The Flattening Level of Organizations:

A formal definition and its variability across firms*

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Based on the existing theoretical literature, we propose a formal definition of the flattening level of hierarchical organizations, which allows a more precise discussion on its measurement and potential correlates than informal definitions used in previous empirical research. Evidence of the relative importance of such correlates (coordination, information and communication, incentives, and workers' knowledge) is provided using a large sample of European establishments. Unlike the prevailing theoretical approaches, which highlight the role of incentives and knowledge, our results indicate that the main correlates of flattening are related to coordination and information or communication policies.

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1. Introduction

The flattening level of firms has attracted the attention of empirical scholars during the last decade (Rajan and Wulf, 2006; Guadalupe and Wulf, 2010; Caliendo, Monte and Rossi-Hansberg, 2015; Friedrich, 2020). However, a formal definition for this concept has not been provided, and empirical applications have been based on proxies such as the span of control or number of hierarchical levels. Furthermore, at the theoretical level, the concept is practically omitted in the literature on production in hierarchies (for a summary, see Chen and Suen, 2019). Therefore, we are unaware of the existence of a formal definition of the flattening level of a hierarchical organization.

In most of the previous theoretical models of production in hierarchies, firm size and hierarchical levels are endogenous variables. The firm's profit function is assumed to be separable on its size profits and on its profits associated with other features of its hierarchical organization (hierarchical organization profits). The profit function is identical for all firms, but the firms differ on certain characteristics, which make them adopt different sizes and hierarchical levels. The separability of the profit function let us distinguish the literature on hierarchical organization (Garicano and Van Zandt, 2012) from other literatures, such as the one focused on the firm size (see, for example, Kumar, Rajan and Zingales, 1999 or Garicano, Lelarge and Van Reenen, 2016). In the theoretical literature, hierarchical organizations have been mainly justified as mechanisms to coordinate tasks (Williamson, 1967), facilitate the flow of information and communication (Radner, 1993), provide motivation (Calvo and Wellisz; 1978, 1979) and make better use of knowledge (Garicano 2000).

This paper provides a formal definition for the flattening level of hierarchical organizations based on two main assumptions: the separability of the profits function and the existence of a unique size at which the hierarchical organization profits of L and L+1 hierarchical levels are identical (isoprofit size). The concept of flattening mostly appears in empirical studies using longitudinal data (see e.g., Rajan and Wulf, 2006; Guadalupe and Wulf, 2010). This suggests that the isoprofit size of one firm can vary along time, becoming flatter when the isoprofit sizes increase. This definition of flattening is based on a comparison of isoprofit

sizes at different moments of time. A similar comparison can also be done in cross-sectional data, a firm is flatter than another when its isoprofit sizes are higher. Variation across firms is the type of isoprofit size variation mostly considered in theoretical models of production in hierarchies (Chen and Suen, 2019).

Unlike previous (informal) definitions of flattening (based on the firm size and number of hierarchical levels), this definition enables one to discuss the assumptions about the properties of the profit function of the firms needed to interpret the outcomes of two probabilistic models (viz, the ordered choice model and the multinomial model for unordered data) as estimates of variations in isoprofit sizes and stress the interpretation problems of the linear regression estimates, which has been extensively used in the empirical literature.

As far as we know, to date, Delmastro (2002) is the only paper that uses an ordered choice model to analyze the associations between the characteristics of the manufacturing systems of 438 Italian firms and their level of flattening. We use a richer data set, which is the European Company Survey (ECS) administered in 2013 to 23 914 establishments in 32 European countries, to extend this analysis in several manners. First, we distinguish the correlates of the flattening level of firms from the correlates of the firm size. Second, we classify the variables from the ECS according to the (broad) mechanisms identified in the theory to justify the use of hierarchical organizations (i.e., task coordination, information and communication, incentives, and knowledge). Finally, we assess their relative importance.

This evidence complements other papers that have used alternative empirical strategies. A set of empirical papers tried to discriminate among different theoretical justifications of hierarchical organizations based on their predictions about the span of control and wages at different hierarchical levels. Without detracting from its contributions, these studies provide evidence on the form of the profits function instead of a test for their correlates and relative importance. For example, Tag (2013), Fiedrich (2015) and Caliendo, Monte and Rossi-Hansberg (2015) rely on an approximation of hierarchical levels (occupational code categories of companies), which are analyzed using one-country administrative data on manufacturing firms. Ortín-Ángel and Salas Fumás (1997, 2002), Rajan and Wulf (2006), Garicano and Hubbard (2007) and Garicano and Hubbard (2012) use self-reported information about the number of hierarchical levels of

firms but typically report only information about the top hierarchical levels. The samples in these studies are usually limited to a few hundred firms belonging to one country or, with a few exceptions (e.g., Caroli van Reenen 2001), to a few countries. Information about the complete hierarchy is only found in case studies (Baker et al. 1994 or Smeets, Waldman and Warzynski 2013). Finally, few papers have identified the effects of exogenous variables, e.g., product market competition (Gadalupe and Wulf, 2010) or demand or productivity shocks (Caliendo et al. 2020), on the span of control and number of hierarchical levels in firms.

The paper is organized as follows. In the next section, we provide a formal definition of the flattening level of a firm. Then, we discuss the way in which this concept could be measured as well as the most appropriate probabilistic models to conduct the estimations. Next, we link the concept of flattening with theoretical literature on hierarchical organizations, discuss our data and present the results. The last two sections discuss our empirical results and offer concluding remarks.

2. The flattening level of hierarchical organizations

2.1. Definition

Chen and Suen (2019) provide a general framework encompassing several existing models of hierarchical organizations. They assume that the profits of a firm with $L \geq 2$ hierarchical levels can be written as:

$$\pi_L(z_1, \dots, z_L, t, x) = G(z_L, t) + g(z_1, x) + \sum_{l=2}^{L} f(z_{l-1}, z_l, x)$$

and

$$\pi_1(z_1, t, x) = G(z_1, t) + g(z_1, x),$$

where the number of hierarchical levels L and the characteristics of each layer z_l are the endogenous variables for the firm. To define the firm's *flattening level*, we follow early models of hierarchical

organizations, such as that of Calvo and Wellisz (1978), interpreting[1] z_l as the number of workers at hierarchical level l, where z_L denotes the firm's production workers and $z_0 \equiv 1$ denotes the firm's top executive (i. e., $l = 0, \ldots, L$).

A commonly used measure of firm size (e) in the economic literature is a firm's number of employees (Shalit and Sankar 1977). For simplicity, let us denote a firm's size as the number of production workers in it ($e \equiv z_L$). Therefore, we can interpret function $G(z_L, t)$ as a firm's profits in relation to its size and function $H_L(z_1, \ldots, z_L, x) = g(z_1, x) + \sum_{l=2}^{L} f(z_{l-1}, z_l, x)$ as its profits in relation to its hierarchical organization—or, more specifically, in relation to its number of hierarchical levels (L) and the number of workers allocated in each layer ($z_l \neq z_L$). Consequently, we interpret t as an exogenous variable (or a vector of variables) affecting the profits associated with a firm's size and x as an exogenous variable (or a vector of variables) affecting the profits associated with a firm's hierarchical organization. Examples of these exogenous variables cited by Chen and Suen (2019) are differences in productivity (t) and differences in delay costs (x). In the next sections, they are discussed with more details.

