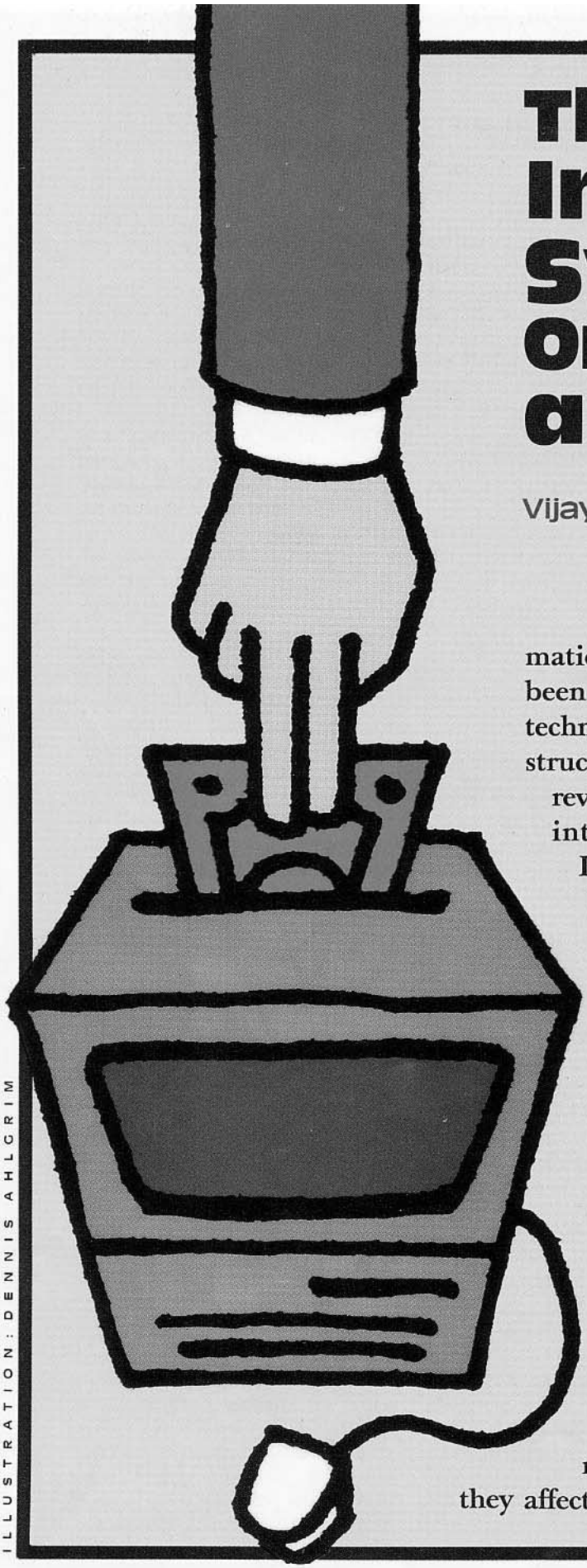


ILLUSTRATION: DENNIS AHLGRIM

The Impact of Information Systems on Organizations and Markets

Vijay Gurbaxani and Seungjin Whang

The adoption of information technology (IT) in organizations has been growing at a rapid pace. The use of the technology has evolved from the automation of structured processes to systems that are truly revolutionary in that they introduce change into fundamental business procedures. Indeed, it is believed that "More than being helped by computers, companies will live by them, shaping strategy and structure to fit new information technology [25]." While the importance of the relationship between information technology and organizational change is evidenced by the considerable literature on the subject,[1] there is a lack of comprehensive analysis of these issues from the economic perspective. The aim of this article is to develop an economic understanding of how information systems affect some key measures of organization structure.

This article analyzes the roles of information systems, how they evolve and how they affect organizations and markets. In particular,

we analyze the impact of IT on two important attributes of firms—firm size and the allocation of decision-making authority among the various actors in a firm. To this end, we start with economic theories of organization as the foundation for our analysis. Two such theories are relevant to our analysis: *agency theory*, initially advanced and developed by Wilson [68], Ross [54], Alchian and Demsetz [2], and Jensen and Meckling [34], and *transaction cost economics*, whose development is due mainly to Coase [18], Klein, Crawford and Alchian [38], and Williamson [65–67].

Agency theory [34] rejects the classical view of the firm as a unified profit-maximizing identity and proposes an alternative model of a firm as an agency relationship built on a set of contracts among *self-interested* agents (employees). As a consequence, when decision-making authority is delegated to agents, it cannot be guaranteed that the decisions will be aligned with the interest of the principal (shareholders). The divergence of interests between the principal and agents can breed numerous problems and is costly to a firm (agency costs). Agency theory (of the firm) tries to explain how a firm can be, and why it is, maintained as a viable form of economic organization even in the presence of these problems.

Transaction cost economics [18] approaches this issue from exactly the opposite direction. It starts by looking at problems in using a *market* and views a firm as a solution to these problems. The theory recognizes that the operation of a market is not costless, as is assumed in classical economic theory, and that it is important to assess *transaction costs* in the analysis of economic activities. According to this theory, the firm is a substitute for the market mechanism, created to reduce transactions costs.

This article is based on the premise that firm size and the allocation of decision-making authority among the various actors in a firm are, to a considerable degree, determined by the costs associated with acquiring, storing, processing and disseminating information. Agency theory and transaction cost economics facilitate the development of the relationships between these information costs and the attributes of organizations. We present a model of a firm which incorporates the considerations of agency costs and transaction costs, as well as operations costs. This framework enables us to study the impact of information systems on organizations and markets. Our research, therefore, complements that of economic and industrial organization theorists by addressing the role of computer-based information systems, which economists traditionally treat as a black box.

The question of whether IT induces the centralization or decentralization of decision making in organizations is of considerable interest [5]. In brief, we argue that as decision-making rights are pushed downward in the organizational pyramid, the costs of communicating information upward decrease while agency costs resulting from goal divergence increase. Therefore, decision rights in an organizational hierarchy should be located where the sum of these costs is minimized. Modern IT can reduce the costs of communicating information by improving the quality and speed of information processing and management's decision making, leading to more centralized management. At the same time, IT can also provide management with the ability to reduce agency costs through improved monitoring capabilities and performance evaluation schemes, inducing decentralization of decision making.

We also argue that IT can have a direct impact on optimal firm size by changing its underlying cost structure. According to our model, the size of a firm is determined by trading off external coordination costs, internal coordination costs and operational costs. On the one hand, cost-effective IT can reduce external coordination costs and can lead a firm to increase its use of markets. However, IT can also reduce internal coordination costs and provide management with the ability to manage a large organization effectively, thus inducing an increase in firm size.

The outline of this article is as follows. In the next section, a brief discussion of agency theory and its implications for internal coordination is presented, followed by an analysis of market, or external, coordination using transaction-cost economics. Next, we synthesize these theories to develop a model of a firm which has three cost components—operations costs, internal coordination costs (of which agency costs are a part), and external coordination costs. The impact of information systems on an organization is pursued next in three parts. An analysis of various roles of information systems is presented, followed by a discussion of how modern IT affects the cost structure of firms, and derive the resulting implications for the allocation of decision rights and firm size. We conclude with a summary of our contribution and a presentation of the implications of our results.

Agency Theory

Following the pioneering works [2, 54, 68], economists realized that their usual assumption that a firm behaves as a *team* to maximize profits was restrictive in analyzing managerial behavior. This approach did not allow an analysis of situations where management behavior was inconsistent with such maximization. Alchian and Demsetz [2] and Jensen and Meckling [34] proposed a view of a firm as *a nexus of contracts among self-interested individuals*. That is, a firm represents a set of agency contracts under which a *principal* (entrepreneur) employs *agents* (employees) to perform some service on his behalf. A strong assumption

[1]See [5, 29, 39, 45] for excellent reviews of research on these issues.

The Impact of Information Systems on Organizations and Markets

of this view is that an agent has as his or her objective the maximization of the agent's individual utility; he or she prefers more rewards and less effort, but pays no regard to the welfare of the principal or nonpecuniary virtues, such as honor, team spirit, integrity and pride of achievement. A body of research on organizations, called *agency theory*,[2] followed from this framework.

