

The Vanishing Hand: the Changing Dynamics of Industrial Capitalism

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In a series of classic works, most notably *The Visible Hand* (1977) and *Scale and Scope* (1990), Alfred Chandler focused the spotlight on the large, vertically integrated corporation. He did this not merely to chronicle the rise of that institution but also to explain it and to give it a prominent place in American economic growth during the last century and a half. Put simply, Chandler's argument is this. In the late nineteenth century, the large vertically integrated corporation emerged in the United States to replace what had been a fragmented and localized structure of production and distribution. The driving force behind this transformation was increased population and higher per-capita income, combined with lowered transportation and communications costs made possible by the spread of the railroad, ocean shipping, and the telegraph.

Adam Smith (1976) had predicted an increasingly fine division of labor as the response to a growing extent of the market; and, although he was actually quite vague on the organizational consequences of the division of labor, Smith was clear in his insistence on the power of the invisible hand of markets to coordinate economic activity.¹ Chandler's account appears to challenge this

¹ In what follows, I will often appear to conform to the now rather outdated distinction between markets and hierarchies, as that seems the best idiom in which to engage the issues as Chandler raises them. Nonetheless, I hope that the narrative will convey, perhaps subtly, my belief that "the market" encompasses a wide range of forms many of which are not anonymous spot contracts but rather have "firm-like" characteristics of duration, trust, and the transfer of rich information. As Brian Loasby (1993, p. 248) puts it, "[m]arkets, like firms (and academic disciplines), need to be organised, and organisation implies some degree of management. Organisation, as Marshall observed, aids knowledge, and whether internal or external organisation (Marshall's terms ...) matters most depends on where the relevant knowledge is concentrated." For an extensive discussion of "network" forms of organization, see Langlois and Robertson (1995).

prediction: internal or managerial coordination became necessary to coordinate the “new economy” of the late nineteenth and early twentieth centuries. “Technological innovation, the rapid growth and spread of population, and expanding per capita income made the processes of production and distribution more complex and increased the speed and volume of the flow of materials through them. Existing market mechanisms were often no longer able to coordinate these flows effectively. The new technologies and expanding markets thus created for the first time a need for administrative coordination. To carry out this function entrepreneurs built multiunit business enterprises and hired the managers needed to administer them.” (Chandler 1977, p. 484.) Thus the visible hand of managerial coordination replaced the invisible hand of the market.

Many would argue that the late twentieth (and now early twenty-first) centuries are witnessing a revolution at least as important as the one Chandler described. Population, income, and economic integration are again driving forces, but the railroad and telegraph have been replaced by the computer, telecommunications technology, and the Internet. In this epoch, Smithian forces may be outpacing Chandlerian ones. We are experiencing a structural revolution as profound as the one of the late nineteenth century. With the help of present-day digital technologies, production is becoming increasingly modular and increasingly coordinated through trading on thick markets. Management retains important functions, of course, including some of the same ones Chandler

described. But as the central mechanism for coordinating high-throughput production, the visible hand — many would argue — is fading into a ghostly translucence.²

This paper is a preliminary attempt to explain why this is so — to provide some theoretical insight into the organizational structure of the new economy. The basic argument — the vanishing-hand hypothesis — is as follows. Driven by increases in population and income and by the reduction of technological and legal barriers to trade, the Smithian process of the division of labor always tends to lead to finer specialization of function and increased coordination through markets, much as Allyn Young (1928) claimed long ago. But the components of that process — technology, organization, and institutions — change at different rates. The managerial revolution Chandler chronicles was the result of such an imbalance, in this case between the coordination needs of high-throughput technologies and the abilities of contemporary markets and contemporary technologies of coordination to meet those needs. With further growth in the extent of the market and improvements in the technology of coordination, the central management of vertically integrated production stages is increasingly succumbing to the forces of specialization.

² The cover story of the April 30, 2001 issue of *Forbes* documents in considerable detail the trend in modern industry toward vertical disintegration and contract manufacturing (Dolan and Meredith 2001). Significantly, the piece is titled “[Ghost Cars, Ghost Brands.](#)”

The evolutionary design problem.

Industrial structure is really about two interrelated but conceptually distinct systems: the technology of production and the organizational structure that directs production. These systems jointly must solve the problem of *value*: how to deliver the most utility to ultimate consumers at the lowest cost. Industrial structure is thus an evolutionary design problem. It is also a continually changing problem, one continually posed in new ways by factors like population, real income, and the changing technology of production and transaction. It was one of the founding insights of transaction-cost economics that the technological system does not fully determine the organizational system (Williamson 1975). Organizations — *governance structures* — bring with them their own costs, which need to be taken into account. But technology clearly *affects* organization. This is Chandler's claim. The large-scale, high-throughput technology of the nineteenth century "required" vertical integration and conscious managerial attention. In order to explicate this claim, we need to explore the nature of the evolutionary design problem that industrial structure must solve.

Like a biological organism, an organization confronts an environment that is changing, variable, and uncertain. To survive and prosper, the organization must perceive and interpret a variety of signals from the environment and adjust its conduct in light of those signals. In short, organizations are information

processing systems. This is no less true of early nineteenth century production networks than it is of an Internet-enabled firm of today: in a real sense, the economy has long been a knowledge economy. Also like biological organisms, business organizations differ in the mechanisms they use to process information and to deal with variation and uncertainty. Nonetheless, as James Thompson (1967, p. 20) argued, all organizations respond to a changing environment by seeking to “buffer environmental influences by surrounding their technical cores with input and output components.” Understanding the ways in which organizations *buffer* uncertainty is thus crucial to understanding organizational structure.

In Thompson’s discussion, buffers seem to take many forms. The “input and output components” he refers to are various kinds of shock-absorbers mediating between a highly variable environment and a more predictable production process. Inventories are a classic example: they can ebb and swell with changes in demand or supply while allowing a smooth flow of product. But Thompson also mentions preventive maintenance, which reduces the number of unplanned outages, as well as the training or indoctrination of personnel, which reduces variability in human performance.

Arthur Stinchcombe (1990) has picked up the human-performance thread and pulled it in a more interesting and useful direction. In his interpretation, a skilled human is an information-processing system that can serve as an

important element in the process of buffering uncertainty. Human cognition can often interpret the data from a complex environment and translate that data into the kinds of predictable or routine information the productive system can use. For example, a professor translates the complex information on an essay exam into a letter grade that the Registrar's office can process; a physician translates the complex inputs from observation and medical instrumentation into a diagnosis, which results in a relatively unambiguous set of instructions for nurses, pharmacists, patients, etc. (Stinchcombe 1990, chapter 2). Businesspeople serve a similar function. They translate complex data from the economic environment into a more-or-less predictable flow of outputs — contracts signed, products delivered, etc. We might even go so far as to associate the buffering role that human cognition plays in business with the very idea of *management*.

Levinthal and March (1993, p. 98) add a perspective on buffering that is relevant to my argument. They associate Thompson's notion with the late Herbert Simon's (1962) well-known analysis of system decomposition. A *decomposable system* is one that is cut into pieces or "modularized" in such a way that most interactions (which we can think of as flows of information) take place within the modules; interactions among modules are kept to a minimum and are

regularized through formal “interfaces.”³ One of the prime benefits of decomposability, in Simon’s view, is that it allows for greater stability in the face of environmental uncertainty: a single piece can be altered, replaced, or even destroyed without threatening the survival of the whole. This is already a kind of buffering. Levinthal and March point out that decomposition entails (or at least allows) “loose coupling” between organizational units, which effectively simplifies the information-processing problem the organization faces. Each department can concentrate on the local consequences of the information it receives from the environment without having to contemplate the global implications. Computer scientists would call this distributed processing. And economists would recognize the argument as akin to [Hayek’s \(1945\)](#) famous account of the price system as a well-decomposed information-processing system. Indeed, I will suggest before long that the decomposition of organization into market can sometimes confer additional buffering benefits well known to economists, notably the ability to spread risks.

In what follows, I trace the history of how organization in the United States has confronted its evolutionary design problem over the last two centuries. The underlying process, I argue, is the Smithian one of specialization and differentiation of function. But, as expanding markets and technological change

³ A perfectly decomposable system is one in which *all* interactions are kept within the subsystems. In reality, however, the best we can probably hope for is a system that is *nearly*

altered the economic environment, so were altered the buffering problems industry faced. The managerial revolution of the nineteenth century was one solution to the buffering problem, appropriate to its time and place. But it is by no means the only solution industry has found; and it is certainly not the approach toward which the new economy is gravitating.

Antebellum organization.

Along one dimension, the American system of production and distribution in the early years of the nineteenth century was indeed coordinated by the invisible hand of the market. The high cost of inland transportation created many isolated local markets, leading to a fragmented and decentralized system of production and distribution.⁴ To the extent that it was possible to aggregate demands, it was the independent merchant or middleman who did so.

Looked at in another way, however, the antebellum value chain reflected a low level of specialization, just as one would expect in a thinly populated country with poorly integrated regional markets. The focus of the economy was not on manufacturing, which was still a matter of local crafts production, but rather on trade. And the central actors were the all-purpose generalist

decomposable. For a further discussion of these ideas and of the theory of modular systems more generally, see Langlois (2002).

⁴ The main constraint, of course, was the capacity of horse-drawn carriage and the sorry state of the network of dirt roads. Indeed, as late as the early twentieth century, “economists estimated that it cost more to haul a bushel of wheat along ten miles of American dirt road than it did to ship it across the ocean from New York to Liverpool” (Gladwell 2001, p. 13).

merchants. Rather than concentrating on a narrow range of commodities or on a single aspect of trade, the merchants diversified widely; and they acquired a wide range of skills necessary to trade.⁵ The merchants were generalists, of course, because the volume of trade was too small to support specialization. Only by aggregating demands for a variety of types of goods could they generate sufficient scale to employ their overhead resources adequately. This meant in addition that marketing techniques, and in many cases the goods themselves, remained “generic” or nonspecialized in order to permit the necessary diversification.