In our empirical application, the information about the hierarchical structure is restricted to the number of hierarchical levels L in a firm. However, with some assumptions, it is possible to derive an expression for a "representative" span of control for the entire firm. Note that the span of control in level l is given by $s = \frac{z_l}{z_{l-1}}$. Assuming that spans of control are constant along a hierarchy[2] and given that $z_0 = 1$, we can write $z_l = s^l$. Then, we interpret $s = e^{1/L}$ as the "representative" span of control of a hierarchy. This interpretation allows us to rewrite the profits function above as follows[3]:

$$\pi_L(e, t, x) = G(e, t) + H_L(e, x).$$

[1] For example, in Garicano (2000), z_l is the knowledge accumulated by the workers at level l; for further discussion, see Chen and Suen (2019).

[2] This is also assumed in theoretical models like those of Williamson 1967 and Qian 1994 and inferred in the work of Pataconi 2009; see Proposition 5.

[3] A closer formulation to the one in Chen and Suen (2019) could be $H_L(e, x) = g(s = e^L, x) + (L - 1) f(s = e^{1/L}, x)$. Note, however, that this profit function would not fulfil the "conditional separability property" defined by these authors.

As is done in the work of Chen and Suen (2019), we assume that firms maximize their profits following a two-stage procedure. First, firms choose the size that maximizes profits for each possible number of hierarchical levels. Second, firms choose the number of hierarchical levels with the highest profits. Hence, the profit maximization problem of a firm can be written as:

$$\max_{L}\left\{\max_{e}\pi_{L}(e,t,x)\right\}$$

Let us define $L^* = L\ (t,x)$ and $e^* = e(t,x)$ as the arguments that maximize the function above for certain values of the exogenous variables *t* and *x*. However, the exogenous variables affecting the profits associated with the size of a firm (*t*) are irrelevant when we compare the profits of two of its consecutive hierarchical levels:

$$\pi_{L}(e,t,x) - \pi_{L+1}(e,t,x) = H_{L}(e,x) - H_{L+1}(e,x).$$

Then, for given values of e^* and *x*, the hierarchical level *L* that generates the highest profits is the one that maximizes the profits related to the hierarchical structure of a firm. Thus, the solution to the profit maximization problem of a firm is:

$$L^* \equiv arg\ \max_{L}\{H_{L}(e^*,x)\}$$

Therefore, the size of a firm is the only channel through which variable *t* affects its optimal number of hierarchical levels (recall that $e^* = e(t,x)$).

Next, we make the assumptions needed to guarantee that whenever a firm suffers a small shock in t and consequently wants to marginally increase its size, it will consider only two alternatives: increasing the span of control or adding one (and only one) additional hierarchical level. Note that the latter alternative is also a result of Proposition 1 in the study of Chen (2017) or Proposition 4 in that of Chen and Suen (2019) (the one-step jump property), which is consistent with empirical evidence given by Caliendo, Monte and Rossi-Hansberg (2015). We assume that there is a firm size m_L (which we call the *isoprofit size*) such that $H_{L}(m_L,x) = H_{L+1}(m_L,x)$—that is, there is a unique intersection (isoprofit size) between the profit functions of hierarchical levels *L* and *L*+1 of a firm. Moreover, we assume that $H_{L}(e,x) > H_{L+1}(e,x)$ for

all $e < m_L$ and $H_L(e,x) < H_{L+1}(e,x)$ for all $e > m_L$. If this isoprofit size does not exist, when $L < L'$, we will always observe that $H_L(e,x) > H_{L'}(e,x)$. Note that the isoprofit size m_L could differ among firms depending on the exogenous variables x. In what follows, we define the isoprofit size function $m_L(x)$ to capture this idea.

Based on the assumptions above, we can state that if $L^* = L\ (t,x)$ and $e^* = e(t,x)$ are the arguments that solve the profit maximization problem $\max_L \left\{ \max_e \pi_L(e,t,x) \right\}$, then:

$$e^* \in [m_{L^*-1}(x)\ , m_{L^*}(x)], \qquad \text{where } m_{L^*-1}(x) < m_{L^*}(x).$$

In other words, we will observe firms with identical size e^* but different numbers of hierarchical levels due to different values of the exogenous variables that affect the profits associated with their hierarchical organizations (x).

In summary, the isoprofit size function $m_L(x)$ indicates the maximum observed size of a firm with the set of characteristics x and L hierarchical levels. Moreover, we assume that to generate profits, firms need to have at least some employees; thus, $m_0(x) = 0$.

By definition, $m_L(x)$ is the firm size that solves the equation $H_L(e,x) - H_{L+1}(e,x) = 0$. Note that if the solution were not dependent on x (i.e., if the isoprofit size of all the examined firms were the same, $m_L(x) = m_L$), we would never observe two firms of the same size with different numbers of hierarchical levels. In other words, information on firm size would be enough to characterize both the number of hierarchical levels L in a firm and its span of control ($s=e^{1/L}$). However, this is not the case if the isoprofit sizes m_L depends on x.

For empirical purposes, let us write $m_L(x) = exp\ (c_L + \mathrm{f}_L(x))$, where the isoprofit sizes of a reference firm r ($\mathrm{f}_L(x_r) = 0$) are $m_L = \exp\ (c_L)$. Consequently, the condition $m_{L^*} > m_{L^*-1}$ requires that the inequality $c_L > c_{L-1}$ is fulfilled. Comparing any examined firm with the reference firm r, we obtain the following: $m_L(x) - m_L(x_r) = (exp\ (c_L))(exp\ (\mathrm{f}_L(x))\text{-}1) = m_L(x_r)\ (exp\ (\mathrm{f}_L(x))\text{-}1)$; thus, $\mathrm{f}_L(x)$ is an approximation of the percentage increase (with respect to firm r) in the examined firm's isoprofit size m_L. To establish a

flattening level definition for all organizations, we assume that $f_L(x) = f(x)$, i.e., this variation is constant for all hierarchical levels of a firm. Then, we propose to define the *flattening level* (*f*) of a firm according to the function $f = f(x)$, namely, the variation in the firm's isoprofit size (with respect to firm *r*). Next, we discuss the empirical estimation of this function.

2.2. Empirical measurement

Let us assume that in a sample of heterogeneous firms, for each firm *i*, we observe its size(e_i), its number of hierarchical levels (L_i) and a set of potential variables correlated to the profits related to its hierarchical organization (x_i). For the sake of simplicity, in this section, we treat x_i as a single variable. If a firm follows the behavior described in the previous section, then its observed size and number of hierarchical levels will be optimal ($e_i = e_i^*$ and $L_i = L_i^*$) and, consequently:

$$L_i^* \equiv arg\ \max_L \{H_L(e_i^*, x_i)\}$$

and

$$e_i^* \in [m_{L^*-1}(x_i), m_{L^*}(x_i)].$$

Let us also assume that the firm *i* hierarchical organization profits ($H_{L,i}$) can be written as[4]:

$$H_{L,i} = H_L(e^*, x_i) = a_L + \beta_L ln e_i + \alpha_L x_i + \varepsilon_{i,L},$$

where a_L, β_L and α_L are constant parameters for all firms and the hierarchical level *L*, while $\varepsilon_{i,L}$ is the usual error term.

