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Organizational Capabilities and the Economic History of the Industrial Enterprise

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As a historian who has spent a career in examining the operations and practices of business firms, I have not given much thought to precise definitions of the firm. I have had little trouble locating information on literally hundreds of individual enterprises. Nor do individuals have difficulty in identifying the firms in which they work or the securities of those in which they invest.

But for economists, the question of defining a firm and its role and functions in modern economies is more significant and complex. Ronald Coase (1937) first raised the theoretical issue years ago when he asked (p. 388): If economics generally argues that the coordination of the flow of goods and services is done through the price mechanisms, "why is such an organisation necessary?" Therefore, he continued (p. 390), "our task is attempt to discover why a firm emerges at all in a specialised exchange economy."

At least four attributes of the firm have since appeared in the theoretical literature. The firm is a legal entity—one that signs contracts with its suppliers, distributors, employees and often customers. It is also an administrative entity, for teams of managers must coordinate and monitor its different activities. Once established, a firm becomes a pool of physical facilities, learned skills and liquid capital. Finally, although this is rarely mentioned in the literature, "for profit" firms have been and still are the primary instruments in capitalist economies for the production and distribution of current goods and services and for the planning and allocation for future production and distribution. I think most economists would agree at least on the first three of these attributes of the firm.

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In both *The Visible Hand* (1977) and *Scale and Scope* (1990), I've concentrated on practice rather than theory. In the first, I investigated the beginnings and subsequent development of what I term the modern multi-unit enterprise (a firm consisting of more than a single plant, shop, or office) in American transportation, communication, production and distribution. In *Scale and Scope*, I focused on the history of the modern industrial firm—the most complex and the most transforming of modern business enterprises—from the 1880s, when such firms first appeared, through World War II. I did so by comparing the fortunes of more than 600 enterprises—the 200 largest industrial firms at three points in time (World War I, 1929, and World War II) in each of the three major industrial economies—those of the United States, Britain and Germany —which until the Great Depression produced two-thirds of the world's output of industrial goods.

What I plan to do in this paper is first to describe the similarities in the historical beginnings and continuing evolution of these enterprises, and then to outline my explanation for these similarities. Next, I relate my explanation of these "empirical regularities" to four major economic theories relating to the firm: the neoclassical, the principal-agent, the transaction cost, and the evolutionary. In the final section, I try to indicate the value of the transactions cost and evolutionary theories to historians and economists who are attempting to explain the beginnings and growth of modern industrial enterprises.

Regularities Described

A new type of industrial enterprise appeared suddenly in the last two decades of the 19th century. Throughout the 20th century, these firms were created and continued to grow in much the same manner, and they continued to cluster in industries with the same characteristics. These industrial firms first appeared as modern transportation and communication networks were completed—networks that themselves were built, operated, enlarged and coordinated by large hierarchical firms. By the 1880s, the new railroad, telegraph, steamship and cable systems made possible the steady and regularly scheduled flow of goods and information, at unprecedented high volume, through the national and international economies. Never before could manufacturers order large amounts of supplies and expect their delivery within, say, a week; nor could they promise their customers comparable large-scale deliveries on some specific date. The potential for greatly increased speed and volume of production of goods generated a wave of technological innovations that swept through western Europe and the United States during the last decades of the 19th century, creating what historians have properly called the Second Industrial Revolution (to differentiate it from the "first" that occurred in Britain at the end of the 18th century, through the application of coal produced steam-powered machinery to mining and the production of textiles, metals and metal products).

Old industries were transformed, including the making of steel, copper and aluminum; the refining of oil and sugar; the processing of grain and other agricultural products; and the canning and bottling of the products thus processed. New industries were created. In chemicals, new processes produced man-made dyes, medicines, fibers and fertilizers. New mass-produced office, agricultural and sewing machines quickly came on the market, as did heavy machinery for a wide variety of industrial uses. The most revolutionary of the new technologies were those that generated and transmitted electricity for lighting, urban traction and industrial power. These new industries drove economic growth and played a critical role in the rapid reshaping of commercial, agrarian, and rural economies into modern, urban industrial ones. The newly formed enterprises that created and expanded these industries almost immediately began to compete in international markets.

Firms in these transformed or new industries differed from older ones, like textiles, apparel, furniture, lumber, leather, publishing and printing, shipbuilding and mining. The new firms were far more capital-intensive, and able to exploit the potential of economies of scale and scope made possible by the new technologies of production far more effectively. Nevertheless, as I wrote in *Scale and Scope* (1990, p. 24):

> These potential cost advantages could not be fully realized unless a constant flow of materials through the plant or factory was maintained to assure effective capacity utilization. If the realized volume of flow fell below capacity, then actual costs per unit rose rapidly. They did so because fixed costs remained much higher and "sunk costs" (the original capital investment) were also much higher than in the more labor-intensive industries. Thus, the two decisive figures in determining costs and profits were (and still are) rated capacity and throughput, or the amount actually processed within a specified time period. (The economies of scale theoretically incorporate the economies of speed, as I use that term in *The Visible Hand*, because the economies of scale depend on both size—rated capacity—and speed—the intensity of which the capacity is utilized.) In the capital-intensive industries the throughput needed to maintain minimum efficient scale required careful coordination not only of the flow through the processes of production but also the flow of inputs from suppliers and the flow of outputs through intermediaries to final users.

Such coordination did not, indeed could not, happen automatically. It demanded the constant attention of a managerial team or hierarchy. The potential economies of scale and scope, as measured by rated capacity, are the physical characteristics of the production facilities. The actual economies of scale and scope, as measured by throughput, are organizational. Such economies depend on knowledge, skill, experience, and teamwork—on the organized human capabilities essential to exploit the potential of technological processes.