Since the antebellum industrial system relied heavily on markets to coordinate among stages of production and distribution, there was a certain amount of “loose coupling” that helped to buffer variation. Inventories were no doubt in widespread use. More generally, the system employed as a buffering mechanism what Jay Galbraith (1973, pp. 22ff.) called “slack resources”: the antebellum economy was not a fast-paced, high-throughput system. But it’s also important to notice that, because the system reflected a relatively low level of division of labor in the Smithian sense, much of the coupling, loose or otherwise,

⁵ “The merchants’ strength rested not so much on their mastery of the ancillary techniques of shipping, insurance, finance, and the like, as on their ability to use them in support of the fundamental trading function, buying and selling at a profit. The merchants exercised this function over a range of goods as varied as the commercial techniques they employed. The histories of individual firms, as well as merchants’ advertisements in colonial and early national period newspapers, demonstrate the merchants’ willingness to sell anything that offered a profit. Coffee, sugar, iron, cloth — all were grist for the merchants’ mills” (Porter and Livesay 1971, p. 17).

was effected by human cognition. Each stage of production encompassed many sub-stages that a larger extent of the market might have transformed into specialties. As a result, buffering by skilled humans played an important role. In crafts production, for example, both parts and finished products could exhibit considerable variation because the artisan, who personally undertook all or most stages of production, was able to buffer the variation in the parts and the variation in the tastes of consumers. Wielding a wide repertoire of skills in a flexible way ([Leijonhufvud 1986](#)), a crafts artisan can translate complex information about tastes and technology into a working finished product.

The most important buffers in the antebellum period (and indeed for centuries before that) were the generalist merchants. It was they who in effect *provided* the (loose) coupling within the market economy. Despite the recurrent features of trading in otherwise diverse goods, the thinness of antebellum markets confronted these merchants with a wide variety of concrete circumstances and special problems to solve on a daily basis. Like crafts artisans, they needed to integrate a wide variety of tasks and process a wide range of signals from the environment. What enabled them to solve these complex information processing problems was the width of their sets of skills and their flexibility in matching skills to problems (Stinchcombe 1990, pp. 33-38). They noticed profit opportunities and solved a myriad practical problems in a way that resulted in the more-or-less smooth delivery of goods and services. In the

low-fixed-cost economy of the period, profitability depended not on the ownership of tangible assets but on specialized knowledge and the ability to adapt.

In the years after 1815, population growth, geographical expansion, and international trade (especially in cotton) combined to increase the extent of the market in a classic Smithian way: by an increase in the volume of goods traded but without much change in the nature of those goods (Porter and Livesay 1971, p. 17). And, as one would predict, merchants began to specialize to a somewhat greater extent by commodity or function, almost always by means of specialized firms rather than through intra-firm specialization.

But merchants were far from completely specialized. Importantly, many merchants combined the middleman function with a financial function, something that was crucial for the development of American manufacturing before the Civil War (Porter and Livesay 1971, pp. 71ff.). As America began industrializing, the manufacturing sector was chronically undercapitalized, especially with respect to working capital. Investment is always a difficult business because of the problem of asymmetric information: the borrower typically has better information about his or her prospects than does the lender. In the absence of institutions designed to reduce these “agency costs,” lenders will be reluctant to part with their money unless they have good information about the borrower and can cheaply monitor the use of the funds. Many firms in

the metals and mechanical trades were forced to rely on the private funds of the owner-manager or on retained earnings. Increasingly, however, merchants became an important source of financing. Since they dealt regularly with the

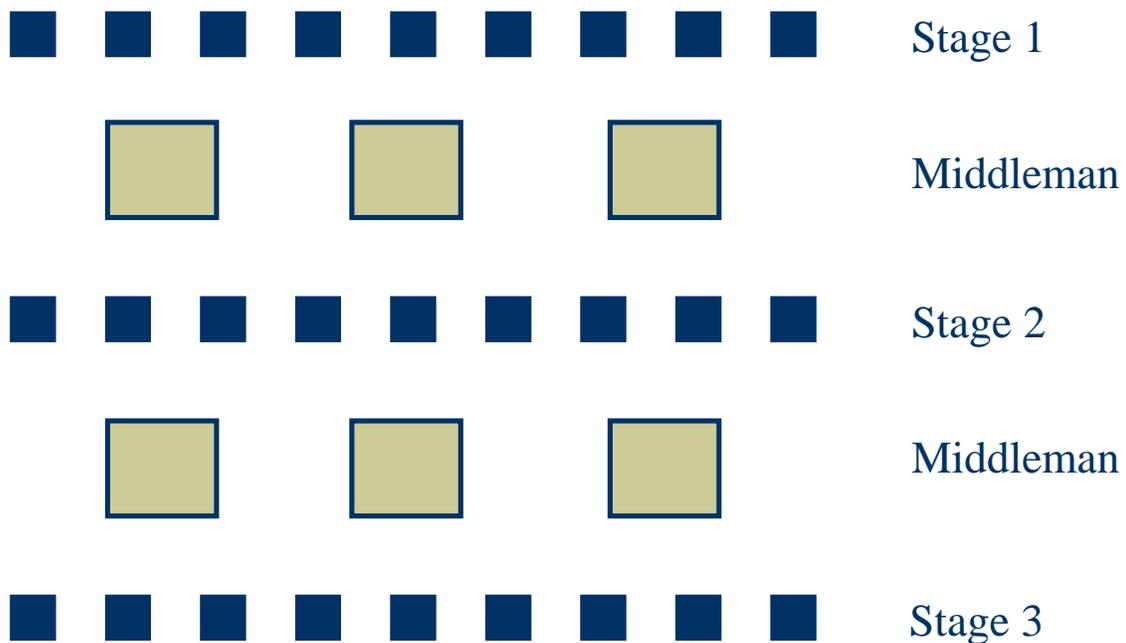


Figure 1: the antebellum value chain.

manufacturers, they had knowledge of their operations and could observe the use of funds lent.⁶ To the extent that banks of the period helped finance industrial development, they did so not as arms'-length lenders but as inside lenders to the networks of merchants and manufacturers who were their

⁶ For example, the merchant James Laughlin bankrolled the Jones and Lauth iron works, which prospered to become the Jones and Laughlin Steel Corporation (Porter and Livesay 1971, p. 67).

principal stockholders.⁷ We can understand this as an instance of using human information processing as a “buffer” on the financial side: closely observing production, or even taking a hand in directing it, is a way of managing the uncertainty of capital provision.

As Figure 1 suggests, then, the “value chain” in the U. S. in the early years of the nineteenth century was one dominated by merchant middlemen, who lowered transaction and agency costs by aggregating outputs and demands from widely dispersed producers and consumers as well as providing capital for the growth of manufacturing.

The managerial revolution.

Is change ultimately a gradual process or is it one that operates through discontinuous jumps or revolutions? This is one of the hoary questions of economic history — and, indeed, of social theory more generally. One’s answer to the question is almost always a matter of perspective. From one viewpoint, for example, the coming of the railroad and telegraph by the time of the Civil War was merely the continuation of a process of decreasing transportation costs

⁷ As Naomi Lamoreaux (1986, p. 659) has shown, the function of banks in this era “was to serve as the financial arms of the extended kinship groups that dominated the economy. As such, banks provided kinship groups with a stable institutional base from which to raise the capital consumed by their diverse business enterprises. Like their modern counterparts, then, early banks tapped the savings of the surrounding community, but they did so mainly selling shares of stock, not by attracting deposits. This too was an important difference. It meant that these early institutions functioned less like modern commercial banks and more like investment pools through which outsiders could participate in the kinship groups’ diverse enterprises.”

already in motion. By 1857, one could travel about twice as far from New York in a day as had been possible in 1830. But the same could be said of the change between 1800 and 1830 (Paullin 1932, plate 138). From another viewpoint, however, the railroad and telegraph had a profound and discontinuous effect on the organization of production and distribution in the United States.

The important consequence of the lowering of transportation and communications costs, of course, was the collapse of geographical barriers and the increasing integration of the domestic market. In effect, nineteenth-century technical change in transportation and communication brought about an all-American version of “globalization,” a topic to which we will return. Larger markets made it possible to adopt new techniques in many transformational and distributional stages in order to take advantage of economies of scale.⁸ With larger markets to serve, it became economical to reorganize some stages using a finer and more coordinated division of labor, what [Leijonhufvud \(1986\)](#) calls factory production. It also became economical to use larger and more durable machines that were often capable of integrating multiple stages of production.⁹ In both cases, larger markets allowed a shift to higher-fixed-cost methods, which

⁸ This is not to say that the rise of large establishments and mass production obliterated specialty producers or the market economy. As many commentators on Chandler have insisted (Atack 1986, Supple 1991, Scranton 1997), small-scale flexible production grew alongside the large firms, provided those firms with many needed inputs, and contributed importantly to economic growth. Nonetheless, the multi-unit mass-producers represented an important new element to industrial structure, one calling out for economic explanation.

⁹ I distinguish these two results of the increasing extent of the market as the *division-of-labor effect* and the *volume effect* (Langlois [1999a](#), [1999b](#)).

were capable of lowering unit costs — often dramatically — at high levels of output.

All of this altered the value chain in two ways. First, it reduced the number of establishments necessary at some transformation and distribution stages. When market size permits economies of scale, a few large plants can operate more cheaply — often far more cheaply — than a larger number of small plants. As Chandler tells the tale, consolidation often played out through a set of typical episodes. First came the cartel, in which previously insulated competitors, having suddenly found themselves operating in the same large market, attempted to manage the allocation of output. Predictably, this met with little success, which prompted the formation of a holding company. By pooling ownership in a single meta-company, in which each individual owner would take a share, the holding company transformed an incentive to cheat on the cartel into an incentive to maximize total capital value. The unintended consequence of this, however, was that the holding company took on a life of its own. Especially as the original owners died out or cashed out, the head office began managing production and investment in increasingly coherent ways, normally with a view to consolidating production in the larger and more efficient plants. The culmination of this was the multidivisional (M-Form) corporation in the twentieth century, in which the old structure of many identical independent producers had been transmogrified into a unified structure with a wholly new

functional division of administrative responsibility. Not all cases followed this model, of course. In fields with few incumbent producers, large unified firms grew up more-or-less directly.