McFadden (1974) shows the assumptions related to the error terms necessary to estimate the parameters of the function above via *the multinomial model for unordered data*. If we assume that the profits of category 1 (*L* = 1) are zero, namely, $H_1(e^*, x_i)$=0, this model allows us to estimate the parameters a_L, β_L

[4] It could also be interpreted as the Taylor approximation to the function $H_L(.)$.

and α_L of the profit function $H_L(e^*, x_i)$ and consequently of the isoprofit size function $m_L(x_i)$. To see why, remember that by definition, $H_L(m_L, x_i)$ - $H_{L+1}(m_L, x_i)$=0. Thus:

$$ln(m_L) = \frac{a_{L+1} - a_L}{\beta_L - \beta_{L+1}} + \frac{\alpha_{L+1} - \alpha_L}{\beta_L - \beta_{L+1}} x_i + \frac{\varepsilon_{i,L+1} - \varepsilon_{i,L}}{\beta_L - \beta_{L+1}}$$

Thus, $m_L(x_i) = exp\,(c_L + f_L(x_i))$, where $c_L = \frac{a_{L+1} - a_L}{\beta_L - \beta_{L+1}}$ and $f_L(x_i) = \frac{\alpha_{L+1} - \alpha_L}{\beta_L - \beta_{L+1}} x_i + \frac{\varepsilon_{i,L+1} - \varepsilon_{i,L}}{\beta_L - \beta_{L+1}}$.

A shortcoming of this approach is that many parameters must be estimated in the realistic case that the profits related to the hierarchical organization of a firm have several correlates. For example, in a scenario involving 10 correlates and 4 hierarchical levels (which is the maximum number of hierarchical levels considered in the estimations below), 40 parameters must be estimated.

One way to reduce the number of parameters to be estimated is to impose a constant flattening level along the examined firm's hierarchy, namely, $m_L(x_i) = exp\big(c_L + f(x_i)\big)$ or in other words, by assuming that $\beta = \beta_{L+1} - \beta_L$, $\alpha = \alpha_{L+1} - \alpha_L$ and $y_L = a_{L+1} - a_L$, where β and α are parameters that do not change across different hierarchical levels (which is not the case for y_L). Therefore, $c_L = \frac{y_L}{\beta}$ and $f(x_i) = -\frac{\alpha}{\beta} x_i - \frac{\varepsilon_i}{\beta}$, where $\varepsilon_i = \varepsilon_{i,L+1} - \varepsilon_{i,L}$.

The theoretical model shows that $L_i^* = L$ when $e_i^* \in [m_{L-1}(x), m_L(x)]$ or what is the same when $\beta ln e_i^* \in \big[\beta \ln\big(m_{L-1}(x)\big), \beta \ln\big(m_L(x)\big) = y_L - \alpha x_i - \varepsilon_i\big]$, if β is positive. Therefore, we can construct the latent variable $y_i^* = \beta ln e_i + \alpha x_i + \varepsilon_i$ with the property that L is the observed hierarchical level when $y_i^* \in [y_{L-1}, y_L]$. Thus, the parameters y_L, β and α can be estimated using an *ordered choice model* (see Zavoina and McElvey, 1975). The only paper that we are aware of that has used ordered choice models in a similar context is that of Delmastro (2002).

It is much harder to make explicit the link between the theoretical discussion and ordinary least squares (OLS) models—which have been used in some previous studies (e.g., Rajan and Wulf 2006; Gadalupe and Wulf, 2010) to estimate the number of hierarchical levels in a firm. Furthermore, the OLS model presents

an additional shortcoming, which is illustrated in the following discussion. Let us assume that the model estimated is:

$$L_i = a + \beta ln e_i + \gamma t_i + \varepsilon_i$$

where γ is a parameter equal to zero because theoretically t_i has no effects on the flattening level of organizations. Given that the number of hierarchical levels increases with the size of a firm, we expect that $\beta > 0$. Therefore, when $e_i \in [m_{L-1}, m_L]$, $L_i = L$ for all possible firm sizes. If t_i is positively correlated with size, then it is negatively correlated with L- $\beta \ln(e_i)$ because $L_i = L$ for firms with the same number of hierarchical levels. The estimation of parameter γ will be negative ($\hat{\gamma} < 0$) and, consequently, t_i will be interpreted as a positive correlate of flattening when it is not.

2.3. Types of variables and their theoretical relevance

The estimation of the flattening level function requires the identification of a set of *x*-type variables, which affect the hierarchical organization profits. Next, we review the theoretical literature that may reveal those variables.

Beckmann (1977) is perhaps the first author to provide a theoretical model where the span of control at different hierarchical levels is an endogenous variable to a firm. Early models of hierarchical organization (e.g., Simon 1957; Williamson 1967) view hierarchies as a coordination device and span of control as a mechanism to reduce the loss of control associated with the process of transmitting information among workers in adjacent hierarchical levels. These models have been extended in a series of subsequent papers (Keren and Lehvari, 1979; Geanokoplos and Milgrom, 1991; Radner, 1993; Bolton and Dewatripont, 1994). Overall, this literature suggests that we should consider factors that affect the need of coordination and the costs of transmitting information as potential *x*-type variables. Examples of these factors are provided by Kremer (1993), who argues that the need of coordination arises when a task is difficult to perform (which is likely when the worker has autonomy, works in teams or rotates across different functions) and Garicano

and Van Zandt (2012), who summarize the literature on the relationship between team decisions and information processing.

Starting with the work of Calvo and Wellisz (1978, 1979), another stream of literature stresses that the loss of control is associated with the decrease in effort exerted in a layer due to the lack of incentives. This body of literature has been called monitoring hierarchies (Qian 1994, Mookherjee 2013, Chen 2017) and suggests that spans of control (and wages) are mechanisms used by firms to elicit worker effort at all levels of the hierarchy. Thus, this literature suggests considering factors related to incentives as potential *x*-type variables.

Since Garicano (2000), a set of models have been developed, where information goes from the bottom to the top of a hierarchy to look for a person with the necessary knowledge to solve a particular problem. Those models (Garicano and Rossi-Hansberg 2004, 2006, 2012) are usually known as knowledge hierarchies because the defining characteristic of a hierarchical level is the knowledge of workers (instead of the number of employees, as was customary in the previous literature). Here, the span of control is perfectly determined by workers' knowledge, and the main exogenous variable is the cost of acquiring knowledge. Therefore, following this literature, we should consider variables related to the workers' knowledge as potential *x*-type variables.

Some models make comparative statics assessing the effect of certain exogenous variables on the hierarchical structures of firms. The work of Keren and Lehvari (1979) is perhaps the first paper analyzing how a delay in a decision-making process influences the span of control and number of hierarchical levels in a firm; effect that has also been investigated in more recent papers (Radner, 1992, 1993; Beggs, 2001; Patacconi, 2009; Chen and Suen, 2019). Meagher (2003) analyzes the effects of improvements in information technologies and Garicano and Rossi Hansberg (2004, 2006) analyze the cost of acquiring knowledge and of improved information and communication technologies. Obviously, comparative statics depend on the assumptions made and do not always produce clear conclusions (Chen and Suen, 2019); however, this literature provides key intuitions to consider variables related to task coordination and knowledge, communication and information as covariates of the hierarchical structures of firms.

In short, from this theoretical literature, we identify four main groups of *x*-type variables. The first group includes variables related to the requirements of task coordination. The second group considers variables related to the communication and information-transmission processes used for such coordination. The third focuses on worker incentive systems. The fourth focuses on the knowledge that workers must have to perform their tasks. In the empirical section, we provide evidence on the relative importance of each group of variables.