Examples of the cost advantages of the economies of scale and scope in the new capital-intensive industries of the Second Industrial Revolution are dramatic. During the 1880s, John D. Rockefeller's Standard Oil Trust concentrated its refining of kerosene in three major new 6,500 barrel-a-day works that reduced unit costs from close to 2.5 cents in 1880, when the largest plants had a capacity of 1,500 to 2,000 barrels a day, to .45 cents in 1885. This reduction permitted Standard Oil's U.S.-made kerosene to outsell competitors in the European market using Russian oil and those in the Asian markets using East Indian oil. Its direct successor, Exxon, is still the world's largest oil company. As to scope, three German firms—Bayer, BASF and Hoechst, still today more than a century later the world's three largest chemical companies—reduced the cost of a single dye, Alizarin, from close to 200 marks per kilo in the early 1870s to 23 marks in 1878 and to 9 marks by 1886. By the 1890s, these firms concentrated their production in one or two giant works on the Rhine in which raw materials brought by water and rail were transformed into a variety of intermediate chemicals which in turn were processed into hundreds of different finished dyes and pharmaceuticals. The addition of each new dye or pharmaceutical added little to the overall production costs and thus permitted the reduction of the unit costs of each individual dye and pharmaceutical far below those of their smaller competitors.

Such enterprises in these new capital-intensive industries began and continued to grow in similar ways. All exploited the cost advantages of scale and scope. Nevertheless, the investment in production facilities large enough to exploit these advantages were in themselves not enough. As is described later, two other sets of investments were made. The entrepreneurs organizing these enterprises created national and then international marketing and distributing organizations. They then had to recruit teams of lower and middle managers to coordinate the flow of products through the processes of production and distribution, and teams of top managers to monitor current operations and to plan and allocate resources for future ones. The first firms to make the three-pronged investments in manufacturing, marketing, and management essential to exploit fully the economies of scale and scope quickly dominated their industries. Most continued to do so for decades.

The tripartite investment by the "first movers," as I term them, provided a base upon which managers and workers learned the potential of the new technologies and the ways of improving processes of production and distribution. Challengers had to construct plants of comparable size and do so after the first movers had already begun to work out the bugs in the new production processes. The challengers had to create distribution and selling organizations to capture markets where first movers were already established. They had to recruit management teams to compete with those already well down the learning curve in their specialized activities of production, distribution, and (in technologically advanced industries) research and development. Such challengers did appear, but only a few of them.

In the new and transformed capital-intensive, oligopolistic industries, the first movers and challengers competed vigorously for market share in national and international markets. Although product pricing remained a significant competitive weapon, these firms competed even more forcefully through functional and strategic efficiency: that is, by carrying out processes of production and distribution more capably; by improving both product and process through systematic research and development; by locating more suitable sources of supply; by providing more effective marketing services; by product differentiation (in branded packaged products primarily through advertising); and by moving more quickly into expanding markets and out of declining ones. In this climate of oligopolistic competition, market share and profits changed constantly.

Consider the history of the automobile industry. Volume production began in the United States in the 1910s. By the 1920s the Big Three dominated the U.S. industry. (In 1935, they accounted for 90 percent of the output.) Except for the Hitler-sponsored "people's car," Volkswagen, that went into production in 1940, today's European leaders dominated their national markets by the early 1930s. Except for Honda, established in 1948, the producers that today account for 90 percent in Japan were all in production during the 1930s. In this industry where the major players remained much the same for well over half a century, market share has changed constantly. And those changes resulted far more from functional and strategic competition than from price competition (Bardou, 1982).

Such competition for market share kept oligopolies from becoming monopolies. The cumulative learning sharpened by such oligopolistic competition created organizational capabilities that became powerful barriers to new entrants. Such capabilities accounted for the long-term persistence of profits by the same players over the decades. Such capabilities and the resulting retained earnings became the basis for their continued growth.

Firms grew by moving backward to control materials and forward to control outlets (vertical integration); but, as will be described shortly, they did so largely in response to the specifics of the short-lived business needs or opportunities. For most, the long-term continuing strategy of growth was expansion into new geographical or product markets. The move into geographically distant areas was normally based on the competitive advantages provided by organizational capabilities learned through exploiting economies of scale. Moves into related product markets rested more on capabilities developed from the exploiting of the economies of scope.

The Importance of Organizational Capabilities

Organizational capabilities, honed by oligopolistic competition, provided the dynamic not only for the continuing growth of such firms, but also for the

industries which they dominated, and for the national economies in which they operated. They were created during the knowledge-acquiring processes that are always involved in commercializing a new product for national and international markets. These learned capabilities resulted from solving problems of scaling up the processes of production, from acquiring knowledge of customers' needs and altering product and process to services needs, coming to know the availabilities of supplies and the reliability of suppliers, and in becoming knowledgeable in the ways of recruiting and training workers and managers. Such learned knowledge manifested itself in the firms' facilities for production and distribution. It was even more evident in the firms' product- and process-specific human skills. Of these skills the most critical were those of the senior executives—the top managers who recruited and motivated the middle and lower level managers, defined and allocated their responsibilities, monitored and coordinated their performance, and who, in addition, planned and allocated resources for these enterprises as a whole.

Such knowledge and skills were developed by learning through trial and error, feedback and evaluation; thus, the skills of individuals depended on the organizational setting in which they were developed and used. Such learned skills and knowledge were company-specific and industry-specific. They were not, of course, patentable. They were difficult to transfer from one industry to another, or even from one company to another, precisely because they had been learned within a very specific organizational context. If these company-specific and industry-specific capabilities continued to be enhanced by constant learning about products, processes, customers, suppliers, and other relationships between workers and managers within the firm, enterprises in capital-intensive industries were usually able to remain competitive and profitable. If not, they normally lost market share in domestic and international markets to those firms that did.