The position of the middleman in the value chain also changed dramatically. As transformation and distribution stages grew in size and shrank in numbers, independent wholesalers were increasingly replaced by in-house purchasing and marketing units. This was so for two reasons. First, the demands of the high-throughput producers began reaching and exceeding the capacities of the middlemen, thus eliminating one of the primary *raison d'être* of wholesalers, the ability to work at higher volumes than one's customers¹⁰ (Chandler 1990, p. 29). Second, standardization of inputs and outputs militated against another of the merchant's comparative advantages, the ability to deal with a diverse set of products (Porter and Livesay 1971). In some cases, like petroleum, producers integrated all the way from raw materials to the final consumer (McLean and Haigh 1954). See Figure 2.

¹⁰ As John D. Rockefeller said of Standard Oil, "we had to create selling methods far in advance of what then existed; we had to dispose of two, or three, or four gallons of oil where one had been sold before, and we could not rely upon the usual trade channels then existing to accomplish this." (Quoted in Chernow 1998, p. 252.)

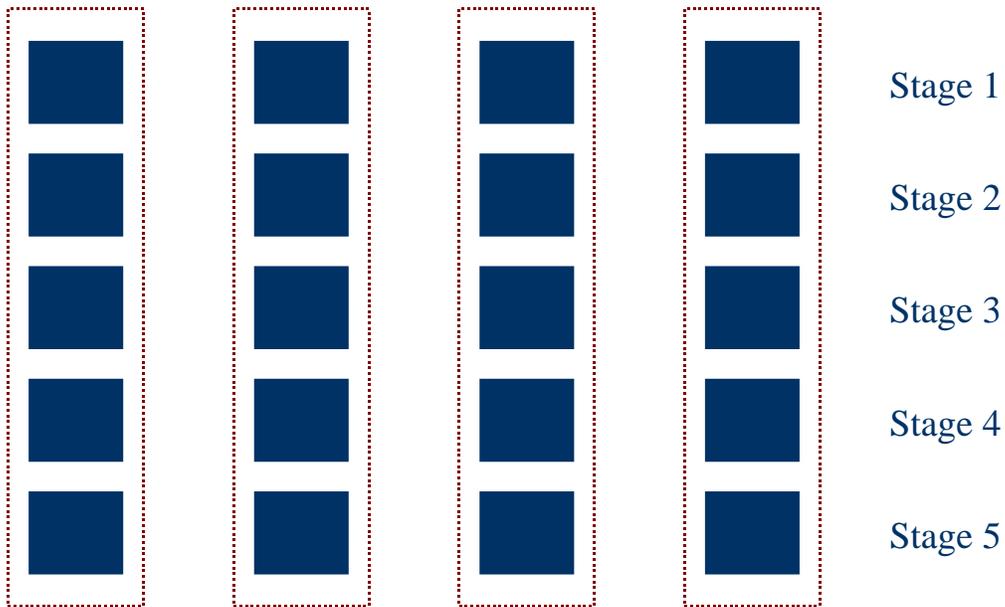


Figure 2: the Chandlerian value chain.

Chandler stresses the ways in which this process differed from what the Smithian division of labor would have predicted; that is, he focuses on the ways in which integration bypassed market relations among previously distinct stages. But it is important to notice that, however visible the hand of management had become, the process Chandler describes is at one level a fundamentally Smithian one. The rise of the modern corporation is very much about increased specialization of function. In an owner-managed firm, management is a craft engaged in by amateurs; in the modern corporation, management is a

profession.¹¹ Moreover, the multidivisional structure that modern corporations came to adopt in the twentieth century reflects a decoupling of the strategic functions from the day-to-day functions of management in order to cope with the greater demands on managerial attention¹² (Williamson 1985, pp. 279-283).

The clearest and most significant way in which the rise of the modern corporation reflects specialization and division of labor, of course, is on the financial side. The corporation evolved in conjunction with developments in securities markets throughout the late nineteenth and early twentieth centuries (and, as we'll see, beyond). These developments encouraged the separation of ownership from control by creating alienable securities that could be traded on increasingly liquid markets. What made such markets possible was the development of social institutions like the limited liability corporation as well as standardized techniques for accounting and financial reporting. These latter made it easier for investors to ascertain the value of securities without detailed

¹¹ Take note that, although specialized to management, the manager was a generalist along another important direction: the manager was skilled in general techniques of management independent of any specific firm or industry. I return to this point below.

¹² In Chandler's eyes, this progressive specialization and separation of function during the rise of the large corporation is indeed a large part of the secret of that system's success. He blames what he perceives to be Britain's lag behind the U. S. and Germany on precisely the British inability to specialize. "In most British enterprises senior executives worked closely in the same office building, located in or near the largest plant, having almost daily personal contact with, and thus directly supervising, middle and often lower-level managers. Such enterprises had no need for the detailed organization charts and manuals that had come into common use in large American and German firms before 1914. In these British companies, selection to senior positions and to the board depended as much on personal ties as on managerial competence. The founders and their heirs continued to have a significant influence on top-level decision-making even after their holdings in the enterprise were diminished." (Chandler 1990, p. 242.)

knowledge of the business or geographic proximity to it, thus somewhat attenuating the costs of asymmetric information (Baskin 1988, pp. 227-230). By reducing the entry requirements to capital supply and by permitting unprecedented opportunities for risk diversification, the development of anonymous securities markets lowered the costs of capital for high-throughput projects and allowed managers to lay off some of the risks — that is, the financial risks — on anonymous markets (Jensen and Meckling 1976). In effect, then, the function of “buffering” financial uncertainties was transferred in part from human information processors — generalist managers — to external market institutions armed with the buffering mechanism of portfolio diversification.

Nonetheless, as Chandler insists, along another dimension the rise of the large corporation reflected a process of *reduced* specialization. Whereas distinct sets of managers had once supervised each stage of production, with only the market standing above them, in the era of the large corporation a single set of managers came to supervise multiple stages of production. At the operational level, of course, the division of labor didn’t necessarily decrease and may have increased. Each subunit of the large corporation had its specialized managers, the counterparts to the managers of the previously distinct stages. Integration of the management function took place at a “corporate” level higher than the day-to-day managers. The head office oversaw multiple stages of production in

much the way a crafts artisan may have overseen multiple stages in the making of an artifact.

Why integration? I have long argued that one can't explain organizational structures without looking at the dynamic processes in which they are created (Langlois 1984). In my view, centralized organization often supplants more decentralized organization when technological and market opportunities call for a systemic reorganization of the structure of production and distribution. This is so for the same reason that decision-making becomes more centralized during a war or other crisis. When many different pieces of the system must be changed simultaneously to create new value, centralized control can often help overcome the narrow visions of the local participants, and centralized ownership can more easily trump the vested interests of those participants (Langlois 1988; Bolton and Farrell 1990). In short, vertical integration often occurs when it can overcome the *dynamic transaction costs* of systemic change (Langlois 1992b).

In many of the nineteenth-century industries Chandler chronicles, the possibilities of economies of scale at various transformation stages called for systemic reorganization in other complementary parts of the system. Consider the story of refrigerated meatpacking (Chandler 1977, p. 299 ff.; Porter and Livesay 1971, pp. 168-173). In the 1870s, the developing railroad network had permitted the shipment of western meat on the hoof to eastern markets, thus taking advantage of economies of scale in western pasturing. But further

economies of scale were possible, and Gustavus Swift realized that, if the system of meat packing, shipping, and distribution were completely redesigned, it would be possible to reduce transportation costs and to take advantage of a number of scale economies, including those of a “disassembly line” in a high-throughput slaughterhouse. Claiming these economies required changing complementary assets and capabilities throughout the system, including the development and production of refrigerated rail cars and the establishment of a nation-wide network of properly equipped branch houses to store and merchandise the meat. Swift found it more economical to integrate into many of these complementary stages than to face the dynamic transaction costs of persuading the various asset owners to cooperate with him through the market.¹³

¹³ Raff and Temin (1991) have attempted to interpret this episode within the strict confines of the doctrine of asset specificity (Klein, Crawford, and Alchian 1978). According to this doctrine, which has arguably become the dominant explanation of vertical integration in the literature of academic economics, cooperating parties are impelled to merge their operations when one or both hold assets highly specific to the transaction they contemplate. This is because in a market setting one of the parties could threaten the other with “hold-up,” thus putting the specific assets at risk. Raff and Temin make an excellent case. But the case they make is mine. They claim that Swift integrated widely because (and only because) all of the assets he came to own were transaction specific and would have put him at risk of expropriation had he left them in the hands of others. Some of the assets involved – railroad cars, maybe – might fit this profile. But many other things Swift bought – like ice --were clearly generic commodities obtainable in thick markets. Raff and Temin try to explain this away: “But Swift could not rely on independent suppliers to provide ice at the time and place he needed. And the cost to him of being without ice at that time and place was very great. ... Swift could be held up by the owner of an icehouse who had the only ice in the neighborhood” (p. 25). But this won’t do. The theory of asset specificity is an equilibrium proposition. In equilibrium, no ice-house master could have threatened to hold Swift up, since Swift had a credible threat to replace his custom, and none of Swift’s assets would depreciate in equilibrium as a result. Of course, Swift cared not a wit about equilibrium. He was worried about all interruptions in service, which – and here is the point – could happen for many reasons in addition to hold-up threats. The ice-house owner could simply be incompetent, or he could have a bad hair day. (Or Swift had acquired superior capabilities for managing the movement of ice to refrigerated cars because he had specialized in that

As Porter and Livesay (1971, p. 171) argue, the development of an integrated (non-independent) system of branch houses was “a response to the inadequacies of the existing jobber system.”