Agency Costs

Agency costs are defined as the costs incurred as a result of discrepancies between the objectives of the principal and those of agents. Consider the owner of a retail software store who hires labor, say, a (self-interested) salesperson to develop the on-site business customer market. Sales increase as the salesperson exerts greater effort, but each additional unit of effort increases sales by a decreasing amount. The question is, what is the optimal compensation contract? Suppose the salesperson receives a fixed salary. The narrow behavioral assumptions of our agency model predict that, in the absence of any cost-effective monitoring device, he will shirk from working, resulting in no additional sales. An alternative is giving the salesperson a certain percentage (say 10 percent) of revenue. Then the salesperson will optimize his utility by choosing the level of effort at which his marginal cost of exerting effort equals *his* marginal revenue, which is one-tenth the overall marginal revenue. The resulting sales volume is likely to be much lower than the amount expected when the store owner, or someone not exposed to agency problems, acts as a salesperson.

There are several possible solutions to this agency problem. The owner can design a contract in which payment is made only when output exceeds a prespecified level which has been determined so that the right amount of labor will be applied to achieve the target. Then, the salesperson will be motivated to apply the right amount of labor, thereby receiving the corresponding wage level. However, this is too naive a scheme since the observed sales depend on many factors (e.g., general business conditions, hardware sales and competitors' marketing activities) which are beyond the control or expectation of either party. Alternatively, the salesperson can pay a fixed amount to the owner and keep the remainder (if there is any). In this case, all the risk due to the uncertainty of the sales outcome is undertaken by the salesperson, who is likely to be more risk-averse than the owner. While the scheme is in the right direction to solve the agency problems, it is unlikely to be acceptable to a risk-averse salesperson.[3] Finally, the owner can hire another person to monitor the salesperson all the time. (And he may have to hire another agent to monitor the monitor, and so forth.) In this case, the owner should balance the *monitoring cost* with the increase in profits due to the monitoring.

Moreover, the salesperson is expected to report often to the store and document all his sales activities, consuming time and effort that could be spent on making sales calls. Such waste would be spared if there were no shirking salespeople. This is another type of agency cost, but it is incurred by the agent[4] and is therefore called the *bonding cost*. Despite monitoring and bonding activities, the principal may still experience a partial loss of her welfare, which is termed the *residual loss*. To summarize, agency costs are the sum of a) monitoring costs, b) bonding costs and c) the residual loss [32].

Agency Costs and Firms

The agency theorists' "nexus of contracts" perspective of a firm leads to the realization that a firm is a Pandora's box full of agency problems. As a result of the separation of ownership and management, managers of a firm are agents who may act in their own interests at the expense of the shareholders.[5] For example, an information systems (IS) manager may be subject to the so-called "empire-builder" syndrome. To him, a large IS center—a large budget, a large staff, state-of-the-art computer equipment and a big office—carries with it power, perks, high salary and a sign of career success. Using his expertise in IS operations to justify his actions, he may overconsume company resources at the expense of the shareholders [46].

Agency problems are not limited to shareholder-manager relationships; manager-employee conflicts are another source of agency problems. Employees may do any of the following: shirk, appropriate corporate goods, receive bribes for illegal favors, and abuse decision rights to their own benefit. The conflicting interests of different departmental managers within a firm are also a source of agency costs. For example, the conflict between manufacturing and marketing has long constituted part of management folklore. Manufacturing is rewarded for operational efficiency, while marketing is rewarded for increasing sales. Not surprisingly, disagreements arise, since these two measures are not always maximized by a consistent set of actions by the two departments. As a result, a company may sometimes benefit by limiting com-

[2]The term "agency theory" has also been used to analyze interorganizational settings [54]. Our usage of the term is more in line with [34] and focuses on intraorganizational issues.

[3]The distribution of risk and the associated rewards are an important element in contract design. However, the subject is beyond the scope of this article. Interested readers are referred to [40].

[4]We assume here that bonding expenditures incurred by agents are ultimately transferred to the principal, so that all agency costs are ultimately borne by the principal.

[5]See Jackall [31] for a detailed treatment of the occupational ethics of corporate managers.

munication between the two departments [1].

How does a firm exist in the face of all these problems? First, direct monitoring is possible. In manufacturing environments, an important role of a group leader is monitoring group members and preventing them from shirking. Mutual monitoring is also common. Second, efficient or semiefficient contracts are available to control agents' activities. Employee compensation is often linked to performance (e.g., for salespeople and taxidrivers whose activities are costly to monitor). IS centers and computer networks are often controlled by organizational arrangements, such as profit centers, cost allocation, and other chargeback policies [3, 44, 72]. Third, outside labor markets, proxy fights, and takeover activities discipline managers [23, 33]. Fourth, institutions such as banks, accounting firms, and insurance companies help reduce agency costs through their monitoring functions. Fifth, cultures and norms nurtured within an organization can play a critical role in mitigating agency problems. As Ouchi [49] points out, a distinct characteristic of Japanese firms (shared by type-Z companies in the U.S.) is their emphasis on noncontractual arrangements that rely on trust and human relationships. Last, but perhaps most important, human nature is not as evil as agency theories paint it. People (including agents) value honor, integrity, human relationships, and the feeling of achievement.

Decision Rights in Organizations

Figure 1 shows an organizational hierarchy, in which the top of the pyramid represents top management and the bottom represents the employees. The employees on the spot generally have better access to local information, which is continually subject to change [26]. If all the decisions are to be made by top managers, there is a need to process information upward in the hierarchy, resulting in a variety of associated information-processing costs: costs of communication, costs of miscommunication, and opportunity costs due to delays in communication. Decision making without relevant information[6] can lead to suboptimal decisions, which entail yet another kind of cost. The sum of these costs, which we call *decision information costs*, increases as a decision right[7] is moved higher in the hierarchy, away from where information is most easily available. This may lead one to hastily conclude that decision rights should be located at the bottom of the hierarchy. This is problematic, however, since the objectives of the principal and the agents may be inconsistent. Jensen [32] notes that, as decision rights are pushed downward in the organizational pyramid, decision-information costs decrease while agency costs increase. Therefore, he argues that decision rights should be located where the combined costs (which we call *internal coordination costs*; see Table I) are minimized.

The cost structure varies from situation to situation. In securities-trading firms, for example, the importance of timely information

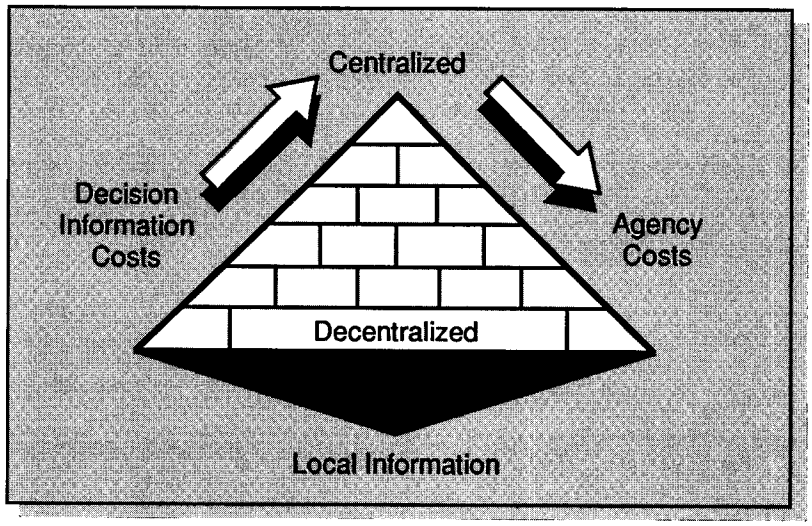
[6]Systematic adherence to this policy leads to a *bureaucracy*, which is an organization run by rules [61]. A rule means the refusal to give discretion to agents who may have specific information relevant to the decision. This deliberate inefficiency is explained by the principal's efforts to reduce agency costs.

[7]We use the term "decision right" synonymously with the terms "decision responsibility" or "decision-making authority," used by other authors.