The creation, maintenance and expansion of such capabilities permitted American and German firms in the two decades before World War I to drive British competitors from international markets, and even Britain's home market, in most of the capital-intensive industries of the Second Industrial Revolution. They made it possible for German enterprises to regain their position in world markets swiftly after a decade of war, defeat and inflation between 1914 and 1924, and to come back again in the 1950s after a far more devastating war. So too, organizational learning permitted Japanese firms, first, to carry out a massive transfer of technology from the west to Japan; then, as Japan's domestic market grew enough to permit building enterprises large enough to exploit potential economies of scale and scope, to develop organizational capabilities necessary for competitive advantage in international markets.

On the other hand, the economies that followed the Soviet model—relying on central planning agencies to coordinate production and distribution and to allocate resources for the future—prevented managers in units of production and distribution from learning how to coordinate effectively. These managers

never developed hands-on organization knowledge about current facilities, available supplies and market demand. The failure to develop such capabilities has been central to the disintegration of these centrally planned economies.

Organizational Capabilities and the Economics of the Firm

How do established theories involving the firm—neoclassical, principal-agent, transactions cost and evolutionary theories—relate to this historical view of the development of the modern industrial firm? How do these theories contribute to an explanation of industrial growth and transformation?

Neoclassical theory in its basic form views the firm as a legal entity with a production set (a set of feasible production plans) the knowledge of which is presumably common. From such a set a manager acts rationally with full information, choosing the one most likely to maximize profits or the present value of the firm (Hart, 1989, p. 1758). Principal-agent theory accepts the neoclassical firm as a production set but gives it managers, and is more specific about the assets of the principals and agents. The proponents of agency theory concern themselves with owners' and managers' problems of coping with asymmetric information, measurement of performance, and incentives. Both theories see the firm as a legal entity that contracts with outsiders (suppliers, dealers, financial institutions and the like) and insiders (workers and managers).

Transactions cost theory, like agency theory, focuses on information asymmetry and the resulting information costs. Where agency theory proponents concentrate on the information involved in designing contractual relations between principals and agents, those of transaction cost focus more on the problems of asymmetric information involved in transactions. They stress that microeconomic activity is organized to economize the costs of production *and* transactions. They also emphasize more strongly than do the users of agency theory the significance of asset specificity—that is, the specialized physical facilities and human skills that, because they can only be used in the production and distribution of specific products and services, lose value if deployed in other activities.

For Oliver Williamson, the leading figure of this approach, asset specificity and bounded rationality and opportunism (the primary causes of information asymmetry) determine whether transactions costs will be lower if they are internalized within the firm than if they are left to be carried out in external markets. In Williamson's words, "Any attempt to deal seriously with the study of economic organization must come to terms with the combined ramifications of bounded rationality and opportunism in conjunction with asset-specificity" (1985, p. 42, also p. 30, 53). Because of his concern with firm-specific assets and skills, I, as an economic historian, have learned much from Williamson.

The basic difference between myself and Williamson is that for him (1985, p. 41): "The transaction is the basic unit of analysis." For me, it is the firm and

its specific physical and human assets. If the firm is the unit of analysis, instead of the transaction, then the specific nature of the firm's facilities and skills becomes the most significant factor in determining what will be done in the firm and what by the market. For example, the new capital-intensive industries had a much greater need to monitor high-level throughput than the older labor-intensive ones. Therefore, firms in the capital-intensive industries internalized distribution, while those in the labor-intensive ones continued to rely on independent distributors (Chandler, 1990, pp. 142–143, 153). Moreover, the pressure to internalize in capital-intensive industries varied from industry to industry because the source of supplies, nature of technology of production, and the size and requirements of markets all varied.

Proponents of the recently formulated evolutionary theory of the firm also see the firm, not the transaction, as the main unit of analysis. That theory, built on the concept of the firm's activities and growth developed by Alfred Marshall, Joseph Schumpeter and Edith Penrose, was first spelled out by Richard Nelson and Sidney Winter in *An Evolutionary Theory of Economic Change* (1982). As Winter notes (1988, p. 173), neoclassical "orthodoxy and transactions costs economics place deal-structuring at center stage, and cast the economics of production and cost in a supporting role." Their emphasis, on the other hand, is placed on production rather than exchange.

In a recent paper, building on his and Winter's past work and the more recent writings of David Teece, Giovanni Dosi, William Lazonick, and myself, Nelson (1991, pp. 67–68) presents "an emerging theory of dynamic firm capabilities." He focuses on "three different if strongly related features of a firm that must be recognized if one is to describe it adequately: its strategy, its structure, and its core capabilities." Such core organizational capabilities are based on "a hierarchy of practiced organizational routines, which define lower order organizational skills [skills required at the lower levels of the hierarchy], and how these are coordinated, and higher order decision procedures for choosing what is to be done at lower levels. The notion of a hierarchy of organizational routines is the key building block under our concept of core organizational capabilities. At any time the practiced routines that are built into an organization define a set of things the organization is capable of doing confidently."

For the history of industrial enterprise, learned routines are those involved in functional activities—those of production, distribution and marketing, obtaining supplies, improving existing products and processes, and the developing of new ones. Even more important are those routines acquired to coordinate these several functional activities. Essential, too, are those learned in the strategic activities of responding to moves by competitors, of carrying on the long, costly, and risky process of moving into new markets and of adjusting to the constantly changing economic, social and political environment. The resulting organizational capabilities permit the enterprise to be more than the sum of its parts. They give it a life of its own above and beyond those of the

individuals involved. The individuals come and go, the organization remains. On the basis of these capabilities many of the enterprises that a century ago helped to fashion the Second Industrial Revolution have prospered and grown during a century of global wars, deep economic depressions, dramatic political changes and continuing profound technological transformations. Let me now turn to indicate the value of using the firm and its learned capabilities as a unit of analysis in explaining the regularities in the beginnings and growth of modern industrial enterprise.