But explaining the origins of vertical integration (or any other structure of organization) doesn't necessarily explain why that structure persists. If integration is temporarily necessary but otherwise grossly inefficient, we would expect the integration to be undone over time. And there are certainly examples of this.¹⁴ But it is also possible that a structure of organization can persist because of “path dependence.” A structure can be self-reinforcing in ways that make it difficult to switch to other structures. For example, the nature of learning within a vertically integrated structure may reinforce integration, since learning about how to make that structure work may be favored over learning

business, and it was more costly for him to transfer that knowledge to others than to integrate.) Even if the owner is guileless and well intentioned, the high-throughput system would be at risk. Nor does it help to say that, although nonspecific in any ordinary sense, the ice had the character of time specificity or location specificity. Apart from forcing the notion of asset specificity to dance on the head of a pin, this ignores the fact that the costs of time and location specificity – what I call dynamic transaction costs (Langlois 1992b) – do not depend on the threat of holdup but can arise from a multitude of causes. The threat of hold-up in the face of specific assets is but a small subset of the much wider problems of buffering that managers of high-throughput systems face.

¹⁴ As Chandler (1992, pp. 88-89) notes: “integration ... 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 [sic] 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.”

about alternative structures.¹⁵ A structure may also persist simply because the environment in which it operates is not rigorous enough to demand change. And organizations can sometimes influence their environments — by soliciting government regulation, for instance — in ways that reduces competitive rigors.

In the end, however, structures that persist for significant amounts of time may indeed do so because they solve the design problem well — or at least well enough.¹⁶ Surely this is Chandler's claim: the large vertically integrated managerial corporation persisted because it was the appropriate solution for the design problem of its day. Reading Chandler and his interpreters, we can discern the outlines of that solution.

At the price of high fixed costs, one could create low average costs — at least so long as one could reliably utilize the fixed assets to capacity.

In the capital-intensive industries the throughput needed to maintain minimum efficient scale requires careful coordination not only of the flow through the processes of production but also of the flow of inputs from suppliers and the flow of outputs to intermediaries and final users.

Such coordination did not, and 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 or of scope, as

¹⁵ See Langlois and Robertson (1989, pp. 367-368) for an example from the early years of the Ford Motor Company.

¹⁶ Biologists understand that, to avoid a tautological theory, evolutionary explanation must mean showing how the biological structure in question would meet "an engineer's criterion of good design" (Gould 1977, p. 42).

determined 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. (Chandler 1990, p. 24.)

In a world of decentralized production, most costs are variable costs; so, when variations or interruptions in product flow interfere with output, costs decline more or less in line with revenues. But when high-throughput production is accomplished by means of high-fixed-cost machinery and organization, variations and interruptions leave significant overheads uncovered. Chandler would say that uncontrolled variation in work flows lowers the effective economies of scale available. Integration and management are an attempt to control — to *buffer* — product-flow uncertainty.

Employing a finely sliced division of labor or large integrated machines or both, traditional mass production always requires the elimination of variation between stages of production. Although never fully realized until the day in 1908 when three of Henry Leland's Cadillacs emerged perfect from a heap of scrambled parts in Brooklands, Surrey,¹⁷ the promise of interchangeable parts had animated the quest for mass production throughout the nineteenth century (Hounshell 1984). As the Brooklands episode suggests, interchangeable parts create a more modular design: parts can be swapped in and out. At the same

¹⁷ For this feat Leland was awarded the Dewar Trophy as winner of the first Standardization Test of the Royal Automobile Club. Cadillac's British operation had in fact instigated the competition as a publicity stunt, and Cadillac was the only contestant; but Cadillac was also

time, however, standardization eliminates one form of “loose coupling” possible in crafts production.¹⁸ Variation in the components becomes increasingly intolerable. In the classic form of mass production, so does variation in the final product: as Henry Ford supposedly remarked, you can have any color Model-T you want so long as it’s black. Moreover, mass production requires operatives (including, eventually, machines) to carry out an unambiguous sequence of steps — a computer program, in effect. Thus the design of the overall production process becomes more highly structured, while discretion and variation are eliminated from the individual stages, a process that unsympathetic scholars have labeled “deskilling” (Marglin 1974) and “fordism” (Sabel 1982).

One important implication of this is that standardization and high throughput do not eliminate the need to buffer uncertainty; indeed, they make it all the more urgent — for any variation that finds its way into a high-throughput system can bring production to a crashing halt. What buffers uncertainty in Chandlerian managerial capitalism is exactly what buffers uncertainty in crafts production or non-specialized merchandising: the information-processing ability of human managers. Because of the new high-throughput structure of production, however, that buffering is no longer distributed to the individual stages of production — from which standardization has eliminated variation —

the only manufacturer capable of the precise machining tolerances necessary to pass the test (Leland and Millbrook 1966, chapter 1).

but has effectively moved “up the hierarchy” to the managers who control the work flow¹⁹ (Stinchcombe 1990, p. 64).

Professional management is specialization in one sense: the manager is manager only and not in any important way a capitalist or anything else. But, like the merchant of yore, the manager is also a generalist: the manager is skilled in general techniques of management independent of any specific firm or industry. The nonspecific training of managers was abetted in the twentieth century by the rise of the business school, which, like other professional schools emerging at the same time, equipped its students with a standardized “toolkit” ([Langlois and Savage 2001](#)). This shouldn’t be surprising. Chandlerian managers are generalists for the same reason that crafts artisans and merchants are generalists: because their function is to buffer uncertainty. They need a wide range of skills that can be applied flexibly in response to an unpredictable array of concrete circumstances.

¹⁸ Contrary to what is sometimes said in the literature on modular product design, modularity does not imply loose coupling, nor does nonmodularity imply tight coupling.

¹⁹ Top managers will not be the only buffers, of course. They will be aided by a large number of discretionary workers at multiple levels. “There will generally be a separate set of skilled manual work departments (maintenance, tool and die making, and special departments that vary with the technology, such as the crew who lay firebricks inside steel furnaces) and skilled staff workers at the managerial levels (engineering, quality control and inspection, scheduling and inventory), besides the whole routinized structure of the production line and the ‘line’ supervisory structure that keeps it running” (Stinchcombe 1990, p. 64).

From scale to scope: the corporate century.

In setting up managerial structures to buffer high-throughput production, the large corporations of the late nineteenth century created something more: a system of *organizational capabilities*.²⁰ Geared initially toward the management of scale, these organizational capabilities soon enabled corporations to expand their scope. In Chandler's words, they "provided an internal dynamic for the continuing growth of the enterprise. In particular, they stimulated its owners and managers to expand into more distant markets in their own country and then to become multinational by moving abroad. They also encouraged the firm to diversify by developing products competitive in markets other than the original one and so to become multiproduct enterprises" (Chandler 1990, pp 8-9).

As Edith Penrose (1959) had suggested, this is an important mechanism by which firms grow. In her theory, firms consist of bundles of "resources," including the managerial resources that Chandler and others call capabilities. Resources are often lumpy, and some are therefore in excess capacity. This means that organizational capabilities developed in one area can spill over to new tasks at low marginal cost. Indeed, as I have suggested elsewhere ([Langlois 1999b](#)), economies of scale and scope are ultimately made of the same stuff: they both involve the reuse of a structure of knowledge, in one case to stamp out more

²⁰ G. B. Richardson (1972, p. 888), who coined the term, called capabilities the "knowledge experience, and skill" of the organization. For further discussion of this idea, see Langlois and Robertson (1995, chapter2).

of the same product, in the other case to produce something different that requires similar knowledge.

Especially early on, diversification was a matter of taking advantage of byproducts — the classic economies of scope of the textbook. For example, Swift and other meatpackers sold fertilizer, leather, glue, soap, and other items made from the byproducts of the slaughterhouse (Chandler 1990, p. 168). Significantly, firms diversified in a modular way by creating for the various products new organizational units that could be dropped into the overall corporate structure. By the twentieth century, however, diversification came to flow more from reusable facilities, knowledge, and business practices. For instance, Swift and his competitors began to distribute butter, eggs, poultry, and fruit using the distribution system originally set up for meat (Chandler 1990, p. 168). Notice that in moving from scale to scope, corporations became generalists to a greater extent, thus reversing the original trend toward product-oriented specialization — and away from generalist merchants — that had created those corporations in the first place. I will suggest soon that the vanishing hand can be understood in part as a continuation of this process of the broadening of capabilities and their decoupling from specific products.

For most of the twentieth century, of course, the process of capability-building that Chandler describes did not challenge the structure of vertically integrated managerial capitalism. Indeed, it reinforced it. As Chandler (1997, p.

64) notes, after world War II especially, “the essential large-scale investments in both tangible and intangible capital were made not by new enterprises as they had been in the past, but primarily by well-established firms whose existing learned organizational capabilities were critical in developing and commercializing the potential the new technologies on a global scale.” The large corporations were recreating significant parts of the U. S. value chain along new lines, which led them to grow internally in the path-dependent way implied by Penrose’s theory.

Such growth placed increasing strain on corporate buffering mechanisms. In part, the firms responded by decentralizing divisions, a kind of buffering in emulation of the market.²¹ But, as Herbert Simon pointed out, buffering mechanisms, which help an organization respond better to variation, are not the only way to attack the problem of environmental uncertainty. “If we want an organism or mechanism to behave effectively in a complex and changing environment,” he wrote, “we can design into it adaptive mechanisms that allow it to respond flexibly to the demands the environment places on it. Alternatively, we can try to simplify and stabilize the environment. We can adapt organism to environment or environment to organism” (Simon 1960, p. 33). In the first century of the managerial revolution, large firms did indeed seek to simplify and

²¹ “Although the transformation from functional to product organizations [the M-Form] has usually been justified as a means to enhance control and coordination (Chandler 1962), it also is a way of segregating experience” (Levinthal and March 1993, p. 98).

stabilize their environments — a phenomenon that has absorbed the ink of legions of economists and pundits over the years.