TABLE I. *Hierarchical Coordination.*

INTERNAL COORDINATION COSTS	AGENCY COSTS	—Monitoring Costs —Bonding Costs —Residual Loss
	DECISION INFORMATION COSTS	—Information Processing Costs • Communication • Documentation —Opportunity costs due to poor information

FIGURE 1. Location of Decision Rights and Costs Tradeoff.



and the volume of information to be processed per unit time are extremely high; consequently the costs of communicating information upward and of making suboptimal decisions without proper information are both very high. As a result, decision rights are located with those who work on the floor. Since agency costs are maximized at this point, such firms commonly adopt performance-based compensation schemes. This is in contrast to some other business situations in which the volume of information processed is relatively small and decision making can be postponed until top management can evaluate and approve it. Alfred Sloan of General Motors was well aware of this tradeoff, when he said (as early as 1920) that production operations should be fully decentralized while financial functions of the corporation should be centralized [71].

In summary, agency theory provides us with a clearer understanding of *internal* coordination costs. To see the relevance of the theory to IT, first note that both components of internal coordination costs (i.e., agency costs and decision-information costs) stem, in large part, from the acquisition of information. Agency costs are related to obtaining information on the agents' behavior, while decision information costs are related to acquiring and processing information surrounding the decision itself. In a later section, we will see how IT, by changing the costs of acquiring these two types of information, affects the organization.

Transaction Cost Theory

Agency theory focuses on organizational problems that arise from informational considerations and on how they are overcome so that firms are a viable form of economic organization. While the theory provides useful insights into organizations, it cannot explain why, under certain conditions, a firm can be a more efficient form of institution than a market. Transaction cost economics posits that there are costs in using a market as a coordination mechanism and that the firm is an alternative mechanism that facilitates economizing on market transaction costs. The existence of a firm and its related activities is now explained from this perspective.

The Marvels of Markets

As Hayek [26] indicates, the "marvel" of markets is the role of their price system as a mechanism for *communicating the knowledge* of the relevant facts which are dispersed among many people. Through its price system, a market collects and transmits knowledge of particular circumstances of time and place that may be prohibitively costly for any central authority to capture. In this sense, the market itself is an information system which serves the whole economy. For example, the futures prices of orange juice concentrate efficiently absorbs real-time information on weather conditions (especially in the winter) in central Florida where more than 98 percent of U.S. orange juice production takes place [53]. In the same vein, the stock or option price of, for example, IBM, almost instantaneously adjusts in response to new information on market conditions and firm performance, such as the company's sales and quarterly earnings reports [7, 50]. Markets, through their price system, provide a coordination mechanism which, without involving a central authority, induces individuals pursuing their self-interests to achieve goals beneficial to society as a whole.

Why a Firm?

The preceding argument supports the rationale behind the market mechanisms of capitalist economies. Consider, however, another predominant feature of these economies—the firm. A firm is essentially a way of bypassing the market system, since within a firm production is coordinated by a central authority (entrepreneurs or managers). Recalling the value of markets, we (following [18]) must ask: Why is such an organization necessary? Specialization in labor and risk sharing will not completely explain its existence, since these functions can be provided in the market as well. Coase's [18] answer is that various kinds of transaction costs are associated with using markets; examples are the *ex ante* costs of acquiring market information and negotiating a deal, and the *ex post* costs associated with preventing and dealing with contract default. Hence, a firm is an economic entity created in an effort to economize on such market transaction costs.

Transaction Costs

"Market transaction costs" used here synonymously with "external coordination costs" means the coordination costs involved in using an *outside* market.[8] The costs of writing a contract and securing means to enforce it are examples of market transaction costs. Suppose a company hires an outside software developer to develop and install some software. The software contract would typically include a large number of items specifying terms and conditions: functional specifications, acceptance-testing procedures, a timetable of the delivery process, protection of trade secrets, repairs and maintenance responsibilities, liabilities due to failures, required documentation, price and payment schedules, options to terminate the agreement, and so forth. Each item requires scrutiny by an attorney to reduce the prob-

[8]Researchers of institutional economics do not fully agree on the use of the terms "agency costs" and "transaction costs." To minimize confusion, we use the term "market transaction costs" for the costs of using outside markets, while we apply the term "agency costs" to the costs due to the divergence of interests between the employer and employees of a firm.

ability of future legal wrangling or a loss of rightful claims as a result of overlooking a seemingly trivial item in the contract—a costly process. These costs result from processing a transaction in the market and must be incurred without adding to the intrinsic value of the software. It is important to note that these costs will be avoided if the company develops the software in-house. To avoid the inconvenience of outsourcing, the company may forgo the benefits of contracting with an outsider who has superior software development expertise. Indeed, these are also market transaction costs.

TABLE II. *Market Coordination.*

EXTERNAL COORDINATION COSTS or: MARKET TRANSACTION COSTS	OPERATIONAL	—Search Costs —Transportation Costs —Inventory Holding Costs —Communications Costs
	CONTRACTUAL	—Costs of Writing Contracts —Costs of Enforcing Contracts

Williamson [65, 66] develops a comprehensive treatment of the characteristics of transactions, industries, and markets that considerably affect the magnitude of transaction costs. He observes, among other things, that the existence of a firm-specific asset (an asset whose value in its next-best use is significantly lower than its value in the current use) is often a source of a large-market transaction cost, since special arrangement—typically through a long-term contract—is required to prevent the other party from acting opportunistically after an irrevocable investment in the specific asset is made.[9]

However, a long-term contract may not be a stable solution when the degree of uncertainty (e.g., in technology or price) is high. In order to prevent one party from exploiting the other if an unspecified event occurs, such a contract must now attempt to account for future contingencies whose occurrence is difficult to predict, making the process extremely costly. On the other hand, an incompletely specified contract leaves the negotiating parties vulnerable to opportunism. An often-utilized solution for reducing market transaction costs witnessed in the marketplace is for buyer and supplier firms to *integrate vertically*. This is because, when facing an ever-changing environment, a firm is relatively more capable (than a market) of immediately and costlessly restructuring decision rights, redeploying resources, and internally resolving possible disputes.

The recent development between General Motors (GM) and its system developer, Electronic Data Systems (EDS), is a case in point [13]. To internalize its transactions with EDS, GM bought EDS (which is a market leader in systems integration) from its founder, H. Ross Perot. The arrangement was that GM issue separate Class E stock for EDS shareholders. Perot stayed on with EDS as a GM director and held a significant share of Class E stock. As a result, the merger was not a vertical integration, but rather a joint venture between GM and Perot. For that reason, conflicts developed over the appropriate transfer price for the services EDS provided to GM. The disputes were resolved in 1987 by GM's purchase of Perot's Class E holdings. That is, vertical integration was used here to save market transaction costs.

Further, the external sourcing of an input factor may entail extra costs in obtaining market information, communicating with geographically separated vendors, transporting goods, and holding inventories. These are also market transaction costs which could be reduced significantly by producing the factor in-house. Accordingly, market transaction costs may be classified into two categories: one is associated with establishing and maintaining contractual relationships with outside parties, while the other is due to the loss of operational efficiencies (see Table II).

Note that modern IT can directly reduce market transaction costs in the latter category by providing cost-effective means to access market information and process transactions. IT also has the potential to reduce market transaction costs related to contracting, since it facilitates tighter interfirm links through information sharing and mutual monitoring.

The Model of A Firm: A Synthesis Of Theories

We have seen how economic theories of organization identify two important cost components of a firm—*internal coordination costs* and *external coordination costs*. In addition, there exist more tangible *operations costs*—the costs which a firm incurs to produce and market its output. This section begins with a discussion of economies of scale in operations. Then, at the risk of oversimplification, we present a model of a firm that incorporates these three cost components and analyze how firm size is determined to minimize the sum of these costs.

Economies of Scale in Operations

Many industries experience economies of scale in the *production* of goods and services, as evidenced by the observation that many of our purchases are produced by large

[9]See [2] for examples.

companies [55]. The major reason for this is that the underlying technology of production is increasingly cost-effective as the scale of production grows. This phenomenon has led to the present economic system where a small number of large and highly specialized firms dominate in many markets [55].