Creating the Base for Organizational Learning

The distinctive feature of firms in the new capital-intensive industries of the late 19th century was that they were able to use new technologies of production to exploit advantages of scale and scope in a way that firms in older labor-intensive industries could not. To reap these advantages, however, they needed to maintain throughput at close to minimum efficient scale. Therefore, their founders were under greater pressure than processors in other industries to be certain of a continuous flow of inputs and a relatively assured market for their large market. This, I must stress, was much less true in the labor-intensive industries such as textiles in past times and the service industries, software and the like today. In labor-intensive industries, the creation of a learning base and the resulting pattern of continuing growth differed substantially.

Transactions cost considerations played a significant part in the determination of the extent of both forward and backward integration. Even when suppliers and distributors were competent and reliable, they were often unable to deliver on schedule and in the quantity and quality required by the new capital-intensive industries. Distributors were often slow in returning sales revenues to the manufacturer or in providing necessary marketing services and information. But the initial move forward into distribution and marketing by entrepreneurs in the new industries of the Second Industrial Revolution was that often suppliers and distributors had neither sufficient knowledge of the novel and complex products nor the facilities required to handle them efficiently.

This is why so many of the new companies met their needs by building almost immediately a national marketing and distribution network staffed by their managers and workers. These organizations either marketed directly to the industrial customer or, where the customers were more numerous, by creating a wholesale network. They rarely moved, however, into retailing, for reasons to be discussed in a moment. In the most technologically complex of the new industries—particularly chemicals, electrical equipment and nonelectrical heavy machinery—industrial customers had little or no knowledge of how to install, maintain, and repair or even use the new machines or materials. Here the new companies relied on direct sales.

In volume-produced light machinery, including agricultural, sewing and business machinery (and a little later automobiles), the companies created wholesale networks. In these industries, the demonstration, repair and other marketing services were as essential as they were in heavy machinery but less complex. But the credit arrangements and collection from a much greater number of customers were more complex. The companies' wholesale network not only assured regular deliveries to retailers, but also monitored the ability of the retailers to provide demonstration and after-sale service and to assure a steady flow of payments from the retailers back to company headquarters. Both direct marketing and wholesale organizations were sources of information on changing short-term market demand and broader knowledge about long-term customer needs, competitors' goods and the characteristics of markets served.

The new enterprises also required a large-scale investment in physical facilities. For example, petroleum and vegetable oil companies needed specialized railway tank cars and sea-going tankers; chemical companies required a variety of railway tank cars; and meat-packers used hundreds of refrigerated cars and a network of refrigerated warehouses. Existing distributors had little incentives to make large investments in these facilities. The manufacturers had more knowledge than the distributors about highly specific requirements of these facilities. Moreover, the distributors realized that if they made such investments they would be captive of the small number of producers of these products.

Because their wholesaling or direct sales organizations met the distribution requirements essential to maintain a steady throughput, few capital-intensive firms felt the need to take on the financial and managerial costs and risks of building their own retail network. The investment in the facilities and then the administrative costs of building one's own national and international retail store network was far greater than setting up wholesale offices and warehouses in 10 to 15 commercial centers. So the manufacturers relied instead on contractual arrangements with franchised dealers who sold their produce exclusively or independent dealers with whom they made contractual arrangements. For much the same reason, new large retailers—department stores, mail order houses and chains—which concentrated on mass marketing goods produced in labor-intensive industries developed strong purchasing organizations to buy directly from the manufacturers. They only entered manufacturing, usually temporarily, when they could not acquire goods in the volume and quality desired. Thus, transactions cost analysis is of great value in analyzing why volume producers rarely entered retailing, and why mass marketers rarely entered manufacturing. But because such costs varied with the specific facilities and skills, as well as the requirements of the parties involved in the reduction of such information costs, the changes by internalizing or externalizing activities can be more fully understood within the context of the firms' organizational capabilities.

Just as the demands of maintaining high volume throughput led to forward integration, they also brought backward integration. But that

integration again should be seen in terms of the enterprise's specific capabilities and needs at the time of the transaction. For example, Williamson (1985, p. 119) notes that: "Manufacturers appear sometimes to have operated on the mistaken premise that more integration is always preferable to less." He considers backward integration at Pabst Brewing, Singer Sewing Machine, McCormack Harvester, and Ford "from a transaction cost point of view would appear to be mistakes." But when those companies actually made this investment, the supply network was unable to provide the steady flow of a wide variety of new highly specialized goods essential to assure the cost advantages of scale. As their industries grew and especially as the demand for replacement parts and accessories expanded, so too did the number of suppliers who had acquired the necessary capabilities.

Once such goods were available from a sizeable number of suppliers, the need for vertical integration through direct ownership lessened. Thus, Ford, who became the industry's first mover by building the Highland Park plant in the first years of the 1910s, became a highly integrated enterprise. By the 1920s, General Motors aimed at owning about a third of its parts and accessory suppliers, in what its managers considered an "insurance policy." Chrysler, which moved into the low-priced market with its production of the Plymouth in 1929, enjoyed ample sources of supplies during the Depression and made a most limited investment in suppliers. But when demand boomed after World War II, however, Chrysler found it necessary to acquire large suppliers. On the other hand, Ford's decision in the mid-1920s to build a huge works with steel and glass-making facilities on the River Rouge was indeed a costly mistake. The point is that an understanding of the changing boundaries of the firm required an awareness of the specific capabilities of the firm and the characteristics of the industry and market in which it operates *at the time* the changes were made.

Many of the first-movers in the new capital-intensive industries which integrated forward into distribution and marketing and backward into control of supplies did so on an international scale. Knowledge gained in the creation of a wholesaling or direct marketing organization at home led to building a comparable one in foreign markets. When such markets grew to the size that permitted the establishment of plants of minimum efficient scale, firms used their learned skills to build new facilities.

