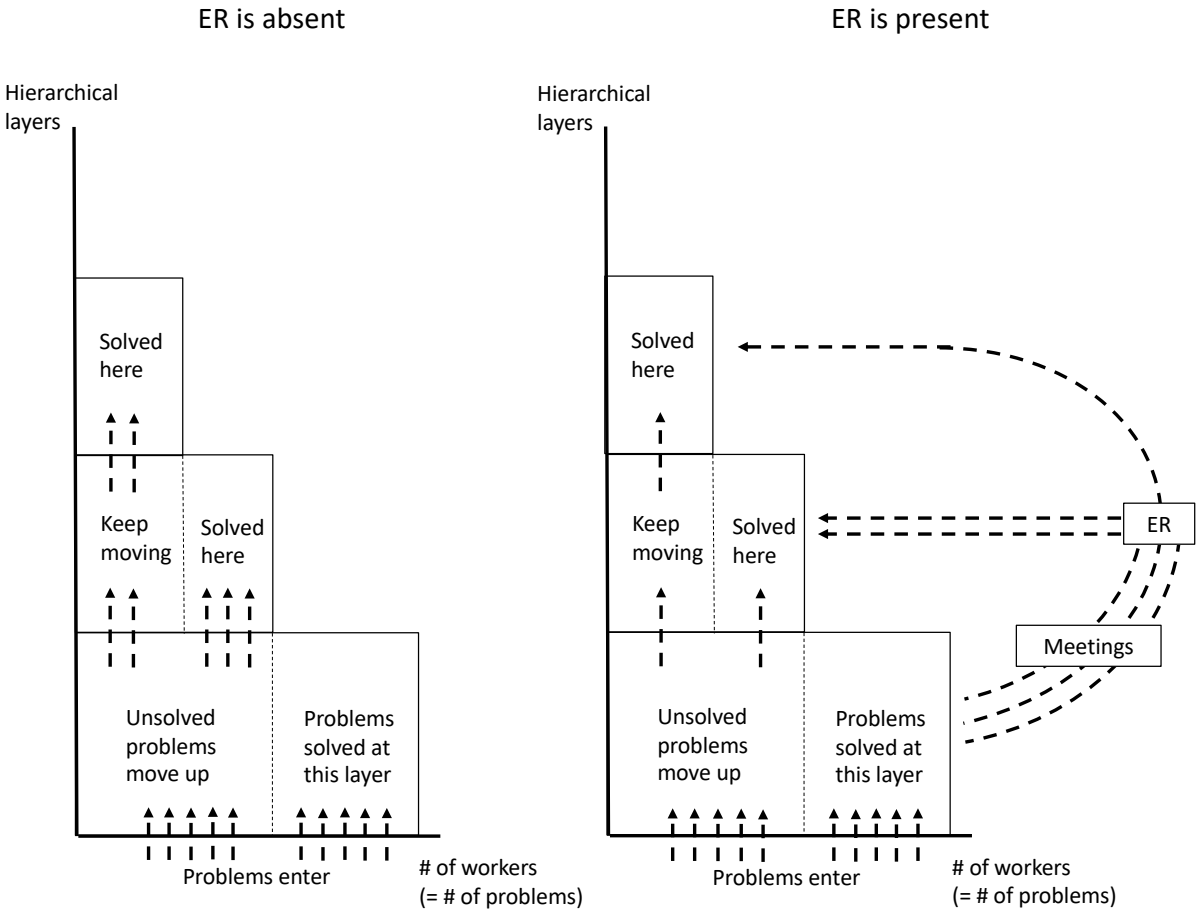
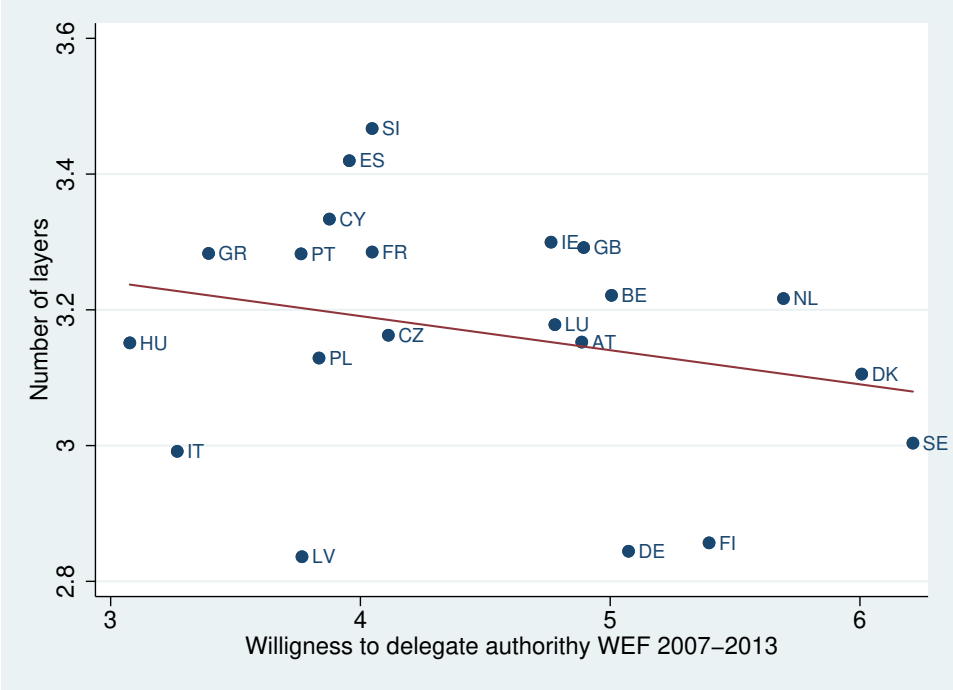
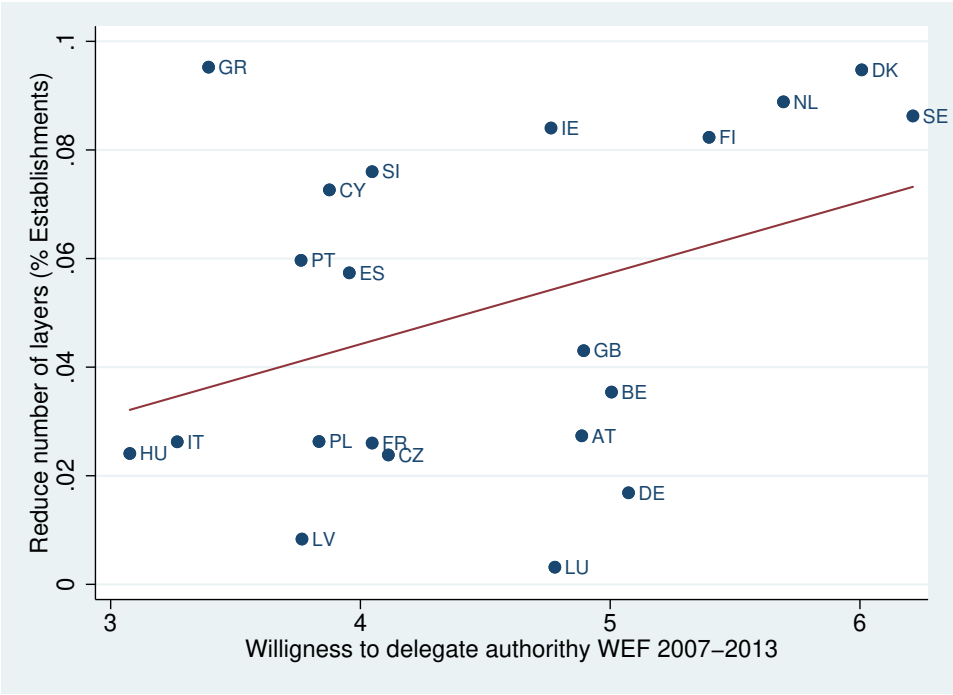


Figure 2: Numbers of layers and willingness to delegate authority: correlation between ECS and GCR-WEF 2007-2013.



