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ABSTRACT

Complex Job Design and Layers of Hierarchy*

The main function of hierarchies is to coordinate activities within an organisation, but a hierarchical structure also provides work incentives, by offering the prospect of hierarchical mobility. An alternative way for organisations to motivate workers is through job design. In organisations offering rewarding jobs, the incentivising role of hierarchies may become obsolete, and the number of hierarchical levels can be reduced. Two job design features are particularly relevant: autonomy and problem solving. We investigate the relationship between the number of hierarchical layers and job design features empirically using the European Company Survey (ECS 2019). We find that the extent of the adoption of both complex job design and autonomous teamwork are negatively associated with the number of hierarchical layers. However, the association between complex job design and the number of hierarchical layers is weakened, and in some cases disappears, in larger organisations where hierarchies have a more important coordination role and it is weakened when the knowledge acquisition costs are high. The use of autonomous teams is robustly negatively associated with the number of hierarchical layers.

JEL Classification: M51, L20, M50

Keywords: job design, hierarchies, job complexity

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1. Introduction

Hierarchies and incentives play a crucial role in modern organisations.[1] Failures in the design of hierarchical and incentive structures result in organisations failing (Garicano and Rayo 2016). Hierarchies and incentives seem to respond to different problems. Hierarchies help organisations manage scarce resources efficiently (Garicano and Rossi-Hansberg 2015). Incentives, by aligning the interests of the agent with those of the principal (Holmstrom and Milgrom 1991), induce desirable workplace behaviours that cannot be mandated through the enforcement of the work contract (MacLeod and Malcomson 1989; Halac 2015). Consequently, the two topics are generally investigated separately.

Instead, we note that hierarchical structures and incentive schemes are deeply interwoven through job design. Job design, which describes the tasks included in a job description and workers' degree of control on their job, is linked to hierarchical structures through the amount of reporting and monitoring it prescribes. At the same time, job design is linked to the incentive structure since it is a source of motivation sustaining work effort (Hackman and Oldham 1976; Oldham and Hackman 2010). There is, thus, a clear path linking hierarchical structures, the way jobs are designed, and workers' motivation (incentives).

The experience from episodes of change illustrates this mechanism. The wave of corporate downsizing that took place in the United States during the 1990s originated from an attempt to remain competitive by streamlining the organisation. By pushing decisions down the hierarchy, organisations could respond more quickly to diverse customer needs and increase market responsiveness (Wulf 2012). In the process, organisations saw the elimination of layers of management and a corresponding increase in the span of control of managerial positions (Rajan and Wulf 2006). The layers above middle management, which were tasked with the coordination of middle managers, disappeared. The role of middle managers had to change accordingly. Middle managers experienced an increase in coordination tasks as they now had to ensure the coordination of their decisions with that of other middle managers. Similarly, the flatter hierarchy provided less opportunities for promotions and consequently middle managers experienced an increase in the tasks directed at sustaining their subordinates' motivation (Osterman 2008). That is, the delayering process impacted the incentive scheme.

In fact, organisational hierarchies can also provide incentives to stimulate work effort through the possibility of hierarchical mobility (upward (promotions) and downward (demotions)). In this respect, a flat hierarchy is a less effective incentive mechanism than a tall hierarchy since the smaller number of layers limits hierarchical mobility. While delayering took place across the board, not all companies delayered to the same extent nor endorsed job design changes to the same extent. In some organisations delayering was accompanied by increased autonomy. In other organisations, delayering implied less autonomy and a larger involvement of senior management in day-to-day business (Wulf 2012). Since jobs, when appropriately designed, can be a powerful motivational lever, organisations that went further in re-designing jobs may not have needed to rely on hierarchical mobility for motivation.

[1] Organisational hierarchies consist of layers of reporting, which are also called levels or rungs. Workers on any given layer report to a manager or supervisor belonging to the layer above them. Managers and supervisors have workers reporting to them and these are usually referred to as subordinates or (direct) reports. The number of subordinates reporting to a given manager or supervisor defines the span of control of the manager in question.

The above account of organisational change shows that hierarchical structures and incentive provision are deeply intertwined, and that job design is at the centre of this relationship. Therefore, the aim of this paper is to investigate the linkages between hierarchical structures and job design using the latest edition of the European Company Survey (ECS 2019), which is a unique source of large-scale comparative information on workplace practices, that enables this type of analysis. Since hierarchies have multiple functions there will be competing explanations for the relationship between job design and the number of hierarchical layers. Therefore, we will examine the robustness of our findings against selected competing explanations.

The structure of the article is the following: Section 2 discusses the expected relationship between hierarchies and the provision of incentives; Section 3 describes the data; Section 4 contains the main results; and finally, Section 5 provides concluding remarks.

2. Levels of Hierarchy and Job Design Features

Hierarchies in organisations play multiple important roles. Arguably the primary function of hierarchies is that of a coordination mechanism. Individuals high up in the hierarchy can make decisions and issue orders for their implementation to people below them in the hierarchy. Therefore, individuals up in the hierarchy can coordinate the actions of their subordinates in a way that would not be possible to the subordinates individually (Hart and Moore 2005). The efficiency of hierarchies in catering to this organisational need is contingent on the organisational strategy and on market characteristics (Anderson and Brown 2010). Tall hierarchical structures are appropriate when organisational success is based on the avoidance of mistakes because the knowledge of multiple decision makers is brought to bear in the decision. Flat structures are more appropriate when organisational success is based on the introduction of innovative goods or services, as they more effectively ensure that no viable product or service innovation is overlooked (Sah and Stiglitz 1986). In stable business environments, organisations are presented with a stable set of problems, and expertise can build at the top. Managers positioned high up in the hierarchy are assumed to be better able at making decisions because of advanced expertise or superior knowledge. Hierarchies can also, however, generate homogenous environments prone to groupthink (Prendergast 1993; Bénabou 2012). This like-mindedness among managers might not be problematic in stable environments. However, when organisations operate in unstable or ambiguous environments with unpredictable outcomes or future product demands, flat hierarchies tend to be more functional as they allow for the aggregation of opinions of a broader set of members of the organisation (Galton 1907; Surowiecki 2005). Consequently, in stable environment, when work is more routine and predictable, hierarchical structures tend to consist of more layers.