The existence of *t*-type of variables is basic for distinguishing the theoretical literature on hierarchical organizations reviewed from other streams of literature related to economic analyses of organizations as the literature on the determinants of firm size (Kumar, Rajan and Zingales, 1999; Garicano, Lelarge and Van Reenen, 2016). For example, Kumar et al. (1999) associate the hierarchical production literature with the technological determinants of the firm size (e.g., coordination or supervision costs can be examples of *x*-type variables) and distinguish these technological variables from other correlates (*t*-type variables), such as organizational (e.g., transaction costs, asset specificities and property rights) and institutional (e.g., market competition and tax or financial regulation) variables. Market competition is an institutional factor that has received attention in the literature. Guadalupe and Wulf (2010) show that an increase in market competition reduces the number of hierarchical levels of firms and increases their span of control. Interpreted in light of the Definition subsection, this result is consistent with two explanations. Market competition reduces firm size because it is a *t-type* variable, or it flattens firms' hierarchical organization because it is an *x-type* variable. Thus, the empirical section complements the estimation of the flattening level function with estimations of the firm size and develop a simple methodology to classify variables into *t*- or *x-type*.

In our empirical application, we do not have specific information about variables that change at each hierarchical level, so we cannot distinguish between those variables (*z-type* variables in the Definition subsection) and variables that can change across firms but are constant across the hierarchical levels of the firm (*x-type*). Thus, the Definition subsection characterizes layers only by their number of employees. This

assumption is common in early theoretical papers on hierarchical organizations (Beckmann 1977; Simon 1957; Williamson 1967). However, since Garicano (2000), workers' knowledge has also been used as an alternative defining characteristic of organizations' layers. Garicano and Hubbard (2012) try to distinguish between these two alternative approaches based on predictions inferred from their different assumptions about the form of the profit functions of the firms. However, this analysis is not direct tests on the correlates of the profit function but an evidence of the form of the function. In fact, several *z*-type variables can coexist, but it is difficult to model the relationships. As far we know, only two models include two *z-type* variables. In Ortín-Ángel and Salas-Fumás (2002), those variables are the workers' knowledge and span of control; in Patacconi (2009), they are the span of control and time devoted to coordination.

3. Data

3.1. Data source.

The European Company Survey (ECS) is an effort of the European Union to provide comparable and reliable data on the working conditions of establishments across Europe. Since 2004, four waves of the ECS have been conducted. The third wave was performed in 2013 and was the first wave to include information about the number of hierarchical levels in the establishments, their size and a large set of other variables that might be classified as the *x*-type and *t*-type variables suggested by the theory, which has been reviewed in the previous section. Although the fourth wave also contained information about the number of hierarchical levels, we did not create a panel merging the third and fourth waves because we do not have identifying information for the examined firms. Additionally, we did not create a single sample because the measures for some of the theoretical concepts were not fully comparable. The third wave is used in this paper because it includes more variables and more establishments[5]. This survey was deployed to 30 112

[5] An online appendix to the paper reproduces most of the tests using the fourth wave. The main conclusions did not change substantially.

establishments with 10 or more employees in almost all economic sectors[6] and in a total of 32 countries[7]. The questionnaire forms were completed through telephone interviews with the firms' management[8], which had an average duration of 27 minutes. In each country, the sample was stratified by size and broad sector of activity (industry vs. services)[9].

3.2. Hierarchical levels and establishment size.

Most of the existing empirical studies using samples of firms typically infer the number of hierarchical levels in a firm from promotions between positions (e.g., Scott, O'Shaughnessy and Cappelli, 1994) or occupational category codes (Caliendo, Monte, and Rossi-Hansberg, 2015), or they have information on only a part of the hierarchy (e.g., Rajan and Wulf, 2006, Guadalupe and Wulf, 2010). In contrast, the dataset used in this study uses a measure of the total number of hierarchical levels, which is directly provided by the establishments. Regarding establishment size, we were unable to obtain the exact number of employees in each establishment because of confidentiality considerations. However, we obtained information on the percentile in which each establishment is positioned (among all the establishments in the sample) as well

[6] The sectors excluded were agriculture, forestry, fishing, activities of households and activities of extraterritorial organizations and bodies.

[7] 28 EU Member States plus Iceland, the Former Yugoslavian Republic of Macedonia, Montenegro and Turkey.

[8] The survey also considers a questionnaire developed for employee representatives, but we focus on only the management questionnaire because the former does not include all the necessary information.

[9] See the online technical report for further details about the construction of the survey https://www.eurofound.europa.eu/sites/default/files/ef_files/surveys/ecs/2013/documents/ecs2013docs/3rdECS2013TechnicalReport.pdf

as on the maximum, minimum, mean, and median (number of workers) of each percentile[10]. For the sake of simplicity,[11] we use the median as an approximation of the number of employees in each establishment.

3.3. Other organizational variables.

Table 1 lists and provides a short definition[12] of the variables provided by the ECS that can be considered *x*-type variables and/or *t*- type variables as discussed in the previous section. Most of them were in continuous or dichotomous forms. However, there were some variables (i.e., *Rotation*, *Internal hiring*, *Further contract*, *Long-term hiring, Work climate*) that were measured using Likert scales with four or more points. To capture this information, at least three dummies for each of these variables should be included in the estimations. A potential problem with this approach is that some of the variable categories have very few observations, which might introduce collinearity in the estimations. To avoid this problem—and for the sake of expositional clarity, we transformed these ordinal variables into dummy variables that took the value of 1 if they were equal to or greater than the integer nearest the median of the ordinal variable and 0 otherwise[13]. Two variables—*Departmentalization criteria* and *Pay for performance*—were created as a combination of other variables; the details are subsequently described.

3.4. Departmentalization criteria.

[10] For example, among the first 50 percentiles these values are practically the same; indeed, there are only 7 percentiles where there are differences (maximum-minimum) of one employee and just one with a difference of two employees. Between the 51st and 80th percentiles, the maximum difference is 13 employees. Between the 81st and 90th percentiles, the maximum difference is 29 employees. Above the 95th percentile, the differences are greater than 100 employees.

[11] We do not use information on percentiles because of the difficulties associated with interpreting such results. We do not use the mean either, because of the well documented skewness of the distribution of firms' size (Lucas, 1978).

[12] The complete questionnaire can be found at https://www.eurofound.europa.eu/surveys/european-company-surveys/european-company-survey-2013/ecs-2013-questionnaire/ecs-2013-questionnaire-translation.

[13] This is a commonly used procedure in the literature (see, for example, Foss and Laursen, 2005 or Barrenechea-Mendez and Ben-Ner, 2017).

The questionnaire asked whether there were functional (74% of the establishments), product-oriented (29%) or geographical (22%) departments in the establishments. Few establishments (near 15%) did not use any of these criteria, while 20% used all three criteria. Therefore, one can deduce that 90% of the establishments using a geographical criterion also use the other two departmentalization criteria. Furthermore, 31% of all establishments used only one criterion, and among them, 83% used the functional criterion. These figures suggest that the number of criteria used by the establishments is strongly linked to the type of criteria used. Specifically, the firms using one criterion mostly rely on functional departmentalization, while the firms using two criteria mostly combine functional and product departmentalization. For the sake of simplicity, instead of including a dummy variable for each possible departmentalization criterion, the main estimations are conducted using only one variable, namely, the number of criteria used. The results obtained with this variable are similar to the results (not presented but available upon request) obtained when we include all the possible dummy variables related to the departmentalization criteria in the estimations[14].

3.5. Pay for performance.

Under the pay for performance heading, the questionnaire included items on individual performance pay (present in 51% of the establishments), payment according to workers' results (40%), profit sharing (38%), team performance pay (33%) and share ownership (8%). The data show that 28% of the establishments did not use any of those pay-for-performance mechanisms, while 20% of the establishments only used one of these criteria. Therefore, 52% of the establishments used combinations of the criteria. For the sake of simplicity, we used a dummy identifying the presence of any type of pay-for-performance compensation in the estimations. The inclusion of further information related to the different types or combinations of pay-for-performance mechanisms has little impact on the results.