One class of such attempts falls within the broad purview of antitrust. That Chandler's large corporations have typically been discussed — and for long periods exclusively discussed — from the perspective of trustification and monopoly is a story too tedious to tell here, and perhaps too trite to be worth telling. Virtually alone among writers on the subject, Joseph Schumpeter argued that behavior derided as restrictive or “anticompetitive” actually can serve the function of controlling environmental uncertainty in a way that facilitates high-throughput production — and thus increases rather than decreases output.

Practically any investment entails, as a necessary complement of entrepreneurial action, certain safeguarding activities such as insuring or hedging. Long-range investing under rapidly changing conditions, especially under conditions that change or may change at any moment under the impact of new commodities and technologies, is like shooting at a target that is not only indistinct but moving — and moving jerkily at that. Hence it becomes necessary to resort to such protecting devices as patents or temporary secrecy of processes or, in some cases, long-period contracts secured in advance. But these protecting devices which most economists accept as normal elements of rational management are only special cases of a larger class comprising many others which most economists condemn although they do not differ fundamentally from the recognized ones. (Schumpeter 1950, p. 88.)

Schumpeter also had a more colorful term for what I have blandly called environmental variation or uncertainty: “the perennial gale of creative destruction” (Schumpeter 1950, p. 84).

Notice that Schumpeter sees the corporation's "safeguarding activities" as akin to buffering techniques like insuring and hedging. Let me focus in on a couple of "protecting devices" that will be of significance down the road. Chandler has long maintained that, in effect, vertical integration is itself a mechanism for controlling the environment — by putting large parts of that environment under the influence of managerial buffering. But within the vertically integrated structure of Figure 2, the stages of production with high fixed cost play a special role. Industrial organization economists have laid great stress on the role of sunk costs in deterring competitive entry and generally slowing the competitive environment (Baumol 1982, Sutton 1991). Fixed costs are not always sunk costs, of course; but they tend to become so when markets for the fixed assets are thin, as will be the case when those and comparable assets are isolated within the internal production of vertically integrated firms. This is relevant to my story: for when markets become thicker, the "sunk" character of assets diminishes, which reduces the benefits of vertical integration.

In some lines of business, vertical integration also threw up transaction-cost problems of a more traditional sort. This was especially true in consumer goods but also in some kinds of producer goods as well. In the days of generalist wholesalers and retailers, merchants were not only purveyors of goods but also guarantors of quality. Soap, flour, butter were undifferentiated products in whose quality the customer trusted because he or she trusted the retailer, whose

good name served as a kind of bond. As high-speed continuous-process technology made it dramatically more economical for the producer rather than the wholesaler or retailer to package commodities (Chandler 1977, pp. 289ff.), the role of these latter in guaranteeing quality all but vanished. In principle, this meant that the costs to consumers of verifying quality would increase, perhaps dramatically. The solution to the problem, of course, was branding, which allowed the producer to speak, as it were, directly to the consumer and to utilize some of the same bonding mechanisms that the local grocer had once used²² (Klein and Leffler 1981). New generalist retailer like Sears and A&P also sprang up to carry a wide variety of branded products, and these were able to add the bonding power of their own names to that of the individual product brands, sometimes even selling the commodities under their own house brand ([Kim](#)

²² It is not correct to say, however, as Kim (2001) seems to imply, that the system of branded products supplanted the earlier system because of its superior transaction-cost properties. In Kim's story, products became more sophisticated because of technological change, making it harder for consumers to judge quality directly. This gave the advantage to big chain stores, which had large amounts of capital with which to bond quality. As Chandler shows, however, the principal innovations in this period were in the nature of process technology. Soap, beans, butter, cigarettes, etc. didn't change much — but they could be packaged much more quickly by machine. Moreover, even in the early nineteenth century, consumers could not directly discern the quality of products by casual inspection: many of the most famous cases of adulteration involved simple commodities like bread or flour. And small generalist retailers were often perfectly capable of certifying the weight and purity of even sophisticated commodities like pharmaceuticals; only now are pharmacists being supplanted by branding, and that is because of a change in the sophistication of testing equipment ([Savage 1994](#)). In the end, the system of branding arose to solve a transaction cost problem caused by — but that was arguably small in comparison with — the major production-cost gains from new process technology. Whether branding is superior to local certification and bonding on purely transaction-cost grounds is an open question.

[2001](#)). In addition, the large multiunit retailers were able to create capabilities, and to exploit scale economies, in quality management and assurance.

Branding did more than solve a transaction-cost problem, of course. It was another method of attempting to control the environment in order to reduce variation and uncertainty. This is clear even from a standard neoclassical textbook. By creating a product differentiated in the eyes of the consumer, a firm can enjoy a more inelastic demand curve, which damps fluctuations in price and quantity. And branding is what makes product differentiation possible. Even if quality is the brand's only distinguishing characteristic — as was arguably the case for commodities like branded gasoline — branding will still have this damping effect (Klein and Leffler 1981).

All of these methods of attempting to control the environment pale in comparison with getting the government involved. Economists and political scientists have long since come around to the idea that regulation is something that firms and industries often work hard to bring upon themselves (Kolko 1963; Stigler 1971). Politicians are often anxious to supply regulation, as it earns them the political support they crave. And firms are equally anxious demanders of regulation, as it serves their interests. Those interests are normally understood in terms of increased profits from government-managed cartelization and restrictions on competitive entry. But clearly government can also serve a

damping function.²³ It provides an environment alternative to, or at least supplementary to, the market — an environment that is either inherently less variable or that can be more easily dealt with by the buffering mechanisms of management. Of course, not all industries fit this picture: it is doubtful that regulation of taxicabs in major cities or of interstate trucks under the old regime of the Interstate Commerce Commission had much to do with buffering in a world of high fixed costs. But many other industries, often supposed “natural monopolies” in undifferentiated products like electricity, phone service, or natural gas transmission, may have sought regulation in part to help control a complex, internally managed production system containing critical components with high fixed costs.²⁴ Even in industries not directly regulated by agencies, government action often came in handy as “safeguarding activities” to buffer demand shocks or to provide a cushion of economic rents.

Although the problems of buffering high-throughput production have not made much impression on the mainstream literature on government and business, there is a line of thought along the fringes that takes this problem as

²³ Government may also be enlisted to serve the quality guaranteeing function alluded to earlier. A classic example of this is the institution of federal inspection of meat (Libecap 1992).

²⁴ I don't mean this to suggest that such regulation is therefore obviously desirable. Although regulation may indeed serve the function of smoothing the environment, and thus of helping a highly integrated structure to make good use of its high-throughput assets, it also has the effect of freezing the environment and of insulating the organization from the changing configuration of relative scarcities and transaction costs in the economy. Without regulation, firms have to control variation by making themselves more adaptable, which

central. Running roughly from Thorstein Veblen (1921) to Williamazonick (1991), this literature sees it as crucial that managers be insulated from the vagaries of the environment, especially those caused by financial and other markets. Veblen considered financial markets “industrial sabotage.” The most eloquent voice in this tradition belonged, however, to John Kenneth Galbraith, whose *New Industrial State* distilled through hyperbole the essence of the corporate century he could see stretching behind him in 1967. Galbraith takes it for granted that technological change always leads to greater complexity and scale. This complexity and scale requires “planning”; such is the imperative of technology, an imperative that can only grow stronger in the future. Planning means not only the attempt to foresee and prepare for future contingencies but also the removal of transactions from the market to the realm of managerial authority. “If, with advancing technology and associated specialization, the market becomes increasingly unreliable, industrial planning will become increasingly impossible unless the market also gives way to planning. Much of what the firm regards as planning consists in minimizing or getting rid of market influences”²⁵ (Galbraith 1971, pp. 42-43).

It is perhaps a fitting reward for the *hubris* this view of planning implies that the not-too-distant future had in store a picture of technology and

may be a better long-run outcome. At the end of the twentieth century, as we will see presently, even regulation couldn’t protect firms from the need to adapt their structures.

organization that would be virtually the diametric opposite of the one Galbraith painted.

From internal to external capabilities: the new economy.

Ruttan and Hayami (1984) have proposed a theory of institutional change that is relevant to my story of organizational-and-institutional change. As they see it, changes in relative scarcities, typically driven by changes in technology, create a demand for institutional change by dangling new sources of economic rent before the eyes of potential institutional innovators. Whether change occurs will depend on whether those in a position to generate it — or to block it — can be suitably persuaded. Since persuasion typically involves the direct or indirect sharing of the available rents, the probability of change increases as the rents increase. And the more an institutional or organization system becomes misaligned with economic realities, the more the rents of realignment increase.

By the 1980s, the large corporation that had looked inevitable and invincible in the 1950s and 1960s had become an organizational structure increasingly misaligned with economic realities — and an organization in the process of redefining itself. Quite apart from any mechanisms of environmental control they may have themselves created, the large American corporations after World War II benefited from the attenuated climate of competition that came

²⁵ The syllogism continues, of course. Since a little planning is good, a lot must surely be better. So the government should largely replace the market system with central planning.

with the destruction of the German, Japanese, and other economies. As those economies revived and trade began expanding by the 1970s, the easy life was coming to an end. Indeed, by the 80s and 90s, the image of invincibility had been virtually replaced by its opposite. As Mark Roe notes, “the image of the corporation as a sweating and not-always-successful competitor has become more vivid” (Roe 1996, p. 106).

