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**Publication Date**
1997-08-01

# Turnkey Production Networks: A New American Model of Industrial Organization?

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Working Paper 92A
August 1997



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Generous support for this work was provided by the Alfred P. Sloan Foundation.

## INTRODUCTION

This paper explores the implications of the following hypothesis: that a significant share of American firms are adapting to volatile and intensely competitive market conditions by "outsourcing" manufacturing functions to specialized merchant suppliers. At the same time, "brand-name" firms have reasserted control over product definition, design, and marketing functions, which are largely being kept in-house despite the spate of high-profile "strategic alliances" formed in the 1990s.

Evidence from the electronics industry suggests that a new American model of industry organization is emerging in the 1990s. American electronics firms are outsourcing an increasing share of their production. As this practice grows, manufacturing capacity is building up in *turnkey production networks* that consist of specialized and highly capable merchant suppliers that provide the industry with a functionally coherent set of commodified production services. When firms that supply external productive capacity develop a *merchant character*, as they have in the American-led electronics industry, manufacturing capacity is essentially shared by the industry as a whole, reducing costs and spreading risks in an increasingly volatile world market. In essence, I argue that market-creating innovative capacity is being hoarded in-house, while market-supplying productive capacity is being allowed to migrate into external economies that can be shared industry-wide. Such external scale economies are coming to reside in a cadre of specialized merchant suppliers that offer access to a *functionally coherent* set of production functions as a service to their customers, the brand name firms. The emerging organizational split between innovation and production is usually enabled by highly formalized links at the inter-firm boundary.

The hypothesis is derived from research on product-level electronics manufacturing (computers, communications equipment, consumer electronics, etc.), where such an organizational shift, from in-house to outsourced manufacturing, has been dramatic in recent years. However, even superficial observations strongly suggest that comparable changes are

underway in many other sectors as well (e.g., apparel and footwear, toys, data processing, home furnishings and lighting, semiconductor fabrication, food processing, automotive parts, brewing, enterprise networking, and pharmaceuticals). The aim of this paper is not to prove that the shift is occurring in every American firm, or even to provide a detailed analysis of the changes in the electronics industry. I have presented the latter evidence more fully elsewhere (Sturgeon, 1990, 1991a, 1991b, 1992, 1997; Sturgeon and Cohen, 1996). Instead, the model of industry organization derived from the electronics case is exposed to some of the key theoretical tools that have been developed to predict and explain industry structure and economic development: Joseph Schumpeter's notion of innovation in the giant firm, Alfred Chandler's ideas about economies of speed and the rise of the modern corporation, Oliver Williamson's transaction cost framework, and theories of the relational production network. It is my opinion that the outlines of a new model of industrial organization in American industry are clear enough to take the next step of using it to test, and perhaps modify, the analytic tools that we currently have at our disposal. Questions of firm structure are inseparable from questions of industry structure: they are the specific and general aspects of the same structure. Accordingly I refer to the theories explored in the paper as theories of *firm and industry organization.*

Section One sets the stage for the later discussion by placing the theories of firm and industry organization in the historical context of the rise of the large, diversified industrial corporation in the United States in the early twentieth century, and the subsequent competitive crises triggered by the appearance of strong Asian competitors in the 1970s and 1980s. I go on to argue that there are signs that American industry has now begun to adapt to the new competition, not through imitation, but by adopting a unique model of networked production. In Section Two, I provide a thumbnail sketch of the new organizational model, which I have dubbed the "turnkey production network," through an example gleaned from the American-led electronics industry. In Section Three I, begin the exercise of discussing the turnkey model in the context of theories of firm and industry organization by analyzing

Schumpeter's ideas about innovation in the giant firm, which were structured by his assumption that innovative capacity would build up alongside productive capacity inside the giant industrial enterprises. In the turnkey model, innovative capacity is organizationally separate from productive capacity, which is pooled into external economies that can be tapped by the industry as a whole. In Section Four, I present Chandler's notion of economies of speed, arguing that we are seeing economies of scale, scope, and speed extending beyond the boundaries of any single firm. Section Five discusses the turnkey network model in the context of Williamson's transaction costs framework. It turns out that Williamson's model goes a long way in explaining why an organizational model based to an extreme degree on outsourcing works well when firm interdependence in limited, but fails to predict the emergence of an organizational structure where interdependence is limited *and* a high degree of outsourcing is practiced. Section Six compares the turnkey network model to other network models that have been introduced in the literature, arguing that all network models need not be based not on trust, social and geographical propinquity, and long-term relationships. The turnkey network model is characterized by limited interdependence, competitive switching, and a full-service orientation by sophisticated merchant suppliers. In conclusion, I speculate about the world-wide convergence of industrial paradigms, and place the turnkey network in the context of the ongoing diffusion and adaptation of nationally-specific models of industrial organization.

## 1. FROM THE MODERN CORPORATION TO PRODUCTION NETWORKS: A PARADIGM SHIFT

Through the mid-1980s, the dominant paradigm for the study of industrial organization and economic development was the modern corporation as best defined by Chandler (1977). There was good reason for this focus. By the 1950s, the large multidivisional (and increasingly multinational) enterprise, with its extensive managerial hierarchy, had become an undeniable force in economic development, not only in its

heartland, the United States, but also in other countries where its features were adopted as a model for local firms. Regardless of analytic stripe (e.g., neoclassical, Weberian, Marxist), the large, multidivisional, hierarchically-controlled corporation provided a set of ordering assumptions for theorists interested in explaining its rise and inner logic (theories of the firm), as well as for those working on problems of economic development where the modern corporation played a central role, such as literature on the transnational corporation and development (e.g., Gershenkron, 1962; Vernon, 1966, Williamson, 1975, 1981, Perrow, 1981). For many, the archetype of the modern corporation that emerged from this work was held up as the pinnacle of capitalist development and for nearly all, the giant firm was recognized as the central force in economic development. As an ideal type, it was well understood, and it was assumed, that firms would, over time, become closer to its image.

During the 1970s and 1980s, changes in the world economy, particularly the failure of large American corporations to adequately respond to new competition from Asia, cast doubt on ideas that used the modern corporation as an organizing principle, plunging a wide range of fields into crisis and triggering research into aspects of industrial organization that had previously been obscured.[1] Until the 1980s the shadow of the modern corporation had rendered alternative organizational forms nearly invisible in the literature, but the faltering of some of the United States' largest manufacturing firms in the face of Asian competition signaled that something was very amiss with the modern corporation. The complacency that had set in over so much of the thinking about industry organization and economic development began to unravel.

Thus began the search for a new model. Some revisited the work on periodic crisis and instability that had been triggered by the Great Depression (van Duijn, 1983), while

[1] Such paradigm shifts typically involve cycles of theoretical consensus and crisis. Periods of consensus allow for a flowering of theoretical work because effort shifts from *constructing* the "object of knowledge" (what and how) to theorizing *about* the object of knowledge (why and in whose interest). While such theoretical paradigms provide basis for debate by bringing some things into sharper focus, phenomena that do not fit the dominant model tend to be obscured. Periods of crisis arise when things that have been obscured, for one reason or another, are forced to the surface. What were "anomalies" under the old paradigm then become the building blocks of the new (Kuhn, 1970).

others noted that many of the problems of the modern corporation could be traced to the emergence of powerful new competitors from Europe and Asia (Bluestone and Harrison, 1982), and set about analyzing industrial systems that did not fit the Anglo-American norm (Schonberger, 1982). Still others found pockets of economic vitality based on networks of small firms, and offered new models of industrial development based on their findings (Piore and Sabel, 1984). Much of this work suggested that the era of United States industrial hegemony had passed along with the modern corporation, and that new, more dynamic models of industrial organization were stepping into the breach (Liepetz, 1982).

After more than ten years of research and debate, the task of building a new paradigm for industrial organization and economic development is well underway, although consensus is still far from being reached. Some of what had been obscured has now come into view. The focus has shifted away from the logic and ramifications of the seemingly inexorable expansion of the *internal structures* of the modern corporation to the *external economies* created by the ongoing interactions between firms.