We also observe *informational* economies of scale [4, 69]. Information is not consumed by its use, and technical information can be used in producing output on any scale [4]. Hence, a firm possessing technically superior information can justify a larger scale of operations. Then, backed by a large financial base, less exposed to risk, and holding an informational lead, the firm can continue to invest in research and development to maintain its supremacy in information, justifying a further increase in scale, and so on. Consider the example of computerized reservation systems (CRSs) in the airline industry. The information captured by these systems allows airlines to improve their pricing strategies, resulting in an increase in the load factor on their flights. A larger airline with more flights can derive correspondingly greater benefits than a smaller airline. Since the costs of such systems are largely fixed, the rate of return is higher for a bigger airline, which can therefore justify a larger initial investment and a correspondingly better system. The resulting gains can then be reinvested to further the informational lead, and so on. Even in pure exchange, superior information can generate large profits—that is, the winner in information acquisition sweeps the market (e.g., insider trading). As a result, firms are motivated to build superior information systems, play big to make the best use of informational economies of scale, and justify the expenses involved.

Yet another type of economies of scale arises from *network externalities* [36]. Consider the personal computer market. A hardware standard with a large installed base will have more software products available in the market. As a result, consumers will prefer machines that conform to the hardware standard, and more units of such machines will be sold. Then, more software will be produced for the standard, and so on. This cycle drives economies of scale and tilts the market heavily toward dominant manufacturers like IBM. Note that, in this case, scale economies arise from the demand side rather than from the production side. Network externalities also exist in businesses such as trucking, airlines, railroads and communications—where firms can achieve increased gains as they increase the geographical scope of their operations.

In aggregate, we term the resulting scale efficiencies from these sources as "economies of scale in operations." If everything else remains the same, large firms can exploit these efficiencies to decrease per-unit operations costs.

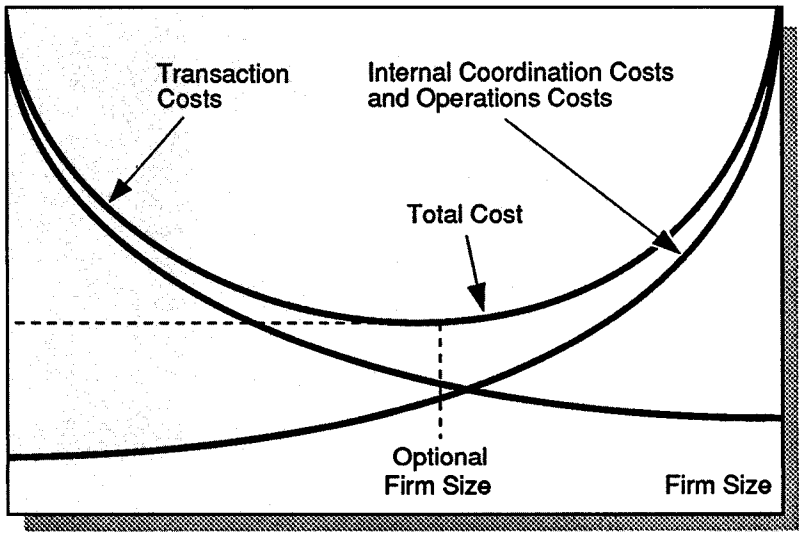
The Size of a Firm

Using the three cost components of a firm, we analyze how firm size is optimally determined, where firm size is defined along two dimensions, *vertical* and *horizontal*.

Vertical Size. The vertical size of a firm is measured by the range of the value chain which the firm spans using its own hierarchy. A vertically large firm would produce in-house an intermediate good which is input to the next stage of the production process. The main advantage of vertical integration is the reduction of market transaction costs achieved by depending more on the hierarchy and less on the outside market.

While a vertically large firm would have lower market transaction costs, two counteracting forces—internal coordination costs and operations costs—work against the growth of such a firm. Consider internal coordination costs. As a firm grows vertically large, both agency and decision information costs increase: A large firm requires more information processing, more bureaucracy, and/or more delegation of decision rights to self-interested agents. Next, if there are

FIGURE 2. Vertical Firm Size and Costs Tradeoff.



economies of scale in the production of input factors, the firm could turn to outside vendors who, because of their larger scale, can produce the factors at lower cost. Accordingly, scale economies may be lost by vertical integration and the self-provision of input factors. In the determination of vertical firm size, therefore, the tradeoff is between market transaction costs (which favor a vertically large firm) and the sum of internal coordination costs and operations costs (which penalize a vertically large firm). As shown in Figure 2, the optimal vertical firm size is determined where the combined cost is minimized.

Horizontal Size. The horizontal size of a firm is a measure of the number and corresponding share of markets in which the firm sells its final goods and services. Thus, horizontal size is positively correlated with the geographic scope of the firm, with the range of the product line,[10] and with a firm's market share. As a firm's horizontal size increases, the benefits from scale economies increase, resulting in lower average operations costs. While internal coordination costs increase with firm size, the impact of firm size on external coordination costs is not unambiguous and can vary among different industries.

Network-type businesses—railroads, airlines, trucking and communications—are a case where external coordination costs can decrease with horizontal growth [66]. For example, a railroad company operating only on the West Coast of the U.S. may incur significant market transaction costs in contracting with other railroad companies to serve customers destined for the East Coast. Horizontal growth would decrease these costs. On the other hand, general trading companies may face a steep rise in external coordination costs as they expand globally. In any case, horizontal firm size is also determined by the tradeoff between operations costs, external coordination costs and internal coordination costs.

In this article, the firm is modeled as facing three costs components—internal coordination costs, external coordination costs and operations costs, whose structures are as described above. The optimal (horizontal and vertical) size of the firm is determined by trading off these costs. It is important to note that the underlying cost structures are closely related to the acquisition of information and can therefore be affected by the use of modern IT.

Organizations And Information Systems

In order to analyze the impact of information systems on organizations, we categorize the role of information systems in a firm, determine what effects modern IT has on the cost structure of a firm, and examine, from the perspective of agency theory and transaction cost economics, how these effects result in changes to various attributes of the firm.

Roles of Information Systems in an Organization

An information system in an organization has multiple roles: a) it increases scale efficiencies of the firm's operations (operations); b) it processes basic business transactions (transaction processing); c) it collects and provides information relevant to managerial decisions and even makes decisions (decision support); d) it monitors and records the performance of employees and functional units (monitoring and performance evaluation); and e) it maintains records of status and change in the fundamental business functions within the organization and maintains communication channels (documentation and communication). This list is not exhaustive (e.g., R&D), and the items are neither clear-cut nor mutually exclusive. We turn to a more detailed discussion of each function and examine its impact on the cost structure of the firm.

Operations. Information systems can have a direct impact on the productivity of manufacturing and service operations. Recent advances in factory automation, CAD/CAM, robotics, CIM (Computer Integrated Manufacturing) and optical scanner technology have contributed to improvement in quality and productivity as well as the reduction of labor costs and agency costs. An often-observed outcome of this trend is "late-mover advantage" which favors late-arriving companies with the better technology and its accompanying organizational structure. Japanese auto makers, Korean steel makers, and clothing retailers like Benetton and the Limited have aggressively adopted new IT and preempted earlier movers in their industries [42, 70].[11]

In this regard, IT has affected the operations cost structure of a firm in two different ways. First, IT has intensified economies of scale in operation by allowing mass production on an unprecedented scale and facilitating the availability of informational scale economies. Further, IT has introduced a high degree of flexibility in production (for example, through flexible manufacturing systems) and significantly reduced the cost of manufacturing a broad product line. The benefits of flexibility have been felt not only in the mass customization of products, but also in the speedy deliveries of goods and services [37].

Transaction Processing. A large portion of the service industry, which represents an increasing portion of the American economy,

[10]The product line is narrowly defined as a group of products (e.g., Intel 80286, 80386 and 80486 microprocessors) that require similar types of equipment and technology. By broadening the product line, the firm can extract greater economies of scale and scope associated with specialization.