The American corporation’s mechanisms of environmental control and its charmed life in the 50s and 60s had permitted it largely to ignore ongoing changes in the scale of technology as well as the increasing thickness and realignment of markets. In startling contrast to Galbraith’s (rather nineteenth-century) view of technological change, innovation often — and perhaps mostly — proceeds by simplifying and by reducing scale.²⁶ Arguably, this has been the dominant trend of the twentieth century.²⁷ For example, in electricity generation, among the most scale-intensive of fields, the development of aero-derivative combined-cycle generating technology (CCGT) has significantly reduced the

²⁶ This seems to have been Adam Smith’s (eighteenth-century) view. What drives innovation is the desire to perform a given set of operations more elegantly and economically. ([Smith 1976](#), I.1.8.)

²⁷ I mean this as a long-run proposition. In the short run, innovation can certainly increase scale. Moreover, the effect of technological change on scale is sometimes subtle, in that scale reduction in one part of the system can lead to increased scale elsewhere. The advent of the small electric motor (eventually) led to the demise of highly centralized steam power in factories (David 1990); but it also increased the extent of the market for electric power and (initially at least) helped increase the scale of its generation. Indeed, in some cases, the Internet and FedEx have clearly had the same scale-increasing effect as the telegraph and the railroad: think of Amazon.com. But over time, holding all else constant, the scale of a given technology tends to decline. (On this point see also Langlois [1999a](#), p. 56.)

minimum efficient scale of new electric capacity (Joskow 1997, p. 123). In telephony, the rise of semiconductor technology in general and the development of the private branch exchange (PBX) in particular turned switching from a centralized to a decentralized-network technology (Vietor 1994, p. 188). At the same time, rising populations, rising income, and newly vibrant international trade generated thicker markets. This meant, among other things, that, even where technology was not threatening to reduce scale, existing structures of fixed cost shrank relative to the extent of the market. For example, by the time CCGT had arrived, increases in market size had long since stripped electric power generation of its natural-monopoly character (Joskow and Schmalensee 1983).

My argument is that these changes in technology and markets opened up attractive rent-seeking possibilities that could be seized only by breaking down or “unbundling” the vertical structure of the managerial corporation. This is perhaps clearest in what most had long considered the intractable cases of vertical integration: regulated utilities. We need only think of long-distance telephony, in which a scale-reducing technical change — microwave transmission, in this case — created opportunities for whoever could open up AT&T’s legal hold on the field.²⁸ Entrepreneur William McGowan of MCI

²⁸ In this case, the possibilities arose in part because of AT&T’s pricing structure, which for political reasons had subsidized local service at the expense of long distance — a

poured resources first into persuading the Federal Communications Commission to alter its policies and then into fomenting the breakup of AT&T (Temin 1987). Similar tales can be told for the deregulation of electricity (Kench 2000) and other industries. A similar process of unbundling is also underway in less-regulated industries, where the impediments to supplying organizational change are substantially lower though not necessarily absent.

In some respects, the internal dynamic of scale and scope that Chandler chronicles contributed in an almost Hegelian fashion to the corporation's own undoing. Driven by the Chandler-Penrose imperative to apply existing managerial skills and other capabilities more widely, the corporation in the 1960s took the idea of diversification to new levels.²⁹ ITT was the paradigm. Originally an international supplier of telephone switching equipment, it bought, among other things, an insurance company, a hotel chain, and the maker of Hostess Twinkies. In assembling conglomerates, as Mark Roe (1996, p. 113) argues, "managers learned that they could move subsidiaries and divisions around like pieces on a chessboard."

Conglomerates were assembled from separate firms, with a central headquarters directing the firm. Their widespread use in the 1960s taught managers that it was possible to mix and match corporate

misalignment with relative scarcities made possible by AT&T's status as a regulated monopoly (Vieter 1994, p. 183).

²⁹ Of course, there were institutional factors as well. Roe (1996) points to the favorable tax treatment of retained earnings relative to dividends. Shleifer and Vishny (1991) argue that stringent antitrust policy in the 1960s discouraged cash-rich firms from acquiring companies in related industries, forcing them into unrelated diversification.

divisions. It was only a small leap of an organizational idea for a conglomerate to bring in an outside firm via a hostile acquisition by buying up the target's stock and tucking the formerly independent firm in as one now managed from the conglomerate headquarters. From there it was only another small mental jump in the 1980s to understand that once the pieces of a conglomerate had been assembled, they could be disassembled as well. (Roe 1996, p. 114.)

Notice also that the managers could move divisions around like pieces on a chessboard in the first instance because of the modular structure of the M-form.

Aided by innovations in the securities markets, the leveraged-buyout wave of the 1980s disassembled the conglomerate of the 1960s. "By and large," write Bhagat, Shleifer, and Vishny (1990, p. 2), "hostile takeovers represent the deconglomeration of American business and a return to corporate specialization." Indeed, specialization became the strategic catchword of the 1990s. Whereas the most influential text on corporate strategy in 1980, that of Michael Porter, had counseled its readers to profit through buffering mechanisms and the control of the environment, the leading gurus of the next decade taught that the keys to success lay within and that firms could prosper only by returning to their *core competences* (Prahalad and Hamel 1990). Shoemaker, stick to your last.

What has been less well observed, however, is that the changes of the 1980s did not amount to a return to the pre-conglomerate days of the 1950s, to the "modern corporation" that Chandler had described. Something fundamental had changed. If a corporation – even a non-conglomerated one -- is a vertical

amalgam of division-modules, then the logical extension of the idea of corporate specialization would be to hive off not only unrelated divisions but also vertically related divisions as well. As G. B Richardson (1972) pointed out, it is highly unlikely that the various vertical stages of a production process should all call for similar kinds of capabilities.

And this is what has happened. “Even a cursory examination of the industrial system of the United States in the 1990s reveals organizational patterns that look not at all like the modern corporation,” writes Timothy Sturgeon.

The largest single employer in the country is not General Motors, but a temporary employment agency called Manpower Inc. The largest owner of passenger jets is not United Airlines, or any other major carrier, but the aircraft leasing arm of General Electric. American automakers have spun-off their in-house parts subsidiaries and outsourced the design and manufacture of entire automotive sub-systems to first-tier suppliers. Since 1992, IBM has literally turned itself inside-out, becoming a merchant provider of the basic components it had previously guarded so jealously for exclusive use in its own products. If what we see today seems to have little relation to the ideal type of the modern corporation, there may be good reason. Perhaps the American industrial system has begun to adapt to the new, more intense global competitive environment that triggered the competitive crisis in the first place. Perhaps we are witnessing the rise of a new American model of industrial organization, and not simply the resurgence of the old (Sturgeon 2000, pp. 6-7).

Figure 3 is a picture of this new model. In many respects, its structure looks more like that of the antebellum era than like that of the era of managerial capitalism. Production takes place in numerous distinct firms, whose outputs are coordinated through market exchange broadly understood. It is in this sense

that the visible hand of management is disappearing. Unlike the antebellum structure, however, the new economy is a high-throughput system, with flows of work even more closely coordinated than in a classic Chandlerian hierarchy.

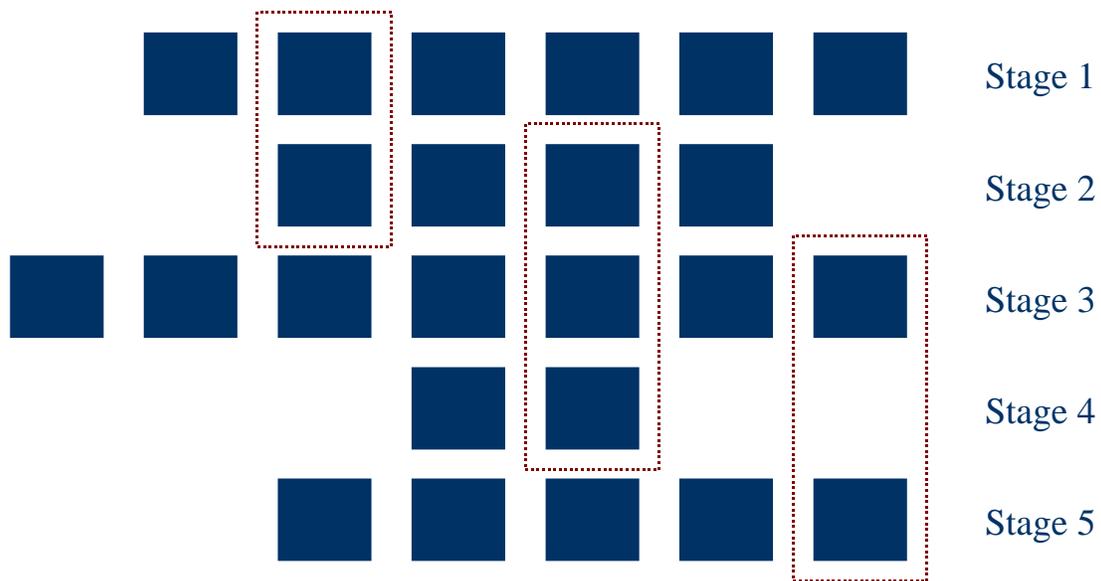


Figure 3: the New Economy value chain.

Vertical disintegration and specialization is perhaps the most significant organizational development of the 1990s, largely ignored in economics but amply documented in the business press. The following examples are illustrative but by no means exhaustive. In electronics, firms like [SCI Systems](#), [Solectron](#), and [Flextronics](#) specialize in assembling on contract electronic systems

of all sorts (Sturgeon 2000). But they neither design³⁰ nor distribute nor market the systems themselves. In pharmaceuticals, the major integrated companies are increasingly outsourcing manufacturing and marketing to firms like [DSM Catalytica](#) and clinical trials to contract research firms like [Quintiles Transnational](#) and [Covance](#) ([Dolan and Meredith 2001](#)). A major new trend in semiconductor manufacturing has been the rise of so-called fabless semiconductor firms. These firms retain design, development, and marketing functions but do not own their own manufacturing plants (called “fabs” in industry argot); instead, they contract out the actual manufacture of the chips to specialized “silicon foundries” ([Langlois and Steinmueller 1999, p. 51](#)). Led by Chrysler in the 1990s, American automobile manufacturers began to modularize their product design and supply chain strategies and to rely more heavily on subcontractors³¹ (Fine 1998, pp. 61-62). The litany could continue.