External economies have appeared in different guises in the literature, depending on the scale of analysis. At the most basic level of firm-to-firm contracting, external economies are created when one firm "outsources" or "sub-contracts" an activity to another firm that had previously been performed "in-house." The totality of the external linkages created by contracting relationships in larger amalgams of firms have been described as "production networks." When such networks are spatially clustered, which they often are, they make up "agglomeration economies" that tend to be located in sector-specific "industrial districts." Ideas about the importance of external economies have come from a variety of academic disciplines. Sociologists and organizational theorists have provided ideas about how trust, reputation, and long-term "relational" contracting can create stable external economies that resist the apparent tendency for capital to aggregate within the ever-larger control hierarchies of the modern corporation (Richardson, 1972; Thorelli, 1986; Johanson and Matson, 1987; Powell, 1987; Lorenz, 1988; Jarillo, 1988; Bradach and Eccles, 1989; Powell, 1990, 1991;

Lorenz, 1992; Cooke and Morgan, 1993). Political scientists and country specialists have provided nationally-specific models of industrial organization that rely extensively on external economies. These models have been derived from research on the industrial systems of Japan (Schonberger, 1982; Dore, 1986; Sayer, 1986; Aoki, 1987; Sako, 1989; Womack et. al., 1990; Florida and Kenny, 1993), Germany (Katzenstien, 1989; Sabel, 1989; Herrigel, 1993), and Italy (Brusco, 1982; Brusco and Sabel, 1983; Piore and Sabel, 1984; Brusco and Righi, 1989). Geographers and planners have provided insights into how the spatial and social propinquity of geographically clustered industrial activity work to buoy ongoing external economies (Storper and Scott, 1988; Storper and Christopherson, 1988; Scott, 1988; Storper and Walker, 1989; Saxenian, 1991, 1992, 1994).

Often these models have been constructed in an effort to explain why firms, industries, and national economies organized according to their tenets outperform industrial systems organized according to the Anglo-American norm. External economies allow for the development of trust; industry-, or at least locality-wide sharing of production capacity; greater opportunities for learning and technology transfer within the system; and perhaps most important, a superior ability to reconfigure the functional elements of production according to rapidly changing output requirements and the rise of new markets.

This work has generated a sorely needed set of alternatives to the paradigm of the modern corporation, but surprisingly, scant attention has been paid to the industrial organization of American manufacturing companies as they have begun to adapt to the new forms of competition that triggered the crisis.[2] Most often portrayed as desperately clinging to the outmoded attributes of the modern corporation (e.g., Harrison, 1994), American firms have been held up as the antithesis of new, more dynamic organizational forms that have emerged in Italy, Germany, and especially Japan.

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[2] There is an extensive literature on recent changes in the *internal* organization of American companies in response to new competition, including work reorganization (e.g., employee involvement and cross-training) and the flattening of corporate hierarchies (e.g., Kochan and Osterman, 1994; Florida and Kenny, 1993; Applebaum and Batt, 1994), though research on the effects of downsizing and outsourcing on internal organization is sorely lacking (Biewener, forthcoming).

The invisibility of American-led production networks in academic literature (but see Sabel, 1989; Donaghu and Bariff, 1991; Levy and Dunning, 1993; Gereffi, 1994; Bonacich et. al., 1994; Saxenian, 1994; and Borrus, 1995) may stem from their recent vintage. On the other hand, it also seems likely that some recent evidence of changes in the organizational characteristics of American firms has been misinterpreted because the system has not evolved in the image of Japanese, German, or Italian industry.

Today, more than twenty years after the competitive troubles of the modern corporation began, we are seeing unmistakable evidence of recovery by American manufacturing firms. In the electronics industry, for example, dire predictions that American firms would continue to lose entire segments of the industry to foreign firms have proved unfounded. The continued dominance of many market sectors for electronic hardware by American firms has surprised observers who warned only a few years ago that Japanese electronics companies were poised to leverage their dominance in core components (e.g., memory chips and flat panel displays) into dominance of markets for high-volume computer-related hardware, just as had happened in consumer electronics (Hart and Borrus, 1992).

So, there are signs of vitality in the heartland of the modern corporation. Still, we cannot simply resurrect models of industrial organization based on the modern corporation as if nothing has happened. Even a cursory examination of the industrial system of the United States reveals organizational patterns that look not at all like the modern corporation (for examples see Tully, 1993, 1994). The largest single employer in the country is not General Motors, but the temporary employment agency 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. Since 1992, IBM has literally turned itself inside-out, becoming a merchant provider of the basic technologies it had previously guarded so jealously for exclusive use in its own products. Lotus Development, a software company that is creating a new market segment (groupware) with its innovative "Notes" product, sells the product to its customers entirely through third-party systems integrators that adapt Notes to specific

customer requirements. Companies as diverse as Nike (athletic footwear), Dell (personal computers), and Samuel Adams (beer), have built substantial market share while building little, if any, in-house manufacturing capacity. If what we see 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 competitive environment that now exists. Perhaps we are witnessing the emergence of a *new American model* of industrial organization, and not simply the crisis of the old.

The following section outlines the features and logic of the new model through the example of the development of turnkey production networks for electronics manufacturing.

## 2. TURNKEY CONTRACT MANUFACTURING IN ELECTRONICS

In April, 1996 Apple Computer announced that it was selling its largest United States personal computer (PC) manufacturing facility in Fountain, Colorado to a little-known company called SCI Systems. Apple had just posted the largest quarterly loss in its history ($740M) and had narrowly avoided being taken over by Sun Microsystems, so it may not have been suprising that it was shedding some of its assets. What seemed strange about this deal was that, according to Apple management and industry pundits alike, Apple's troubles did not stem from poor demand, but from its inability to meet demand.[3]

[3] Apple's gambit to protect its market share against those companies offering PCs based on Microsoft's Windows operating system and Intel's x86 microprocessor architecture (known in the industry as "WINTEL") by offering cheaper, lower-performance machines backfired when customers flocked to Apple's higher-performance products instead. Apple's manufacturing operations were not nimble enough to make up for this poor forecasting by quickly increasing production of higher-end machines. The PC industry as a whole had grown 25% during 1995 and many key components, particularly memory chips, were in short supply. Orders for high-end machines went unfilled and low-end machines began piling up in inventories. The result was that Apple lost its already tenuous hold on some of its customers, who, unable to buy Apple machines with the capability of fully utilizing the industry's new "killer application," the World Wide Web, migrated to readily available, powerful, and relatively inexpensive WINTEL machines. By April 1996, Apple's share of the worldwide PC market had fallen to an all-time low of 5.8%, down from 7.7% in the first quarter of 1995. Apple's new CEO, Gilbert Amelio, who was brought in to address the crisis, instituted a three-track plan to revive Apple by targeting new product development on Internet and multimedia products, streamlining the company's crowded product line, and drastically restructuring its operations (e.g., by outsourcing its manufacturing, technical support services, and internal telecommunications system management to third party vendors) (San Francisco Chronicle, April 30 and August 14, 1996).

Why would a company that is having trouble meeting demand sell one of its most important production facilities? One could easily imagine an effort to improve responsiveness and efficiency at existing facilities, but a move to decrease capacity at such a moment, on the face of it, seemed foolish. Did Apple plan to make up for the resulting loss in manufacturing capacity by expanding its remaining facilities in Ireland or Singapore, moving production to lower-cost offshore locations? A closer look at Apple's restructuring strategy and its partner in the deal, SCI, provides some answers to this puzzle and serves as a thumbnail sketch of the organizational sea-change that is currently underway in the electronics industry.

