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COORDINATING PLANS AND ACTIONS

If there really were some basic intrinsic advantage to a system which employed prices as planning instruments, we would expect to observe many organizations operating with this mode of control, especially among multidivisional business firms in a competitive environment. Yet the allocation of resources within private companies (not to mention governmental or nonprofit organizations) is almost never controlled by setting administered transfer prices on commodities and letting self-interested profit maximization do the rest. The price system as an allocator of internal resources does not pass the market test.

Martin Weitzman[1]

[I]t is surely important to inquire why coordination is the work of the price mechanism in one case and of the entrepreneur in another.

Ronald Coase[2]

[M]odern business enterprise took the place of market mechanisms in coordinating the activities of the economy and allocating its resources. In many sectors of the economy, the visible hand of management replaced what Adam Smith referred to as the invisible hand of market forces.

Alfred Chandler[3]

In this chapter we explore some of the many ways in which economic coordination is achieved in economies and within organizations other than through a highly decentralized system of prices and markets. We examine the characteristics of different specific sorts of coordination problems and of the mechanisms used to solve them, and we develop elements of theories to help us understand which solutions are efficient in which situations. Because the subject matter of this chapter has received less

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[1] "Prices versus Quantities," *Review of Economic Studies*, 41, October 1974, 477–91.

[2] "The Nature of the Firm," *Economica*, 4, 1937, 386–405.

[3] *The Visible Hand: The Managerial Revolution in American Business* (Cambridge, MA: The Belknap Press of Harvard University Press, 1977), p. 1.

scrutiny from economists than other parts of the theory of organizations, the development here is less complete and the conclusions more tentative than elsewhere in this text.

In Chapter 3, we saw that a price system could sometimes solve the fundamental and immensely complex problem of coordinating the plans and actions of all the diverse decision makers in a modern economy. According to the central result developed there in the fundamental theorem of welfare economics, if prices on a complete set of competitive markets are set so that the quantities of each good supplied and demanded are equal, then the resulting allocation of resources is efficient. Moreover, the price system achieves this remarkable feat of coordination without requiring communication among individual decision makers of anything more than the summary information about the economy embodied in the prices and without requiring any individual to do other than what he or she deems to be in his or her own best interests. We also saw that sometimes the price system can be used inside firms to obtain similarly efficient results. And even though actual markets do not fully meet the assumptions of the theorem, the evidence across nations and over the years is overwhelming that a decentralized system of prices and markets based on private ownership is an extremely effective mechanism for solving the coordination problem.

Yet, as Martin Weitzman argues in the quotation that opens this chapter, formal organizations make at most quite limited use of prices to coordinate their internal activities. Indeed, as we have suggested already in Chapters 2 and 3, organizations can be thought of as arising and supplanting the market when they offer more efficient mechanisms for coordinating economic activity and motivating people to carry out the resulting plans. Given this, it would be somewhat surprising to see them rely very heavily on an internal price system. Instead, managers more usually formulate general strategies, make these operational by specifying quantitative goals, develop specific plans to realize these goals, and then direct people to carry out their specified roles using the resources they have been allocated. Routines are developed, and administrative processes and procedures are instituted to guide activity. All this is done in telephone conversations and meetings and is embodied in memos and spreadsheets. The language used is not that of prices but rather of technological, organizational and individual capabilities, quantitative performance levels, specific plans and budgets, and detailed work assignments and operations schedules. And when changing availabilities and capabilities of people and physical resources within the organization require adaptation, the signals that indicate this need and guide the organization's responses are rarely prices.

Even in market systems, there is extensive use of means of coordination besides prices. Governments in particular favor giving direct orders that specify particular actions to be taken. They set quantity limits on the pollutants that a vehicle or factory can emit, on the amounts of impurities that foods and medicines can contain, on the speed that drivers can select, and on the minimum number of years children must spend in school. They command resources directly, as in a system of compulsory military service. They provide goods and services without explicitly pricing them: roads, police services, health care, food for the needy, and so on. In some countries, including Japan and South Korea, they target industries for expansion and new technologies for development and then coordinate explicitly the realization of these plans. In the centrally planned communist economies, governments have attempted to coordinate the finest details of resource allocation through quantity plans and orders. And, during World War II, government planners in the most market-oriented economies directed the production and use of a variety of high-priority goods, including not just steel and rubber, but also sugar and meat.