[14] All these results are available upon request. This applies for all the results mentioned from now along the text and not provided in the paper.

Following this theoretical discussion, we classify these organizational variables into five groups: i) Tasks, ii) Communication & information, iii) Incentives, iv) Knowledge and v) Other variables, which are those that cannot be clearly related to the previous groups. The survey also allows us to control for economic sector and country fixed effects.

[Insert Table 1 Here]

4. Results

4.1. Hierarchical levels and size.

The first two columns of Table 2 present the distribution of establishment size (measured by the mean and the median) conditional on the number of hierarchical levels in the establishments.

[Insert Table 2 Here]

As predicted in the theoretical discussion, we can see that the size of the establishments increases with the number of hierarchical levels[15]. Columns 3 and 4 of Table 1 show that the range of establishment sizes across the L and L-1 hierarchical levels are very overlapped. For example, the 50th percentile of the size distribution of the establishments with one hierarchical level is 17 (Column 3) and corresponds to the 25th percentile of the size distribution of the establishments with two hierarchical levels (Column 4). In line with previous studies (e.g., Caliendo, Monte and Rossi-Hansberg 2015, Guadalupe and Wulf, 2010, Rajan and Wulf 2006, Delmastro 2002), these figures show that the size of an establishment is not enough to explain

[15] Size differences (in mean and median) between the hierarchical levels are statistically significant. At the 1 percent level of significance, a Wald test rejects the null hypothesis of equal means between the hierarchical levels L and L+1. This result holds in all the examined cases except that between hierarchical levels 1 and 2, where the difference is positive but not statistically significant at conventional levels of significance. Regarding the medians, a k-sample equality of median test rejects the null hypothesis of equal medians between all the hierarchical levels at conventional levels of significance.

the number of its hierarchical levels and thus support the need to introduce the concept of the degree of flattening to enable a better understanding of the hierarchical structure of organizations.

4.2. Econometric approach

We propose to estimate the parameters of the following equations:

$$H_{L,i} = a_L + \beta \ \ lne_i \ + \alpha_t t_i + \alpha_x x_i + \varepsilon_i$$

$$lne_i = \delta_t t_i + \delta_x x_i + v_i,$$

where v_i and ε_i are random variables that are assumed to be uncorrelated among them and with the other independent variables in their equations. As usual, the expressions to be estimated are (respectively) interpreted as the Taylor's first order approximations of functions $H_L(e,x)$ and $ln(e(t,x))$, where $e^* = e(t,x)$. From Section 2, we expect that $\beta > 0$, $\alpha_x \neq 0$, $\alpha_t = 0$ and $\delta_t \neq 0$ (note that the theoretical section does not provide clear predictions about δ_x). Based on the estimated coefficients, the variables can be classified as i) correlates of the flattening level (*x-type*), ii) correlates of the firm size but not of the flattening level (*t-type*), or iii) noncorrelates of the flattening level and firm size.

Obviously, we cannot guarantee or test that all assumptions of the econometric model are fulfilled. For example, one could argue that there are omitted *x-type* variables, which would lead to inconsistent estimations of β, α_x and α_t. With our data, the solution for this endogeneity problem will require the use of instrumental variables (Chesher, Rosen, Smolinski, 2013; Guevara, 2015; Chesher and Rosen, 2017). Thus, *t-type* variables are established "a priori", precisely the question that requires empirical corroboration. Furthermore, we may be providing inconsistent estimates for δ_t and δ_x because most of the independent variables of the survey refer to mechanisms to address organizational problems (e.g., pay for performance) and not to the source of those problems (e.g., lack of incentives). The relations of the former variables with the firm's size and flattening level are not considered in our econometric approach nor in the reviewed theoretical literature.

Apropos of this discussion, we remark that we have little confidence that the use of any instrument extracted from the survey can properly address these issues, and confidentiality prevents us from

supplementing the data with other sources of information. Therefore, we only provide evidence on how the level of flattening and size vary across establishments with different characteristics. As highlighted in the paper, this exercise is a step further compared to the previous empirical literature. The exercise tightens the link between empirical and theoretical literature and provides initial evidence on basic issues of the theoretical literature. The effect of possible limitations on our conclusions is an issue for future research.

4.3. Identifying x-type variables.

Table 3 shows the estimates of ordered logit models[16] that take dependent variable the number of hierarchical levels in the firms and as independent variables the size of each establishment as well as a series of the potential correlates of the degree of flattening that were identified in the theoretical discussion. As can be observed, the coefficient of establishment size is positive and statistically significant in all the estimations—a result that is consistent with the patterns observed in Table 2. By far, this variable has the highest explanatory power in all the models estimated.

[Insert Table 3 Here]

Column (1) of Table 3 shows the estimations including only the country and economic sector dummies and using a sample of 23 914 observations. The data reject, at conventional statistical levels of significance, the null hypothesis of equal effects among the country or economic sector dummies. The pseudo R-square of this estimation is 0.1368, 0.1133 of which is associated with the establishments' size[17] and 0.0108 and 0.0017 of which is (respectively) associated with the country and economic sector dummies. The remaining 0.011 is due to joint effects. In Column (2), we add 20 variables (in addition to the country and economic sector variables), and in Column (3), we add 6 more variables. Due to the existence of missing values, these

[16] The ordered probit models offer similar conclusions but with slightly lower pseudo R-squares and log-likelihoods. These results are not presented but (as with all the results cited in the text but not provided) are available upon request from the authors.

[17] There is a reduction in the pseudo R-square when we omit this variable. These estimations are not shown.

estimations are performed with fewer observations (20,450 and 10,412, respectively). The addition of these 26 variables increases the pseudo R-square by 0.019. Presented by their z-values (in parentheses), the degree of flattening is positively related to *Departmentalization criteria* (10.88), *Information dissemination* (6.11), *Pay for Performance* (3.72), *University degree* (3.05), *Employee surveys* (3.00), *Teams* (2.80), *Temporary meetings* (2.78), and *Performance appraisal* (1.81) and negatively related to *Single independent establishment* (-4.84)*, Workers' autonomy* (-4.20), *Work climate* (-3.86), *Further contract* (-2.03) and *Open regular meetings* (-1.79)[18].

For comparative purposes, in Column 4, we re-estimate the specification of Column 2 using the sample of 10, 412 observations used in column 3. Comparing Columns 3 and 4, we observe that the inclusion of the six additional variables in Column 3 has a negligible impact on the coefficients of the other variables. On the other hand, the coefficients in Column 2 generally have higher significance levels than the coefficients estimated for the same variable in Column 4. The most likely explanation for this difference is an improvement in the precision of the estimates because of the increase in the number of observations used (20,450 vs. 10,412). For example, the variable *Rotation* is not statistically significant in Columns 3 and 4, but it is in Column 2. In summary, of the 26 potential theoretical determinants of the degree of flattening, 17 are significant in at least one estimation, and only 4 of them (*Rotation*, *Information systems*, *Regular meetings*, and *Establishment age*) are not statistically significant in at least one of the models.