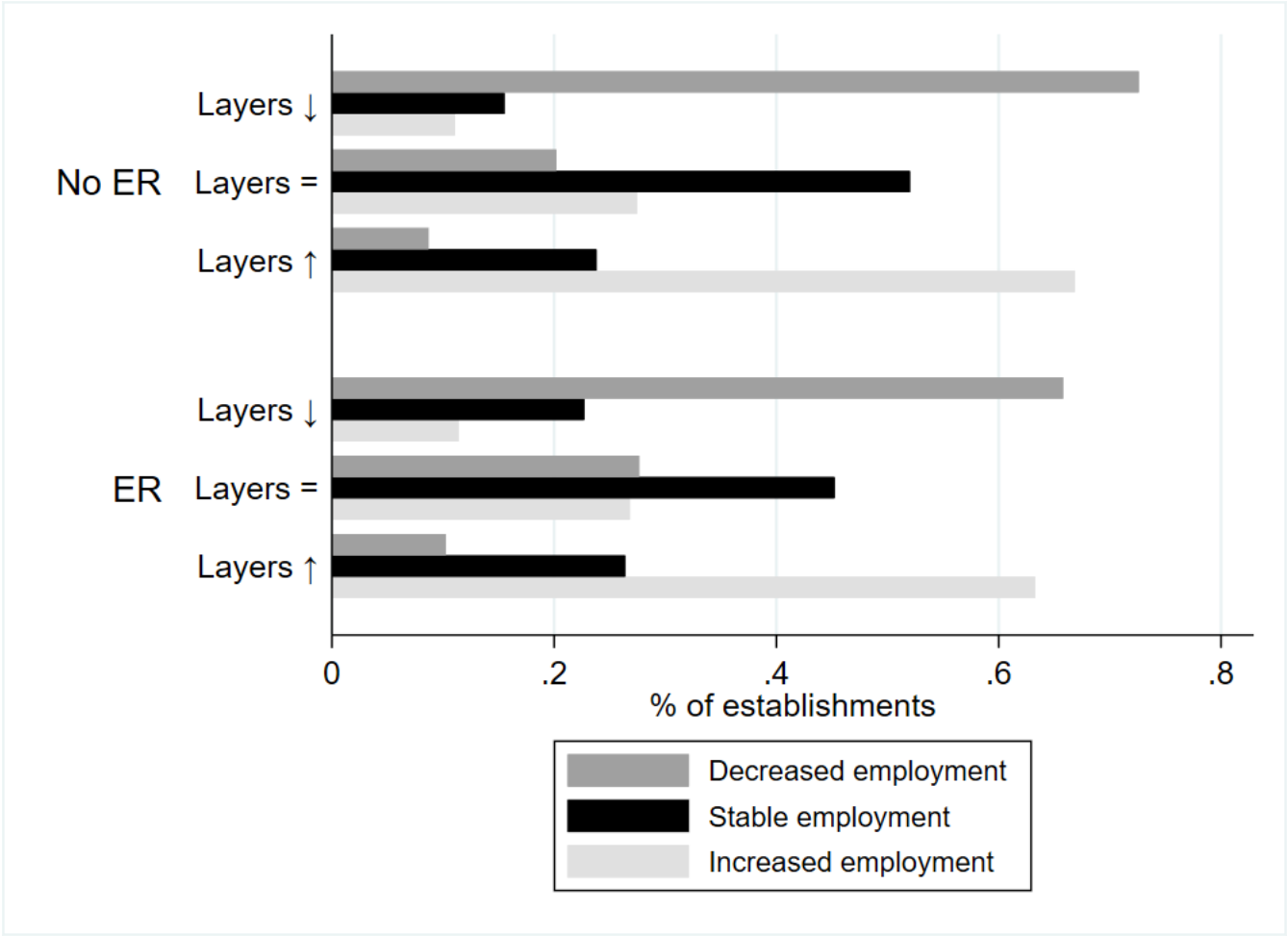
Notes: This figure displays the correlation between the average number of layers per establishment in ECS 2013 and average country-level scores on "Willingness to Delegate Authority" in the Global Competitiveness Index (World Economic Forum). GCI country-level scores are based on the following question: In your country, how do you assess the willingness to delegate authority to subordinates? [1 = not willing at all-senior management takes all important decisions; 7 = very willing-authority is mostly delegated to business unit heads and other lower-level managers"]

Figure 3: Probability of delayering and willingness to delegate authority: correlation between ECS and GCR-WEF 2007-2013.