[11]For example, the new Kwangyang plant, a highly automated Korean steel mill, turns out 933 tons of steel per worker a year, as compared to an average of 528 tons in Japan and 262 tons in the United States [42].

depends heavily on information systems for its basic business functions. Commercial banks, investment banks, insurance companies and credit card companies spend up to five percent of their revenue on IS-related activities. Many employees in this industry are simply middlemen to link customers to information systems. The Automatic Teller Machine, Shelternet (a computer-based mortgage network built by First Boston, [70]) and Eaasy Sabre (a scaled-down version of AMR's Sabre reservation system, [70]) represent examples in which even this middleman is eliminated.

Recent advances in IT have obviously introduced a great deal of operational efficiency in the market economy by providing more efficient market mechanisms and thus lowering the associated market transaction costs [43]. In particular, modern IT has facilitated the creation of value-added partnerships (VAPs) through which a set of independent companies work closely together along the value chain [35]. McKesson Corporation, one of the largest distributors of pharmaceuticals, introduced a sophisticated order-processing system into its business with independent drugstores [17]. A retailer makes a round of her drugstore to check if any items are out of stock. Using a special optical scanner, the magnetized characters of every out-of-stock item are scanned; this is the order entry process. The ordered items arrive the next day packed in the sequence of the order entry. Hence, a single round through the store aisles is enough to restock the items. This new system helped retailers to reduce inventory and labor costs. With cost-effective IT, market transaction costs have been driven down considerably, and many firms now seek to reap economic benefits through a variety of similar interorganizational information-sharing arrangements.

Monitoring/Performance Evaluation. From the perspective of agency theory, the availability of cost-effective monitoring devices is of crucial value in reducing agency costs. Information systems contribute to this end by providing an effective tool to monitor agents' actions directly and by keeping track of the performance records of an agent or a functional unit in a firm. The first function is exemplified by the use of optical scanners. Contrary to our presumptions, an optical scanner in grocery stores is more of a monitoring device to enforce retail unit work discipline than a measure to save labor costs (the payback period is over ten years) or to reduce the waiting time of a customer (more labor is as good a substitute) [73]. Another example is provided by Frito-Lay, which now issues hand-held computers to all its salespersons [41]. While also reducing the time required to process a transaction, the computers provided management with a powerful monitoring tool. The system allows management to record such events as when each salesperson began his/her day, interarrival times between stores, and even the number of cardboard boxes returned by the salesperson. There are numerous other examples of computers being used to monitor the activities of employees, such as data-entry personnel and telephone operators.

Direct monitoring, however, is often costly and superficial. For this reason, firms adopt explicit contracts or implicit rules of the game to evaluate the performance of agents and compensate them accordingly. In many such instances, where previously it had been feasible for management to examine only summary reports (which make it relatively easy to disguise unusual activity), modern IT has given management the ability to keep track of performance at the level of an individual transaction.

The different approaches that firms adopt to mitigate agency problems manifest themselves in the structuring of information systems. The following example is due to Ouchi [49]. Recall that Japanese firms, in contrast to U.S. firms, favor noncontractual solutions to agency problems. A U.S.-trained accounting professor at a Japanese university remarked that the status of accounting systems in Japan is primitive when compared with those used in the U.S. Profit centers, transfer prices, and computer-based accounting systems are barely known even in the largest companies in Japan. As Ouchi indicates, this is not surprising in view of their management philosophy, which is not to closely monitor each individual's performance at the expense of team spirit.

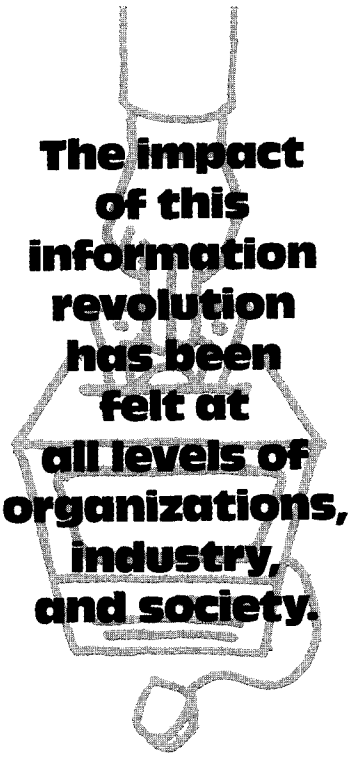
Note that this is not because of the absence of information systems. In fact, Japanese companies are well known for aggressively developing and adopting new IT [47]. The Ministry of International Trade and Industry (MITI) has successfully promoted the development and diffusion of IT because it believes that the information industry "holds the key to future competitiveness across a whole range of industrial sectors—not only high technology (robotics, machine tools, telecommunications)—but also the old-line industries (steel, automobiles, chemicals) and even the services (banking, insurance, distribution)" [47, p. 29]. However, the emphasis of their information systems does not appear to be on the function of monitoring, evaluating, and motivating employees, but on increasing operational productivity and providing management with decision-relevant information.

Documentation / Communication. There are ample reasons for a company to keep track of corporate status and business activities. The status and changes in the assets of the company must be reported to shareholders and the IRS. Corpo-

rate goals and plans must be continually disseminated to employees in units that are geographically distributed. Further, due to employee turnover, a company will lose track of detailed business activities without proper documentation. For example, engineers spend a substantial amount of their time documenting their activities for the company. In many cases, documentation and communication can be viewed as bonding activities to log the services provided by the employees.

Moreover, a company whose business function is geographically dispersed faces problems of standardization. For example, DeLorean pointed out that as many as 30 percent of all Chevrolet's new car orders had errors, such as a dealer mistakenly ordering a Nova model with an engine which was unavailable for that car line. His solution was to build an efficient information system [71]. In this light, Honda Motor Company's billion-yen investment in an international network linking all its divisions scattered throughout the world sounds quite reasonable [21]. In the same vein, the huge investment in organization-wide database management systems and wide and local area networks (WANs and LANs) is partly intended to maintain *corporate memory* and reduce inconsistencies within an organization. All in all, by providing cost-effective means of acquiring and processing decision-relevant information within the organization, IT has again contributed to decreasing internal coordination costs.

Decision Support. Needless to say, information is a critical element in decision making. In this regard, the functions of IS range from simple information collection and computation to automated decision making via sophisticated artificial intelligence techniques. Many myopic, *ad hoc* decision-making processes are now replaced or aided by automated management science techniques. For example, computer systems help Hertz in fleet scheduling [20] and Avis with its fleet-purchasing plan [6]. The airline industry is dependent on computer programs for its pricing decisions, a practice known as yield management [70]. Homart, a subsidiary of Sears, runs a mixed integer program to determine the tenant mix within a newly developed shopping mall [8]. Many Wall Street transactions are triggered by computers. Some experts blame computer-based program trading for the 1987 stock market crash [22]. In order to forecast the most cost-effective way to satisfy the future needs of an international telephone network, AT&T runs an optimization model (using Karmarkar's algorithm) involving 42,000 decision variables [12]. Aid in solving such large problems has been brought within the reach of a decision maker, thanks to modern IT.



These are examples in which computers solve well-formulated models under well-defined constraints and objectives. Recent AI techniques, however, have significantly expanded computers' capability to solve problems that are less structured and whose solutions require reasoning and perception—tasks which used to be exclusively in the domain of human intelligence. When a nuclear plant experiences irregular conditions, a computer system sends a warning message to engineers along with its own diagnosis and prescriptions. MYCIN assists physicians in the selection of appropriate antimicrobial therapy for hospital patients with blood infections [64]. Ford Aerospace uses Intellicorp's KEE to diagnose malfunctions in the company's communication satellites [27], and Inference Corporation has developed an expert system to help control the flight of the Space Shuttle [28]. American Express has an expert system which analyzes credit requests in order to determine whether or not to approve a transaction [24]. Avco Financial Services uses a neural network to evaluate loan applications [56].

While Herbert Simon's [58, 59] bounded rationality paradigm remains valid, the "bounds" that prohibit informed optimization have been constantly relaxed, and now the bounds take on different meaning and forms. Information systems have reduced decision information costs by allowing decision makers cost-effective access to information and powerful tools (e.g., simulation and econometric modeling) for analyzing the retrieved information. The improvement in decision quality in turn increases operational efficiency. For example, accurate forecasting of future demands, coupled with efficient handling of material flows and production scheduling, can achieve a significant reduction of inventory costs. Indeed, the impact of this information revolution has been felt at all levels of organizations, industry, and society as a whole.