Hierarchies also provide incentives for individuals to contribute to the success of the organisation. This is achieved through hierarchical mobility and monitoring. Hierarchical mobility allows for an upward or downward passage from one layer of the hierarchy to the next. The possibility of a promotion (or a threat of demotion) incentivises workers to improve their work performance and disincentivises harmful behaviour (Lazear and Rosen 1981; Prendergast 1993; DeVaro 2006; Oosterbeek, Sloof et al. 2007; Zábojník 2012). Monitoring is important in situations in which organisational outcomes cannot be easily linked to individual contributions (non-separable production function), when individuals have an incentive to shirk, leading to output losses (the metering problem). Supervisors can monitor input – workers' behaviour – to induce that workers engage with the appropriate amount of effort (Alchian and Demsetz 1972).

Finally, hierarchy functions as a talent allocation mechanism (knowledge, ability, skills) by leveraging the gains from specialisation of different types of workers in the hierarchy. Workers are paid wages corresponding to their skill set; so, higher skilled workers are paid more than low skilled workers. For example, in the case of knowledge, the optimal design of the hierarchy depends on the balance between communication and knowledge acquisition costs. Communication costs represent the costs incurred in evaluating a problem and referring it to higher layers in the hierarchy. Communication costs increase with the number of layers. Knowledge acquisition costs reflect the costs of acquiring the necessary knowledge to deal with problems typically referred to the various layers of the hierarchy. Knowledge acquisition costs decrease with the number of layers in the hierarchy. Assume that tasks can be ordered in increasing levels of difficulty. Simple jobs, requiring few or no skills, are allocated at the bottom of the hierarchy. Complex jobs, requiring advanced skills, are allocated to the middle or top of the hierarchy. By adopting a pyramidal hierarchical structure, organisations can minimise the total wage bill by recruiting skilled workers in positions high up in the hierarchy (Garicano 2000; Garicano and Rossi-Hansberg 2004; Garicano and Prat 2013; Garicano and Rossi-Hansberg 2015).

The most important job design features allowing for decentralisation of decision making are autonomy and problem solving (and the adoption of autonomous teams). We will refer to jobs involving these two features as complex jobs (or complex job design).[2] Complex job design can provide many of the advantages provided by hierarchical structures. Complex job design can sustain work motivation. This is recognised by two important motivational theories: the job design theory (Hackman and Oldham 1976; Oldham and Hackman 2010) and the self-determination theory (Deci, Olafsen et al. 2017; Gagné 2018). Complex job design can incentivise workers to contribute to the success of the firm. Workers' autonomy has been found to be positively associated with measures of engagement (Crawford, Lepine et al. 2010; Parker, Morgeson et al. 2017) and with reciprocity in social exchange (Falk and Kosfeld 2006; von Siemens 2013; Burdin, Halliday et al. 2018; Schmelz and Ziegelmeyer 2020). At the same time, decision-making and (successful) problem-solving are linked to the satisfaction of the need for mastery, which in turn leads to engagement and job satisfaction (Morgeson and Humphrey 2006; Humphrey, Nahrgang et al. 2007; Morgeson and Humphrey 2008; Parker, Morgeson et al. 2017).

Job complexity has also been found to incentivise information and knowledge circulation: motivated and engaged workers share knowledge and information with each other (Boer, van Baalen et al. 2004; Boer, Berends et al. 2011; Battistelli, Odoardi et al. 2019; Gagné, Tian et al. 2019; Nguyen, Nham Phong et al. 2019).

Complex job design can also function as a coordination mechanism when it is implemented through the adoption of autonomous teams. In fact, the adoption of self-directed teams emerged around the same time that companies were actively delayering (Appelbaum, Bethune et al. 1999). Self-directed teams are complex work environments since team members need to go beyond their role to perform managerial tasks – involving problem-solving and autonomy (de Sitter, den Hertog et al. 1997; Powell and Pazos 2017). They can therefore be expected to also produce the same motivational effects as complex jobs.

[2] Complex jobs are mentally demanding jobs and challenging to perform (Campion 1988). Since autonomy and problem solving increases the skills requirements of jobs (Pouliakas and Russo 2015), in line with Boning, Ichniowski et al. (2007) we will refer to jobs with these job design features as complex jobs.

Job design and hierarchical structures can provide different solutions to the same set of organisational issues. Consequently, our working hypotheses are (1) that the higher the degree of adoption of complex job design the fewer the number of hierarchical layers; and (2) that the adoption of self-directed teamwork rather than management led teams is associated with a smaller number of hierarchical layers. Our assumption is that the hypotheses will be driven by the extent to which job design and hierarchical structures provide work incentives. However, since there are competing explanations based on coordination and knowledge acquisition and circulation, we will assess the robustness of our initial results to these factors.