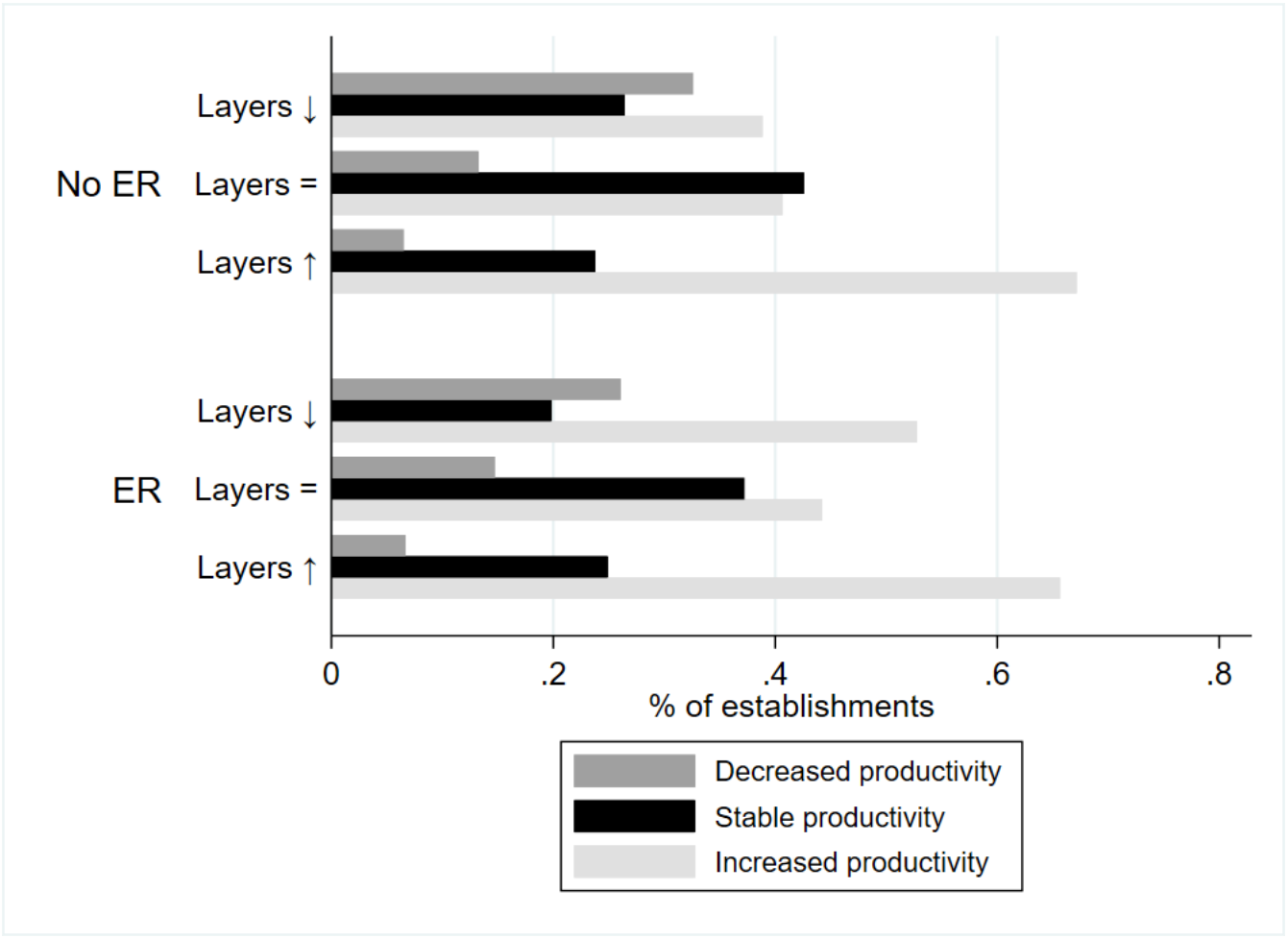
Notes: This figure displays the correlation between the fraction of establishments in each country reporting a reduction in the number of hierarchical layers between 2010 and 2013 (according to ECS 2013) and the average country-level scores on "Willingness to Delegate Authority" in the Global Competitiveness Index (World Economic Forum). GCI country-level scores are based on the following question: In your country, how do you assess the willingness to delegate authority to subordinates? [1 = not willing at all-senior management takes all important decisions; 7 = very willing-authority is mostly delegated to business unit heads and other lower-level managers"]

Figure 4: Changes in employment and layers: period 2010-2013.



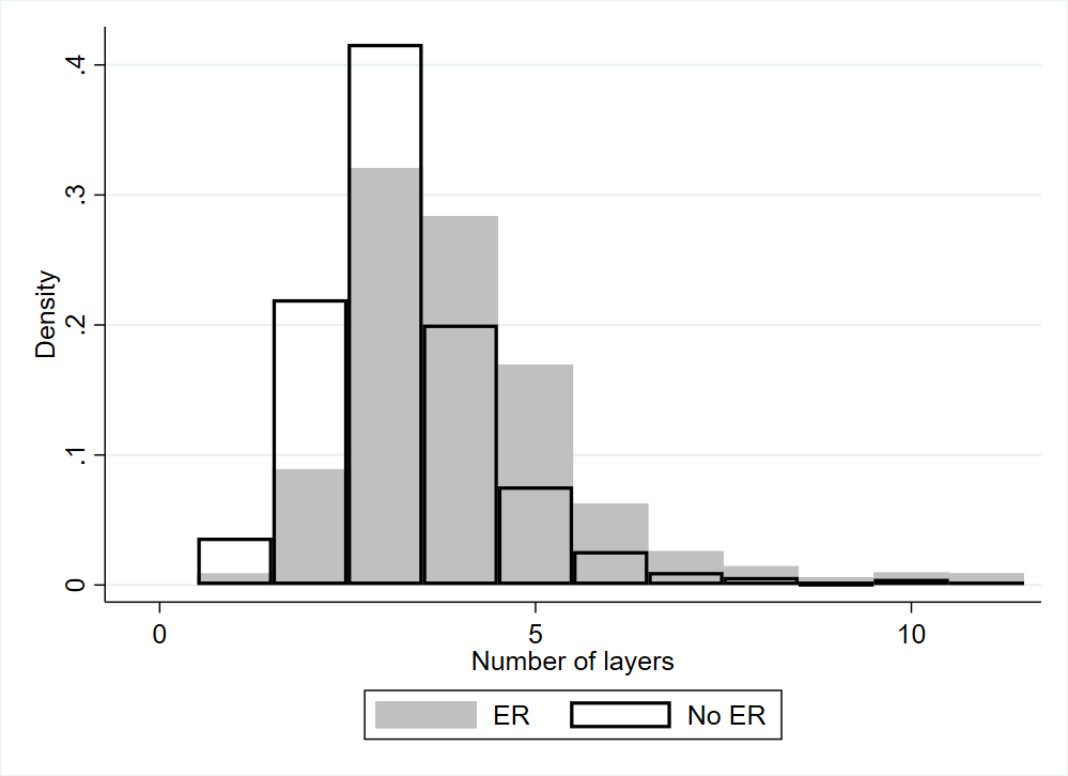
Notes: Pooled data from the European Company Survey 2013. Sample restricted to private-sector establishments in EU21 countries. E21 includes the former 15 "old" member states (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom) plus six of the 10 new Member States which joined the European Union in 2004 (Czech Republic, Cyprus, Latvia, Hungary, Poland and Slovenia).

Figure 5: Changes in productivity and layers: period 2010-2013.