Impacts of Information Technology on an Organization

We now study the impacts of IT on

two attributes of organizations—the location of decision rights and the size of the firm.

IT and Decision Rights. We have argued earlier that decision rights should be located where the sum of decision information costs and agency costs are minimized. IT enables organizations to process decision-relevant information in a more cost-effective way, thus improving the quality and speed of upper management's decision-making processes. This phenomenon may lead decision rights to move upward in the organizational hierarchy, leading to more *centralized* management.

- Many bank transactions previously processed locally by tellers are now handled by a centralized database/data communications system. Also, many nationwide hotel chains centrally process reservation transactions.
- Avis developed a computer-based optimization system that supports its fleet-purchasing plan, and Hertz developed a short-term fleet control system. In both cases, the related decision rights were more centralized [6, 20].
- DeLorean, upon arriving at Chevrolet, built an efficient information system to take control of business functions that previously were dispersed in thirteen plant sites [71].
- The Otis elevator company developed the OTISLINE applica tion system that centralized the customer service system, which previously had been distributed among numerous remote field offices [60].

At the same time, however, IT provides the ability to improve monitoring and performance measurement, reducing agency costs and thus inducing the *decentralization* of decision rights.

- An insurance company developed an application system that allowed it to measure the performance of a salesperson based on the entire portfolio of any customer rather than on a per-sale basis. This system increased the scope of decisions now made by the sales staff [10].
- According to [66] (also see [15]), the most significant organizational innovation of the 20th century was the development of the multidivisional (M-form) structure in which operating decision making is separated from strategic decision making and delegated to the divisional manager. This approach relieves the general office of routine operational activities so it can devote itself to monitoring divisional performance, allocating resources, and making strategic decisions. Williamson [66] adds, "And *the internal auditing and control techniques* which the general office had access to served to overcome information impactedness conditions and permit fine-timing controls to be exercised over the operating parts." Without doubt, IT was instrumental in providing efficient auditing and control techniques.

Indeed, a firm may use IT to centralize some decision rights while decentralizing others, leading to a hybrid structure. Clearly, the choice depends on the specific cost structures of the firm and the industry. All in all, therefore, the net effect of cost-effective IT on the location of decision rights is not so obvious. This bidirectional trend is consistent with the findings in the empirical literature [5].

IT and Firm Size. We noted earlier that both vertical and horizontal firm size are determined by trading off external coordination costs, internal coordination costs, and operational economies of scale. IT has a direct impact on optimal firm size by changing the underlying cost structure of a firm.

Cost-effective IT *reduces external coordination costs* in a variety of ways and can lead firms to turn to *markets* rather than to integrate vertically with factor suppliers. This result was previously reported in [43], which provides an excellent description of how these cost reductions are achieved.

- More than 70 percent of airline reservations are now made through travel agencies due to the introduction of CRSs [43]. Thus, flight reservation, which was previously an intrinsic function of the airline business, is now disintegrated from hierarchical control.
- As mentioned earlier, IT has facilitated the development of VAPs by allowing cost-effective interorganizational coordination [35]. Benetton [21], for example, operates a network of 4,000 shops in 62 countries with estimated revenues of $1.2 billion in 1989. The company uses a communication network that transfers daily retail sales data to corporate headquarters. Using advanced information systems, information specialists analyze large amounts of data to capture ever-changing consumer trends, and new fashion products are designed using CAD systems. Production is also highly computerized, and distribution processes are aided by robots. Each year 50 million pieces of clothing are distributed. Operations of this scale and agility were previously unheard of in the garment industry. In spite of its large-scale of operation, however, Benetton has only 1,500 employees and relies on a VAP consisting of hundreds of outside contractors and subcontractors employing 25,000 people scattered throughout the world. Relying on IT, Benetton manages a large horizontal scale of operation while being vertically small.

Note, however, that the impact

of new technology in computers and networking is not limited to the reduction of external coordination costs but extends to the *reduction of internal coordination costs*. Since internal coordination costs grow as firm size increases, the ability of inexpensive and powerful IT to reduce these costs may decrease their relative importance in the determination of optimal firm size. If everything else remains the same, by reducing internal coordination costs, cost-effective IT will induce a *vertically* and *horizontally larger* firm.

- As discussed earlier, it was not pure coincidence that the intensified evolution of the mid-1940s to the late 1960s which transformed modern corporations to M-forms, conglomerates, or multinational enterprises took place almost parallel in time with the diffusion of new telecommunication and computer technology [16, 66].
- To a certain extent, the evolution remains an ongoing process. The past two decades have witnessed a number of "megafirms" that are both vertically and horizontally large. For example, IBM, whose revenues have grown from $400 million in the early 1950s to $62.7 billion in 1989, remains vertically integrated from chip making to computer equipment production, distribution and systems integration. Its horizontal size, measured by the range of its product line and the geographic size of its market, is at an unprecedented level. GM is another example of a megafirm; it grew through a series of horizontal and vertical integrations and remains highly integrated (e.g., Delco, EDS, GMAC and Hughes). Similarly, Ford Motors recently purchased Associate First Capital to strengthen its financial service unit, obtained effective control over the Hertz car-rental company, and acquired Jaguar, a British auto company. Not surprisingly, these companies are frequently quoted as aggressive users of IT. Another such example is the Limited, a leading clothing manufacturer with sales of $4.6 billion, which pioneered the use of IT in the garment industry. Using a global telecommunication system, the Limited manages a highly integrated chain of design, manufacturing, marketing, distribution and retailing that spans the world [70].

In some information-intensive industries, certain synergistic activities that were previously too costly to govern and were therefore not performed, may now be amenable to hierarchical governance. In this case, IT has contributed to *increasing the degree of vertical integration* or *the scope of firm activities*.

- In the 1970s and early 1980s, Reuters Holding PLC, a British news agency, expanded its traditional news agency services to span the entire value-added chain of securities information services [70]. Reuters integrated 1) stock/news reporting, 2) stock quotation systems, 3) deal settlement networks, and 4) exchange systems. Further, Reuters also purchased Rich & Company, a leading developer of computerized trading systems [62, 70]. In the United States, Dow-Jones Inc. publishes the *Wall Street Journal* and operates the Dow-Jones stock/news retrieval system [70]. Dow-Jones recently acquired Telerate Systems Inc., which provides electronic stock quotation systems. Telerate recently acquired FX Development, which designs and develops computerized trading systems, and has a joint venture with AT&T to sell a computerized dialing system for foreign exchange [14, 63].
- A series of attempts have been made by several airlines, including UAL and SAS, to build an integrated travel service that combines the airline, car-rental and hotel businesses using a CRS [70]. The expected synergy from this integration along the service value chain is a more comfortable environment for the traveler. For example, a user of the integrated service does not have to claim his or her baggage at the destination airport but instead picks up a previously reserved rental car at the airport location and heads directly for the conference site (or the beach). Arriving at the hotel room, he or she finds the baggage that was checked at the beginning of the trip. Further, the whole trip is arranged either by a phone call to a travel agent or directly through a videotex system (such as CompuServe or Prodigy). While the attempt by UAL was aborted and that by SAS is still ongoing, these cases exemplify new synergies that can be realized by integrating multiple stages of a value delivery chain.

Finally, IT has been instrumental in *creating and reaping economies of scale in operations*. The recent trend of a firm's horizontal growth can be explained partly by the reduction of internal coordination costs and market transaction costs often accompanied by the *scale economies of production and information*.

- According to [16], the globalization of modern enterprises started in the late nineteenth and early twentieth centuries. To fully realize the scale economies arising from continuous process technologies, a number of firms in capital-intensive industries adopted the new transportation and communications technologies and grew to multinational enterprises (MNE) by investing abroad, first in marketing and later in production. During the two decades following 1950, international communication and computer networks became available and have been heavily utilized to coordinate marketing and production functions within a MNE. As the cost of accessing the international market has been further lowered in recent years, even medium-sized companies have been able to take a position

in the global market. This way, IT has been a major force in shaping the current configuration of modern global competition [16].