3. Data

The European Company Survey 2019 (ECS 2019) is an EU-wide establishment survey, commissioned by the European Foundation for the Improvement of Living and Working Conditions (Eurofound) and the European Centre for the Development of Vocational Training (CEDEFOP).[3] It covers European establishments with at least 10 employees carrying out "market activities", excluding agriculture.[4] The survey is addressed to two respondents: a (human resource) manager and a member of the employee representative body (if present).

The ECS 2019 is the first pan-European establishment survey carried out using a push-to-web approach. The approach consisted of a short telephone screener interview to assess eligibility, identify and contact the management respondent to secure cooperation and obtain the contact details of an employee representative respondent (where present). These target respondents were subsequently invited to complete the questionnaire online.

The survey was carried out among a stratified random probability sample of EU establishments with 10 employees or more, oversampling large establishments. Where possible a high-quality establishment level business register was used; however, in half the countries, establishment level registers were not available or of insufficient quality, and company level registers were used. In those countries, the screener included a first step to enumerate all establishments within the company (if more than one) and up to three of those establishments were selected.

The yield rate for the management interviews, as in other business survey, was low; 5% overall, and varying between 2% in Poland and 16% in Lithuania. The data are weighted to correct for the sample design and for response bias in terms of sector of activity and size class. A non-response analysis was carried out to assess whether the conversion from telephone to web would introduce bias, but not evidence of this was found. The data collected were of good quality in terms of response patterns (e.g. speeding, item non-response, straight lining, substantive inconsistencies etc); less than 1% of responses had to be discarded due to quality concerns. An external data quality assessment concluded

[3] https://www.eurofound.europa.eu/surveys/2019/european-company-survey-2019

[4] NACE Rev 2 categories B to N, R and S (see https://ec.europa.eu/competition/mergers/cases/index/nace_all.html). The public sector has been excluded for lack of suitable sample frames. Due to an error in the sampling that was discovered after data collection, NACE categories M, N, R and S were excluded from the Slovenian sample.

that the internal validity of the management dataset is high.[5]

The total achieved sample of management interviews is 21,869, and varies between 122 cases in Cyprus, and 1498 cases in Italy. We use only the management data set in the current analysis, and the estimation sample is reduced to 18,287 observations after the listwise deletion of missing cases.

The dependent variable – the number of hierarchical layers - is derived from the following question: "*Counting in the same way as is done in the examples below, how many hierarchical levels you have in this establishment?"*

The question was accompanied by two examples showing organigrams, with three and four levels of reporting.

Answers ranging between 1 and 10 levels were kept and considered valid.[6] Only about 1% of establishments reported having 6 hierarchical levels or more. The dependent variable has been recoded into five categories, with the first 4 categories corresponding with the reported number of hierarchical layers and the last category containing all establishments where the number of layers was five or more. Most establishments have three or four levels; 60% and 18% of the sample, respectively.

To capture the extent to which establishments have adopted complex job design we have used the percentages of workers (non-managerial employees) whose job includes independently organising their time and scheduling their tasks and whose job includes finding solutions for unfamiliar problems.

Table 1 shows that the majority of establishments only offer work autonomy and problem solving to a minority of employees, in 53% of establishments less than 40% of employees are in jobs offering work autonomy and in 62% of establishments less than 40% of employees are in jobs allowing for problem solving.

Table 1: Proportion of establishments by fraction of employees in jobs with autonomy and problem solving, weighted (N=18,287).

Proportion of employees	Autonomy	Problem Solving
Less than 20%	0.338	0.390
20% - 39%	0.198	0.234
40% - 59%	0.134	0.150
60% - 79%	0.121	0.098

[5] The external data quality assessment can be accessed through Eurofound's site (https://www.eurofound.europa.eu/sites/default/files/wpef19017.pdf). Additional technical information on the survey methodology and quality of the data can be found in the technical report (https://www.eurofound.europa.eu/sites/default/files/wpef20011.pdf).

[6] In 24 cases the answer provided was considered out of range (and coded to missing); in seven cases the answer was 0, in the other 17 cases it was (much) greater than 10.

80% or more	0.209	0.128

The variables measuring the incidence of work autonomy and problem solving were combined into a scale to measure the incidence of complex job design (Cronbach alpha = 0.66%). The scale ranges from 1 (less than 20% of employees) to 5 (80% or more of employees) with higher values indicating a larger incidence of complex job design.

A second dimension of complex job design is captured by the presence of autonomous self-directed teams. The ECS 2019 shows that autonomous teams are utilised by only 15% of establishments, most establishments have management led teams, while 29% of establishments do not utilise teamwork at all.

Prima facie evidence of the negative relationship between the degree of delegation of decision-making and the number of layers in the hierarchy is presented in Table 2: establishments with one or two hierarchical levels have a larger incidence of workers in jobs with complex job design.

Table 2: The relationship between job complexity and the depth of the hierarchy at the establishment, weighted (N=18,287).

Number of hierarchical levels	Average job complexity
1	2.545
2	2.747
3	2.474
4	2.318
5 or more	2.355

In addition, the average number of hierarchical layers is 3.1 in organisations using management directed teams while it is 2.8 in establishments adopting autonomous teams.

The empirical analysis in the next section will focus on two variables: on the extent of adoption of complex job design and on the adoption of autonomous teams. To check for confounding factors a large number of control variables will be included in the empirical model (Angrist and Pischke 2017). These include the percentage of workers in jobs requiring continuous training, and the percentage of workers in jobs not requiring learning new skills, the percentage of workers in jobs in which a computer is used, if data analytics are used to improve the production process or to monitor workers' performance. Finally, establishments will be characterised by the incidence of workers with permanent and with part-time contracts.