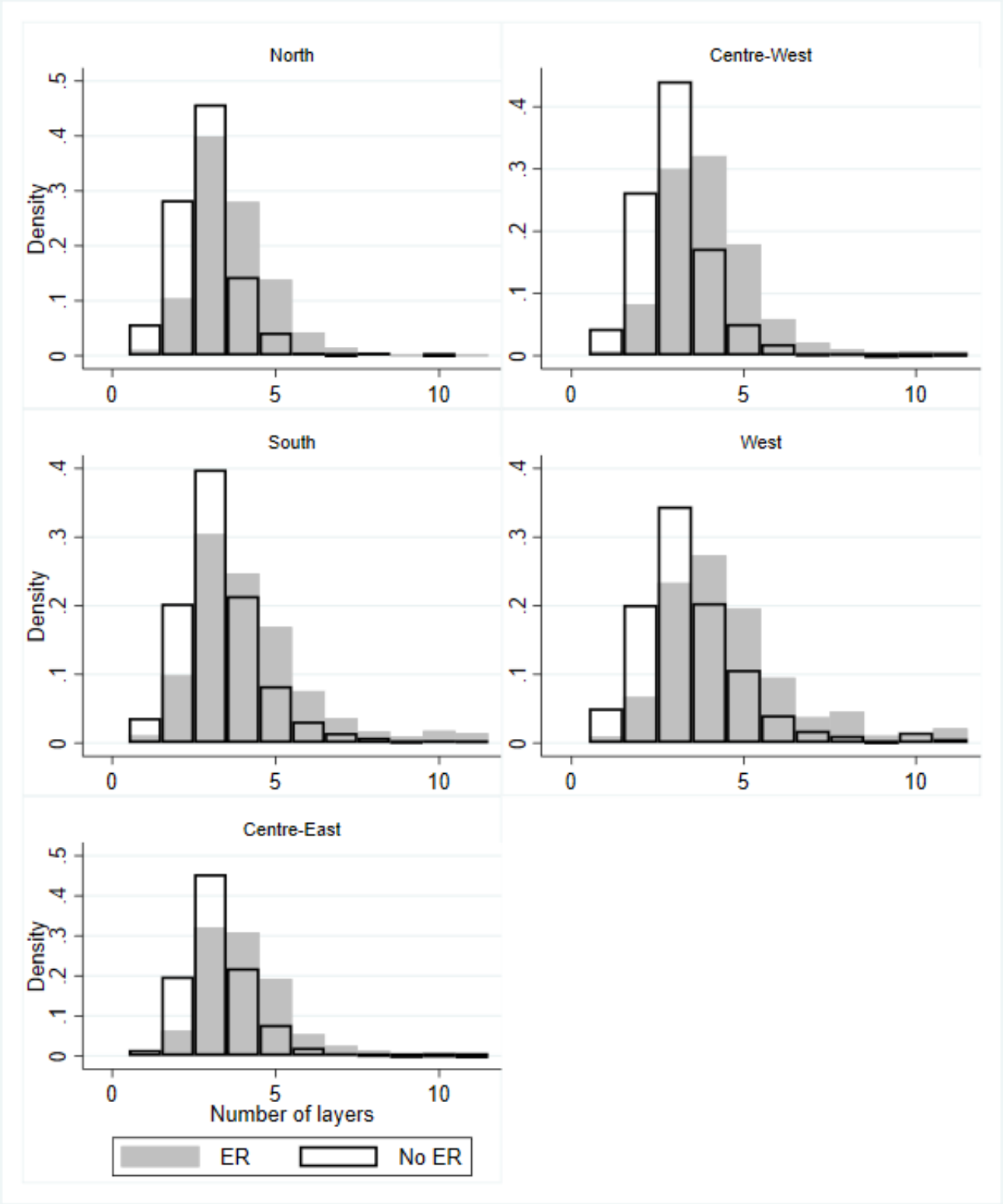
Notes: Pooled data from the European Company Survey 2013. Sample restricted to private-sector establishments in EU21 countries. E21 includes the former 15 "old" member states (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom) plus six of the 10 new Member States which joined the European Union in 2004 (Czech Republic, Cyprus, Latvia, Hungary, Poland and Slovenia).

Figure 6: Histogram of number of hierarchical layers.



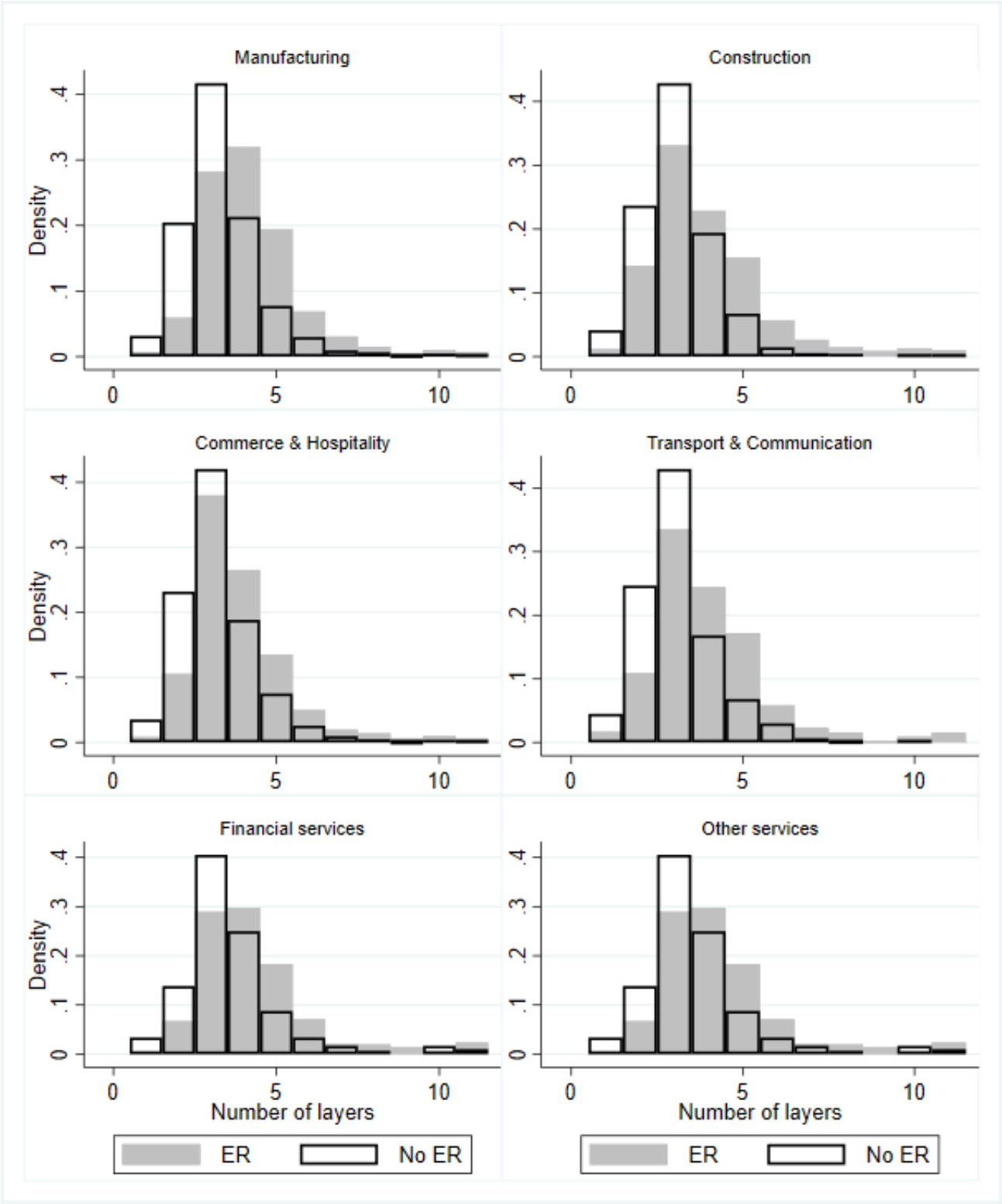
Notes: Pooled data from the European Company Survey 2013. Sample restricted to private-sector establishments in EU21 countries. E21 includes the former 15 "old" member states (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom) plus six of the 10 new Member States which joined the European Union in 2004 (Czech Republic, Cyprus, Latvia, Hungary, Poland and Slovenia).

Figure 7: Histogram of number of hierarchical layers by groups of countries with different industrial relations regimes.