First, the sale to SCI did not mean that Apple computers would no longer be produced in the Colorado facility. On the contrary, the deal included a three-year agreement for SCI to continue to manufacture Apple products in the plant. SCI is the largest of an emerging cadre of specialized firms whose sole business is to provide electronics manufacturing services to the industry on a contract basis; accordingly, companies like SCI are known as "contract manufacturers." SCI had the right to use the plant's production lines to manufacture products for any of its other customers as well as Apple, which at the time included more than fifty firms including Hewlett Packard and IBM, companies that compete directly with Apple in the PC market. The majority of the five-year-old plant's 1,100 workers were to stay on as SCI employees.

So, Apple wasn't selling one of its US plants to some burgeoning local electronics company and moving its own production offshore: it was contracting with SCI to continue to manufacture Apple products in Colorado. According to Apple CEO Gilbert Amelio, the company's strategy was to outsource production to companies such as SCI in order to reduce Apple's manufacturing overhead and inventory carrying costs while concentrating the company's resources more intensively on marketing and product design (Electronics Buyers News, 1996). As Kwok Lau, Apple's Director of operations put it, Apple was moving to a "variable cost position" *vis-a-vis* its manufacturing operations. This meant that more of the

company's manufacturing assets were to be held by outside companies. Instead of using fixed assets, namely production facilities owned and operated by Apple, to manufacture computers and peripheral equipment bearing the Apple nameplate, the company was to use the production assets of specialized outside suppliers, such as SCI. After the sale, Apple was able to alter the volume of its production, upward or downward, on very short notice without installing or idling any of its own plant and equipment. Of particular interest to Apple's management was the improved "upside flexibility" (i.e., the ability to quickly ramp up production volumes to meet unexpected surges in demand) that the deal with SCI provided.[4]

Another oddity about the press reports surrounding SCI's acquisition of the Apple's Fountain plant was the following statement by Fred Forsyth, Apple's senior vice president of worldwide operations: "By outsourcing the manufacturing activities of our Fountain site to a company of SCI System's size, experience, and broad business base, Apple has the opportunity to benefit from SCI System's economies of scale" (Apple Computer, 1996). Although SCI is a large company, it is less than a third the size of Apple. How could a company of SCI's size achieve greater manufacturing and component purchasing scale economies than a company whose market share in the PC industry has hovered between number one and three since the birth of the industry in the late 1970s? The answer lies in the fact that SCI's sole business is contract manufacturing. The company has no internal product development capacity. Its sales and marketing activities are limited to developing its business as a manufacturer of other firms' products. In fact, despite its size, and the fact that it manufactures no products under its own name, SCI's twenty world-wide plants may well contain more manufacturing capacity than any other single electronics firm.[5]

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[4] As recent events at Apple proved, inability to meet demand during an industry upturn is just as devastating in a fast-moving marketplace such as PCs as being stuck with excess capacity during an industry downturn.

[5] The manufacturing-specific business profile of SCI can be demonstrated by the following comparison. In 1995, SCI generated $1.8 billion in revenues while assembling 50 million circuit boards (devices which provide the functionality for all electronics products) ($36/board). Hewlett-Packard, a well known brand name company that had half of its 20 million circuit boards assembled by contractors in 1994, generated $20 billion in revenues ($1,000/board). If SCI generated as much revenue per circuit board as Hewlett-Packard, it revenues would be $50B. By comparison IBM, one of the largest electronics firms in the world, generated $64B in 1994.

Was the Apple/SCI deal unusual? Certainly not. If anything, according to some industry watchers, some of Apple's problems stemmed from the fact that it had been too slow to “outsource” its manufacturing operations, even though nearly 50% of the company’s manufacturing was already performed by contractors prior to the sale. By selling the Colorado facility to SCI, Amelio was simply placing Apple more completely on a bandwagon that was already well underway. Since the mid-1980s, and particularly in the 1990s, large and well-known American electronics companies such as Apple, IBM, NCR, Philips, ATT, Hewlett Packard, and DEC have been abandoning their internal manufacturing operations in droves and turning to contract manufacturers such as SCI to build their products. At the same time, many younger, faster growing electronics firms, many of them based in Silicon Valley, CA, have always used contract manufacturers; few new firms have built internal manufacturing capacity even as they have grown (e.g., Sun Microsystems, Silicon Graphics, and Cisco Systems).

Increased outsourcing has created an unprecedented boom in contract manufacturing revenues, especially during the past five years. From 1988 to 1992 the sum of revenues generated by 1995's largest twenty contractors grew at an annual rate of 30.7%. Since 1992, however, revenue growth has been accelerating dramatically year by year: from 1992 to 1995, revenues grew 46.4% each year, with the fastest growth coming from 1994 to 1995, when revenues expanded 51.2% (see Figure and Table 1). At the time of this writing the unprecedented growth in the industry is showing no sign of slowing down (for example, SCI's revenues grew 65% to more than $5.3B in calendar year 1996).

Revenue growth for contractors has come from several sources. First, the purchase of a customer's facility often includes at least short-term prospects for increased business as the contractor assumes responsibility for current and future production volumes. Besides increased volume, contractor's revenue growth has been driven by component purchasing and the provision of new services. For example, contractors are now expected to purchase components for their customers, in what is known in the industry as a "turnkey" contract. In

this arrangement, the contractor essentially acts as a lender to its customers by purchasing and holding component inventories. Cash outlays are only recouped as finished products are delivered to the customer. Turnkey component buying increases the flow of capital through the contractor, driving up revenues and creating strong market linkages with component suppliers. Also, contractors have been vertically integrating in relation to their specialty: manufacturing. Besides the core electronics manufacturing process, circuit board

Figure 1. Revenues; 1995's Top Twenty Contract Manufacturers, 1986-1995
(billions of current dollars)

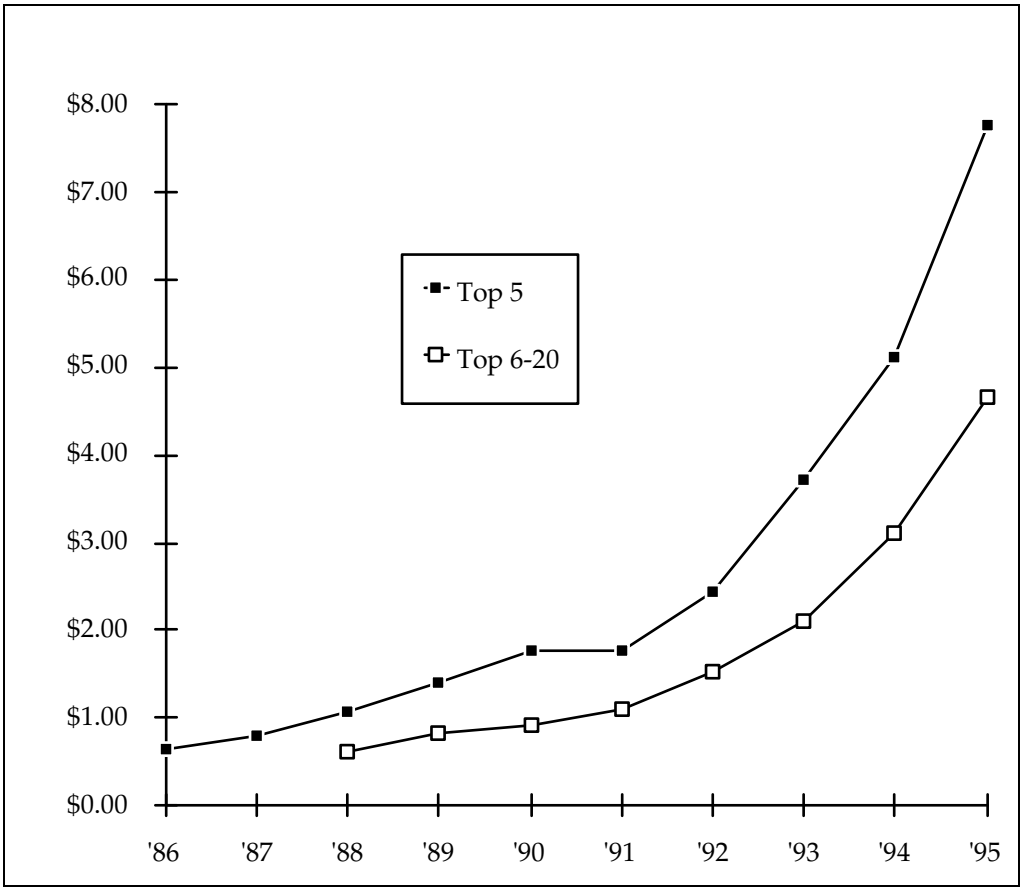



Table 1. Revenues; 1995's Top Twenty Contract Manufacturers, 1988-1995
(thousands of current dollars)

| | CM Revenues (thousands of $) | | | Annual Average Growth Rates | | |
|---|---|---|---|---|---|---|
| | '88 | '92 | '95 | '88-'92 | '92-'95 | '94-'95 |
| Top 5 | 1,077,366 | 2,433,127 | 7,772,792 | 24.4% | 47.3% | 51.9% |
| Top 6-20 | 606,000 | 1,534,200 | 4,672,382 | 49.1% | 45.0% | 50.0% |
| Top 20 | 1,683,366 | 3,967,327 | 12,445,174 | 30.7% | 46.4% | 51.2% |

