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Information and trust in hierarchies

Vicente Salas-Fumás *, J. Javier Sanchez-Asin [1]

University of Zaragoza, Faculty of Economics, Gran Vía, n° 4, 5005 Zaragoza, Spain

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ABSTRACT

This paper examines how information costs and congruence in the objectives of collaborators in production jointly affect the equilibrium number of managers and employees in an economy where individuals with different endowments of skills make occupational choices. We use the ratio of employees per manager, i.e. the average span of control (ASC) in the equilibrium, as a summary of how production is organized in the economy. The theory predicts that generalized trust, favoring congruence in objectives, will imply higher ASC in the equilibrium, while the intensity of use of information and communication technologies that lowers information costs has an undetermined effect on the equilibrium span of control. The empirical test of the hypotheses, with data from the Spanish regions, confirms that social capital-trust has a positive effect on the average span of control, while the sign of the effect of information–communication capital varies with the kind of information assets: communications, software or hardware.

1. Introduction

Social scientists have been aware for many years of the relevance of information and trust in overcoming the limits of organization, increasing production efficiency and contributing to economic progress [6]. Empirical research finds that the productivity of individual firms [15,40] and of the whole economy [37,49,64], is higher in environments of generalized trust. The contribution of information and communication technologies (ICT) to productivity growth, on their own and in combination with organization capital, is also well documented [12,13,20,22,45].[2] Furthermore, advances in ICT offer practically unlimited technological possibilities for the creation and expansion of technology-supported virtual markets, but the economic viability of these ventures strongly depends on the parallel development of trust-building mechanisms [7,9,36, for a survey].

Although research broadly supports Arrow's [6] vision on trust and information as "lubricators" of hierarchies and markets, a close examination of the joint influence of trust and information in the structure and functioning of hierarchies, as organizational solutions for the production of goods and services, remains unexplored.[3] This paper examines the endogenous formation of hierarchies in economies where individuals with different endowments of skills, make occupational choices of either working as managers (occupying high hierarchical positions) or as employees (being employed in low-level positions). Studying the size distribution of hierarchies in the context of occupational choice models is relevant because the distribution of sizes is matched with the allocation of skilled individuals in management and operational job positions, with implications for productivity and productivity growth over time.

In Lucas [41] and Rosen's [57] occupational choice models, individuals are endowed with general skills to use in their job position. Managers make decisions on the strategy of the business and coordinate and supervise direct employees for proper execution; employees perform operational tasks. The joint production technology shows scale economies of skills in management positions because higher skills imply better management decisions, affecting the productivity of all employees under the direction of the manager; the supervision function, however, shows decreasing returns. In Garicano [28] and Garicano and Rossi-Hansberg [29] individuals differ in cognitive skills and managers help employees in solving operational problems. The

* Corresponding author. Tel.: +34 976 761 803; fax: +34 976 316 764.
E-mail addresses: vsalas@unizar.es (V. Salas-Fumás), jjsa@unizar.es (J.J. Sanchez-Asin).
[1] Tel.: +34 976 763029; fax: +34 976 316 764.

[2] Organization capital refers to the capabilities built in the firm as the result of changes in the organization of work and in the human resource policies implemented at the time of investment in ICT. The "new" organization involves more teamwork, more decentralization, more employee voice, and more trained workers [13,22]. Other research examines the interaction of ICT capital with management practices, especially human resource management [17].

[3] Markets (price-guided decentralized decisions) and hierarchies (conscious coordination and authority-based motivation mechanisms) have been viewed as solutions to the limits of individual rationality for solving complex resource allocation problems [35,44,58,59]. Some papers propose using price [56] and non-price [8,34] mechanisms in decentralized allocation of resources in firm-hierarchies. More broadly, the coexistence of markets and hierarchies in resource allocation is viewed as the consequence of transaction costs in collaboration and exchange [26,62].

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limits to the size of the hierarchy come from the limited time available for coordination and supervision that a manager allocates to employees on a one-to-one basis [57], or from communication costs that limit the consultation of managers by lower-level employees [28]. The two limits are broadly referred to as "organizational diseconomies".

The market equilibrium from occupational choices is summarized in the variable *average span of control* (ASC), calculated as the ratio between the number of individuals that choose to work as employees and the number of managers, in the equilibrium. The ASC depends on the parameters of the model capturing information costs, degree of goal congruence, intensity of product market competition and dispersion in the distribution of skills. The main focus of our paper is on how the use of ICT and the level of generalized trust interact in determining information costs and the goal congruence of collaborating agents and, finally, in determining the equilibrium ASC. The analysis is completed with other theoretical determinants of the size of hierarchies, such as competition and the distribution of skills in the population. The theory predicts greater ASC in environments of greater trust, more intense product market competition, and more dispersion in the distribution of skills. However, the predictions from intensity in use of ICT on ASC are more ambiguous, as they depend on whether the ICT asset lowers communication costs (i.e. mobile phones) or lowers the information acquisition costs, as for example the ERP [29].