Moreover, firms often do not arrange their dealings with one another as simple market transactions. For example, they may work cooperatively with their suppliers to develop together the specifications for the inputs they seek, and they negotiate complex requirements contracts under which one firm has the power to direct how much the other will supply to it. Less formally, they may share information on plans and estimated requirements. They set up joint ventures and enter other sorts of alliances, they design complex royalty agreements and franchise contracts, and they put law firms on retainer, paying them even if they do not use their services. Within these relationships, they may exchange large amounts of information and often formulate joint plans.

In Chapter 3 we explored reasons why a price system would not yield an efficient outcome and so might be replaced: increasing returns, externalities, missing insurance and futures markets, excessive search costs, and the possibility of unemployment equilibria. In this chapter we focus mostly on situations where, in principle, the price system could be used and the fundamental theorem of welfare economics would hold, and yet other mechanisms for coordination are actually employed.

Planning and coordinating economic activity never come for free. It takes real resources to plan—people with offices, files, data banks, and the computing and communication equipment to support them. In addition to the planners' time, planning demands time from production people who must fill out forms, complete reports, and answer the planners' queries. At the end of the planning process, errors inevitably still occur, both because the prices or plans are based partly on guesses and partly on erroneous, incomplete, or misleading information and because miscalculations and mistakes occur.

In actual economies, a loose mix of systems is used to coordinate and manage the various kinds of activities. What determines which system is or ought to be used in any particular set of circumstances? How can we account for Weitzman's observation that prices are often ignored in internal decision making, so that "the price system as an allocator of resources does not pass the market test"? To answer these questions, we need to study coordination problems and systems in more detail.

The Variety of Coordination Problems and Solutions

Robinson Crusoe, living alone before meeting Friday, took care of all his own needs. Gathering and preparing his own food and securing his own shelter, Crusoe spent no effort coordinating his activities with those of anyone else. The need for coordination comes from specialization, in which various tasks are divided among a group of people, each of whom relies on the others for part of the job. As noted in Chapters 2 and 3, specialization creates the opportunity for enormous increases in productivity. People who specialize in a job can prepare specialized tools, gain specialized training, develop specialized methods, and exploit their accumulated experience to get more done, more quickly and with fewer resources.

The kind of coordination that is most effective depends on the nature of the task. It is helpful to distinguish among several kinds of problems to understand the kinds of solutions that are used. The most general kind of coordination problem we consider is called a **resource allocation problem**. This is a problem of allocating a fixed set of resources among various possible uses. The term resource can be interpreted broadly enough to classify virtually every kind of important economic or business decision as a resource allocation problem. In this chapter, however, it is useful to distinguish particular attributes of resource allocation problems that make one system of coordination or another especially effective.

Design Attributes

We are especially interested in problems with **design attributes**. These are problems in which (1) there is a great deal of *a priori* information about the form of the optimal solution, that is, about how the variables should be related, and (2) failing to achieve the right relationship among the variables is generally more costly than are other kinds of errors, including especially slight misspecifications of the overall pattern, as long as the individual pieces fit. In this discussion, the word design is a general term describing a system in which the pieces must fit together in a predictable way, thus narrowing the search for efficient decisions. Two common kinds of problems with design attributes are synchronization problems and assignment problems.

Synchronization Problems An extreme example of a **synchronization problem** arises in the sport of crew, in which it is crucially important that each rower make his or her stroke at precisely the same moment. The coxswain solves the synchronization problem by determining a rhythm for the crew and calling out the signal for each stroke. Like most centrally directed solutions, synchronization has the disadvantage that the centrally made decision cannot be fully responsive to information of the others in the system. In this case, the coxswain can only guess how tired the individual crew members are. This could be an important disadvantage if the coxswain pushes the crew too hard early in the race, leaving them too weak for a strong finishing sprint. However, the great advantage of the system is it synchronizes the actions of the crew, making their individual efforts much more effective. The costs of not setting quite the right pace are very small compared to those of failing to have everyone pulling in unison.

Though it seems ridiculous to contemplate using prices in this context, it is illuminating to see what a price solution for this problem would be and why it would not work well. In this application, a price system would entail the coxswain telling each rower the "price" of effort, that is, how valuable a unit of extra effort at this moment would be to the team. Then, each rower would choose his or her own action, taking full account of his or her own physical condition and the summary information supplied in the form of prices by the coxswain. In principle, if the coxswain could determine the right prices and could costlessly communicate them to the crew, and if the crew could make the right decisions based on that information, the resulting level of effort would be just right. In practice, a system of prices would fare badly for various reasons. First, it would be too difficult or costly for the coxswain to obtain the relevant information from the rowers and then to determine the prices. Second, communicating the prices back to the rowers would be too difficult and too slow. Third, the crew might respond inaccurately to the prices, failing to achieve coordination even if the prices were set correctly. Finally, small errors that disturbed the synchronized rhythm of the crew would be very costly. The price system has the same advantages in this application as in others with multiple producers. It takes full account of information about the individual condition of each producer, but that advantage comes at too high a cost in this synchronization problem.