Source: Technology Forecasters, 1996. Note: Some data for years prior to 1994 in some companies in the 6-20 ranking are estimated. Calendar years are used where possible.

assembly, most contractors have added a range of back- and front-end services, such as process R&D, design for manufacturability, product-specific process development and documentation, various forms of testing, final product assembly, final packaging, software loading and document duplication, and shipping to distribution. Contractors that have grown the fastest have specialized in newer manufacturing processes, such as surface mount technology, which drive product miniaturization and performance forward.

The Apple/SCI deal, then, is best understood as part of a larger shift in the way electronics production is being organized. The recent boom in contract manufacturing revenues highlights the fact that a basic shift is underway in the organizational fabric of the electronics industry. Production capacity is moving decisively out-of-house, where it can be shared by the industry as a whole. In general, the only firms that can justify making long-term investments in internal manufacturing capacity are those with steadily growing high-volume demand profiles.[6] Given the ongoing dynamism and volatility that exists in the electronics industry, managers who believe they can count on such demand profiles are increasingly rare.

The evidence provided here suggests that American electronics firms are developing new ways of exerting substantial market power without the fixed costs of building and supporting a gigantic corporate organization. The strategy for brand-name systems firms is to outsource all of those functions that do not have direct relation to the establishment and maintenance of market power. Brand names, product definition and design, and marketing are being kept in-house, while manufacturing, logistics, distribution, and most support

[6] For example, two firms that have held unusually stable positions as market share leaders in their respective sub-industry sectors, Compaq Computer (PCs) and Seagate Technology (disk drives) have recently expanded their internal production capacity (although both make extensive use of contractors as well). In February 1994 Compaq announced that it would invest $20 million to add seven new manufacturing lines for desktop and portable PCs at its operations in Houston (EDGE, 1994). In June 1996 Seagate announced that it was building a $19M printed circuit board assembly plant in Malaysia to support its existing disk manufacturing operations in Singapore and Indonesia (San Francisco Chronicle, June 4, 1996). On the whole, however, brand name electronics firms are leaving such investments to contract manufacturers.

functions are being outsourced. Outside suppliers must provide necessary levels of technology, quality, and delivery—and be easily substitutable (i.e., operate in a *merchant* environment). When production networks are open in this way, external capacity is better pooled by the industry as a whole, and stronger *external economies* are more likely to be the result.

This environment of competitive switching in turnkey production networks results from each party to the relationship maintaining enough partners to limit interdependence at all times. In contrast to models of external economies from Japan and Italy, production networks in American electronics production have evolved a pronounced merchant character. To help define this, we can oppose the image of a *merchant service provider* to the image of a *captive supplier*. Merchant service providers guard against becoming overly dependent on any single customer by spreading their output across a large number of customer firms. In the American electronics industry, contract manufacturers *and* their customers, the brand name "systems" firms, strive to maintain the share of each other's business at or below 20%. This "20% rule" reduces the penalties associated with ending inter-firm relationships, and keeps the fortunes of one party from becoming too tightly tied to those of their partner's. A merchant network environment reduces firm interdependence, yielding a system with greater organizational and geographical flexibility.

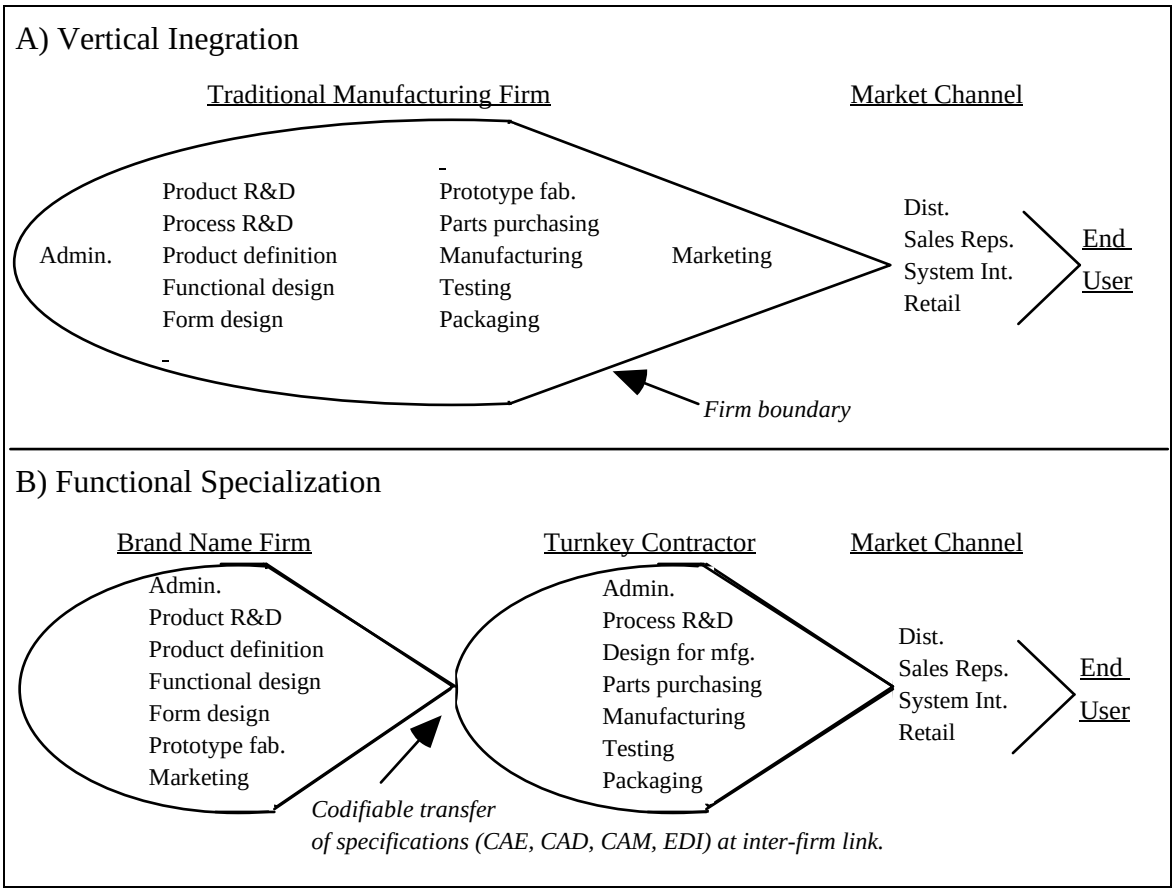
In the turnkey network, suppliers tend to focus their business on *functionally coherent* sets of production activities that have wide application in the industry in which they operate, making the act of switching to new customers easier. As a way to broaden their market and spread their risk, turnkey suppliers tend to focus on functionally-specific *base processes* that cut across specific firms and product categories such as food processing, metal machining, semiconductor manufacturing, circuit board assembly, and brewing; rather than on processes that are idiosyncratic or highly customer-specific. Turnkey suppliers, then, tend to be *functionally specialized.*[7] However, within the parameters of the base process, product

[7] Because these activities take place in context of external economies, functional specialization in this case is

variation can be very large. Most of the contract manufacturers in the sectors mentioned above use highly automated manufacturing systems (apparel assembly (i.e., sewing) is a major exception) that can be programmed and reprogrammed on short notice to produce a wide product variety.