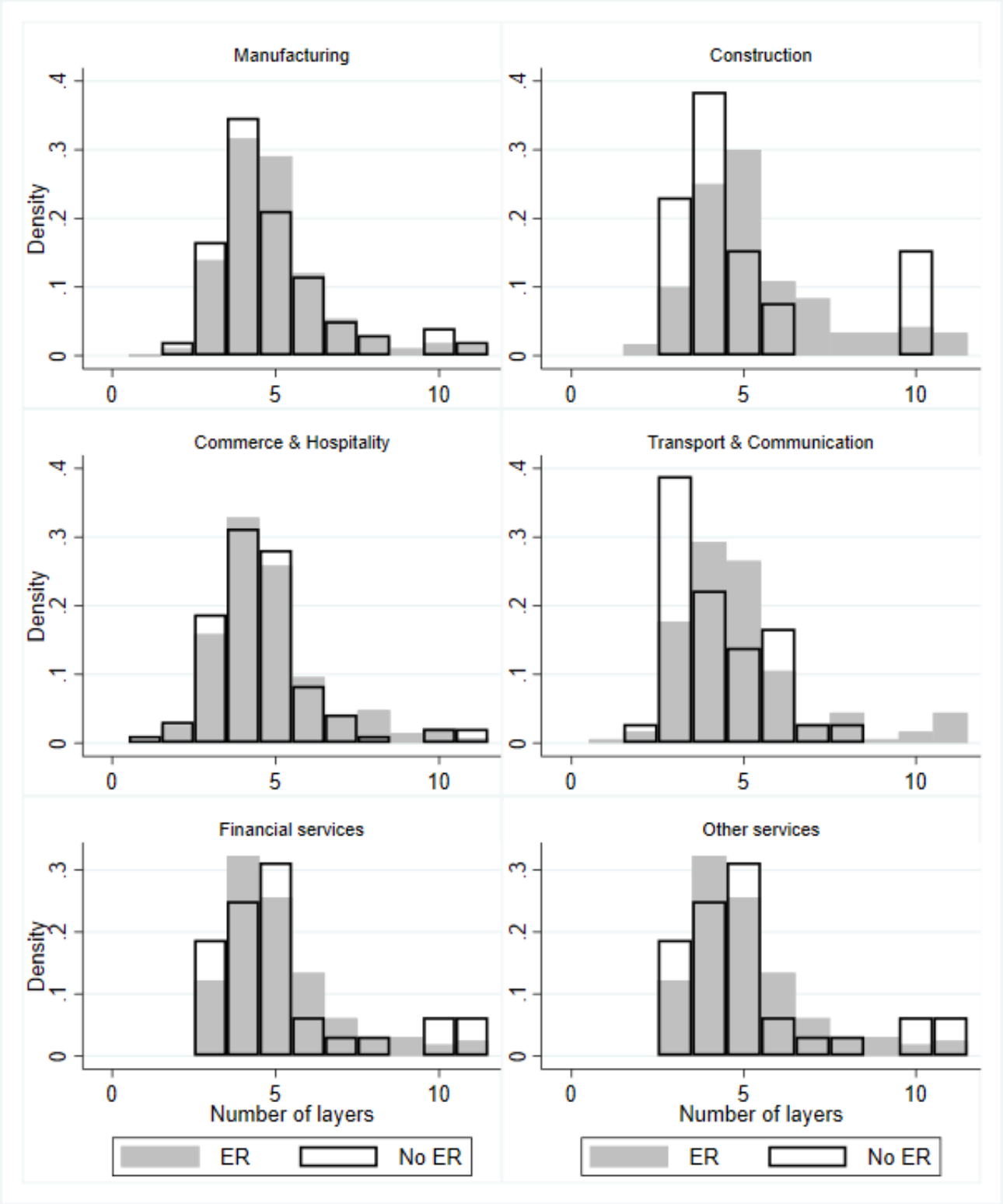
Notes: Countries were classified according to industrial relations regimes as proposed by Visser (2009): North (Denmark, Finland, Sweden); Centre-West (Belgium, Germany, Luxembourg, Netherlands, Austria, Slovenia); South (Greece, Spain, France, Italy, Portugal); West (Ireland, Malta Cyprus, UK); Centre-East (Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Slovakia). Pooled data from the European Company Survey 2013. Sample restricted to private-sector establishments in EU21 countries.

Figure 8: Histogram of number of hierarchical layers by industry.



Notes: Pooled data from the European Company Survey 2013. Sample restricted to private-sector establishments in EU21 countries. E21 includes the former 15 "old" member states (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom) plus six of the 10 new Member States which joined the European Union in 2004 (Czech Republic, Cyprus, Latvia, Hungary, Poland and Slovenia).

Figure 9: Histogram of number of hierarchical layers by industry: only large establishments (250+ employees).



Notes: Pooled data from the European Company Survey 2013. Sample restricted to private-sector establishments in EU21 countries. E21 includes the former 15 "old" member states (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom) plus six of the 10 new Member States which joined the European Union in 2004 (Czech Republic, Cyprus, Latvia, Hungary, Poland and Slovenia).

Table 1: Main variables' description.

Variable	Description as in the ECS questionnaire
Employee representation	An official employee representation currently exists in the establishment (yes/no)
Number of layers	Number of hierarchical levels in the establishment, including the highest and the lowest level
Delayering	In the last three years, the number of hierarchical levels has decreased (yes/no)
Increasing layers	In the last three years, the number of hierarchical levels has increased (yes/no)
Individual autonomy	The employee undertaking the tasks is who normally decides on the planning and execution of the daily work tasks (yes/no)
Team autonomy	Team members decide among themselves about the tasks to be performed by the teams (yes/no)
Ownership change	In the last three years, a change in ownership affected the establishment substantially (yes/no)
Organizational change	In the last three years, this establishment introduced an organizational change (yes/no)
Paid time off for training	% of employees received paid time-off from their normal duties to undertake training in the past 12 months
Change coordination	In the last three years, the establishment made changes in ways to coordinate and allocate work to employees (yes/no)
Meetings to all	Regular staff meetings open to all employees are used to involve employees in how work is organised (yes/no)
Meetings managers	Regular meetings between employees and immediate manager are used to involve employees in how work is organised (yes/no)
Multi-site	The establishment is one of a number of establishments at different locations belonging to the same company (yes/no)
Information systems	Information systems are used to minimize supplies or work-in-process (just-in-time or lean production systems or working according to a zero buffer principle) (yes/no)
Outsourcing	The establishment partly or entirely outsources production of goods and services to a third party that is not owned by the establishment or the company it belongs (yes/no)
Functional managers	The establishment has departments based on functions (sales, production, administration, research) (yes/no)
Share of workers with complex tasks	% of employees working in jobs that require at least one year of on the job learning in order for the person to become proficiency in his/her task
Subsidiary site	The establishment is a subsidiary site (yes/no)
Employee delays	Involving employees leads to unnecessary delays in the implementation of changes (yes/no)

Table 2: Descriptive statistics.

Variable	Mean	Std. Dev.
ER (dummy var.)	0.299	0.458
Number of layers (in logs)	1.067	0.391
Delayering (dummy var.)	0.037	0.190
Increasing layers (dummy var.)	0.061	0.239
Individual autonomy (dummy var.)	0.469	0.499
Team autonomy (dummy var.)	0.198	0.398
Ownership change (dummy var.)	0.084	0.277
Organizational change (dummy var.)	0.321	0.467
Paid time off for training (dummy var.)	3.104	2.092
Change coordination (dummy var.)	0.317	0.465
Meetings to all (dummy var.)	0.588	0.492
Meetings managers (dummy var.)	0.853	0.353
Multi-site (dummy var.)	0.235	0.424
Information systems (dummy var.)	0.445	0.496
Outsourcing (dummy var.)	0.265	0.441
Functional managers (dummy var.)	0.738	0.439
Share of workers with complex tasks (%)	36.793	38.817
Subsidiary site (dummy var.)	0.068	0.268
Small firm: 10-49 employees (dummy var.)	0.851	0.355
Medium firm: 50-249 employees (dummy var.)	0.129	0.335
Large firm: 250+ employees (dummy var.)	0.018	0.135
Manufacturing (dummy var.)	0.273	0.445
Construction (dummy var.)	0.093	0.290
Commerce (dummy var.)	0.311	0.462
Transport (dummy var.)	0.068	0.253
Financial services (dummy var.)	0.033	0.179
Other services (dummy var.)	0.220	0.414

Notes: Pooled data from the European Company Survey 2013. Sample restricted to private-sector establishments in EU21 countries. E21 includes the former 15 "old" member states (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom) plus six of the 10 new Member States which joined the European Union in 2004 (Czech Republic, Cyprus, Latvia, Hungary, Poland and Slovenia). Means are weighted by ECS sampling weights.