- In labor-intensive industries, which apparently have few economies of scale but require severe coordination for horizontal growth [16], a new breed of firms has harnessed scale economies by exploiting IT. Examples include Benetton and the Limited in the garment industry and CitiCorp and American Express in the finance market [70]. These firms have established new modes of competition in domestic and international markets by aggressively adopting modern IT. In the same vein, the last decade has seen a gradual shift to globalization in a number of classical service businesses, such as auditing, advertising, general trading and securities firms, where informational economies of scale exist [51].

Network-type businesses have also experienced considerable horizontal growth. In this case, the incentive toward horizontal integration is twofold: exploitation of the scale economies in operations arising from *network externalities* and savings in horizontal market transaction costs. Firms in network-type industries aggressively invest in IT to acquire the ability to control a *horizontally large* corporation.

- In the second half of the nineteenth century, the railroad industry experienced a series of horizontal mergers between neighboring railroad companies. Since there were few, if any, economies of scale in production or information, only the efforts to save on market transaction costs can possibly explain this phenomenon [66]. It should be noted that this saving was made possible partly through the telegraph and telephone systems, which provided a means to better coordination of interregional operations. In this example, cost-effective IT contributed to increasing the horizontal size of the firm.
- In the past decade following deregulation, network-based markets have experienced rapid concentration. In the airline industry, for example, the six largest carriers control 84 percent of the U.S. market, representing a large increase from 73 percent in 1978 [11]. IT, as manifested in CRSs and frequent-flier tracking systems, has been central in providing competitive advantage to the larger airlines.

In summary, we observe two opposing effects of IT on firm size, whose net effect may vary from situation to situation, depending on the cost structure of the firm and the modes of synergy generated by integration.

Conclusion

This article examines the impact of information technology on two attributes of firms—firm size and the allocation of decision rights among the various actors in a firm. Our approach builds on existing organization theories—agency theory and transaction cost economics. We present a model of a firm that develops the cost structure of markets and hierarchies by integrating elements of the two theories. Our analysis shows that a considerable share of the costs is related to the acquisition and processing of information and can therefore be reduced by the application of information technologies.

Our research shows that the direction of trends in the location of decision rights is not definitive and depends on other organizational and environmental factors such as the role of information systems in the firm, characteristics of the information flows, and organization culture. In fact, a firm may use information systems to decentralize some decision rights and to centralize others, exploiting the merits of both systems and leading to a hybrid structure.

We also demonstrate that when IT plays a significant role in reducing *internal coordination costs*, a firm may find it advantageous to grow horizontally and vertically. Megafirms, such as IBM and GM, have capitalized on IT to obtain such reductions, while also achieving scale economies in operations and reducing market transaction costs. On the other hand, value-added partnerships offer an alternative to the megafirm structure. Some firms have leveraged their use of IT to form VAPs. While a motivation of such an arrangement is the reduction in *market transaction costs* achieved through the nurturing of a cooperative relationship, IT facilitates the coordination necessary between the partners along the chain. Firms in a VAP obtain *operational scale economies* and lower internal coordination costs by choosing to be vertically small and horizontally large. In the garment industry, for example, the Limited is horizontally and vertically large, while Benetton is horizontally large but vertically small. Still other firms have experienced rapid horizontal growth to exploit operational economies of scale. A prominent example is in network-type businesses where scale economies arise from network externalities. Other examples include a number of service businesses, such as auditing, advertising, general trading and securities firms, where informational economies of scale exist. In all of these cases, IT is heavily relied on to facilitate internal coordination.

Previous research (e.g., [43]) has focused on the impact of IT on external coordination costs, leading to the prediction that vertical firm size will decrease as the use of IT grows. Our model shows that this is clearly one likely outcome. However, our results demonstrate the importance of developing an integrative model

that also considers internal coordination costs and the corresponding role of IT. Our model provides a comprehensive description of the cost structure of a firm. Based on the model, we conclude that a firm's use of IT can result in an increase or decrease in either the horizontal or vertical dimension of firm size.

It is hoped that our analysis provides a theoretical framework within which to assess the impact of an information system. The framework highlights the roles of information technology in organizational activities and their impact on the cost structures of firms and markets. It is important to note, however, that information systems should be assessed and compared with regard to specific managerial contexts. Business functions, market conditions, industry characteristics, and organization cultures each constitute different dimensions in which to evaluate an information system; a monolithic application of IT concepts at the firm level without regard to these factors is likely to be incomplete and incorrect. This observation leads to the conclusion that more focused investigation is necessary in order to understand the impact of IT on organizations and markets. One such avenue for further research is the pursuit of firm-level and industry-level cross-sectional analyses—which may bring invaluable insights to various issues raised, but not fully answered, in the present article.

Acknowledgments.

The authors have greatly benefitted from the constructive comments of Cynthia Beath, Chuck Holloway, Evan Porteus, Neal Stoughton, Nick Vitalari and the anonymous referees and the editor. The research was supported in part by the UCI Committee on Research and the Fletcher Jones Foundation.

References

1. Ackoff, R.L. Management misinformation systems. *Manage. Sci. 14,* 4 (Dec. 1967), B147–B156.
2. Alchian, A.A., and Demsetz, H. Production, information costs and economic organization. *Am. Eco. Rev. 62,* 5 (Dec. 1972), 777–795.
3. Allen B. Make information services pay its way. *Harvard Bus. Rev.* (Jan.-Feb. 1987), 57–65.
4. Arrow, K. Technical information, returns to scale, and the existence of competitive equilibrium. Tech. Rep. 465, IMSSS, Stanford University, May 1985.
5. Attewell, P. and Rule, J. Computing and organizations: What we know and what we don't know. *Commun. ACM 17,* 12 (Dec. 1984), 1184–1192.
6. *Avis Rent-a-Car.* Harvard Business case, 9-172-275, 1972.
7. Ball, R., and Brown, P. An empirical evaluation of accounting income numbers. *J. Account. Res. 6* (Autumn 1968), 161–234.
8. Bean, J., Noon, C., Ryan, S. and Salton, G. Selecting tenants in a shopping mall. *Interfaces 18* (Mar.-Apr. 1988), 1–9.
9. Bressand, A., Distler, C. and Nicolaidis, K. Networks at the heart of the service economy. *Strategic Trends in Services,* Bressand and Nicolaidis, Eds., Ballinger Publishing Company, 1989, 17–32.
10. Bruns, W.J. and McFarlan, F.W, Information technology puts power in control systems. *Harvard Bus. Rev.* (Sept.-Oct. 1987), 89–94.
11. *Business Week.* Is deregulation working? (Dec. 22, 1986), 50–55.
12. *Business Week.* The startling Discovery Bell Labs kept in the shadows. (Sept. 21, 1987), 69–70.
13. *Business Week.* EDS: How sweet it is to have a sugar daddy. (Sept. 18, 1989), 110–111.
14. *Business Week.* Bob Allen is turning AT&T into a live wire. (Nov. 6, 1989), 140–152.
15. Chandler, A.D. *The Visible Hand: The Managerial Revolution in American Business.* Cambridge Mass, Belknap Press, 1977.
16. Chandler, A.D. The evolution of modern global competition. In *Competition in Global Industries,* M.E. Porter, Ed., Harvard Business School Press, Boston, Mass. 1986, 405–448.
17. Clemons, E.K., and Row, M. McKesson Drug Company. *IEEE, TH 0214-7* (1988), 141–149.
18. Coase, R.H. The nature of the firm. *Economica 4* (Nov. 1937), 386–405.
19. De Alessi, L. Property rights, transaction costs, and X-efficiency: An essay in economic theory. *Am. Eco. Rev. 73,* 1, pp. 64–81.
20. Edelstein, M., and Melnyk, M. The pool control system. *Interfaces 8,* 1, Part 2 (Nov. 1977), 21–42.
21. Edvinsson, L. and Richardson, J. Services and thoughtware: New dimensions in service business development. *Strategic Trends in Services,* Bressand and Nicolaidis, Eds., Ballinger Publishing Company, 1989, 33–50.
22. Essinger, J. The debate over computer-assisted trading: Who is right? *Financial Executive* (Jan/Feb 1989).
23. Fama, E.F. Agency problems and the theory of the firm. *J. Polit. Eco. 80,* 21 (April 1980), 288–307.
24. *Fortune.* Now, live experts on a floppy disk. (Oct. 12, 1987), 69–82.
25. *Fortune.* The winning organization. (Sept. 26, 1988), 50–60.
26. Hayek, F.A. The use of knowledge in Society. *Am. Eco. Rev. 35,* 4 (Sept. 1945), 519–530.
27. *High Technology.* Intellicorp: The selling of artificial Intelligence. (Mar. 1985), 22–25.
28. *High Technology.* Software tools speed expert system development. (Mar. 1985), 16–20.
29. Huber, G.P. A theory of the effects of advanced information technologies on organizational design, intelligence, and decision making. *Acad. Manage. Rev. 15,* 1 (Jan. 1990), 47–71.
30. Ives, B. and Learmonth, G. The information system as a competitive weapon. *Commun. ACM 27,* 12 (Dec. 1984), 1193–1201.
31. Jackall, R. *Moral Mazes.* Oxford University Press, New York, 1988.
32. Jensen, M.C. Lectures on organization theory. William E. Simon Graduate School of Business Adminstration, University of Rochester, 1985.
33. Jensen, M.C. Takeovers: Folklore and science. *Harvard Bus. Rev.* (Nov-Dec 1984), 109–121.
34. Jensen, M.C., and W.H. Meckling. Theory of the firm: Managerial behavior, agency costs and ownership structure. *J. Financ. Eco. 3* (Oct. 1973), 305–360.
35. Johnson, R. and Lawrence, P.R. Beyond vertical integration-The rise of the value-adding partnership. *Harvard Bus. Rev.* (July–Aug. 1988), 94–101.