Managerial attitudes towards employees will be captured by two variables: whether managers control if employees follow the tasks assigned to them or rather facilitate employees' work, and the extent to which employee involvement is believed to be a source of competitive advantage.

The investment in skills is captured by a variable characterising the speed with which skill

requirements change at the establishment and by the percentage of workers participating in training during paid working time and the percentage of workers receiving on-the-job training.

Small establishments (10-49 employees) make up for the largest group in the sample (63%); medium (50 – 249 employees) and large (250 employees and above) establishment account for 28% and 9% of the sample, respectively. Only 14% of the establishments surveyed have been in operation for less than 10 years, 23% have been in operation between 11 and 20 years, while 27% and 37% had been in operation for a very long time, for 20 to 30 year and more than 30 years, respectively. Single establishments companies account for 73% of the sample, the remaining 27% of the sample consists of establishments belonging to multi-establishments companies. Of these, 63% (or 17% of the whole sample) are headquarters while 37% (or 10% of the whole sample) are subsidiaries.

The conditions in which establishments operate are captured by the predictability of product demand, the intensity of competition in the product market, product market strategy (whether the emphasis is on price, quality, customisation, product/service innovation or a combination of those).[7]

The descriptive statistics in the estimation sample for all the variables used in the empirical analysis are shown in Appendix A.

4. Empirical analysis

4.1 Main model

A regression model is used to investigate the relationship between the numbers of layers in the hierarchy (Y) and the degree of adoption of complex job design in establishments:

$$Y_i = \beta X_i + \epsilon_i$$

Where X is a matrix of explanatory variables, β a vector of parameters to be estimated and ϵ an i.i.d. error term.

The OLS estimates are shown in Table 3, Panel A, baseline model.[8] The extent of adoption of complex job design is negatively associated with the number of hierarchical layers. Establishments that go further in the adoption of complex job design tend to adopt hierarchical structure with fewer levels of hierarchy than establishments that were more conservative in the adoption of complex job design. Similarly, establishments adopting autonomous teams have flatter hierarchies than establishments adopting management led teams (or establishments that do not use teamwork at all). The estimates from the baseline model imply that going from the lowest incidence of complex job design (less than 20% of the workforce) to the highest (above 80% of the workforce) and adopting autonomous teams tally up to half a hierarchical layer.

[7] In addition, country dummies and 1-digit NACE industry dummies will be used in the empirical models.

[8] The OLS approach does not account for the fact that the range of the dependent variables is restricted between 1 and 5. This is not likely to be a problem in our case since none of the predicted values falls outside the admissible range [1,5].

Table 3: Regression estimates of the number of hierarchical levels on team autonomy and extent of the adoption of complex job design, standard errors in parenthesis, weighted (*: significant at α = .05, **: significant at α = .01).

Panel A	Baseline model	Emphasis on employee input		Data analytics to improve the production process	
	OLS	Low (high cost)	High (low cost)	Used (low cost)	Not used (high cost)
Workers in complex jobs	-0.038 **	-0.030 **	-0.046 **	-0.053 **	-0.022
	(0.009)	(0.013)	(0.010)	(0.010)	(0.015)
Teamwork					
No teams	-0.194 **	-0.212 **	-0.163 **	-0.147 **	-0.213 **
	(0.019)	(0.033)	(0.014)	(0.021)	(0.029)
Autonomous teams	-0.148 **	-0.171 **	-0.121 **	-0.108 *	-0.183 **
	(0.019)	(0.017)	(0.034)	(0.042)	(0.029)
N	18,287	9,759	8,528	9,135	9,152
Panel B	Quantile de-meaning			Product demand	
	Ventiles	Deciles	Quintiles	Predictable	Unpredictable
Workers in complex jobs	-0.016	-0.017	-0.020 *	-0.028 *	-0.056 **
	(0.009)	(0.009)	(0.009)	(0.013)	(0.013)
Teamwork					
No teams	-0.161 **	-0.162 **	-0.168 **	-0.183 **	-0.234 **
	(0.017)	(0.017)	(0.017)	(0.016)	(0.043)
Autonomous teams	-0.142 **	-0.140 **	-0.141 **	-0.136 **	-0.173 **
	(0.016)	(0.015)	(0.015)	(0.022)	(0.046)
N	17,493	17,493	17,493	12,463	5,859

Note: The full set of estimates of the baseline model is shown in Appendix B. The regressions in the table also include all variables in Appendix B. The reference group of the variables is in parenthesis: Teamwork (management led teams), Establishment size (small, 10 – 49 employees), managers create an environment in which employees can autonomously carry out their tasks, no innovation introduced (innovation introduced), Establishment age (10 years or less), Design and development of new product and services (carried out in house), Production of goods, assembly of parts, delivery of services (carried out in house), Product market strategy (price), Type of establishment (single establishment), Industry (mining and quarrying), and Country (Austria).

4.2 Robustness analysis: importance of employee input as a proxy for knowledge acquisition cost

The relationship between the measures of job complexity and the number of hierarchical levels could be driven by knowledge acquisition costs (Garicano 2000; Garicano and Prat 2013).

A larger volume of knowledge available reduces the cost of knowledge acquisition for decision makers. Managers striving to improve the efficiency of operations may increase the volume of knowledge available to them by tapping workers' (tacit) knowledge. To do so, organisations need to induce workers to put forward suggestions on how to improve operations and open up the right channels of communication. Note that organisations cannot mandate workers to make this information available. Workers need to be induced to make their knowledge available by means of appropriate incentives.