4.4. Identifying t-type variables.

We develop an exercise to identify *t*- type variables, which are related to the firm size but unrelated to their flattening levels. To describe its logic, we formally state the (standard) assumptions used for the

[18] We also estimate Column 3 of Table 3 using Multiple Imputation Analysis (Rubin 1976, 1987) to impute the missing data of the variables with the most missing values (University degree, Further contract, Information systems, Gender and Worker age). More specifically, we impute the missing values for each of these variables, one at a time, and conduct the estimations. Overall, the results of each of these estimations are very close to those presented in Column 3 of Table 3. These estimations are not presented in this paper, but they are available upon request from the authors.

interpretation of Table 3 estimates. Let us set $\frac{df(\bar{x})}{dx}$ equal to 1, where $\bar{x}$ is the average of the variables *x* in the examined population, and define $x = \sum_{j=1}^{J} \alpha_j X_j$; here, X_j represents the set of *J* (=26) independent variables—other than *Establishment size*—used in the estimations shown in Table 3 and $\alpha_j = \frac{df(\bar{x})}{dx}\frac{\partial x}{\partial X_j}$ denotes the corresponding set of coefficients. The theoretical arguments developed in previous sections differentiate between two types of variables: *x* and *t*. To separate the effects of these variables, we also define $t = \sum_{j=1}^{J} \delta_j X_j$, which allows us to separate the effects of the *x* and *t* variables on the size of the establishments $e^*(x,t)$, $\frac{\partial e^*()}{\partial X_j} = \frac{\partial e^*()}{\partial x}\frac{\partial x}{\partial X_j} + \frac{\partial e^*()}{\partial t}\frac{\partial t}{\partial X_j} = \frac{\partial e^*()}{\partial x}\alpha_j + \frac{\partial e^*()}{\partial t}\delta_j$. In what follows, we identify the variables that are correlated with only the establishment size profits (*t*), i.e., the variables fulfilling these two conditions: $\alpha_j = 0$ and $\delta_j \neq 0$ after estimations.

Table 4 shows the ordinary least squares (OLS) estimations of *Establishment size*. These estimations include the same variables and, to ensure proper comparability, employ—in columns 1–3—the same set of samples used in Table 3. The variables that are statistically significant in at least one of columns 2 and 3 of Table 4 but not statistically significant in any of the columns in Table 3 are *Training*, *Workers' age, Long-term hiring, Internal hiring, Suggestion schemes, Discussion social media*, *Private firms*, and *Information systems*.

[Insert Table 4 Here]

Note, however, that there are three variables (*University degree, Performance appraisal* and *Regular meetings*) that are statistically significant in Table 3 and nonsignificant in either column 2 or 3 of Table 4 ($0 = \frac{\partial e^*()}{\partial X_j} = \frac{\partial e^*()}{\partial x}\alpha_j + \frac{\partial e^*()}{\partial t}\delta_j$) and one variable (*Rotation*) that is statistically significant in both tables, although they have different signs ($0 < \frac{\partial e^*()}{\partial X_j} = \frac{\partial e^*()}{\partial x}\alpha_j + \frac{\partial e^*()}{\partial t}\delta_j$ and $\frac{\partial e^*()}{\partial x}\alpha_j > 0$). These results indicate that it is not straightforward to classify each independent variable as either an *x* or *t* variable.

To provide an approximation to $\frac{\partial e^*()}{\partial x}$, the last column of Table 4 introduces the variable *x* as a regressor. The values of the parameters $\alpha_j (x = \sum_{j=1}^{J} \alpha_j X_j)$ are those previously estimated in Column 3 of Table 3. The estimate of this variable (1.158) is obtained from an OLS estimation (not presented) that does not include the X_j independent variables considered in the previous analyses (but it includes the economic sector and country dummies). The R-square of this regression is 28.71, which is 18.56 points higher than the regression that includes only the economic sector and country dummies (not presented; estimated with 10,412 observations) and 5.43 points lower than the regression that considers all the variables (3). To avoid collinearity, the remaining (26) estimates in Column 4 are estimated by using OLS while fixing the coefficient of the variable *x* at 1.158. Thus, it is possible to interpret these estimates as approximations of $\frac{\partial e^*()}{\partial t}\delta_j$.

Comparing the results in the last column of Table 4 with those in Table 3, we can see that the variables *Information dissemination*, *Teams*, *Pay for performance*, *Further contract* and *Work climate* are related to the flattening level but not to the establishment size profits. The other variables are associated with both profits. Notably, four of these variables (*Employee surveys*, *Temporary meetings*, *Open regular meetings*, *Establishment size*) have identical signs in Tables 3 and 4, whereas the other variables (*Departmentalization criteria*, *University degree*, *Performance appraisal*, *Rotation*, *Regular meetings, Workers' autonomy* and *Independent establishment*) have opposite signs. Table 5 classifies each variable as *x*- type or *t*- type and shows the sign of its relations with the profits function.

[Insert Table 5 Here]

4.5. Relative importance of different theoretical approaches.

We now try to assess the relative importance of the different theoretical strands of literature on hierarchical organizations. To conduct this analysis, we use the classification of variables presented in Table 1 to assign each of the 26 variables (which are denoted by *J*) to a unique category *d* (= *Tasks*,

Communication & information, Incentives, Knowledge, Others). More formally, we assume that $x_i = \sum_{d=1}^{5} \alpha_d y_{d,i}$, where $y_{d,i} = \sum_{j \in d} \frac{\alpha_j}{\alpha_d} X_{j,i}$. The coefficients α_d can be interpreted as a measure of the (relative) importance of each category *d*.

The first column of Table 6 shows the ordered logit estimates of the parameters α_d. Again, we use the coefficients in Column 3 of Table 3 as values of α_j. For each establishment *i*, we create the variables $y_{d,i} = \sum_{j \in d} \alpha_j X_{j,i}$ and then standardize these values. These standardized variables are included as correlates of the firms' hierarchical structure profits (together with *Establishment size* and the country and economic sector dummies). All the coefficients are positive and statistically significant, and the *Tasks* Category has the highest coefficient (0.281), which is followed by the *Communication and Information* (0.209) and *Others* (0.152) categories. The lower coefficients are those associated with the *Incentives* (0.115) and *Knowledge* (0.110) categories; in fact, we cannot reject that these two coefficients are equal at the usual levels of statistical significance.

[Insert Table 6 Here]

In the second column of Table 6, we replicate the estimation in Column 4 of Table 4 but use $y_{d,i}$ as independent variables instead of the 26 variables separately. Only the *Communication and Information* category is positive and statistically significant. The *Knowledge*, *Tasks* and *Incentives* categories are now negative and statistically significant, while the *Others* category is not statistically significant.

An alternative approach to investigate the relative importance of the examined competing theoretical approaches would be to look for the existence of components (or index variables) related to different theoretical strands behind the *J* (= 26) variables instead of relying on an a priori classification of these variables into theoretical categories. For this purpose, we conduct a principal component analysis. This alternative analysis shows that only 12.6% of the variance is explained by the first factor and that the first 7 factors explain less than 70% of the variance in each variable (uniqueness greater than 0.3) and less than

50% of the variance in 18 of the 26 variables. In short, the evidence does not support the existence of strong underlying factors behind the variables.

Nevertheless, it can hardly be asserted that the y_d categories are independent. Table 7 shows that the correlations among the y_d categories are statistically significant, with 0.358 being the highest correlation coefficient. Although the theoretical literature has treated such categories separately (presumably for tractability reasons), our data show a much more complex scenario.