Table 3: Number of hierarchical layers.

	(1)	(2)	(3)	(4)	(5)
ER	0.109***	0.093***	0.091***	0.086***	0.080***
	(0.008)	(0.009)	(0.009)	(0.009)	(0.009)
Medium firm	0.292***	0.270***	0.269***	0.262***	0.241***
	(0.009)	(0.009)	(0.010)	(0.010)	(0.010)
Large firm	0.486***	0.463***	0.456***	0.444***	0.411***
	(0.016)	(0.018)	(0.018)	(0.018)	(0.019)
ER × Medium firm	-0.032***	-0.025*	-0.025*	-0.019	-0.015
	(0.012)	(0.013)	(0.013)	(0.013)	(0.013)
ER × Large firm	-0.044**	-0.055***	-0.049**	-0.046**	-0.035*
	(0.019)	(0.021)	(0.021)	(0.021)	(0.021)
Observations	18,906	16,464	16,064	15,527	15,181
R-squared	0.255	0.271	0.273	0.274	0.280
Country + industry dummies	Yes	Yes	Yes	Yes	Yes
Establishment-level controls	No	Yes	Yes	Yes	Yes
Outsourcing	No	No	Yes	Yes	Yes
Information Systems	No	No	No	Yes	Yes
Manager's controls	No	No	No	No	Yes

Notes: Estimation by ordinary least squares with robust standard errors in parentheses. The dependent variable is the number of layers (in logs). Establishment-level controls: workforce composition (gender, age, education, fraction of part-time, permanent employees), firm size, multi-plant, change in employment, productivity, organizational structure and ownership in the last three years, subsidiary site, share of workers involved in complex tasks. Estimates reported in column 3 control for outsourcing of production activities. In Column 4, we add controls for the use of information systems. In Column 5, we add controls for manager's characteristics (gender, position, tenure). The small firm category (10-49 employees) is the benchmark category for size dummies. *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Probability of delayering (reduction in number of layers between 2010 and 2013).

	(1)	(2)	(3)	(4)	(5)
ER	0.014***	0.003	0.003	0.002	0.003
	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)
Medium firm	0.010**	0.009*	0.008	0.006	0.006
	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)
Large firm	-0.014**	-0.012*	-0.014**	-0.016**	-0.018**
	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)
ER × Medium firm	0.011	0.013	0.015*	0.017**	0.016*
	(0.008)	(0.008)	(0.008)	(0.009)	(0.009)
ER × Large firm	0.040***	0.032***	0.035***	0.036***	0.035***
	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)
Observations	18,982	16,534	16,124	15,582	15,230
R-squared	0.024	0.067	0.068	0.067	0.068
Country + industry dummies	Yes	Yes	Yes	Yes	Yes
Establishment-level controls	No	Yes	Yes	Yes	Yes
Outsourcing	No	No	Yes	Yes	Yes
Information Systems	No	No	No	Yes	Yes
Manager's controls	No	No	No	No	Yes

Notes: Estimates from Linear Probability Models with robust standard errors in parentheses. The dependent variable equals to one if the establishment experienced a reduction in the number of hierarchical layers in the last three years. Establishment-level controls: workforce composition (gender, age, education, fraction of part-time, permanent employees), firm size, multi-plant, change in employment, productivity, organizational structure and ownership in the last three years, subsidiary site, share of workers involved in complex tasks. Estimates reported in column 3 control for outsourcing of production activities. In Column 4, we add controls for the use of information systems. In Column 5, we add controls for manager's characteristics (gender, position, tenure). The small firm category (10-49 employees) is the benchmark category for size dummies. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Probability of increasing the number of layers between 2010 and 2013.

	(1)	(2)	(3)	(4)	(5)
ER	-0.000	0.002	0.001	-0.001	0.001
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Medium firm	0.042***	0.031***	0.032***	0.029***	0.026***
	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)
Large firm	0.042***	0.021	0.024	0.021	0.019
	(0.013)	(0.015)	(0.016)	(0.016)	(0.016)
ER × Medium firm	-0.040***	-0.034***	-0.034***	-0.031***	-0.029***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
ER × Large firm	-0.043***	-0.032*	-0.033*	-0.032*	-0.030*
	(0.015)	(0.017)	(0.017)	(0.017)	(0.018)
Observations	18,982	16,534	16,124	15,582	15,230
R-squared	0.011	0.056	0.056	0.056	0.060
Country + industry dummies	Yes	Yes	Yes	Yes	Yes
Establishment-level controls	No	Yes	Yes	Yes	Yes
Outsourcing	No	No	Yes	Yes	Yes
Information Systems	No	No	No	Yes	Yes
Manager's controls	No	No	No	No	Yes

Notes: Estimates from Linear Probability Models with robust standard errors in parentheses. The dependent variable equals to one if the establishment experienced an increase in the number of hierarchical layers in the last three years. Establishment-level controls: workforce composition (gender, age, education, fraction of part-time, permanent employees), firm size, multi-plant, change in employment, productivity, organizational structure and ownership in the last three years, subsidiary site, share of workers involved in complex tasks. Estimates reported in column 3 control for outsourcing of production activities. In Column 4, we add controls for the use of information systems. In Column 5, we add controls for manager's characteristics (gender, position, tenure). The small firm category (10-49 employees) is the benchmark category for size dummies. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Delayering and task-related individual autonomy.

	(1)	(2)	(3)	(4)	(5)
ER	-0.010	-0.017*	-0.018*	-0.016*	-0.018*
	(0.009)	(0.009)	(0.009)	(0.010)	(0.010)
Delayering	0.022	0.019	0.022	0.020	0.020
	(0.025)	(0.026)	(0.027)	(0.028)	(0.028)
ER × Delayering	0.023	0.026	0.020	0.020	0.021
	(0.031)	(0.033)	(0.033)	(0.034)	(0.034)
Observations	18,947	16,508	16,098	15,558	15,208
R-squared	0.098	0.124	0.126	0.127	0.129
Country + industry dummies	Yes	Yes	Yes	Yes	Yes
Establishment-level controls	No	Yes	Yes	Yes	Yes
Outsourcing	No	No	Yes	Yes	Yes
Information Systems	No	No	No	Yes	Yes
Manager's controls	No	No	No	No	Yes

Notes: Estimates from Linear Probability Models with robust standard errors in parentheses. The dependent variable equals to one if employees are the ones "who normally decide on the planning and execution of the daily work tasks" at the establishment. Establishment-level controls: workforce composition (gender, age, education, fraction of part-time, permanent employees), firm size, multi-plant, change in employment, productivity, organizational structure and ownership in the last three years, subsidiary site, share of workers involved in complex tasks. Estimates reported in column 3 control for outsourcing of production activities. In Column 4, we add controls for the use of information systems. In Column 5, we add controls for manager's characteristics (gender, position, tenure).*** p<0.01, ** p<0.05, * p<0.1.