Complex job design can do so since both autonomy and problem solving are a source of work motivation that can induce workers to draw on their skills and knowledge.

The ECS 2019 contains four variables bearing on the emphasis put on tapping into employees' knowledge: the importance for employees of making suggestions for improving the way things are done in the company to be positively evaluated, the importance of increasing the capacity of employees to articulate ideas about improvements to the establishment as a reason to provide training to employees, the extent to which involving employees in work organisation changes gives the establishment a competitive advantage, and the extent to which employees directly influenced management decisions regarding the organisation and efficiency of the work process.

Latent class analysis suggested that establishments can be classified into two groups on the bases of the four indicators. In the first group, group 1, answers on the four indicators were "fairly" and "non-very" important and "to some" or "to a small" extent. The second group, group 2, the answers on the four indicators were "fairly" and "very" important and "to some" or "to a large" extent. In other words, the degree of emphasis put on obtaining information from employees to improve operations is higher for establishments in the second group (group 2) than for establishments in the first group (group 1). Consequently, establishments in the second group have a lower knowledge acquisition cost than establishments in the first group. The two groups are of roughly equal size (53% of establishments belong to group 1 and 47% to group 2).

To assess the impact of knowledge acquisition costs on the relationship between job complexity and the number of hierarchical levels we split the sample and estimate the baseline model on the two subsamples. The results are presented in Table 3, Panel A, emphasis on employee input.

The relationship between the extent of the adoption of complex job design and the number of hierarchical levels appears to be weakened among the establishments with high knowledge acquisition cost. However, a Wald test reveals that the difference in the coefficients on the extent of the adoption of complex job design in the subsamples with high and low knowledge acquisition costs is not statistically different from zero (the Wald test statistics is 0.75 with a p-value of 0.385). The difference in the coefficient on the adoption of autonomous teams is also not significant (the Wald test statistics is 0.88 with a p=value of 0.349). In other words, the widespread adoption of complex job design and the presence of autonomous teams is associated with a small number of hierarchical levels in both the subsamples of establishments with high and low knowledge acquisition costs.

4.3 Robustness analysis: use of technology as a proxy for knowledge acquisition cost

Knowledge acquisition costs can also be affected by technology. Establishments using data analytics to improve the production process would have lower knowledge acquisition costs than establishments that do not have such systems in place. In our sample, the number of establishments that use data analytics to improve the production process is roughly equal to the number of establishments that do not. We split the sample and estimated the same regression in the baseline model on the two subsamples, users and non-users of data analytics to improve production process, the results are presented in Table 3, Panel A, by use of data analytics.

The relationship between job complexity and the number of hierarchical levels is weakened among the non-users (high cost of knowledge acquisition) and becomes non-significant. However, the difference

between the coefficients in the two groups is not statistically significant (the Wald test statistics is 3.13, and the p-value= 0.077).

Similarly, the coefficients on autonomous team adoption are negative and significant and the difference between the coefficients in the two subsamples of users (low knowledge acquisition costs) and non-user (high knowledge acquisition costs) is not statistically different (the Wald test statistics is 2.10, and the p-value= 0.148). In other words, the difference in cost of acquiring knowledge does not appear to affect the negative relationship between the adoption of autonomous teamwork and the number of hierarchical layers.

4.4 Robustness analysis: the importance of coordination and of a stable product demand

In the present analysis complex job design is defined by a combination of autonomy and problem solving. Often, job complexity includes a third dimension: job interdependence. Interdependence arises when job performance in a set of jobs is mutually dependent (Lazear and Gibbs 2009).

A greater degree of job interdependency may result in a greater need for coordination. Establishments may adopt complex job design more extensively when jobs are less interdependent. At the same time, the lack of interdependency decreases the need for coordination in the establishment. Consequently, a negative association between the extent of adoption of complex job design and the number of hierarchical layers may be spurious, resulting instead from a low need for coordination (Zhou 2013).

Things are different when looking at the adoption of teamwork. The team structure helps coordinating the execution of interdependent jobs. In this case, the negative association between the adoption of autonomous teams and the number of hierarchical layers is less likely to be spurious, as the need for coordination is internalised by the team structure (Zhou 2013).

Our working hypothesis is that establishments of similar size may have roughly the same pattern of job interdependency and the same difficulties in coordinating activities; therefore, it is plausible that in these establishments, hierarchies would have an equally important role in coordinating production activities. The data do not include explicit information on the need for coordination and it is therefore included in the error term. However, establishments in the same size quantile can be assumed to have (roughly) similar “needs for coordination”. Under this assumption, the within quantile de-meaning of dependent and independent variables would also remove the “need for coordination” from the error term. We acknowledge that this is a big assumption. We do not claim that the within-quantile demeaning will cleanly remove the influence of the need for coordination. We acknowledge that using establishment size as a proxy for the need for coordination is a rather coarse way to assess the importance of the coordination role of hierarchies. However, if the procedure captures at least part of the importance of the coordination role of hierarchies, the relationship between the provision of incentive through job design and the number of hierarchical levels should be affected.

The results of this analysis, based on the division of the establishment size distribution in 5, 10 and 20 quantiles are shown in Table 3, Panel B, Quantile de-meaning.[9]

[9] The de-meaning procedure results in a loss of 794 cases.