The hypotheses on determinants of ASC are tested with data from 18 Spanish regions (Autonomous communities AACC) during the period 1984–2005. The main explanatory variables are: i) Social capital index for each AACC and year [45], as a measure of the level of trust; ii) the stock of ICT assets, also for each AACC and year (IVIE-BBVA Foundation data base), separated into three classes, software, communication, and hardware; and iii) certain proxies of market competition and distribution of skills variables. We find a positive effect of social capital on ASC, as expected if trust contributes to goal congruence. The intensity of each ICT capital affects the ASC with a different sign: negative for the software capital (which is consistent with the prediction from the theory if software assets lower information acquisition costs), and positive for the communication capital (lower communication costs). The empirical analysis also finds cross-product effects between social capital and ICT assets on the ASC, pointing to the existence of complementarities between trust and information related variables.

Our paper contributes to the literature on the determinants of the internal organization of firms and its implications for productive efficiency, in several ways. First, we offer a comprehensive explanation of how variables such as economy-wide social capital and the stock of ICT assets affect the internal organization of firms, the size distribution of management hierarchies, and the total output produced in the economy. Research has documented the general trend towards more delegation of decision power to lower levels of the hierarchy [13,47], and towards the flattening of hierarchies [50,55] in modern firms. But the net effect from these changes in the trade-off between centralization and decentralization and in the size of the firms, is more ambiguous than might be expected [63] so empirical research should help to disentangle such ambiguity. Moreover, existing research explains the observed heterogeneity in management practices and organization of work across firms and countries [14], but does not explain the differences in equilibrium solutions for an economy as a whole, as we do in this paper.

Second, this paper focuses on differences in the organization of production with all variables simultaneously: trust, ICT assets, competition, and distribution of skills. Empirical research with firm-level data has examined how trust [15,36] and ICT assets [16] affect organization decisions, as well as the size and the productivity of firms. But these analyses are carried out with one set of variables at a time, while we consider the whole set of variables and their interactions (complementarities). Third, modeling ASC, as representative of the organization solution for the production of goods and services in the economy, is new in the literature. There have been papers interested in explaining differences in the size of firms [21,38,39,42], but occupational choice models explain ASC, not the size of the firm.

In the rest of the paper, Section 1 presents the theoretical models of hierarchies and market equilibrium solutions from occupational choices, and the formulation of the hypothesis. Section 2 contains a description of the data sources and the variables used in the analysis, together with the descriptive statistics. Section 3 shows the results from the estimation of the econometric models. The final section contains a discussion of our results and conclusions.

2. Theory and hypotheses

A hierarchy is defined as a collection of nodes and connecting lines ordered as an inverted tree with one or more levels. The study of hierarchies in the social sciences reveals at least three kinds: information, authority, and skills hierarchies.

In *information-hierarchies* the nodes are individuals/job positions and the connecting lines are communication channels. There is full congruence of objectives (the group is a "team" organization in the language of Marschak and Radner [44]) and the information flows through the communication channels responding to coordination needs. The organization design sets the number of hierarchical levels and the span of control in each of them, jointly with the decision on the amount of centralization (sending information to one point to make more informed decisions) or decentralization (making decisions at each point based on the limited available information) in decisions. The trade-off between the benefits of more informed decisions and information costs are the main determinants of these design decisions.[4]

The *authority-hierarchy* responds to motivation needs when collaboration takes place under null or limited goal congruence, with or without additional coordination needs. The "power" of the higher levels of the hierarchy over the lower levels is in the form of: giving orders on what to do [26,62]; supervising the quality and quantity of effort contributions [3]; setting up incentives [51,54]; and holding residual decision rights under incomplete contracts [2]. Information costs continue to play an important role in design decisions within authority-hierarchies, for example in the measurement of variables that will be part of the complete contract between managers and employees.[5] But other costs are possible, for example those resulting from decisions on the allocation of ownership rights when contracts are incomplete.

The *skills-hierarchy* is based on the division of labor in production among individuals with different skills. There are two kinds of job positions, management and operational jobs. Managers decide what to produce, where to sell, how to organize production and so on. The quality of these decisions will affect the productivity of the majority of individuals in the organization. Managers also are concerned with the diligent implementation of these decisions by employees performing operational tasks. Efficiency considerations justify placing more skilled individuals in management positions, while the less skilled will perform operational tasks. Scale economies in skills would justify concentrating most of the operational jobs and staff under the direction of the most skilled individuals, but there are trade-offs to be considered; for example, organizational diseconomies of size from supervision and coordination activities by managers. Models differ in the kind of skills considered, general skills that can be applied either to one function or the other [41,57], or cognitive problem-solving skills [28].

In this section, we solve for the equilibrium ASC and its determinants in economies where individuals differ in their endowment of skills and make occupational choices as to whether to become managers or employees. The theoretical results will be the basis for the

[4] For models of hierarchies that solve coordination problems see [4,18,23,60,61].

[5] Calvo and Welliz [24] and Qian [54] model hierarchies that solve coordination and motivation problems at the same time.