Table 7: Delayering and task-related team autonomy.

	(1)	(2)	(3)	(4)	(5)
ER	0.001	0.001	0.001	-0.000	0.000
	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)
Delayering	0.013	0.014	0.012	0.010	0.009
	(0.020)	(0.022)	(0.022)	(0.022)	(0.022)
ER × Delayering	0.037	0.046	0.043	0.045	0.049*
	(0.026)	(0.028)	(0.029)	(0.029)	(0.029)
Observations	18,982	16,534	16,124	15,582	15,230
R-squared	0.066	0.071	0.071	0.071	0.073
Country + industry dummies	Yes	Yes	Yes	Yes	Yes
Establishment-level controls	No	Yes	Yes	Yes	Yes
Outsourcing	No	No	Yes	Yes	Yes
Information Systems	No	No	No	Yes	Yes
Manager's controls	No	No	No	No	Yes

Notes: Estimates from Linear Probability Models with robust standard errors in parentheses. The dependent variable equals to one if production is organised in self-managed teams in which "team members decide among themselves by whom the tasks are to be performed." Establishment-level controls: workforce composition (gender, age, education, fraction of part-time, permanent employees), firm size, multi-plant, change in employment, productivity, organizational structure and ownership in the last three years, subsidiary site, share of workers involved in complex tasks. Estimates reported in column 3 control for outsourcing of production activities. In Column 4, we add controls for the use of information systems. In Column 5, we add controls for manager's characteristics (gender, position, tenure).*** p<0.01, ** p<0.05, * p<0.1.

Table 8: Delayering and functional centralization.

	(1)	(2)	(3)	(4)	(5)
ER	0.046***	0.042***	0.041***	0.038***	0.038***
	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)
Delayering	0.086***	0.085***	0.081***	0.083***	0.086***
	(0.019)	(0.020)	(0.020)	(0.021)	(0.021)
ER × Delayering	-0.046**	-0.049**	-0.048**	-0.060**	-0.067***
	(0.022)	(0.024)	(0.024)	(0.024)	(0.024)
Observations	18,949	16,509	16,101	15,564	15,214
R-squared	0.118	0.136	0.138	0.145	0.153
Country + industry dummies	Yes	Yes	Yes	Yes	Yes
Establishment-level controls	No	Yes	Yes	Yes	Yes
Outsourcing	No	No	Yes	Yes	Yes
Information Systems	No	No	No	Yes	Yes
Manager's controls	No	No	No	No	Yes

Notes: Estimates from Linear Probability Models with robust standard errors in parentheses. The dependent variable equals to one if the establishment is organised in functional departments (sales, production, administration, research etc.), Establishment-level controls: workforce composition (gender, age, education, fraction of part-time, permanent employees), firm size, multi-plant, change in employment, productivity, organizational structure and ownership in the last three years, subsidiary site, share of workers involved in complex tasks. Estimates reported in column 3 control for outsourcing of production activities. In Column 4, we add controls for the use of information systems. In Column 5, we add controls for manager's characteristics (gender, position, tenure).*** p<0.01, ** p<0.05, * p<0.1.

Table 9: Number of hierarchical layers. IV results.

	(1)	(2)	(3)	(4)	(5)
ER (instrumented)	0.315***	0.329***	0.315***	0.307***	0.317***
	(0.069)	(0.081)	(0.082)	(0.086)	(0.089)
Medium firm	0.289***	0.267***	0.269***	0.274***	0.252***
	(0.097)	(0.041)	(0.042)	(0.043)	(0.044)
Large firm	0.338***	0.262**	0.292**	0.279**	0.246**
	(0.086)	(0.103)	(0.101)	(0.101)	(0.104)
ER × Medium firm (instrumented)	-0.124***	-0.136***	-0.135**	-0.144**	-0.138**
	(0.058)	(0.067)	(0.067)	(0.069)	(0.070)
ER × Large firm (instrumented)	0.014	0.020	0.010	0.019	0.028
	(0.097)	(0.117)	(0.115)	(0.114)	(0.118)
Observations	18,906	16,306	15,918	15,394	15,055
R-squared	0.219	0.228	0.237	0.240	0.240
Country + industry dummies	Yes	Yes	Yes	Yes	Yes
Establishment-level controls	No	Yes	Yes	Yes	Yes
Outsourcing	No	No	Yes	Yes	Yes
Information Systems	No	No	No	Yes	Yes
Manager's controls	No	No	No	No	Yes
First-stage (ER): Sectoral bargaining	0.104***	0.095***	0.094***	0.091***	0.088***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)

Notes: Estimation by 2-stage least squares with robust standard errors in parentheses. The dependent variable is the number of layers (in logs). The instrumental variable is a dummy coded 1 if the firm belongs to an employers' organisation and 0 otherwise. Establishment-level controls: workforce composition (gender, age, education, fraction of part-time, permanent employees), firm size, multi-plant, change in employment, productivity, organizational structure and ownership in the last three years, subsidiary site, share of workers involved in complex tasks. Estimates reported in column 3 control for outsourcing of production activities. In Column 4, we add controls for the use of information systems. In Column 5, we add controls for manager's characteristics (gender, position, tenure). The small firm category (10-49 employees) is the benchmark category for size dummies. *** p<0.01, ** p<0.05, * p<0.1.

Table 10: Mechanisms: training, coordination and meetings.

	(1) Paid time off for training	(2) Skill development	(3) Change in ways to coord. and allocate work	(4) Meetings open to all employees	(5) Meetings between employees and immediate manager	(6) Employee involvement causes delays
ER	0.196***	0.056***	0.033***	0.046***	0.029***	0.001
	(0.022)	(0.018)	(0.010)	(0.010)	(0.007)	(0.009)
Delayering	-0.030	0.014	0.137***	0.042	0.019	0.007
	(0.068)	(0.043)	(0.028)	(0.027)	(0.017)	(0.026)
ER × Delayering	0.031	-0.004	0.045	0.003	-0.011	0.041
	(0.080)	(0.061)	(0.034)	(0.033)	(0.020)	(0.032)
Observations	15,123	4,840	15,175	15,202	15,203	14,897
R-squared		0.083	0.124	0.071	0.060	0.035
Country + industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Establishment-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Outsourcing	Yes	Yes	Yes	Yes	Yes	Yes
Information Systems	Yes	Yes	Yes	Yes	Yes	Yes
Manager's controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: In column 1, we report estimates from Ordered Probit Models with robust standard errors in parentheses. The dependent variables (see definition in footnote 8) are the fraction of workers engaged in on-the-job training and the fraction of workers entitled to paid time off for training, respectively). In Columns 2-6, we report estimates from Linear Probability Models with robust standard errors. Establishment-level controls: workforce composition (gender, age, education, fraction of part-time, permanent employees), firm size, multi-plant, change in employment, productivity, organizational structure and ownership in the last three years, subsidiary site, share of workers involved in complex tasks. Estimates reported in column 2 control for outsourcing of production activities. In Column 3, we add controls for the use of information systems. In Column 4, we add controls for manager's characteristics (gender, position, tenure).*** p<0.01, ** p<0.05, * p<0.1.