The coefficient on the extent of adoption of complex job design is negative and significant in the model in which the demeaning is based on the quantiles, but not significant, across all other model specifications (10 and 20 quantiles). In addition, the coefficient on the extent of the adoption of complex job design in Table 3, Panel B, Quantile de-meaning (20 quantiles) is noticeably smaller than the coefficient on the same variable in the baseline model .[10] Our analyses suggest that, to the extent that establishment size correlates with the need for coordination, the negative association between incentives offered through complex job design and the number of hierarchical layers is drastically reduced so that its size is not significant among establishments relying heavily on hierarchies to coordinate production activities.

Across all three model specifications, establishments adopting autonomous teamwork tend to have fewer hierarchical layers than establishments in which teams are led by managers. The difference in the coefficients on management lead teams and autonomous teams in Table 3, Panel B, Quantile de-meaning (specification with 20 quantiles) is not different from the one on the same variables in the baseline model. In other words, the "need for coordination" does not appear to affect the negative relationship between the adoption of autonomous teamwork and the number of hierarchical layers.

The provision of incentives through job design is negatively associated with the number of hierarchical layers. The adoption of autonomous teams is robustly associated with a reduction in the number of hierarchical layers. Our analyses suggest that the strength of the association between the extent of adoption of complex job design and the number of hierarchical layers is affected by the importance of the coordination role played by hierarchies in establishments.

Hierarchies tend to be effective in companies operating in stable product markets. To further assess the impact of product demand stability on the relationship between job complexity and the number of hierarchical levels we split the sample and estimate the baseline model on the two subsamples characterized by a product demand that is predictable or unpredictable. The results are presented in Table 3, Panel B, by Product demand.

The relationship between the extent of the adoption of complex job design and the number of hierarchical levels appears to be weakened among the establishments facing a predictable (stable) product demand. However, a Wald test reveals that the difference in the coefficients on the extent of the adoption of complex job design in the subsamples facing predictable and unpredictable product demand is not statistically different from zero (the Wald test statistics is 1.761 with a p-value of 0.184). The difference in the coefficient on the adoption of autonomous teams is also not significant (the Wald test statistics is 0.471 with a p=value of 0.495). In other words, the widespread adoption of complex job design and the presence of autonomous teams is associated with a small number of hierarchical levels in both the subsamples of establishments facing predictable or unpredictable product demand.

5. Conclusions

The central idea we investigate in this paper is that workplaces providing incentives through job design are less reliant on hierarchical mobility for motivating employees.

[10] The coefficient on the extent of adoption of complex job design is 0.018 also when 50, 100, and 200 quantiles are used.

Complex job design, which allow for autonomy and problem solving and the adoption of autonomous teams, is a source of motivation. We find that the more extensive the adoption of complex job design – the higher the percentage of employees in complex jobs – the flatter the hierarchical structure. Also, establishments adopting autonomous teamwork have flatter hierarchies (consisting of fewer hierarchical layers) than otherwise similar establishments adopting management led teams.

There are concurring causes that could produce a similar negative correlation: the need for coordination (more interrelated jobs needing a greater deal of coordination and the stability of the product environment) and the management of scarce resources (i.e., information and knowledge). Consequently, we have investigated the robustness of our results to these concurring factors.

The trade-off between the extent of adoption of complex job design and the number of hierarchical layers appears to be weakened or undone when job complexity is accompanied by job interdependency, which requires a stronger coordination capacity of hierarchies. The analysis assumes that the degree of interdependence between jobs is equal among establishments of similar size. We acknowledge that this is, at best, a crude approach. On the other hand, the negative relationship between the extent of the adoption of complex job design and the number of hierarchical layers is present regardless of the product demand conditions faced (stable and unstable product demand).

Our results suggest that the negative relationship between the number of hierarchical layers and the extent of adoption complex job design is robust to the introduction of knowledge acquisition costs. Knowledge acquisition costs have been proxied in two ways: by the emphasis the organisation puts on inducing employees to put forward suggestions on how to improve how things are done and by the use of data analytics for process improvement and performance monitoring. When using this second proxy for high knowledge acquisition costs, the relationship between the extent of adoption of complex job design and the number of hierarchical levels is weakened among establishments with high knowledge acquisition costs. However, when knowledge acquisition costs are proxied by the emphasis organisations put on stimulating cooperation between employees and motivating employees to make suggestions for improvements, our results suggest that the negative relationship between the number of hierarchical layers and the extent of adoption complex job design holds in organisations with high and low knowledge acquisition costs.

Finally, we find a negative and significant relationship between the adoption of autonomous teams and the number of hierarchical layers. This result holds across all models based on the within quantile transformations, regardless of the stability of the product demand faced (stable or unstable), and in all subsamples identified by the variables used to proxy knowledge acquisition costs. The adoption of autonomous teams, which addresses the issues of job interdependence and knowledge management, is robustly linked to a reduced number of hierarchical levels.

All in all, our analysis supports the notion that hierarchical structures and incentive mechanisms are tightly interwoven and that they should be studied together.