The basic technological characteristics of an industry in which the firms operated at the time of overseas investments were more important than imperfect information costs in determining the number and location of plants built abroad. When the minimum efficient scale of production was very high, as it was in steel, copper and aluminum, building abroad was rare. Such construction would crowd and so bring overcapacity in that market, resulting in the higher costs of operating well below full capacity. For chemicals and heavy machinery, where the cost advantages of scope required concentrating production of a number of outputs within a single facility, branch plants usually carried out only one or two of the final processes. In light machinery, such as sewing, agricultural and business equipment, plants were usually built to meet

the needs of a major region—Europe, Asia, or the Far East. In consumer products such as food, drink, and over-the-counter drugs, where the technology of production is relatively simple, minimum efficient scale was low, local suppliers were available, and tastes varied, plants usually were built to serve smaller national markets, rather than one or two for all of Europe or the Far East.

The Historical Experience

The ability to gain and maintain market share and profits tests the efficiency of a capitalist enterprise, particularly in foreign markets where different laws, customs, working habits, and availability of supplies tend to favor domestic producers. If so, then the swift and dramatic success of the German and American integrated companies over their less-integrated British rivals in the last decades before World War I demonstrates how the creation of organizational capabilities through the initial investment in production and distribution permitted first-movers in the new and the transformed industries of the Second Industrial Revolution—chemicals, electrical equipment, light and heavy machinery and metals—to conquer world markets quickly and to raise powerful barriers to subsequent entrants.

The chemical industry was the most technologically advanced of the new industries, and provided the widest range of new industrial and consumer products including man-made dyes, medicines, fertilizers, textiles, film, and other materials.

The first major products of this industry were synthetic dyes, and here British entrepreneurs were the pioneers. An Englishman, William Perkin, invented the first such dyes. The world's largest market for man-made dyes remained, until after World War II, the huge British textile industry. Dyes are made from coal, and Britain had the largest supplies of high quality coal in Europe. In the 1870s, the new dye industry in Britain had almost every advantage. By any economic criterion the British entrepreneurs should have quickly dominated the world. But they failed to make the essential investments in production, distribution and management. Bayer, BASF, Hoechst and three smaller German enterprises did.

In the 1880s and the 1890s, these pioneering German firms became the industry's first movers. They began to build one or two giant works along the Rhine, carefully planned to utilize economies of scope. Where the British works produced only 30 or 40 dyes, the Germans were making 300 to 400. While the British continued to rely on jobbers to distribute the product, the Germans created a worldwide sales force; for every user of dyes in the production of cloth, leather, paper, and other materials had to be taught how to apply the new products. For example, by the time Bayer had completed its works at Leverkusen, its sales force of trained chemists was working worldwide with

more than 20,000 customers. By the turn of the century Bayer and the other German chemical leaders had created the largest and most carefully defined industrial managerial hierarchies the world had yet seen. These organizational capabilities permitted Bayer and the other first movers to commercialize and market worldwide several hundred different dyes and a wide range of new man-made pharmaceuticals and films.

The resulting German *competitive advantages* quickly demolished Britain's economic *comparative advantages*. In 1913, 160,000 tons of dyes were produced worldwide. The German firms made 140,000 tons (72 percent of this output by the Big Three); 10,000 more were produced by Swiss neighbors up the Rhine. Total British production was 4,100 tons. The story was much the same for pharmaceuticals, films, agricultural chemicals, and electro-chemicals.

The electrical equipment industry, while employing a smaller number of professionally trained technicians and scientists, transformed economic life even more than chemicals. The new industry provided new sources of light and power that altered urban living and transportation, and also changed the workplace. Moreover, a new electrolytic process transformed and greatly reduced costs of producing copper, aluminum, and several chemicals.

In the first years of this industry, British pioneers were as active as those in Germany and the United States. But within a decade after the establishment of Thomas Edison's first central power station in 1882 in New York City, two first movers in the United States (General Electric and Westinghouse) and two in Germany (Siemens and Allgemeine Elektricitäls Gellsellschaft, AEG) had made the investments in production, distribution and management to exploit economies of scale and scope. Nothing comparable occurred in Britain, even though Sir William Mather, senior partner of Mather & Platt, one of the largest British textile machinery manufacturers, had obtained the Edison patents at the same time as had Emil Rathenau at AEG.

As a result, by 1913, two-thirds of the electrical equipment made in British factories by British labor was produced by subsidiaries of General Electric, Westinghouse and Siemens. AEG sold more products in Britain than did the largest British firm. Mather & Platt had become a minor producer of electrical equipment for factories. From the 1890s on, continuing research and development that improved existing products and developed new ones in this critical science-based industry was carried out in Schenectady, Pittsburgh, and Berlin, but not in Britain.

What was true of chemicals and electrical equipment was also true in steel, copper and other metals and in heavy and light machinery. In metals the British pioneered, but the Germans and Americans made the necessary investments that quickly drove the British from international markets. In machinery the British did not even try. The Germans quickly dominated the production of heavy processing machinery and equipment, while the Americans acquired a near global monopoly in light machinery produced in volume by the fabricating and assembling of standardized parts, a process that by the 1880s had already been known as "the American system of manufacturing."