4.6. Unique flattening degree assumption.

The previous analysis assumes that each hierarchical level has the same flattening function. This assumption is made for simplicity, since it is difficult to interpret differences in estimations with a large number of parameters—which might result from the estimations of a multinomial logit model. However, for robustness, we estimate a multinomial logit model (using the same variables used in the estimation of the order logit model presented in Column 3 of Table 3; not presented). The log-likelihoods of the multinomial and order logit models are -11639.149 and -11814.379, respectively, and the log-likelihood test of the difference is $\chi^2(130) = 350{,}46$. At this value, the null hypothesis that the 130 additional parameters are equal to zero is rejected. However, the Bayesian information criterion suggests that the complexity of the model does not compensate for the increase in its explanatory power[19].

5. Discussion of results

The empirical application of the paper addresses three main issues. First, it analyzes whether the main determinants of the hierarchical organization profits emphasized by the existing theoretical literature (task coordination, information and communication processes, incentives, and worker knowledge) are related to the measure of the flattening level of a hierarchical organization proposed in this paper. In general, the

[19] The Akaike information criteria assigns practically the same value to the multinomial and order logit models. The results of the multinomial logit model are available from the authors upon request.

variables (provided by the ECS) related to higher needs of coordination, information, incentives and knowledge are associated with a decrease in flattening level of the organizations examined in this study. In fact, when we construct a unique measure for each one of the theoretical determinants, the coefficients are statistically significant and with the predicted signs.

Second, it investigates the relative importance of those determinants. We find that both incentives and workers' knowledge—the most emphasized categories in the recent theoretical literature—have less explanatory power than the other categories. Moreover, the coefficients of the Task coordination and Information and Communication categories are nearly three and two times (respectively) greater than the coefficients of the Incentives and Knowledge categories.

Third, it decomposes the correlates of the firms' profits into those related to a firm's size and those related to its hierarchical organization. Eight variables are statistically significantly related to the size of the examined establishments, which is not significantly related to the flattening level (*t*-type). These results support the usual assumption of separability of the firms' profits in the theoretical literature.

In addition, from the theory, it is not possible to exclude the existence of a flattening function for each hierarchical level of a firm. However, for tractability reasons, we conducted the estimations assuming a unique flattening function for the entire organization, so we could use an order choice instead of a multinomial model. To assess the convenience of this approach, we compare the two models, which can be interpreted as a trade-off between loss of information and number of parameters to be estimated, and we found that the assumption for a single flattening level is reasonable.

Obviously, the evidence presented does not offer a complete picture of the variability in the flattening levels of firms. For example, we do not find clear patterns showing that the variables grouped under a given category are highly correlated, which can cast some doubts on our a priori classification of variables into different categories. Thus, our four-factor perspective must be interpreted as a first inquiry to analyze the correlates of the flattening level of the firm. Furthermore, some results suggest that some variables can have opposite signs in the profits functions associated with size and hierarchical organization profit functions, e.g., *Departmentalization criteria*, *University degree*, *Performance appraisal*, *Rotation*, *Regular meetings,*

Workers' autonomy and *Independent establishment*. More research is needed to provide a better understanding of these patterns in the data.

Similar to any other empirical application, this study is not free of limitations. First, the theoretical concepts under analysis are not perfectly reflected in the survey. For example, the total number of employees is used as a proxy of the number of direct workers. In addition, the theory relates the profits of hierarchical organizations to problems of coordination, information processing, knowledge, and incentives, but the variables in the empirical application mostly refer to mechanisms to address such problems. Second, some theoretical variables are not available in the data. For example, we do not have data specific to each layer. This deficiency may explicate why we fail to explain an important part of the variance in firms' flattening level. Either luck is very important, or we have omitted some relevant correlates. As usual, the results are interpreted assuming that such limitations do not affect our estimations. Further research is required to confirm this to be the case.

6. Conclusion

This paper provides a definition of the flattening level of a firm based on the separability property of the profits function highlighted by the existing theoretical models of hierarchical organizations, which can be estimated using standard econometric models. The evidence presented, using a sample of European Union firms, shows that this flattening level is negatively related to the presence of (by order of importance) task coordination, information and communication mechanisms, incentives, and worker knowledge.

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Table 1—Classification of Organizational Variables

Broad category	Variable	Short definition	Type
Tasks	*Departmentalization criteria*	Number of criteria used for creating departments	*Continuous*
	Workers' autonomy	Employee decides on the planning and execution of his/her daily work tasks	*Dummy*
	Teams	There are teams of workers in the establishment	*Dummy*
	Rotation	Employees at this establishment rotate tasks with other employees	*Dummy*
Communication & information	*Information dissemination*	Dissemination of information through newsletters, websites, email, etc.	*Dummy*
	Employee Surveys	Employee surveys conducted among employees	*Dummy*
	Temporary meetings	Meetings of temporary groups, committees or adhoc groups	*Dummy*
	Open regular meetings	Regular staff meetings open to all the employees at the establishment	*Dummy*
	Information systems	Use of information systems to minimize supplies or the amount of work-in-process	*Dummy*
	Regular meetings	Regular meetings between employees and their immediate managers	*Dummy*
	Suggestion schemes	Collection of voluntary ideas and suggestions from employees	*Dummy*
	Discussion social media	Discussions with employees through social media	*Dummy*
Incentives	*Performance appraisal*	% of employees who have performance appraisals or evaluation interviews	*Continuous*
	Pay for performance	The existence of variable extra pay linked to individual, team or firm performance	*Dummy*
	Internal hiring	Management looks for internal candidates first when hiring	*Dummy*
Knowledge	*University degree*	% of employees who have a university degree	*Continuous*
	Further contract	Employees who had a temporary contract and received another contract afterwards	*Dummy*
	Training	% of employees who received paid time off from their normal duties last year	*Continuous*
	On-the-job training	% of employees who received on-the-job training last year	*Continuous*
	Long-term hiring	Employees who were hired with the intention of long-term employment	*Dummy*
Other variables	*Independent establishment*	Company with a single independent establishment (1) or one with many establishments (0)	*Dummy*
	Work climate	Good climate according to employees' rating	*Dummy*
	Establishment age	10 years or older	*Dummy*
	Private firm	Private sector (1) or public sector (0)	*Dummy*
	Gender	% of employees who are female	*Continuous*
	Workers' age	% of employees who are older than 50 years	*Continuous*

Table 2—Distribution of Establishment Size by Number of Hierarchical Levels

L	Mean	Median	Percentile (Median *L*-1)	N
(1)	(2)	(3)	(4)	(5)
1	34.2886	17		4106
2	80.8968	31	25	8857
3	175.7727	80	22	5852
4	324.7637	164	30	5099
All	148.1092	49		23914