Assignment Problems Similar difficulties arise in **assignment problems**, in which there are one or more tasks to accomplish and there is a need for just one person or unit to do each. The coordination problem is to ensure that each task is done and that there is no wasteful duplication of effort. For example, if someone is seriously injured in an automobile accident, there typically is a need for one ambulance at the site of the accident as soon as possible. In practice, someone calls for an ambulance and then a central dispatcher assigns a particular ambulance to drive to the site. Even coordination be achieved? The answer is that the design variables themselves should be communicated. Each rower in the crew must know the intended stroke rate; the timing needs to be communicated to the rower. Each member of the product introduction team must know the introduction date and the weight and other design parameters of the new car. The ambulance driver must be told which crisis to attend, when, and where. This form of control minimizes communication by the Hurwicz criterion and reduces the cost of error associated with more indirect methods. The appendix to this chapter contains a more formal treatment of design decisions, establishing that communicating the design variables is informationally efficient for the class of design decisions, just as communicating prices is informationally efficient for the class of resource allocation problems treated in the informational efficiency theorem.

Coordination and Business Strategy

Strategic business decisions present complicated problems. Good strategic decision making virtually always requires that effective use be made of line managers' knowledge about how the operations actually work and what capabilities the business has, but they may also involve using knowledge about new technologies, new markets, new business partners, or new forms of organization about which the line managers' knowledge may be limited. In our lexicon, strategic decisions often have innovation attributes. In addition, especially in manufacturing industries, but in some service industries as well, there are important economies of scale that mitigate against completely decentralized decision making. Finally, as we argue later, business strategy decisions commonly have important design attributes. There are predictable elements of fit in any good strategy that make it important to coordinate the actions of various parts of the organization closely. All these factors work against using prices or other very decentralized means of coordination and favor direct communication and other more systematic, centralized control systems.

Scale, Scope, and Core Competencies of the Firm

As we have already seen, when there are scale economies, the efficient level of output in a firm cannot be determined by prices alone. *Operational scale* itself is a design variable. Depending on the volume of sales that a firm anticipates, it will adjust its production capacity and the size of its sales force and secure supplies and distribution equipment and facilities (such as trucks and warehouses)—all tailored to the expected scale of its operations. If the actions taken by the marketing, production, personnel, distribution, and procurement managers are to be coherent, then all these people need a shared vision of the intended scale of operations.

Scale and Structure The anticipated scale of a firm's operations predictably affects more than just the scale of each part. As the GM and Toyota examples from Chapter 1 illustrate, it also determines the degree of specialization the firm should adopt. With larger operations, a firm may be able to afford more specialized equipment, more distribution outlets located nearer to customers, a larger number of plants, training programs for its employees tailored to particular circumstances, and so on. A smaller firm, operating without specialized equipment, may be more likely to rely on suppliers for many more of its components because the suppliers may be better positioned to enjoy economies of scale of their own by serving many firms. Thus, a larger firm with more specialized capital equipment may find it profitable to be more vertically integrated than would its smaller competitors. By definition, economies of scale in production allow a firm to reduce its costs compared to small-scale production, and these costs are an important element in determining the prices to be charged. Lower marginal costs, other things equal, lead the firm to charge lower prices, which increases the potential product demand, which in turn supports an increased scale of production.

Operational scale is a design variable because it meets the two conditions. It has predictable implications for the various parts of the organization, and many of the mistakes associated with incorrect perceptions of scale by parts of the organization—for example, having too few raw materials or components to keep an expensive factory operating at full capacity—can be very high. Thus, firms that are large enough to assign different management functions to different decision makers take special pains to forecast market growth, competitors' plans, technical changes, input availabilities, and so on, all so that they can use those forecasts to plan the growth (scale) of their own operations and coordinate based on these plans. By making sure that its managers share common expectations about what it is trying to do, the firm takes an important step toward coordinating their plans and behavior.

ECONOMIES OF SCOPE Even when a firm operates at too small a scale in any individual product market to enjoy significant economies of scale, it may still enjoy them in producing components that are used in each of several products. For example, a firm like General Electric may enjoy economies of scale in producing small electric motors, using those motors to make food processors, hair dryers, fans, vacuum cleaners, and various other products. A firm like Casio may enjoy economies of scale in the manufacture of liquid crystal displays (LCDs), using them to produce calculators, wristwatches, electronic address books, and other products.