This is specialization, of course. But notice also that these subcontractors are also generalists. Flextronics will put together virtually any kind of electronic device you ask it to; DSM Catalytica will produce whatever drug you hand it; and the silicon foundries of Taiwan (and elsewhere) will manufacture whatever

³⁰ More correctly, they do not *brand* their own systems. These firms will often supply design and engineering services when asked. For example, Flextronics and Solectron not only manufactured the Handspring Visor but were also involved in its design in order to smooth manufacturing and quicken time to market ([Dolan and Meredith 2001](#)). On the other hand, design services are a specialty that can also be purchased on the market. [Ideo](#), a specialist design firm, is responsible for Handspring’s new model, the [Visor Edge](#).

³¹ In 2000, the American Big Three and several other car makers formed an electronic B2B supplier network called [Covisint](#).

chip design you send them electronically. In the auto industry, parts suppliers are generalizing their capabilities across major subsystems (Fine 1998, p. 65). This coupling of specialization of function with generalization of capabilities recalls the generalist merchants of the early republic.³² It is in fact a typical feature of the Smithian process. In his famous analysis of that process, George Stigler (1951, p. 192) referred to what he called “general specialties.” He had in mind activities like railroads, shipping, and banking that can benefit a variety of industries; but contract suppliers are clearly examples in the small – microcosmic instances of what economists now call *general-purpose technologies* (Helpman 1998). This trend toward general specialties is a continuation of the process of decoupling capabilities from products that Chandler observed in *Scale and Scope*. It is also a mechanism by which the market system buffers uncertainty. Since a general specialist is not tied to a particular product or brand, taking in work from many purveyors of products and brands, it can diversify its portfolio more effectively. This smoothes demand and facilitates high-throughput production.

The relationships between subcontractors and their clients are clearly market relationships, even if they are also often collaborative relationships involving trust, permanence, and the transfer of rich information ([Helper, MacDuffie, and Sabel 2000](#)). But in many sectors of the new economy — including some aspects of subcontracting — market relationships sometimes

³² Not to mention Chandlerian managers, who specialized in management but possessed

approximate the extreme of anonymous arms'-length spot contracts. What makes such simple relationships possible is the increasing modularity of many products and organizational structures.³³ In the Chandlerian firm, the visible hand of management – or at any rate the internal routines of coordination that management set up and oversaw -- provided the coordinative glue that held the stages of production together. In the new economy, the visible hand has been socialized into technical standards³⁴ that permit external mechanisms of coordination and reduce the need for rich information transfer. At the same time, the buffering function that management had exercised is devolving to the buffering mechanisms of modularity and the market — informational decomposition, flexibility, and risk spreading.

Just as did the high-throughput technologies of classical mass production, modular systems require and arise out of standardization. But unlike classical mass-production technologies, which standardize the products or processes themselves, modular systems standardize something more abstract: the rules of

general management capabilities.

³³ In fact, of course, modularity actually lies behind the scene of many instances of collaborative market relationships as well. Indeed, in the industry Helper, MacDuffie and Sabel use as their example – automobiles – what animates the new American collaboration, like Japanese collaboration before it, is *increased modularity*. Rather than handing suppliers detailed instructions, manufacturers now give suppliers interface specifications and then encourage them to design the parts as they see fit. So called first-tier suppliers may even be ceded authority for major components of the automobile (Womack, Jones, and Roos 1990). Although some collaboration and exchange of general knowledge takes place, the underlying design parameters of each part become hidden information from the perspective of the manufacturer.

³⁴ I am indebted to Martin Kenney for this phrase.

the game, or what Baldwin and Clark (2000) call *visible design rules*. So long as they adhere to these rules, participants need not communicate the details of their own activities, which become *hidden design parameters*. By taking standardization to a more abstract level, modularity reduces the need for management and integration to buffer uncertainty. One way in which it does so is simply by reducing the amount of product standardization necessary to achieve high throughput. This is the much-remarked-upon phenomenon of mass customization ([Cox and Alm 1998](#)). For example, the highly modular structure of the personal computer as it developed during the 1970s and 1980s (Langlois 1992a) made it possible for Michael Dell and others to begin selling PCs to order by assembling them like Legos from a set of standardized components ([Kraemer and Dedrick 2001](#)). In so doing, PC makers could blanket more fully what economists call the product space ([Langlois and Robertson 1992](#)), that is, they could fine tune products more closely to the needs of individual users. When economies of scale no longer require largely identical products to be manufactured *en masse* on spec, a major source of environmental uncertainty disappears, and with it the need to buffer that uncertainty.³⁵

³⁵ Flexible specialization didn't originate with the Internet economy, of course. General Motors pioneered an analogous strategy in the early automobile industry when it offered a variety of slightly differentiated variant models based on a common set of underlying mass-produced parts (Raff 1991) — a classic American idea that Marshall (1920, I.viii.2, p. 141) called “multiform” standardization. But when open modularity is feasible, the possible variants multiply greatly. And the Internet has clearly accelerated the movement to mass customization by lowering the costs of acquiring information about the tastes of consumers.

When a modular product is imbedded in a decentralized production network, benefits also appear on the supply side³⁶ ([Langlois and Robertson 1992](#)). For one thing, a modular system opens the technology up to a much wider set of capabilities. Rather than being limited to the internal capabilities of even the most capable Chandlerian corporation, a modular system can benefit from the *external capabilities* of the entire economy. External capabilities are an important aspect of the “extent of the market,” which encompasses not only the number of possible traders but also the cumulative skill, experience, and technology available to participants in the market. Moreover, because it can generate *economies of substitution* (Garud and Kumaraswamy 1995) or *external economies of scope* (Langlois and Robertson 1995), a modular system is not limited by the weakest link in the chain of corporate capabilities but can avail itself of the best modules the wider market has to offer.³⁷ Moreover, an open modular

³⁶ The supply-side aspect of modular standards have gone largely unnoticed in the economics literature, which has focused almost exclusively on the possibilities of demand-side network effects.

³⁷ This is not to say that a modular system will always outperform a nonmodular one. In a theory related to the idea of dynamic transaction costs articulated earlier, Christensen, Verlinden, and Westerman (1999) have laid great stress on the ability of a nonmodular system to outperform a modular system. In the short run (that is, holding the performance of available modules constant), a nonmodular system targeted toward high performance in a particular application can generally outperform a collection of off-the-shelf modules. To Christensen and his coauthors, this means that vertical integration (which can best coordinate a nonmodular system) will prevail when performance is at a premium. Later, however, as supply moves down the demand curve to those who require less performance, the baton passes to a modular system, since such a system can best compete on price and quantity, which is what comes to matter in a market less interested in performance. This is certainly a persuasive story in the context of a number of high-tech products. But one should keep in mind that, in the long run, the modular system may come to outperform the highly optimized nonmodular system because of the supply-side mechanisms detailed here.

system can spur innovation, since, in allowing many more entry points for new ideas, it can create what Nelson and Winter (1977) call rapid trial-and-error learning.³⁸ From the perspective of the present argument, however, the crucial supply side benefit of a modular production network is that it provides an additional mechanism of buffering.

The case of Enron illustrates how markets — eventually including electronic exchange markets — came to solve the buffering problem. Enron was formed in 1985 by the merger of two established natural gas pipeline firms. By the end of the 1980s, the company began responding to the deregulation of natural gas transmission by inventing “products” that could be traded on liquid markets. In effect, Enron did this by creating novel financial contracts complementary to the company’s physical assets.

In 1989 negotiations broke down with a Louisiana aluminum producer who sought to obtain fixed-price gas from Enron. Enron’s costs to physically transport the gas made the transaction unattractive. Just as everyone was getting up from the negotiating table, the negotiating team suggested that the aluminum firm continue to buy its gas locally — at floating prices, plus transportation costs. Enron could then write a financial contract in which the aluminum producer would effectively pay Enron fixed payments while Enron paid the producer’s floating prices. The

To put it another way, innovation in a previous modular system may be a precondition for the high performance of the succeeding generation of nonmodular system.

³⁸ Baldwin and Clark (2000) have recently explicated this last point in the language of finance theory. If we think of each experiment taking place in the system as a *real option*, then an open modular system can create more value than a closed corporation even if the same number of experiments takes place in each system. This is a consequence of the theorem in finance that says that a portfolio of options (the modular system) is worth more than an option on a portfolio (the experiments within the corporation).

aluminum producer could minimize its costs of physically obtaining gas, while using a financial contract to tailor the form of its payments. Though the Enron team did not realize it at the time, they had executed what in hindsight was one of the first natural gas swaps. ... From 1990 through 1993, Enron spent \$60 million to develop its Financial Trading System, staffed by a mix of gas experts and Wall Street traders, to develop an information and trading system that permitted the organization to function as the trading desk of an investment bank. (Bhatnagar and Tufano 1995, p. 5.)

On the supply side, Enron revived a turn-of-the century contract, now called a Volumetric Production Payment (VPP), to securitize ownership rights to gas reserves in an alienable way. The company then applied the idea of modular tradable rights to other areas such as electricity, and it now maintains major [electronic exchanges](#) trading a wide variety of commodities, including bandwidth, over the Internet.³⁹

The reader may have noticed that the Internet and other present-day technologies of coordination have played a supporting role in my story rather than a starring role. This is somewhat in contrast to the billing technology has received in other venues. For example, in an argument akin to the vanishing-hand thesis offered here, Malone and Laubacher (1998, p. 147) take changing information technology as central. “The coordination technologies of the industrial era — the train and the telegraph, the automobile and the telephone, the mainframe computer — made internal transactions not only possible but

advantageous.” But the development of even more powerful coordination technology — personal computers and broadband communication networks — has had precisely the opposite effect. “Because information can be shared instantly and inexpensively among many people in many locations, the value of centralized decision making and expensive bureaucracies decreases” (p. 147).