Figure 2 presents a conceptual map of the shift from the vertically-integrated organizational form of the modern corporation to the functionally specialized form of the turnkey production network. Note that R&D remains a vital function for each firm in the turnkey network, where it is functionally specialized into product and process applications.

Figure 2. The Shift from Vertical Integration to Functional Specialization: The Rise of the Turnkey Network




semantically distinct from the Weberian notion of administrative grouping by function within the bureaucracy, though both are organizational tools that are deployed to manage complexity.

Now that I have presented the major features of the turnkey model trough, the example of contract manufacturing in the electronics industry, I begin the exercise of placing the model in the context of theories of firm and industry organization. As we shall see, the capitalist mode of production, if nothing else, proves remarkable in its variety of forms, its adaptability, and its tolerance of increasingly complex organizational arrangements.

## 3. THE DELINKING OF PRODUCTION FROM INNOVATION IN THE TURNKEY NETWORK

The work of Joseph Schumpeter was deeply affected by the rise of the large corporation. Schumpeter's early work The Theory of Economic Development (1934), first published in German in 1911, focused on the role of the small-firm entrepreneur in driving innovation. Entrepreneurs continually create disequilibrium in existing capitalism through the formation of new firms in an environment of easy market entry. Schumpeter's later work recognized the empirical reality of the rise of the large firm in American industry during the first few decades of the twentieth century. By the time he wrote Capitalism, Socialism, and Democracy (1942), Schumpeter's focus had shifted from the innovative entrepreneur to innovation in the R&D laboratory, from tacit to codified knowledge, from low to high market entry barriers, and from small to large firms (Nelson and Winter, 1982; Malbera and Orsenigo, 1995). He argued that observable productivity increases in the American economy were largely due to innovations delivered by the R&D laboratories of large firms in an environment of high barriers to market entry (Schumpeter, 1942).

Schumpeter believed that the stability provided by oligopolistic market structures created a better environment for industrial research. Large firms have the longevity and financial resources to build up the "knowledge base" required to apply scientific principles to ever more complex innovative problems. As the importance of codified knowledge increased in the early twentieth century, barriers to entry were erected that reduced the role of small-

firm entrepreneurs who tended to base their innovations on tacit knowledge.[8] In the context of monopoly theory, these ideas became known as the *Schumpetarian hypothesis:* "the claim that a market structure involving large firms with a considerable degree of market power is the price that society must pay for rapid technological advance" (Nelson and Winter, 1982, p. 278). In the long run, Schumpeter believed that oligopolistic market structures would inevitably be torn asunder by ongoing rounds of innovation, competition, and new market creation.

Nelson and Winter (1982) build on Schumpeter's conception of innovation as the motor of capitalist development to construct their theory of "evolutionary economics." To follow the biological metaphor of evolution used by Nelson and Winter, the development of the economy moves according to a "survival of the fittest" logic, with the likelihood of survival increasing with firm profitability. Profitability is determined by the effectiveness of company-specific routines (ways of doing things) that are passed on as the firm develops in the same manner that genes are passed on in biological systems. The "search" routines which firms apply to crisis situations (e.g., the need to respond to a competitor by developing an innovative new product) determines the likelihood of their survival as they adapt, or "mutate," in response to new situations.

Because successful firms tend to invest in additional productive capacity, the dynamic process of industrial evolution tends to create larger firms and more concentrated market structures over time (up to the point where market concentration begins to stifle competition and, hence, innovation). Nelson and Winter devised computer simulations that produce these results, using the variables of aggressiveness of investment policies, realization of potential productivity gains, the degree of difficulty in imitating the firm's innovations, and how successful the firm's innovative efforts are. In the simulation where the value for the first

[8] However, Schumpeter did not recognize, as Williamson (1975) does, that the internalization of production functions can lead to "information impactedness" (e.g., isolation from the state of the art) that can suppress innovation in the large firm. The literature on production networks stresses the superior environment for learning and cross-fertilization of ideas, and therefore innovation, provided by network forms of industry organization (Powell, 1990).

variable, aggressiveness of investment policies, was assigned a high value, imitation was made more difficult, latent productivity was better realized, and as a result, industry structure showed markedly higher levels of concentration than in simulations where capital investments were suppressed.[9]

The assumptions in this model point out the key problem with using the Schumpetarian approach to predict the evolution of industry organization. In this schema, firms tend to get larger over time because successful innovations lead to higher profits and greater investments in productive capacity that put them further ahead of their competitors. Aggressive capital investment becomes a barrier to entry for new and existing firms and as a result, firms become larger and market structure more concentrated over time. But what if we allow for the possibility that increases in market share can be organizationally *delinked* from increases in firm-specific capital investment? In the American electronics industry, for example, firms are increasingly relying on outside sources (i.e., contract manufacturers) for manufacturing capacity. If a firm successfully innovates (e.g., develops a personal computer with dramatically better price/performance characteristics than any existing competitor), it can quickly ramp up production through its contract manufacturers *without the lag or risk associated with building up internal capacity.* In the turnkey network market concentration may increase, but *vertical* industry structure remains relatively disaggregated.[10] Moreover, barriers to entry based on the holding of productive capacity by leading firms fail to develop.

As such merchant *external economies* develop, the link between innovative capacity and market share, on one hand, and firm size and scope, on the other, begins to break down. This link was the cornerstone of Schumpeter's conception of industry structure and his explanation for the rise of the large, vertically integrated industrial firms in the early part of

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[9] Nelson and Winter's model intentionally suppresses the common assumption of standard neoclassical economic theory that a firm with dominant market share position might restrain investment to restrict output growth and keep prices high.

[10] By "vertical" industry structure I mean the supply chain that leads to a product with a specialized end-use. Industry structure, at the level of functionally specialized base processes, on the other hand, can aggregate even as the firms supplying vertical markets remain specilized in their market niche.

the twentieth century. Firms that outsource a large share of their manufacturing no longer have to carry the financial, administrative, and technical burdens of fixed capital related to production (i.e., plant and equipment), allowing them to focus on innovation and become more organizationally and geographically flexible. Innovation, in this system, has been freed from the shackles of large-scale capital investment, allowing the innovating firm's resources to be more tightly focused on the ongoing process of new product development.

On the other hand, the market positions of dominant firms are not protected by large-scale, firm-specific investments in plants and equipment, making market penetration more feasible because brand-name firms are no longer buffered from competitive pressure by large, in-house, fixed capital. Barriers to entry are lowered because competitors can tap the same turnkey production networks and therefore gain access to leading-edge, global-scale production capacity (unless specific institutional constraints are present). The turnkey suppliers, because they are not tied too tightly to any single customer, simply apply more of their manufacturing capacity to the firm that has gained market share, while scaling back (or increasing more slowly) the manufacturing of products for the firm(s) that have lost market share. Barriers to entry are reduced and markets remain more fluid because gains in market share are not necessarily associated with large increases in the size of firms. The model moves closer to the Marshallian norm in that barriers to entry are low, as long as suppliers offer their production services widely (i.e., according to the merchant model), and limit dependence on any single customer.