In office machinery, such first movers as Burroughs Adding Machine, National Cash Register, Remington Typewriter Company, and the Computing-Tabulating-Recording Company (renamed International Business Machines in the early 1920s) dominated their industries worldwide. In sewing machines the Singer Sewing Machine and in agricultural equipment McCormick Harvesting Machine (it became the core of International Harvester, a 1902 merger) were the world leaders. Indeed, in 1913, the two largest commercial enterprises in imperial Russia were Singer and International Harvester. By then Singer produced 79,000 machines annually in its Moscow factory with a work force of 2,500 wage earners and 300 salaried employees; while its salesforce of more than 27,000 covering the vast territory from the Sea of Japan to the Baltic. At the same time, Harvester distributed through a network of branch offices in 11 cities that encompassed 80 percent of the implement dealers in Russia. For both companies, their Russian operations were smaller than those of their other European business based on Singer's factories in Scotland and Germany and Harvester's major plant in Germany. By World War I, American firms had achieved comparable global competitive power in the production of elevators (Otis Elevator), pumps (Worthington Pump), boilers and other steam equipment (Babcock & Wilcox), printing equipment (Merganthaler Linotype), and heating equipment (American Radiator).

Why did British pioneers fail to make the investments necessary to develop the organizational capabilities required to compete with German and American firms? The answer is enormously complex, involving economic and noneconomic institutions, class and cultural considerations, and historical timing. It cannot be examined here. The point of recounting this bit of history is to document that, unless investments were made essential to utilize the cost advantages of scale and scope, the enterprises and the industries and national economies in which they operated lost out in international markets to foreign enterprises that made them. Moreover, without such a base for organizational learning, company- and industry-specific capabilities in production, distribution, R&D, purchasing, and labor relations, the necessary competitive strength could not be developed.

Continued Growth Through Utilization and Expansion of Organizational Learning

In the years following World War I, the first movers and a small number of challengers continued to grow by entering markets abroad and those of related industries. Such growth was more important to the history of the modern corporation than that of vertical integration. The latter came in response to specific technological and market situations. Growth into new markets

remained a far more continuing long-term strategy of expansion. Such growth was driven much less by the desire to reduce transaction, agency and other information costs and much more by a wish to utilize the competitive advantages created by the coordinated learned routines in production, distribution, marketing, and improving existing products and processes. In geographical expansion that utilized the capabilities honed in exploiting the economies of scale, the firm usually concentrated on a single line of products. In entering related product markets which reflected knowledge acquired in utilizing the economies of scope, the firm often entered more than a single line. Such expansion abroad and into related industries became itself a learning experience as to the ways of capturing of new markets and of managing an enlarged multi-market enterprise.

After World War I, leaders in these major capital-intensive, oligopolistic industries continued to expand existing foreign beach-heads and to enter new territories. In the context of this strategy, the primary impact of World War I was to weaken German industrial leaders. During the war, their subsidiaries in Allied nations were expropriated and usually turned over to their competitors in those countries. Moreover, the German firms were kept at a distance in international markets during the decade of war, defeat, occupation of industrial areas and hyperinflation. Nevertheless, in the brief period between 1925 and the onslaught of the Great Depression, the learned knowledge and skills of the German enterprises in chemicals, electrical equipment, machinery and metals permitted the German enterprises to by 1929 regain their earlier position in world markets. Their competition came less from British and French companies and more from firms in neutral nations who had benefitted from the hiatus of German dominance to expand their capabilities. These included such firms as Sandoz, Ciba, Geigy in chemicals and Brown, Boveri in electrical equipment in Switzerland; Philips in electrical equipment in Holland; and Ericsson in telephone equipment in Sweden.

For U.S. companies, the war and German's postwar difficulties boosted the growth of overseas sales for chemical, machinery and metal companies. The diversification in chemical companies in the new products (to be described shortly) helped to make them significant players in world markets. In electricity, the two U.S. first-movers began to pull ahead of the Germans. By 1929, General Electric dominated the world's electrical equipment market. Its subsidiaries in Britain and France were the largest producers in those nations. It held 25 percent of the stock of Germany's AEG and had comparable investments in leading electrical manufacturers in Mexico, South Africa, and Japan. In Japan, GE controlled Tokyo Electric and had a minority interest in Shibaura. (These two companies merged in 1937 to become Toshiba as the Japanese began to take over American enterprises.)

In telephones and related equipment, the international division of AT&T's Western Electric (and its successor ITT) remained the world's largest producer. And in automobiles, the great new transforming and growth industry of the

interwar years, the first mover, Ford, and its two challengers, General Motors and Chrysler, quickly dominated world markets. In 1929, American manufacturers turned out 85 percent of the world's production. Subsidiaries of Ford and General Motors were leading producers in Germany, Britain, Australia and Japan.

Makers of branded packaged food, drink, drugs, and paints expanded even more energetically than had those in light volume produced machinery before 1914. During the interwar years, IBM, Remington Typewriter and Timken Roller Bearing went abroad in the ways in which Singer, Harvester, and other machinery companies had done earlier. Of the leading food and drug firms during the interwar years, Quaker Oats, Heinz, Coca Cola, American Cotton Oil, Parke-Davis, United Drug and Sherwin-Williams all had substantial investments overseas before 1914. After the war Borden, Carnation, Pet Milk, Corn Products Refining, National Biscuit, California Packing (Del Monte), Wrigley (chewing gum), American Home Products, Sterling Drug, Procter & Gamble, and Colgate-Palmolive-Peet all had built manufacturing establishments abroad.

Growth into new product markets was more complex than expansion abroad, because it almost always required new investment in complementary physical and human assets. That is, it required the creation of new capabilities. For example, a move based on the economies of scope in production required the building of a new marketing organization. A move based on utilizing those in distribution usually called for an investment in new production and often research and development facilities and skills.

The expansion into related product markets came first in science-based industries, where opportunities were greater for exploiting economies of scope in production and R&D. The German dye makers began in the 1890s to produce a wide variety of pharmaceuticals and a little later of film. Bayer's well known aspirin was one of several sedatives and barbiturates developed before 1900. In 1892, Hoechst brought on the market one of the first serums for diphtheria, followed by Novocaine and other pain killers; fever-depressing drugs and vaccines for cholera and tetanus; and one of the earliest chemotherapeutical drugs, Salvarsan, the first effective remedy for syphilis. The smaller AGFA, besides producing pharmaceuticals and specialty dyes, led the way in photochemicals. These companies quickly created a separate worldwide marketing organization for each of their new lines.