36. Katz, M.L and C. Shapiro. Network externalities, competition, and compatibility. *The Am. Eco Rev.* (June 1985), 424–440.
37. Keen, P. *Competing in Time: Using Telecommunications for Competitive Advantage.* Ballinger Publishing Company, Cambridge, Mass., 1988.
38. Klein, B., Crawford, R. and Alchian, A. Vertical integration, appropriable rents, and the competitive contracting process. *J. Law and Eco. 21* (Oct. 1978), 297–326.
39. Kling, R. Social analyses of computing: Theoretical perspectives in recent empirical research. *Comput. Surv. 12*, 1 (Mar. 1980), 61–110.
40. Levinthal, D. A survey of agency models of organizations. Tech. Rep. 443 Center for Research on Organizational Efficiency, Stanford University, March 1984.
41. Linder, J. Frito-Lay, Inc.: A strategic transition. Harvard Business Case 0-187-065, Harvard Business School, 1986.
42. *Los Angeles Times.* Forging an Economic Miracle, May 23, 1988.
43. Malone, T.W., Benjamin, R.I. and Yates, J. Electronic markets and electronic hierarchies: Effects of information technology on market structure and corporate strategies. *Commun. ACM 30*, 6 (June 1987), 484–497.
44. Markus, L. Chargeback as an implementation tactic for office communication systems. *Interfaces 17*, 3 (May-June 1987), 54–63.
45. Markus, L. and D. Robey. Information technology and organizational change: Causal structure in theory and research. *Manage. Sci. 34*, 5 (May 1988), 583–598.
46. Mendelson, H. *The Economics of Information Systems Management.* Prentice-Hall, Englewood Cliffs, N.J., 1991.
47. Okimoto, D.I. *Between MITI and the Market: Japanese Industrial Policy for High Technology.* Stanford University Press, Stanford, Calif. 1989.
48. Ouchi, W.G. Markets, Bureaucracies, and Clans. *Adminis. Sci. Q. 25* (Mar. 1980), 129–141.
49. Ouchi, W.G. *Theory Z.* Avon Books, 1982.
50. Patell, J.M., and Wolfson, M.A. Anticipated information releases reflected in call option prices. *J. Account. Eco. 1* (Aug. 1979), 117–140.
51. Petit, P. The organizational approach to internationalization of services. In *Strategic Trends in Services,* Bressand and Nicolaidis, Eds., Ballinger Publishing Company, 1989, 121–136.
52. Porter, M.E. and Millar, V.E. How information gives you competitive advantage. *Harvard Bus. Rev. 63*, 4 (July 1985), 149–160.
53. Roll, R. Orange juice and weather. *Am. Eco. Rev. 74*, 5 (Dec. 1984), 861–880.
54. Ross, S. The economic theory of agency: The principal's problem. *Am. Eco. Rev LXIII*, 2 (May 1973), 134–139.
55. Samuelson, P. *Economics,* 10th Edition, 1976, McGraw-Hill Kogakush, Ltd.
56. *San Jose Mercury News.* Neural Networks are being taught how to learn. Dec. 8, 1987.
57. Signorelli, S. and Heskett, J.L. Benetton. Harvard Business case 9-685-014, 1986.
58. Simon, H.A. *Administrative Behavior.* MacMillan, N.Y., 1947.
59. Simon, H.A. A behavioral model of rational choice. *Q. J. Eco. 69* (Feb. 1955), 99–118.
60. Stoddard, D. OTISLINE. Harvard Business case 9-186-304, Harvard Business School, 1986.
61. Tirole, J. Hierarchies and bureaucracies: On the role of collusion in organizations. *J. Law, Eco., and Org., 2* (1986), 181–214.
62. *Wall Street Journal.* Dow-Jones & Co., telerate approve definitive merger. Nov. 6, 1989.
63. *Wall Street Computer Review.* Trading systems: To build or to buy. (Jan. 1989), 36–44.
64. Waterman, D.A. *A Guide to Expert Systems.* Addison Wesley, Reading, Mass., 1986.
65. Williamson, O.E. *Markets and Hierarchies.* Free Press, N.Y., 1975.
66. Williamson, O.E. The modern corporation: Origins, evolution, attributes. *J. Eco. Lit. 19* (Dec. 1981), 1537–1568.
67. Williamson, O.E. *The Economic Institutions of Capitalism.* 1985.
68. Wilson, R. The theory of syndicates. *Econometrica 36* (Jan. 1968), 119–132.
69. Wilson, R. Informational Economies of Scale. *Bell J. Eco. 6* (1975), 184–195.
70. Wiseman, C. *Strategic Information Systems,* Irwin, Homewood, Ill., 1980.
71. Wright, J.P. *On a Clear Day You can See General Motors.* Wright Enterprises, 1979.
72. Zimmerman, J. The costs and benefits of cost allocations. *The Account. Rev. LIV,* 3 (July 1979), 504–521.
73. Zmud, R.W. and Apple, L.E. Measuring the infusion of a multibusiness unit innovation. Working Paper, Florida State University, 1988.

CR Categories and Subject Descriptors: K.4.3 **[Computers and Society]:** Organizational Impacts

General Terms: Economics, Management

Additional Key Words and Phrases: Agency theory, decision rights, firms and markets, firm size, transaction cost economics

About the Authors:

VIJAY GURBAXANI is an assistant professor of information systems and computer science at the Graduate School of Management at the University of California, Irvine. His primary research interests are in the application of microeconomics to the study of managerial issues in the information systems context. Major foci of his research include information systems budgets, the diffusion of information technology, and the organizational impacts of information technology. **Author's Present Address:** University of California, Irvine, Graduate School of Management, Irvine, CA 92717; email: Vijay@Ucippro (Bitnet); Vgurbaxa@uci.edu. (Internet).

SEUNGJIN WHANG is an assistant professor of decision sciences and Fletcher Jones Faculty Scholar for 1989–90 at the Graduate School of Business, Stanford University. His research interests include the control of computer resources within an organization, the impact of information technology on organizations and markets, and the issues of standards and compatibility of information systems. **Author's Present Address:** Stanford University, Graduate School of Business, Stanford, CA 94305; email: Fwhang@gsb-why.stanford.edu.