Table 3—Estimation of the Firms' Degree of Flattening

Independent variables	(1)	(2)	(3)	(4)
Establishment size	0.963***	0.783***	0.753***	0.756***
	(0.019)	(0.019)	(0.022)	(0.022)
Departmentalization criteria		0.266***	0.248***	0.254***
		(0.018)	(0.023)	(0.023)
Workers' autonomy		-0.334***	-0.400***	-0.383***
		(0.069)	(0.095)	(0.095)
Teams		0.202***	0.155***	0.166***
		(0.042)	(0.055)	(0.056)
Rotation		0.085***	0.077	0.071
		(0.031)	(0.049)	(0.048)
Information dissemination		0.334***	0.327***	0.335***
		(0.039)	(0.054)	(0.053)
Employee surveys		0.136***	0.136***	0.144***
		(0.032)	(0.045)	(0.046)
Temporary meetings		0.145***	0.113***	0.119***
		(0.029)	(0.041)	(0.040)
Open regular meetings		-0.099***	-0.078*	-0.069
		(0.028)	(0.044)	(0.043)
Information systems		0.024	0.009	0.008
		(0.030)	(0.046)	(0.046)
Regular meetings		0.154***	0.131	0.142*
		(0.055)	(0.084)	(0.084)
Suggestion schemes		0.016	0.019	0.016
		(0.030)	(0.043)	(0.043)
Discussion social media		0.003	0.0346	0.052
		(0.046)	(0.062)	(0.061)
Performance appraisal x 100		0.155***	0.113*	0.146**
		(0.040)	(0.063)	(0.060)
Pay for performance		0.199***	0.209***	0.221***
		(0.038)	(0.056)	(0.056)
Internal hiring		0.037	0.026	0.000
		(0.031)	(0.045)	(0.044)
Long-term hiring		0.006	0.058	0.027
		(0.033)	(0.048)	(0.044)
Independent establishment		-0.247***	-0.232***	-0.236***
		(0.040)	(0.048)	(0.047)
Work climate		-0.149***	-0.194***	-0.184***
		(0.034)	(0.050)	(0.050)
Establishment age		0.116***	0.091	0.104*
		(0.038)	(0.057)	(0.056)
Private firm		-0.085	0.029	0.003
		(0.063)	(0.083)	(0.081)
University degree x 100			0.290***	
			(0.1)	
Further contract			-0.100**	
			(0.050)	
Training x 100			0.130	
			(0.081)	
On the job training x 100			0.035	
			(0.065)	
Gender x 100			-0.127	
			(0.082)	
Workers' age x 100			0.176	
			(0.124)	
Economic sector	Yes	Yes	Yes	Yes
Country	Yes	Yes	Yes	Yes
Cut1	1.510	1.747	1.639	1.554
Cut2	3.713	4.099	4.001	3.916
Cut3	5.216	5.664	5.551	5.461
N	23914	20450	10412	10412
Wald chi2	3907.81	5584.55	3843.38	3625.12
Prob > chi2	0	0	0	0
Pseudo R2	0.137	0.157	0.150	0.149
Log-pseudo likelihood	-27752.935	-23096.909	-11814.379	-11827.877

*Significant at the 10%, **5 or ***1 percent level. The standard errors in parentheses are robust to correlation with observations in the same country and economic sector.

Table 4—Estimations of the Establishment Size

Independent variables	(1)	(2)	(3)	(4)
X				1,158***
				(0.041)
Departmentalization criteria		0.270***	0.249***	-0.038***
		(0.010)	(0.014)	(0.014)
Workers' autonomy		-0.241***	-0.253***	0.210***
		(0.038)	(0.057)	(0.056)
Teams		0.188***	0.222***	0.043
		(0.024)	(0.038)	(0.038)
Rotation		-0.035*	-0.053**	-0.142***
		(0.019)	(0.026)	(0.026)
Information dissemination		0.383***	0.422***	0.043
		(0.027)	(0.040)	(0.040)
Employee surveys		0.292***	0.250***	0.092***
		(0.032)	(0.035)	(0.035)
Temporary meetings		0.299***	0.299***	0.168***
		(0.020)	(0.027)	(0.027)
Open regular meetings		-0.210***	-0.182***	-0.091***
		(0.026)	(0.031)	(0.031)
Information systems		0.198***	0.216***	0.205***
		(0.027)	(0.033)	(0.033)
Regular meetings		-0.028	-0.031	-0.183***
		(0.028)	(0.040)	(0.040)
Suggestion schemes		0.154***	0.160***	0.138***
		(0.023)	(0.027)	(0.027)
Discussion social media		0.149***	0.118***	0.078**
		(0.029)	(0.034)	(0.034)
Performance appraisal x 100		-0.001	0.028	-0.103***
		(0.023)	(0.034)	(0.034)
Pay for performance		0.234***	0.217***	-0.026
		(0.027)	(0.032)	(0.032)
Internal hiring		0.093***	0.111***	0.081***
		(0.018)	(0.026)	(0.026)
Long-term hiring		-0.175***	-0.147***	-0,214***
		(0.019)	(0.027)	(0.027)
Independent establishment		-0.159***	-0.129***	0.140***
		(0.026)	(0.032)	(0.032)
Work climate		-0.197***	-0.203***	0.021
		(0.023)	(0.032)	(0.032)
Establishment age		0.488***	0.424***	0.320***
		(0.028)	(0.031)	(0.031)
Private firm		-0.235***	-0.150***	-0.184***
		(0.041)	(0.050)	(0.050)
University degree x 100			-0.052	-0.388***
			(0.068)	(0.068)
Further contract			-0.089***	0.028
			(0.029)	(0.029)
Training x 100			0.108**	-0.043
			(0.045)	0.045)
On the job training x 100			-0.028	-0.069**
			(0.034)	(.034)
Gender x 100			0.095	0.242***
			(0.064)	(0.064)
Workers' age x 100			0.543***	0.340***
			(0.092)	(0.092)
Economic sector	Yes	Yes	Yes	Yes
Country	Yes	Yes	Yes	Yes
N	23914	20450	10412	10412
F	28.01	85.76	63.88	63.88
Prob > F	0	0	0	0
R2	0.084	0.356	0.341	0.341

*Significant at the 10, **5 or ***1 percent level. The standard errors in parentheses are robust to correlation with observations in the same country and economic sector.

Table 5—Summary of the Effects of Each Variable on the Firms' Hierarchical Organization and Establishment Size Profits

Broad Category	Variable	Degree of flattening (x)	Establishment size (t)
Tasks	Departmentalization criteria	+	-
	Workers' autonomy	-	+
	Teams	+	0
	Rotation	+	-
Communication & information	Information dissemination	+	0
	Employee surveys	+	+
	Temporary meetings	+	+
	Open regular meetings	-	-
	Information systems	0	+
	Regular meetings	+	-
	Suggestion schemes	0	+
	Discussion through social media	0	+
Incentives	Performance appraisal	+	-
	Pay for performance	+	0
	Internal hiring	0	+
Knowledge	University degree	+	-
	Further contract	-	0
	Training	0	0
	On the job training	0	-
	Long-term hiring	0	-
Other variables	Independent establishment	-	+
	Work climate	-	0
	Establishment age	+	+
	Private firm	0	-
	Gender	0	+
	Workers' age	0	+

Table 6—Relative Importance of Different Theoretical Approaches

Independent variables	Flattening degree	Establishment size
X		1,158***
		(0.041)
Establishment size	0.753***	
	(0.022)	
Tasks	0.281***	-0.038**
	(0.023)	(0.015)
Communication &	0.209***	0.118***
information	(0.024)	(0.017)
Others	0.152***	0.015
	(0.021)	(0.017)
Incentives	0.115***	-0.037**
	(0.027)	(0.016)
Knowledge	0.110***	-0.105***
	(0.024)	(0.017)
Country dummies	Yes	Yes
Industry dummies	Yes	Yes
Cut1	0.407	
Cut2	2.770	
Cut3	4.320	
N	10412	10412
Equivalent to	Col 3 Table 3	
F		57.66
Prob > F		0
R2		29.71

*Significant at the 10, **5 or ***1 percent level. The standard errors in parentheses are robust to correlation with observations in the same country and economic sector.

Table 7—Correlation Matrix among the Y_d Categories

	(1)	(2)	(3)	(4)	(5)
(1) Tasks					
(2) Communication & information	0.357***				
(3) Incentives	0.256***	0.358***			
(4) Knowledge	0.153***	0.247***	0.220***		
(5) Other variables	0.190**	0.164***	0.087***	0.018*	