Thus, for the innovating firm, competitive outcomes become more tightly tied to product-level innovation (i.e., product definition, development, and design) as productive capacity migrates into turnkey networks. At the industry level, turnkey production networks make it possible for market share to change hands without the idling of any productive capacity, mollifying the "destructive" aspect of innovation predicted in Schumpeter's conception of "creative destruction." For example, Cisco Systems, an innovative Silicon Valley-based company that designs and sells high-performance switches for data

communications, has gained a wide market share lead without building any internal manufacturing capacity, depending instead on a world-wide network of highly proficient contract manufacturers for all of its output. If, however, another firm develops a faster and cheaper switch, Cisco's contract manufacturers would certainly be willing and able to build it. Nelson and Winter, like Schumpeter, do not conceive of organizational innovations that would allow for such a delinking of investment in plant and equipment from product-level innovation and market-share growth. In the turnkey production network environment, successful innovation does not necessarily lead to the giant corporation.

The proposition that innovation can be effectively separated from manufacturing investment may be suprising for some. The growing split between innovation and production in the electronics industry seems to contradict recent literature on product development that argues for tighter coordination between design and manufacturing within the firm (e.g., Florida and Kenny, 1991). But as the electronics industry has evolved, certain kinds of knowledge have become increasingly codified. International standard setting bodies (e.g., the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC)) have emerged to help develop industry-wide classification and specification of components and processes. At the same time, brand name electronics firms are increasing their use of standardized rather than proprietary components in order to reduce design time and lower costs.[11]

Increasingly, electronics firms are using information technology to communicate across the firm boundary using these standard classification systems as a basis. For example, firms are increasing their use of data communications technology to pass computer aided engineering and design (CAE/CAD) files to compatible computer-aided manufacturing systems on the factory floor. Components with exact specifications can be located and purchased with electronic purchasing systems. These standards make the practice of outsourcing production easier. Brand name firms are able to pass along the electronic design

[11] I am indebted to Greg Linden for this point.

files to contract manufacturers, who feed them into CAD systems that determine the exact circuit-board "layout" for the product. Increasingly, these CAD layout systems are directly linked to electronic purchasing systems that order components and to highly sophisticated vision-assisted robotic assembly equipment on the factory floor. The result is a highly formalized link at the inter-firm boundary, as depicted in Figure 2, that lowers asset specificity and allows for a high degree of outsourcing *and* limited buyer-supplier interdependence.

In all of his work, Schumpeter offered a powerful dynamic vision of capitalist development that was derived from Marx; he saw that capitalist firms endogenously created, in many respects, the environment that would condition their future development. Innovation was the driving force in Schumpeter's conception of economic change; it could be deployed through any of five strategies: new products, processes, markets, transportation technologies, and/or approaches to industry organization. This last possibility, using an innovative approach to industry organization as a competitive tool, is especially important for the case study of this paper, since this is exactly the approach currently being applied by the American-led electronics industry.[12] It is this last entry, organizational innovation, that provides the link between Schumpeter and recent literature on the performance advantages of external economies, outsourcing, and production networks.

However, seen from the perspective of the late twentieth century, it is clear that Schumpeter's conception of which organizational strategies might be effective was too narrow. His focus on the organizational strategy of vertical and horizontal integration and ever increasing firm size is understandable given the industrial structure that was on the rise at the time of his writing, but today a wider range of organizational possibilities should be recognized. At the same time, Schumpeter was right that industry organization can be

[12] The idea of innovative approaches to industry organization as a competitive tool is one of the things that sets Schumpeter apart from Chandler, whose work focuses on the first four entries on Schumpeter's list of possible innovative strategies. Chandler (1962, 1977), in contrast to Schumpeter, sees industry organization (expressed in his case by increasing internal organization as firms expand their scope of operations) as following automatically from the strategies related to new products, processes, markets, and transportation technologies.

deployed *as a strategy in its own right* and is not simply a function of other strategies, as Chandler would have it. This paper seeks to help revive industry organization to its rightful place alongside other tools of capitalist competition. Industry organization, the social division of labor, if you will, has been and is now a central force in capitalist development (Sayer and Walker, 1993).

## 4. ECONOMIES OF SPEED IN THE TURNKEY PRODUCTION NETWORK

Chandler (1966, 1977) does not offer a general theory of organizational change. The task he set out for himself was to describe and explain the rise of the modern corporation on the American industrial landscape between 1840 and 1920. The giant corporation did not reflect any abstract law of economic truth, but a set of *strategies* employed by those in control of the firm. However, an implicit theoretical argument can be distilled from Chandler's work because he did present the modern corporate form as providing certain *advantages* over earlier modes of capitalist development. According to Chandler (1977), the advantages of the large multidivisional corporate form, and likewise of internal organization, over market transactions are 1) lower transaction costs inside the firm because intra-firm interactions can be better routinized, 2) more accurate information on prices and supply when transmitted inside the firm, and 3) better coordination of inputs and outputs through the productive apparatus, which leads to better utilization of plant and equipment and increased throughput. Although Williamson built his theory of the firm on the *first* advantage, reduced transaction costs, Chandler (1981) is clear that the *third* advantage of internalization; faster throughput, is the most important to his explanation of the modern corporation.

According to Chandler, the elaborate control hierarchies and the large size of the modern corporation arose to solve the problems of *fixed costs*. In a high-volume production environment, the time needed to put management, labor, machine, and supply systems in place creates a lag between product innovation and initial sales that increases the risk of investment. If investments in fixed costs are to prove profitable, plants need to come on line

quickly and utilization rates need to be continuously high. Because faster throughput leads to higher productivity and greater returns on investment, the likelihood that the firm's products will succeed in the marketplace is greater. Chandler called the advantage of high throughput "economies of speed." It was not increases in the "optimum scale" of "indivisible" production technologies as much as the need to ensure their maximum utilization that spurred the expansion of internal economies over time (Lazonick, 1991).

Ongoing efforts to improve economies of speed form Chandler's central explanation of the tendency for the internal economies of the modern corporation to grow. The argument proceeds as follows. First, because investments in high-volume plant and equipment require increased throughput, expanded managerial structures are needed to better plan and coordinate the flow of materials and payments through the system.

Second, vertical integration follows from the need to better control the flow of inputs purchased outside the firm on the market (resulting in backward integration into materials and components) and the sale of outputs through intermediaries (resulting in forward integration into distribution). High throughput depends on uninterrupted sources of supply and unimpeded sales, so functions formerly mediated by the market tend to accumulate within the boundaries of the firm (variable costs tended to decrease and fixed costs tended to increase). Management's role, to use a metaphor, is to dredge the channels upstream and downstream from the productive apparatus of the firm, increasing the volume of flow. During the early twentieth century the deployment of new, more productive capital equipment (e.g., highly mechanized continuous process equipment for cigarette manufacturing) heightened the throughput problem by acting as a powerful pump in the center of the channel. High volume production systems can be damaged if the channel is allowed to run dry or if the outlet is allowed to back up.

Third, the addition of upstream and downstream functions to the existing corporate structure adds to the problem of fixed costs, to which the modern corporation responded by further increasing its managerial organization. Newly added functions were upgraded and

streamlined to match the throughput needs of existing operations. The dynamic created by successive rounds of investment in high-volume facilities, vertical integration, and organizational expansion propels the modern corporation to ever greater size and scope, *as long as markets continue to expand to absorb the growth in output.*

It is clear that the rise of international competition in the 1970s and 1980s negated this last assumption for many American firms. However, the problem of fixed costs as outlined by Chandler has persisted. In the electronics industry for example, more productive, expensive, and difficult-to-master production technologies (e.g., surface mount) have come on the scene since 1985, requiring greater throughput and more intensive utilization of plant and equipment than ever before. But because increased competition and market volatility mean that no amount of advertising, product innovation, or new market development can assure capacity utilization rates great enough to easily justify new investments in plant and equipment, productive capacity has begun to build up outside, not inside, innovating firms. The firms that supply these production services, the contract manufacturers, specialize in coordinating the flow of inputs and outputs and balancing the flow of orders through their global-scale production system, relieving the management of the innovating (a.k.a., brand name) firm from that administrative burden. Because the new equipment can effectively be shared across the contractor's customer base, economies of speed are maintained despite market uncertainty faced by any single brand name firm. Furthermore, because cash outlays for investments in plant, equipment, and the purchasing of materials are the responsibility of the contractor, the brand name firm needs only to risk the (still substantial) investments required to successfully develop and market new products. In the turnkey network, new products are brought to market faster and with less risk because economies of scale, scope, and speed in production have moved beyond what could be provided by any single firm.