The U.S. chemical companies waited until World War I to embark on comparable strategies of diversification, but then they entered into new product markets even more energetically than did the Germans. In the 1920s, Du Pont, Union Carbide, Allied Chemical, Dow and Monsanto all diversified into a wide variety of products that reflected their specialized major technological base. Du Pont relied on its nitrocellulose chemical capabilities; Union Carbide on its experience in electrochemicals and carbides and then on its pioneering in petrochemicals; Allied on its knowledge of coal tar based chemistry; Dow on

chloride and other salt-based chemicals; and Monsanto on saccharin-based ones. Although the production of these products were scope-related, their marketing called for the creation of new organizations. For example, production of cellophane at Du Pont used much the same capabilities as those of rayon, but the product went to a completely different set of industrial customers with very different needs. In the United States, the chemical firms were among the first to adopt a multidivisional structure—that is, to set up autonomous divisions to integrate production and distribution of major product lines with a central corporate headquarters, which in turn monitored the performance of and planned and allocated resources for the divisions.

The German and American first-movers in electrical equipment—Siemens, AEG, GE and Westinghouse—also quickly used their specialized skills and facilities to enter a variety of markets. In the years before World War I they produced equipment not only to generate and transmit electric power and light, but also made street railway and subway equipment, electric motors for industrial purposes, and (the Germans more than the Americans) produced electrochemicals and telephone and telegraph equipment. And again, the Germans more than the Americans concentrated production in huge works to exploit more effectively the economies of both scale and scope. In the 1920s, these firms developed first-mover advantages in X-rays and other equipment (that helped to transform medical practice), in electrical appliances (stoves, refrigerators, washing machines, heaters and the like that helped transform household living) and radio (that helped to transform communication, entertainment and politics). RCA, the first mover in radios in the United States, was a joint venture of GE, Westinghouse and AT&T. Its European counterpart Telefunken was a joint venture of Siemens and AEG. At GE, the lines whose operating results were accounted for separately rose from 10 in 1900 to 193 in 1930 to 282 in 1940.

In nonelectrical machinery, the early organizational learning shaped later growth. The German heavy machinery firms that began by utilizing scope economies had a broader line and lower volume; while the producers of American light machinery which concentrated on exploiting those of scope produced only a relatively small number of product lines. Thus in the 1920s, Maschinenfabrik-Augsburg-Nürnberg (MAN) used scope economies to manufacture in three works an extraordinary variety of machines for the mining, metal, metal-processing, metal-fabricating, ship-building, chemicals, food, textile, lumber, and printing press industries and also for utilities; while Singer and the business machine companies continued to concentrate on a small number of closely related product lines for much the same markets.

Even in less research-intensive industries, opportunities existed for expansion into new markets. The meat packers, for example, used their distribution network to market butter, eggs, poultry and fruit. By 1900, Armour was the nation's largest seller of butter. Again, these new businesses required investment in new processing and purchasing facilities and personnel. The producers

of branded, packaged, consumer food products such as soap and other toiletries moved into the production of food. Even before the 1920s, Procter & Gamble in the United States and Lever Brothers in Britain had become leading producers of cooking oil and margarine. So too, food companies such as Quaker Oats, Borden and Corn Products Refining developed chemical products, usually by setting up joint ventures with chemical companies. On the other hand, before World War II, the oil companies explicitly turned down opportunities to enter petrochemicals because their capabilities lay in handling a huge volume of a single line of products and not in a wide variety of goods for different markets. Thus Union Carbide, the first to build large petrochemical plants in the United States, did so by constructing one next to Standard Oil of Indiana's Whiting Refinery and South Penn Oil Company's refinery in Charleston, West Virginia. In all these moves into related product markets, the competencies of the existing companies clearly shaped the direction, timing and methods of diversification. Before the 1960s, industrial enterprises in the United States and Europe rarely moved into markets where their learned capabilities did not give them a distinct competitive advantage.

Organizational Learning and the Creation of New Industries

The ability of large established firms to use learned routines and integrated capabilities to enter related product markets helps to explain a significant change in the ways in which major new industries are coming to be created. In earlier years, entrepreneurs like Rockefeller, Carnegie, Coffin (of GE), Ford, and Eastman created the enterprises that became the first movers in oil, steel, electrical equipment, automobiles and cameras. More recently firms like Xerox and Polaroid have made the three-pronged investments essential to become first movers in somewhat more specialized industries. But in others, first movers have been established enterprises. This has been true not only in radio and TV, but also in the therapeutic revolution that in the 1940s and 1950s transformed the U.S. drug industry, the polymer revolution of the same years that transformed the chemical industry by creating new types of man-made fibers, rubber and other materials, and the mainframe computers that in the 1960s sparked the information revolution.

Until World War II, U.S. drug companies concentrated on two lines of products—those produced in bulk to be retailed or mixed into prescriptions by pharmacists and to be sold over the counter without prescriptions. The development of sulfa, penicillin, and other antibiotics reshaped the industry's ways of production, distribution and research. Production became a complex chemical process rather than a single mixing one. Marketing turned from selling over-the-counter products to reaching doctors who wrote the prescriptions and hospitals where they were used. Research became far more science-based. But the well-established firms knew the basic market and understood testing

procedures to meet quality and safety demands of customers and government regulations. They invested in and continually learned the new ways of product development, scaling up and marketing. Those companies that made the transformation into the new prescription drugs in the 1940s and 1950s—including Merck, Abbott, Pfizer, Eli Lilly, Upjohn, and Parke-Davis (now the pharmaceutical branch of Warner-Lambert)—are still today's industry leaders.