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Appendix A: Descriptive statistics

Table A: Descriptive statistics (unweighted)

	Mean	Std. Dev.	Min	Max
Number of hierarchical levels	3.058	0.815	1	5
Workers in complex jobs	2.317	1.241	1	5
Workers in jobs in which the pace of work set by machines	1.889	1.359	1	5
Workers in jobs in which there is needs of continuous training	2.265	1.472	1	5
Workers in jobs in which there is no need to learn new skills	1.955	1.281	1	5
Workers in jobs in which computer is used	2.908	1.640	1	5
Workers with permanent contracts	4.483	1.131	1	5
Workers on part-time contracts	1.491	1.055	1	5
Teamwork				
No teams	0.257	0.437	0	1
Management led teams	0.590	0.492	0	1
Autonomous teams	0.152	0.359	0	1
Establishment size (number of employees)				
Small (10 - 49)	0.629	0.483	0	1
Medium (50 - 249)	0.284	0.451	0	1
Large (250 and more)	0.086	0.281	0	1
Data analytics to improve production process	0.500	0.500	0	1
Data analytics to monitor workers' performance	0.321	0.467	0	1
Managers control if employees follow the tasks assigned to them	0.709	0.454	0	1
No innovation introduced	0.460	0.498	0	1
Skills requirements change	2.371	0.634	1	4
Workers in training during paid work time	2.764	1.574	1	5
Workers in jobs in on-the-job learning	2.852	1.490	1	5
Employee representation body present	0.378	0.485	0	1

Employee involvement causes delay	2.149	0.858	1	4
Employee involvement is a source of competitive advantage	2.878	0.893	1	4
Product demand (very stable to very volatile)	2.725	0.648	1	4
Intensity of competition in the product market	3.192	0.741	1	4
Establishment age				
10 years or less	0.141	0.348	0	1
11 to 20 years	0.235	0.424	0	1
21 to 30 years	0.257	0.437	0	1
more than 30 years	0.367	0.482	0	1
Design and development of new product and services				
Carried out internally	0.307	0.461	0	1
Carried out in cooperation with other establishments same company	0.037	0.188	0	1
in collaboration with other companies	0.089	0.285	0	1
Contracted out	0.020	0.141	0	1
No design and development	0.547	0.498	0	1
Production of goods, assembly of parts, delivery of services				
Carried out internally	0.463	0.499	0	1
Carried out in cooperation with other establishments same company	0.051	0.220	0	1
in collaboration with other companies	0.121	0.326	0	1
Contracted out	0.043	0.204	0	1
No production of goods or delivery of services	0.322	0.467	0	1
Product market strategy				
Price	0.116	0.320	0	1
Quality	0.357	0.479	0	1
Customisation	0.287	0.452	0	1
Innovation	0.085	0.279	0	1
All equally important	0.046	0.209	0	1
Customisation, innovation, and quality	0.028	0.164	0	1

Customisation and quality	0.033	0.178	0	1
Customisation and innovation	0.006	0.076	0	1
Innovation and quality	0.007	0.082	0	1
Price and quality	0.010	0.097	0	1
Price and customization	0.003	0.058	0	1
Price and innovation	0.005	0.069	0	1
Price, quality, and customization	0.013	0.115	0	1
Price, quality, and innovation	0.003	0.059	0	1
Price, innovation, and customization	0.001	0.038	0	1
Type of Establishment				
Single establishment	0.728	0.445	0	1
Headquarter	0.171	0.376	0	1
Subsidiary	0.101	0.301	0	1
Industry (NACE)				
Mining and quarrying	0.004	0.064	0	1
Manufacturing	0.247	0.431	0	1
Electricity, gas, steam and air conditioning supply	0.008	0.090	0	1
Water supply sewerage waste management and remediation activities	0.015	0.121	0	1
Construction	0.103	0.304	0	1
Wholesale and retail trade , reparation of motor vehicles	0.201	0.401	0	1
Transportation and storage	0.059	0.236	0	1
Accommodation and food services activities	0.059	0.235	0	1
Information and communication	0.040	0.196	0	1
Financial and insurance activities	0.020	0.140	0	1
Real estate activities	0.013	0.114	0	1
Professional, scientific, and technical activities	0.067	0.250	0	1
Administrative and support services activities	0.031	0.174	0	1
Arts, entertainment, and recreation	0.029	0.169	0	1

Other service activities	0.103	0.304	0	1
Country				
Austria	0.047	0.211	0	1
Belgium	0.047	0.212	0	1
Bulgaria	0.045	0.207	0	1
Croatia	0.024	0.154	0	1
Cyprus	0.005	0.071	0	1
Czechia	0.040	0.196	0	1
Denmark	0.049	0.216	0	1
Estonia	0.023	0.149	0	1
Finland	0.051	0.220	0	1
France	0.062	0.241	0	1
Germany	0.033	0.178	0	1
Greece	0.023	0.149	0	1
Hungary	0.049	0.217	0	1
Ireland	0.013	0.112	0	1
Italy	0.068	0.252	0	1
Latvia	0.023	0.151	0	1
Lithuania	0.022	0.148	0	1
Luxembourg	0.011	0.103	0	1
Malta	0.006	0.078	0	1
Netherlands	0.051	0.220	0	1
Poland	0.036	0.187	0	1
Portugal	0.046	0.209	0	1
Romania	0.034	0.182	0	1
Slovakia	0.016	0.125	0	1
Slovenia	0.026	0.158	0	1
Spain	0.067	0.250	0	1

Sweden	0.050	0.218	0	1
United Kingdom	0.032	0.177	0	1
Number of cases	18,287			

Appendix B: Estimation Results

Table B: Estimation results, standard error between brackets (*: significant at 5%, **: significant at 1%), weighted.