More than most historians, Chandler's inquiry was influenced by the questions of economists, such as efficiency, economies of scale, and the emergence of oligopolistic market structures. But unlike the economists with whom he was in conversation, Chandler's

project was not to make absolute theoretical statements about the evolution of capitalism. Chandler's training as a historian gave him an evolutionary approach. Effective administrative control over a geographically dispersed corporate structure could *only* arise after the railroad and telegraph systems had been put in place in the 1880s. Manufacturers integrated forward into distribution and marketing *only* in those industries and cities where existing sales channels were inadequate (e.g., where they could not provide for specialized needs such as technical sales, after-sales service, or refrigeration of perishable goods) (Chandler, 1981). Similarly, I argue that turnkey production networks, whatever their advantages, can only develop when a significant number of highly capable merchant suppliers emerge in an industry. This takes time.[13]

Chandler's analysis was derived from examination of a specific set of firms during a specific time period; he left it to others to formally abstract his findings into a more general predictive theory of industry organization. It was Oliver Williamson who most notably took up this task.

## 5. UNCERTAINTY AND ASSET SPECIFICITY IN THE TURNKEY NETWORK: A CRITIQUE OF TRANSACTION COSTS FRAMEWORK

Central to the project of explaining and predicting firm and industry structure is the question of whether a firm "makes or buys" a given input or service. The story of the rise of the modern corporation is one of companies successively choosing the "make" option over the "buy" option, causing the firm to become larger, more integrated, and more diversified over time. Why would firms choose to internalize functions previously purchased from other firms through the market? While there is no place for such questions in standard neoclassical

[13] As contract manufacturers have grown in size, gained more business acumen and technological sophistication, and taken on more manufacturing-related functions for their customers, their prior image in the electronics industry as low-technology, low-quality "board stuffers," "job shops," and "contract assemblers" has begun to be completely dispelled. Contractors now define themselves as "contract manufacturers" and their industry as "electronic manufacturing services," denoting the full service orientation that so many of them have adopted (see Sturgeon, 1997a, for a full account of the evolution of the sector).

economic theory, the key question (a.k.a., dependent variable) of transaction cost economics, and by extension current institutional economics, is the determination of firm boundaries. The image of the Marshallian firm is one where supply is automatically adjusted to demand through the price mechanism. The role of the firm is to produce the supply, period. Questions about what *portions* of the supply a given firm should produce are not asked. In 1937, Ronald Coase began to explore the make vs. buy tradeoff within the framework of neoclassical economics. In doing so he was essentially asking a question new to mainstream economics: why are there firms? While he maintained his confidence that the market/price mechanism operated between firms (in the market) he noted that managers, not the price mechanism, allocated resources within the firm. "If a workman moves from department X to department Y, he does not do so because of relative prices, but because he is ordered to do so" (Coase, 1937, p. 387).

Coase argued that firms existed because in some cases there were costs to using the market. Accurate knowledge (a.k.a., perfect information) of prices can not be assumed, and buyers can not always specify exactly what they want from sellers ahead of time. Moreover, the time and effort involved in negotiating and concluding each purchase through the market is not costless, as is assumed by standard neoclassical theory. Within the firm, one open-ended contract can effectively substitute for many, reducing "marketing costs" (a.k.a., transaction costs) and increasing efficiency.

Just as with the monopoly theorists of the 1930s (e.g., Chamberlin, 1933), the concept that large firms signified market failure was rejected. For Coase, firms existed, not because markets failed to produce the most efficient outcomes, but because markets could, in some cases, operate more efficiently *inside* the firm. The market was simply absorbed by the firm. By adapting the concept of the market to the realm inside the firm, one of the key distinctions of the word "market" was lost: that it signifies economic relationships *between autonomous economic actors*. Using the costs of "markets" to explain the make vs. buy choice became meaningless when the term "market" was made so plastic it could be applied to either

internal or external transactions. In his rush to adapt the firm to the tenets of the neoclassical paradigm, Coase failed to account for his own observation that managers allocate resources within the firm, not prices.[14]

Oliver Williamson (1975, 1981, 1985; Williamson and Ouchi, 1981) has built an elaborate framework on Coase's notion that there are costs to using markets. His project has been to "operationalize" the concept of transaction costs as a way to predict when a firm would choose the make option over the buy option. Williamson calls for an economic theory that treats the firm not as a production function, but as a "governance structure" defined in its extent by transaction costs. If transaction costs are high, the internal governance structure of the firm will grow; if transaction costs are low, the governance structure will not grow.

Williamson's first step in building his framework is to ask: what basic assumptions should we hold about market transactions? For these Williamson reaches to the Hobbesian roots of neoclassical economics, arguing that the self-interested behavior of economic actors could extend to "opportunism," meaning tactics of guile and deceit (Granovetter, 1985). Such "cheating" in economic relations requires another assumption: that the party being cheated remains unaware, at least at first, that they are being done in. Williamson adopts the phrase "bounded rationality" from the work of Herbert Simon as a way to include in his model the assumption that economic actors cannot know everything in advance.

Here Williamson is introducing two elements that directly challenge the assumptions of textbook neoclassical economics: that self-interested behavior would be checked to "gentlemanly" levels by competition and that economic actors would have access to "perfect information" about the conditions of the market (e.g., real prices). Williamson argues that, under certain conditions, bounded rationality and opportunism could raise the costs of doing business in the market, resulting in "transaction costs." Transaction costs are a determining factor in industry structure because they affect when a firm will make or buy a particular

[14] Williamson does not fall into this trap. In his scheme, markets *do not* operate within firms. Inside the firm, resources are directed by "fiat;" hierarchical control is exercised through the authority of managers over their subordinates.

input or service. Higher transaction costs lead firms to internalize functions, while low transaction costs (or zero transaction costs as assumed by textbook neoclassical theory) result in industry structures where amalgams of smaller firms interact through arm's-length, price-based market transactions (the Marshallian norm).

Williamson's next step is to "operationalize" the assumptions of opportunism and bounded rationality in a way that can predict when a firm will make or buy. He introduces three independent variables: frequency, uncertainty, and asset specificity. The threat of opportunism, under conditions of bounded rationality, raises the risk of higher costs unexpectedly coming to light. In such an *uncertain* environment, optimal actions cannot be defined because the element of *risk* is involved (Williamson's framework, then, appears not to be based solely on efficiency, but on the strategic tradeoff between cost and risk). Influenced by legal scholars writing on contract law (Alchian and Densetz, 1972; Macneil, 1974; Jensen and Meckling, 1976; Goldberg, 1980), Williamson's chief examples of uncertainty are contracts where price could not be agreed upon ahead of time because the nature of the transaction is too complex or uncertain to pre-specify all contingencies.[15] Such "relational contracting" exposes both parties in the transaction to risk. Williamson argues that contracting firms will avoid assuming risk by internalizing uncertain transactions, as long as the costs of doing so are not too high.[16]

In the transaction cost framework, infrequent transactions, even if they involve highly specific assets (e.g., custom made goods or services), will tend to take place in the market context. The costs of building internal capacity to provide a good or service that is rarely

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[15] Curiously, Williamson has never used uncertainty related to technological change or market volatility as examples in his work. The relationship between these two forces, technological change and market volatility, has had a hand in triggering the formation of new external linkages in the electronics industry (see Sturgeon, 1997a, for a detailed argument).