Appendix

A.1 Communication costs when ER is absent

Here, we provide a simple example to grasp the intuition of how we obtained the communication costs component of Equation (1) in the main text of the paper.

In an organization without ER, per-capita communication costs equal the number of all the unsolved problems transmitted from a worker of lower layer to a worker of a higher layer, multiplied by the unit (per-problem) cost of communication, all divided by the total number of workers involved in the organization. Suppose to have an organization with $L = 4$. Under the assumption that one worker can solve only one problem and therefore that the number of problems solved at a layer l equals the number of workers at a layer l (i.e. s_l), per-capita communication costs can be written as:

$$\frac{c}{N} \quad (\quad \underbrace{\sum_{l=1}^{L} s_l}_{\substack{\# \text{ of probs arrived at } l=1 \\ \underbrace{\qquad\qquad}_{\substack{\# \text{ of probs passed from } l=1 \text{ to } l=2}}}} - \underbrace{s_1}_{\substack{\# \text{ of probs solved at } l=1}} \quad + \quad \underbrace{\sum_{l=2}^{L} s_l}_{\substack{\# \text{ of probs arrived at } l=2 \\ \underbrace{\qquad\qquad}_{\substack{\# \text{ of probs passed from } l=2 \text{ to } l=3}}}} - \underbrace{s_2}_{\substack{\# \text{ of probs solved at } l=2}} \quad + \quad \underbrace{\sum_{l=3}^{L} s_l}_{\substack{\# \text{ of probs arrived at } l=3 \\ \underbrace{\qquad\qquad}_{\substack{\# \text{ of probs passed from } l=3 \text{ to } l=4}}}} - \underbrace{s_3}_{\substack{\# \text{ of probs solved at } l=3}} \quad) \tag{A.1.1}$$

For each l, s_l can be written as:

$$s_1 = \sum_{l=1}^{L} s_l - \sum_{l=2}^{L} s_l \tag{A.1.2}$$

$$s_2 = \sum_{l=2}^{L} s_l - \sum_{l=3}^{L} s_l \tag{A.1.3}$$

$$s_3 = \sum_{l=3}^{L} s_l - \sum_{l=4}^{L} s_l \tag{A.1.4}$$

Substitute (A.1.2), (A.1.3) and (A.1.4) in (A.1.1):

$$\frac{c}{N}\left(\sum_{l=1}^{L} s_l - \sum_{l=1}^{L} s_l + \sum_{l=2}^{L} s_l + \sum_{l=2}^{L} s_l - \sum_{l=2}^{L} s_l + \sum_{l=3}^{L} s_l + \sum_{l=3}^{L} s_l - \sum_{l=3}^{L} s_l + \sum_{l=4}^{L} s_l\right) \tag{A.1.5}$$

which simplifies to:

$$\frac{c}{N}\left(\sum_{l=2}^{L} s_l + \sum_{l=3}^{L} s_l + \sum_{l=4}^{L} s_l\right) \tag{A.1.6}$$

Equation (A.1.6) can be written as:

$$\frac{c}{N}(\underbrace{\sum_{l=1}^{L} s_l - s_1}_{\sum_{l=2}^{L} s_l} + \underbrace{\sum_{l=1}^{L} s_l - s_1 - s_2}_{\sum_{l=3}^{L} s_l} + \underbrace{\sum_{l=1}^{L} s_l - s_1 - s_2 - s_3}_{\sum_{l=4}^{L} s_l}) \tag{A.1.7}$$

that, in more general terms, is:

$$\frac{c}{N}\underbrace{(L-1)\sum_{l=1}^{L} s_l}_{\substack{\sum_{l=1}^{L} s_l + \\ \sum_{l=1}^{L} s_l + \sum_{l=1}^{L} s_l}} - \underbrace{\sum_{l=1}^{L-1} s_l(L-l)}_{\substack{s_1+s_1+s_1+ \\ s_2+s_2+s_3}} \tag{A.1.8}$$

A.2 Additional results

Table A.2.1: Probability of delayering (reduction in number of layers between 2010 and 2013). Probit estimates.

	(1)	(2)	(3)	(4)	(5)
ER	0.161***	0.060	0.071	0.054	0.069
	(0.050)	(0.055)	(0.055)	(0.056)	(0.057)
Medium firm	0.112**	0.117*	0.115*	0.094	0.097
	(0.054)	(0.062)	(0.063)	(0.064)	(0.066)
Large firm	-0.256*	-0.289	-0.332*	-0.348*	-0.347*
	(0.135)	(0.179)	(0.193)	(0.195)	(0.194)
ER × Medium firm	0.054	0.079	0.089	0.111	0.095
	(0.072)	(0.081)	(0.083)	(0.084)	(0.085)
ER × Large firm	0.461***	0.500***	0.549***	0.546***	0.527***
	(0.145)	(0.189)	(0.204)	(0.205)	(0.204)
Observations	18,982	16,534	16,124	15,582	15,230
Country + industry dummies	Yes	Yes	Yes	Yes	Yes
Establishment-level controls	No	Yes	Yes	Yes	Yes
Outsourcing	No	No	Yes	Yes	Yes
Information Systems	No	No	No	Yes	Yes
Manager's controls	No	No	No	No	Yes

Notes: Estimates from Probit model estimates with robust standard errors in parentheses. The dependent variable equals to one if the establishment experienced a reduction in the number of hierarchical layers in the last three years. Establishment-level controls: workforce composition (gender, age, education, fraction of part-time, permanent employees), firm size, multi-plant, change in employment, productivity, organizational structure and ownership in the last three years, subsidiary site, share of workers involved in complex tasks. Estimates reported in column 3 control for outsourcing of production activities. In Column 4, we add controls for the use of information systems. In Column 5, we add controls for manager's characteristics (gender, position, tenure). The small firm category (10-49 employees) is the benchmark category for size dummies. *** p<0.01, ** p<0.05, * p<0.1.

Table A.2.2: Number of hierarchical layers, probability of delayering and probability of increasing the number of layers between 2010 and 2013. Propensity Score Matching.

	ATT: Linear ER effects		
	[1] Number of layers	[2] Delayering	[3] Increasing layers
ER	0.178***	0.028***	-0.006
	(0.006)	(0.003)	(0.004)
# of obs. (treated + control)	26546	26614	26614
t	29.098	8.880	-1.581
Common support	Yes	Yes	Yes
Balancing property	Satisfied	Satisfied	Satisfied
Matching ATT estimators	Nearest neighbour	Nearest neighbour	Nearest neighbour
	ATT: Interaction effects of ER × Large firm		
	[1] Number of layers	[2] Delayering	[3] Increasing layers
ER (if Large firm = 1)	-0.055*	0.050***	-0.033*
	(0.032)	(0.010)	(0.017)
# of obs. (treated + control)	4411	4433	4433
t	-1.718	5.064	-1.959
Common support	Yes	Yes	Yes
Balancing property	Satisfied	Satisfied	Satisfied
Matching ATT estimators	Nearest neighbour	Nearest neighbour	Nearest neighbour

Notes: Estimates from Propensity Score Matching. Matching is based on sector of activity and on whether the firm is member of any employers' organisation which participates in collective bargaining. The large firm category refers to firms with 250+ employees. *** p<0.01, ** p<0.05, * p<0.1.