	Regression Baseline model	
% workers in complex jobs	-0.038	**
	(0.009)	
% workers in jobs in which the pace of work set by machines	-0.008	
	(0.013)	
% workers in jobs in which there is needs of continuous training	0.003	
	(0.007)	
% workers in jobs in which there is no need to learn new skills	0.011	
	(0.006)	
% workers in jobs in which computer is used	0.017	**
	(0.006)	
% workers with permanent contracts	0.005	
	(0.006)	
% workers in part-time contracts	-0.025	**
	(0.007)	
Teamwork		
No teams	-0.194	**
	(0.019)	
Autonomous teams	-0.148	**
	(0.019)	
Establishment size (number of employees)		
Medium (50 - 249)	0.492	**
	(0.037)	
Large (250 and more)	0.900	**

	(0.044)	
Data analytics to improve production process	0.069	**
	(0.019)	
Data analytics to monitor workers' performance	0.054	*
	(0.026)	
Managers control if employees follow the tasks assigned to them	-0.010	
	(0.030)	
No innovation introduced	-0.045	
	(0.031)	
Skills requirements change	-0.012	
	(0.010)	
Workers enrolled in training during paid time	0.000	
	(0.004)	
Workers who received on-the-job learning	0.022	**
	(0.007)	
Employee representation body present	0.138	**
	(0.024)	
Employee involvement causes delay	0.030	
	(0.021)	
Employee involvement is a source of competitive advantage	0.022	**
	(0.008)	
Product demand conditions (very stable to very volatile)	0.023	
	(0.013)	
Intensity of competition in the product market	-0.023	
	(0.022)	
Establishment age		
11 to 20 years	0.073	**
	(0.014)	

21 to 30 years	0.028	
	(0.017)	
More than 30 years	-0.001	
	(0.018)	
Design and development of new product and services		
Carried out in cooperation with other establishments same company	0.045	
	(0.044)	
In collaboration with other companies	0.028	
	(0.019)	
Contracted out	0.008	
	(0.045)	
No	-0.019	
	(0.014)	
Production of goods, assembly of parts, delivery of services		
Carried out in cooperation with other establishments same company	0.025	
	(0.058)	
In collaboration with other companies	0.022	
	(0.021)	
Contracted out	-0.067	*
	(0.030)	
No	-0.014	
	(0.016)	
Product market strategy		
Quality	0.019	
	(0.017)	
Customisation	0.035	
	(0.022)	

Innovation	-0.001	
	(0.020)	
All equally important	-0.066	
	(0.064)	
Customisation, innovation, and quality	-0.112	*
	(0.046)	
Customisation and quality	-0.049	
	(0.053)	
Customisation and innovation	-0.081	
	(0.070)	
Innovation and quality	-0.141	
	(0.071)	
Price and quality	-0.085	
	(0.082)	
Price and customisation	-0.222	*
	(0.098)	
Price and innovation	-0.453	**
	(0.123)	
Price, quality, and customisation	-0.138	
	(0.084)	
Price, quality, and innovation	-0.374	**
	(0.103)	
Price, innovation, and customisation	0.016	
	(0.121)	
Type of Establishment		
Headquarter	0.047	*
	(0.019)	
Subsidiary	0.034	

	(0.037)	
Industry (NACE)		
Manufacturing	0.124	
	(0.082)	
Electricity, gas, steam and air conditioning supply	0.223	*
	(0.102)	
Water supply sewerage waste management and remediation activities	0.128	
	(0.125)	
Construction	0.143	*
	(0.062)	
Wholesale and retail trade , reparation of motor vehicles	0.081	
	(0.083)	
Transportation and storage	0.017	
	(0.111)	
Accommodation and food services activities	0.155	*
	(0.067)	
Information and communication	-0.090	
	(0.113)	
Financial and insurance activities	0.028	
	(0.082)	
Real estate activities	0.106	
	(0.119)	
Professional, scientific, and technical activities	-0.026	
	(0.070)	
Administrative and support services activities	0.014	
	(0.145)	
Arts, entertainment, and recreation	0.154	*
	(0.073)	

Other service activities	0.132	
	(0.075)	
Country		
Belgium	-0.017	
	(0.013)	
Bulgaria	-0.010	
	(0.008)	
Croatia	0.039	
	(0.021)	
Cyprus	0.254	**
	(0.011)	
Czechia	0.137	**
	(0.018)	
Denmark	-0.286	**
	(0.016)	
Estonia	-0.033	**
	(0.009)	
Finland	-0.029	
	(0.018)	
France	0.202	**
	(0.020)	
Germany	-0.037	**
	(0.013)	
Greece	0.019	
	(0.015)	
Hungary	0.163	**
	(0.021)	
Ireland	0.184	**

	(0.016)	
Italy	0.006	
	(0.015)	
Latvia	-0.037	
	(0.018)	
Lithuania	-0.127	**
	(0.007)	
Luxembourg	0.053	**
	(0.014)	
Malta	0.442	**
	(0.013)	
Netherlands	-0.000	
	(0.010)	
Poland	0.100	**
	(0.016)	
Portugal	0.097	**
	(0.017)	
Romania	-0.021	*
	(0.010)	
Slovakia	0.112	**
	(0.010)	
Slovenia	0.084	**
	(0.015)	
Spain	0.152	**
	(0.012)	
Sweden	-0.133	**
	(0.025)	
United Kingdom	0.290	**

	(0.013)	
Constant	2.369	**
	(0.123)	
R2	0.211	
N	18,289	

The reference group of the variables is in parenthesis: Teamwork (no teamwork), Establishment size (small, 10 – 49 employees), managers, no innovation introduced (innovation introduced), Establishment age (10 years or less), Design and development of new product and services (carried out in house), Production of goods, assembly of parts, delivery of services (carried out in house), Product market strategy (price), Type of establishment (single establishment), Industry (mining and quarrying), and Country (Austria)