In these sorts of circumstances, the firms are said to enjoy *economies of scope*; that is, they can produce their several products together at less cost than could a group of single-product firms. Unsurprisingly, economies of scope entail all the same needs for coordination that economies of scale do. The problems are often harder, however, because coordination in planning is required among the managers responsible for different products. As Casio grew, for example, a forecast of large sales in the market for calculators led to falling costs for LCDs, making it more profitable to enter the market for wristwatches that use LCDs.

CORE COMPETENCIES When a firm introduces new products relatively frequently, one very important kind of scale economy that it may enjoy is at the level of product development. That is, a firm may acquire generalized expertise in the important skills that are required to design and market new products in a set of related markets or in using a set of related technologies. For example, a computer maker may develop expertise in microprocessor design, display technologies, memory chips, operating systems, computer manufacturing, data communications, networking, and so on—skills that it expects to be able to apply over and over again as it continues to introduce new products. Scale economies at this level are so important in modern management theory that a new name has been coined for them: **core competencies of the firm**. In a dynamic environment, a firm's capacity to introduce new products and to manufacture them efficiently can be even more important than are the economies of scale it achieves in making its existing product line. In that setting, a strategy of developing scale economies translates into one of building the core competencies of a firm.

In an abstract sense, core competencies are just another kind of shared component, but there is an important practical difference in that the cost of building the competency is shared with a series of products that does not yet exist. Investments in new manufacturing technologies today may actually raise the costs of today's products if the old manufacturing system is well understood and well implemented. The gains to be enjoyed on account of the new system will come over a longer period, as the firm learns to use the new system, refines its methods, and adjusts the rest of its operations to take full advantage of the capabilities of the new technology. In such a case, managers need to plan for the demands of generations of products not yet even imagined. They also need to keep the price of the current products low enough to sustain a strong volume of sales, even if the company appears to be losing money on each sale, recognizing that these losses are actually an investment in the capabilities needed to produce profitable products in the future. This is just another illustration that when there are economies of scale, individual production and pricing decisions cannot be evaluated in isolation.

More controversially, the same ideas may be applied at the level of national industrial planning—a process about which many economists are skeptical but which has been used successfully in Japan and South Korea. The key first step in successful planning is to identify (groups of) industries to promote, which "fit" together with each other and with the country's existing competencies and advantages. For example, in Japan, the push to develop high-definition television (HDTV) in the 1990s is firmly grounded in that nation's strong positions in semiconductors, consumer electronics, and display technologies. To coordinate Japan's drive into HDTV, the Japanese national broadcasting company, NHK, has announced a set of technological standards that serves both to focus cooperative development efforts within groups of Japanese firms and to intensify competition among groups.

Complementarities and Design Decisions

Complementarities among a set of activities are an important source of design attributes. The standard definition of complementarity in economics is market oriented. Two inputs to a production process are said to be *complements* if a decrease in the price of one causes an increase in the demand for the other. In order to be able to employ the concept of complementarity usefully to study choices of levels of various internal activities as well as levels of input purchases, we introduce an alternative, more inclusive, definition: Several activities are mutually **complementary** if doing more of any one activity increases (or at least does not decrease) the marginal profitability of each other activity in the group.[8]

For example, where there are declining marginal costs due to learning or other kinds of economies of scale in producing a component, then the activities of producing various products using those components are complements. If General Electric's marginal cost of producing small electric motors declines with increasing volume, then the activities of producing electric fans and food processors are complementary because producing more fans makes it cheaper and therefore more profitable to produce more food processors as well.

Complementarities lead to predictable relationships among activities. A decision to increase the level of one activity will raise the profitability of any contemplated increases in levels of any complementary activities. Thus, high levels for all the elements of a group of complementary activities go together. This predictability is one

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[8] In mathematical terms, the complementarity relationship among a group of activities can be characterized as follows. Let $x = (x_1, \ldots, x_n)$ be the levels at which the activities are conducted and let $\pi(x)$ be the resulting profits. If π is a smooth function, then the activities are mutual complements if for all $i \neq j$, $\partial^2\pi/\partial x_i \partial x_j \geq 0$; an increase in the j^{th} activity raises the marginal return to the i^{th} activity.

When a change occurs that makes any one of the complementary activities more profitable or less costly and encourages the firm to do more of that activity, then the marginal returns to the other activities are also increased, leading to more of those activities as well. The increased levels of the complementary activities further increase the marginal returns to the first activity, possibly leading to another round of increases in it and all the related activities.