With the exception of Control Data, long-established firms were the first enterprises to commercialize mainframe computers. They included IBM, which became the industry's first mover with the development of the Series 360 in the 1960s; the other leading business machinery companies like National Cash Register, Burroughs Adding Machine and Remington Rand (all three were first movers in their industries in the 1880s); and Honeywell, an established producer of heat control systems, that (like cash registers and adding machines) lent themselves to computer control. They had the competitive advantage over other mainframe pioneers in their long experience in the huge new potential market of business enterprises. While they were expanding at home and abroad, entrepreneurial start-ups such as Digital Equipment and Data General developed a different architecture for more specialized educational and scientific markets. They were quickly challenged by the well-established firms. By 1980, Digital Equipment and Data General were second and fourth in size of sales in minicomputers with IBM first, Burroughs third, and Hewlett-Packard fifth.

Then microcomputers offered a new architecture for a new market, the individual user. In the late 1970s three first movers—Apple, Tandy, and Commodore—accounted for 72 percent of U.S. dollar sales. By 1982 IBM, NEC and Hewlett-Packard had moved in and captured 35 percent of the market, driving down the entrepreneurial start-up firm's share to 48 percent.

Nearly all the major chemical products developed in the past decades have been commercialized (though certainly not invented) by long established firms. These include fibers based on polymer chemicals (by 1985 cotton, wool, silk and other natural fibers accounted for less than 30 percent of fibers consumed in the United States) and such specialties as additives, catalysts, industrial coatings, electrical chemicals, medical systems and devices based on chemical technology, advanced materials such as fiber and metal matrix composites, engineering plastics, ceramics and new electronic materials. Even in the emerging field of biogenetics, large firms, both chemical and pharmaceutical, are playing a major role in commercializing these new products.

Established firms in recent years have played a greater role in the creation of new industries than entrepreneurial start-ups because the time and cost of commercializing technologically complex new products and processes is *not* in invention or research. It is in development—in the long and complex course required to produce goods in large enough quantity and with high enough quality to be purchased by a substantial number of customers in national and global markets. The commercializing of a new product or process, in itself a

continuing learning experience, rests on cumulative organizational learning in the development, production and marketing of earlier products. Moreover, large industrial multi-market firms—be they American, European or Japanese —have throughout this century used retained earnings (the profits from products earlier commercialized) to fund the high cost of developing new ones.

Conclusion

This brief review of the beginning and growth of the modern industrial enterprise suggests how the evolutionary theory of the firm, which emphasizes continuous learning that makes a firm's assets dynamic, provides an understanding of why in the past new firms began through the process of integrating production and distribution and why and how they grew by expanding into new markets. I believe that a similar analysis of today's industrial enterprise, particularly the relative competitive success and failures of the U.S., European and Japanese firms, requires much the same type of analysis, but that is a subject for another paper. Here, I make only two points about the relevance of organizational learning and capabilities to explain today's competitive strengths and weaknesses.

First, the full impact of the international competition that began a century ago was held back by world events. Two world wars and the intervening Great Depression weakened the competitive strength of the U.S. firms' most powerful rivals, particularly the Germans. The international competition which had been developing before 1914 did not become a full-fledged reality, therefore, until the 1960s. It did so after the economic health of the European nations had been fully restored and after their companies had returned to international markets, and after Japan, following a large-scale transfer of new technology, began to industrialize rapidly. Interindustry competition also intensified in the postwar years, as the great increase in research and development expenditures indicates.

Secondly, the response of U.S. firms to this competitive challenge delineates the ways in which a firm's core competence helps to determine successful paths of, as well as limits to, growth. Many U.S. firms did not respond to the intensified competition and the resulting decline in their rate of return on investment by reinvesting in maintaining and expanding existing capabilities. Instead, they used the retained earnings to acquire facilities and personnel in other existing business, in which their own capabilities did not give them a competitive edge. In most cases, they were in time forced to pull back in and to concentrate on businesses that were closer to their core competencies. Indeed, one of the most significant and historically unique stories of the past three decades in American industry has been this expansion, the resulting discovery that competencies determine the limits of growth and then the following contraction. Today the product lines of large multimarket industrial firms have become far more focused on their core capabilities (Scheifer and Vishny, 1991).

Just as I find the earlier growth of the industrial firm difficult to explain fully in terms of transactions, agency and other information costs, so I find it hard to explain the recent process of expansion and contraction with these same concepts. Nor can they explain why firms in American industries such as chemicals, pharmaceuticals, computers, aircraft and aerospace, oil refining and food processing continue to be global leaders, whereas others in automobiles, tires, semiconductors, consumer electronics and machine tools have fallen behind. The answer requires a consideration of how the enterprises evolve their organizational capabilities and how their long-term competitive strength and weakness reflect these learned capabilities as well as those of their competitors from abroad and related industries.

Besides providing tools for historical analysis and explanation, evolutionary theory raises significant questions for study. How precisely were the learning processes carried out? How and why did industry-specific and particularly company-specific characteristics vary? Why were some capabilities more easily transferred to different geographic and new product markets than others? What were the contents of the routines developed to evaluate and capture new markets and move out of old ones? Why has functional and strategic competition in modern capitalistic economies played a larger role in changing market share and profit than price? What are the determinants of competitive success in national industries and even national economies?

In pursuing these questions, I am convinced that the unit of analysis must be the firm, rather than the transactions or contractual relations entered into by the firm. Only by focusing on the firm can microeconomic theory explain why this legal, contracting, transacting entity has been the instrument in capitalist economies for carrying out the processes of production and distribution, for increasing productivity and for propelling economic growth and transformation. Only by focusing on the firm can theory predict the firm's continuing role as an instrument of economic growth and transformation, and assist in developing policies and procedures for maintaining industrial productivity and competitiveness in an increasingly global economy.

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