This is certainly part of the story. But the hypothesis I offer here is a bit more subtle — or at least a bit more complicated — and arguably more general. In my view, the phenomenon of the vanishing hand is a further continuation of the Smithian process of the division of labor on which Chandler’s managerial revolution was a way station. Thus the vanishing hand is driven not just by changes in coordination technology but also by changes in the extent of markets — by increasing population and income, but also by the globalization of markets. Reductions of political barriers to trade around the world are having an effect analogous to the reduction of technological barriers to trade in the America of the nineteenth century. Is this a revolution or the continuation of a long-standing trend? Again, the answer depends on one’s perspective. My argument is that, just as the American “globalization” after the Civil War was revolutionary in its systemic reorganization of production toward standardization and volume, the new era is revolutionary in its systematic reorganization toward modular

³⁹ “Enron’s e-commerce site, which handled some 550m transactions with a notional value of \$345 billion in 2000, its first full year of operation, is the most successful Internet effort of any firm in any business.” (*The Economist*, February 10, 2001.)

systems in response both to changes in coordination technology and to plain-old increases in the extent of markets.

Indeed, it is not clear that we are entitled to see coordination technology as an entirely exogenous influence on organization form. Perhaps we might grant the deployment of the telegraph as an exogenous event that helped to integrate markets and thus helped bring about the managerial revolution. But when we think of much of the rest of the technology employed by managerial organizations — from filing cabinets to carbon paper to typewriters to mimeograph machines (Yates 2000) — we might more usefully think in terms of the coevolution of technology and organization. Physical and social technologies⁴⁰ influence one another by each throwing up problems the other is challenged to solve. On the one hand, this reinforces the notion that an organizational structure biases technological change in ways that reinforce that structure. On the other hand, it reduces the extent to which we can view such technological change as independently causative. Was the Internet an exogenous event like the telegraph that altered organizational form decisively? Perhaps. But it is well to remember that, back when the currency of the digital world was dots and dashes rather than zeroes and ones, the international hub of e-commerce was Manchester, England, where the telegraph served as a vibrant element in one of history's most vertically disintegrated production systems – the

British cotton textile industry (Farnie 1979, p. 64). In my view, the relationship among coordination technology, transaction costs, and industrial structure remains an open research agenda.

Figure 4 summarizes the vanishing-hand thesis in visual form. I have called the independent variable “thickness of markets,” which is driven by exogenous factors like population, income, and the height of technological and political trade barriers. The vertical axis is called “urgency of buffering,” by

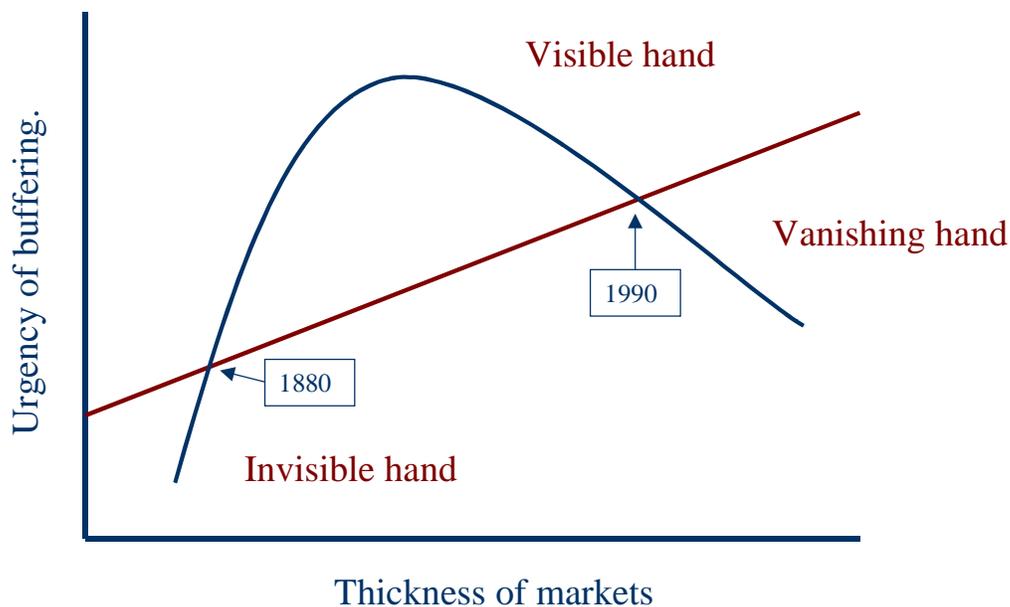


Figure 4: the vanishing-hand hypothesis.

⁴⁰ To use the language of Nelson and Sampat (2001). Their point is that institutions – including generic organizational forms – evolve in much the same way that technology does.

which I mean to capture the degree to which the technology of production is complex, sequential, and high-throughput. Producing cotton cloth under the putting out system would have a low degree of urgency of buffering; producing electricity for the state of California would have a high degree of urgency of buffering. The straight line moving northeast from the vertical axis represents the boundary between firm and market. Above the line, buffering through integration and management is less costly; below the line, buffering through markets (of a thickness given on the horizontal axis) is preferable. That the line slopes upward simply reflects the increased ability of markets to buffer product-flow uncertainty as they thicken.

The more-or-less parabolic curve superimposed on this space represents the vanishing-hand hypothesis. Think of it as a path in time, rather like the plot of an explorer's progress on a map.⁴¹ The possibilities for high-throughput technologies and mass production made possible in the late nineteenth century generated a rapid and sudden increase in the urgency of buffering. This is reflected in the initially steep slope of the curve: markets were insufficiently thick to buffer product-flow uncertainty, just as they were initially too underdeveloped to handle financial risk. Over time, two things happen: (a) markets get thicker and (b) the urgency of buffering levels off and then begins to decline. In part, urgency of buffering declines because technological change

begins to lower the minimum efficient scale of production. But it also declines because improvements in coordination technology — whether applied within a firm or across firms — lower the cost (and therefore the urgency) of buffering.

More or less arbitrarily, I have labeled as 1880 the point at which the path crosses the firm-market boundary. This is the start of the Chandlerian revolution. Equally arbitrarily, I label as 1990 the point at which the path crosses back. This is the vanishing hand. Far from being a general historical trend, the managerial revolution — in this interpretation — is a temporary episode that arose in a particular era as the result of uneven development in the Smithian process of the division of labor.

The past and future of management.

If, as I argue, the once visible hand of management is becoming increasingly ethereal, will the activity of management therefore pass away completely? Clearly not. Management has always been with us and will always be with us. The antebellum merchants who traded in whale oil were managers, as are the executives at Enron who design new tradable securities and set up online exchange systems. They are no less managers than the Chandlerian executives of Standard Oil or ExxonMobil. Management is related to – maybe management *is* – the cognitive ability of humans to buffer the variability of an uncertain world

⁴¹ The technically inclined may want to view it as the projection onto two dimensions of a curve in three-dimensional space, with the third (*z*) dimension being time.

and to transform it into something more predictable. Buffering of that sort will always be necessary, and it will flourish wherever human cognition has a comparative advantage as a buffering mechanism (Simon 1960). The vanishing-hand thesis is about the changing industrial structure of management or, to put it another way, about the changing comparative advantage of humans and markets in the task of buffering.

My argument is about long-run tendencies. In the short run, the economic environment may occasionally generate the very kind of circumstances that led to the managerial revolution. For example, in the 1980s, when vertical unbundling was the rule of the day, Nicolas Hayek was busy creating a Chandlerian corporation out of the remnants of the fragmented Swiss watch industry (Langlois 1998). Like Gustavus Swift, he needed to rearrange capabilities in a systemic way – and to do it quickly.⁴² Centralized ownership and control was the most effective way to bring about the necessary reorganization. Nonetheless, this kind of integration is less and less likely to be the norm.

At the risk of lapsing into a cliché of the business literature, the message of this thesis for management is that managers will need to learn how to define themselves in a world where markets and modular systems do some of the work

of buffering environmental variation. In one sense, the executives at Enron are doing exactly what entrepreneurs in Chandler's world were doing: actively remodularizing production to take advantage of the profit opportunities afforded them by the nature of markets and the transaction technology of the day. Like Chandler's managers, these executives had to invest resources to create new production technologies; they had to overcome the dynamic transaction costs of change by systemically reorganizing production and distribution.⁴³ But rather than orienting management around high-throughput physical assets, the company oriented management around what Stinchcombe (1990) refers to as a *fiduciary* function: the business of transforming high-risk inputs into predictable, low-risk products.⁴⁴

As Enron executives think of it, the post-Chandlerian revolution of the late twentieth and early twenty-first centuries is about "the transition from hard assets to soft assets." Or perhaps we might say: the transition *back* from hard assets to soft assets. As we saw, the antebellum merchant relied on knowledge, skill, and adaptability. That the new economy is a knowledge economy is

⁴² Unlike the case of Swift, however, it wasn't the promise of scale economies that impelled Hayek but rather the creative destruction wrought by the Japanese development of electronic watch movements, which rendered obsolete existing Swiss capabilities in mechanical movements.

⁴³ For example, it took eighteen months and millions of dollars to craft the VPP contract (Bhatnagar and Tufano 1995, p. 7).

⁴⁴ Perhaps surprisingly, Stinchcombe's example of fiduciary management is the research university, which transforms risky investments in the uncertain research programs of its faculty into the relatively standardized and liquid output of a university degree.

another cliché of our times. And, although the Chandlerian manager might have claimed with some justification that knowledge was important to his or her job, it is nonetheless true that, as we saw, high-throughput assets were a crucial feature of the competitive landscape. In the new modular economy, managers must look elsewhere for competitive advantage. Recognizing the underlying fiduciary function of management may be a first step toward discovery.

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