

Flexible manufacturing systems and the internal structure of the firm

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Abstract

We investigate the relationship between the internal structure of the firm and the extent of flexibility of its technology. We demonstrate that increased vertical separation within the firm as implied, for instance, by subcontracting or by additional vertical layers of management yields investment in a more flexible technology. In contrast, increased horizontal separation as implied by lack of cooperation among different (horizontal) divisions within the firm has ambiguous implications on flexibility. When divisions of the organization confront significantly different levels of uncertainty, horizontal separation enhances technological flexibility. Otherwise, when the extent of uncertainty confronting different divisions is comparable it is cooperation that yields greater flexibility of the technology. We show that the attributes of the technology selected by a given firm may depend upon the internal structure of its competitor if those attributes can be observed by the competing firm. In particular, the firm chooses a less flexible technology if its competitor is vertically separated rather than integrated. © 2002 Elsevier Science B.V. All rights reserved.

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1. Introduction

The face of manufacturing has been changing significantly in the late twentieth

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century. Flexible manufacturing systems, robotization, computer integrated manufacturing and 'just in time' systems have been considered essential in guaranteeing success in the market place. The shift to flexible manufacturing has been accompanied by new organizational strategies and workforce management policies. Greater reliance on teamwork and cooperation among different functions within the firm as well as increased utilization of independent suppliers and subcontractors have been key ingredients of the organizational changes. These two adjustments of the organizational form are consistent with the flexible, general purpose type of investments that modern manufacturing entails. The flexibility, which facilitates frequent adjustments of the production line and, an extended product mix, requires greater coordination among traditionally separate functions of design, engineering and marketing, thus yielding the increased reliance on teams (see Milgrom and Roberts, 1990). The general purpose type of investment reduces the extent of asset specificity in relationships with independent contractors. Since investment incentives are improved, as a result vertical separation becomes a more attractive option, as explained in the transaction cost literature (Klein et al., 1978; Tirole, 1986; or Williamson, 1986).

In the present paper we reconsider the relationship between the flexibility of the technology and the internal structure of the firm by focusing more narrowly on the inherent motive for flexibility in the production process. Essentially, firms seek flexibility since they face uncertainties in their environment and wish to respond more smoothly and less expensively to fluctuations in consumers' tastes or in cost conditions. Given that the firm chooses to adjust its production to different realizations of the state of the world, the extent of flexibility of the technology is directly related to the extent of ex-post variability of its production decision. We evaluate how this variability depends upon the internal structure of the firm as reflected by a choice between vertical integration or separation and the extent of cooperation the firm fosters among its different (horizontal) divisions.

The underlying assumption behind our analysis is the existence of asymmetry of information between the owner of the firm and her managers (or her outside independent contractors) as well as among managers of different divisions within the firm. The choice among different organizational structures affects the extent of informational asymmetries and, as a result, the nature of the agency costs incurred by the firm. Since such agency costs influence the variability of the firm's production decision, the desired level of technological flexibility depends upon organizational structure.

To incorporate environmental uncertainty in our model we assume that two separate activities in the production process are subject to random shocks the sum of which determines the cost of production. When the firm is vertically integrated the owner can observe the random shocks herself and condition the production decision on such observations. In contrast, with vertical separation it is only the manager in charge of a given activity that can observe the random shock affecting this activity. With vertical separation, the owner can choose between an organiza-

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