[16] The likely strategy for the supplier firm under such conditions was not theorized in Williamson's model. The entire project of organizational theory is skewed in this manner. As buyer firms integrate and become larger, it is assumed that supplier firms shrink and disappear. In a static, "zero-sum" economy this would be true, but in a dynamic, growing economy, suppliers continue to grow with their customers over time. The supplier firm does not have the option, in most cases, of internalizing risky transactions (a.k.a., integrating forward) because it would be eliminating its market by competing directly with its customer(s). In practice, suppliers in turnkey production networks try to protect themselves from risk by limiting their dependence on any single customer by diversifying their customer base (a practice I call "volume spreading").

required cannot usually be justified unless it is unavailable on the market. If, on the other hand, market transactions for the same input become too frequent, the risk of opportunism on the part of the supplier becomes greater (because of increasing asset specificity—see below), therefore triggering the internalization of the function. Note that this is *not* an argument about scale economies (although Williamson does evoke the notion at times), which would require a different set of assumptions, but an argument about cost/risk tradeoffs given the possibility of opportunism in an environment of bounded rationality.

The third and most important independent variable that Williamson offers as a tool to predict organizational outcomes in the transaction costs framework is asset specificity, by which he means the degree that capital assets (e.g., machinery or skills) are specific to the transaction in question (i.e., specialized, dedicated, or customized to make a specific product). If asset specificity is high, then it is likely that the activity will be internalized. Of the three independent variables in Williamson's framework, asset specificity is assigned the greatest causal power. More than frequency or uncertainty, Williamson argues that "a considerable amount of explanatory power turns on" the notion of asset specificity (Williamson 1981, p. 1546).

> ...neither frequency nor uncertainty…individually or in combination…justifies the creation of internal organization (with its associated transaction-specific governance structure) (Williamson and Ouchi, 1981:352).

Williamson identifies several kinds of asset specificity: *site specificity*, a condition in which, for whatever reason, there are benefits to be gained through physical proximity (e.g., an engine plant located near an auto assembly plant to reduce transport costs); *physical asset specificity*, where machinery is dedicated to a particular product; and *human asset specificity*, where skills and routines are product-specific. Although Williamson does not affix it with a formal title, he identifies a fourth dimension of asset specificity (Williamson 1981, p. 1546) that I will call *relational specificity* and which Williamson describes as follows:

> Additional [to site, physical, and human] transaction specific savings can accrue at the interface between supplier and buyer as contracts are successively adapted to unfolding events, and as periodic contract renewal agreements are reached. Familiarity here permits communications economies to be realized: specific language develops and nuances are signaled and received in a sensitive way. Both institutional

> and personal trust relationships evolve. In consideration of the value placed upon economies of these kinds, agents who engage in recurring, uncertain, idiosyncratic transactions have a strong interest in preserving the exchange relation. Autonomous contracting modes give way to internal organization as the value associated with exchange continuity [i.e., long term relationships] increases (Williamson and Ouchi, 1981:353).

The notable thing about this passage, besides its move toward the "socialized notions" of economic life offered by sociologists and network theorists (e.g., Granovetter, 1985), is its *historical* dimension. Williamson never states that assets *always* become more specific over time, but he strongly suggests that the tendency exists. Consider the following passage:

> The production cost advantage of markets decrease and the (comparative) governance costs of markets increase as assets become *progressively more specific*. Thus as assets *become more fully specialized* to a single use or user, hence are less transferable to other uses or users, economies of scale can be as fully realized when a firm operates the asset under its own internal direction as when its services are obtained externally, by contract. And the market's advantage in pooling risks likewise shrinks. Simultaneously, the transactions in question take on a stronger bilateral character, and the governance costs of markets increase relatively…What may have been (and commonly is) an effective large-numbers-bidding situation at the outset is sometimes *transformed* into a bilateral trading relation thereafter [Williamson 1981:1548, italics mine, except in the last instance].

Williamson assumes that specific assets (particularly of the relational kind) tend to build up over time with repeated contracting as the parties to the relationship accrue transaction-specific attributes. Although he does not formally acknowledge the assumption of the *tendency of asset specificity to increase over time* as he does with his assumptions of opportunism and bounded rationality, it is on this assumption that the historical, evolutionary element of Williamson's theory rests.

It is through this device that Williamson attempts to weld his argument to Chandler's empirical case by using his transaction-cost theory to explain the rise of the modern corporation.[17] Because he drew heavily on Chandler's account of the modern corporation, Williamson's operational mechanism is slanted toward the "make" side of the make/buy equation. His assumption that *there is a tendency for asset specificity to increase over time* tips the scales. In Williamson's model, the emergence of the modern corporation is a result of a general tendency for firms to choose the "make" over the "buy" option *because* asset

[17] In response to Williamson's efforts in the regard, Chandler clearly maintains that economies of speed (the need for high throughput) have more to do the rise of the giant corporation than the need to economize on transaction costs (Chandler, 1981).

specificity tends to build up over time. This attribute of Williamson's theory is not surprising. From the vantage point of the 1960s, 1970s, and even the 1980s, the chief problem for organizational theory was to explain the accretion of more and more functions within the modern corporation, first in its "U-form," (vertically integrated) then in its "M-form" (multidivisional), and on to its conglomerate and multinational incarnations. If we accept Williamson's assumption that asset specificity tends to build up over time, and also accept his argument that high asset specificity results in internalization, the expanding size and scope of the modern corporation becomes the *only possible outcome*. If this is so, what accounts for *increased production outsourcing* in electronics and other sectors of the United States economy during the last ten years?

As asset specificity increases, higher transaction costs signal the firm to internalize the production function in question. Now let us assume that after some period of time an exogenous cause renders outsourcing a less costly alternative (e.g., the build up of external scale economies, business or process innovations by suppliers, etc.). Since the link with the market has been severed with internalization, the ability to measure transaction costs is eliminated. When the function is internalized, the frequency of the external transaction drops to zero and uncertainty is eliminated. Since all the assets in question are now owned by the firm, transaction costs are not affected by the emergence of specialized (i.e., proprietary) plant, equipment, and routines. Lacking information on prices for goods and services it no longer buys, and with no corrective instrument in place, the modern corporation is left without a mechanism to signal it to tap external economies as they emerge.

Now let us rehearse the transaction cost framework with the empirical case of the rise of contract manufacturing in American-led electronics production. First, frequency is very high in the case study, suggesting internalization, not the opposite. In general, brand name firms are using contract manufacturers for an increasing percentage of their production needs. Some brand name firms, such as Dell Computer, have *no* internal manufacturing at all. At this level of outsourcing (100%), frequency reaches its theoretical maximum. Here we see

that, in this instance at least, frequency is largely a descriptive variable because it increases directly in proportion with additional contracting out.

Second, uncertainty in the electronics industry varies depending on the kind of uncertainty considered. In terms of *market uncertainty,* the electronics industry is extremely volatile. Market leaders are unseated with stunning regularity, particularly in fast-moving product categories such as laptop computers and modems. Such volatility creates risks that can be mollified by tapping turnkey production networks, which pool industry-wide investment risk into *external economies.* Through increased outsourcing, brand name firms are passing investment risks out of house to their contractors, who can maintain consistently high plant and equipment utilization rates by spreading production volumes, and therefore risk, across their entire customer base. Ongoing market volatility has been one of the driving forces of increased contract manufacturing in electronics. As such, the outcome in the electronics industry falsifies this element of the transaction cost framework, which predicts internalization in the face of uncertainty.

But at the more constrained level of *contract uncertainty* that Williamson focuses on, the predictive power of the model is borne out, because *electronics manufacturing technology has become increasingly definable and standardized*. As production processes have become more capital intensive and elaborate quality regimes have been put in place on the factory floor, the ability of contractors to specify in advance the costs of production has dramatically improved.

That turnkey production networks in electronics production have arisen in an environment of increasing definablity and standardization supports Williamson's third hypothesis that extensive market relationships require low asset specificity. Because contract manufacturers can quickly re-program their computer-controlled robotic production equipment to serve any of their customers the key assets in the transaction are general, not specific. However, the case study of the case falsifies Williamson's fourth (implied) assumption that asset specificity tends to increase over time. As the electronics industry has

developed, industry-wide standards for nearly all crucial aspects of production have emerged. As this process has moved forward, the tendency to develop external economies along *functionally specialized* lines has increased (i.e., aggregations of functionally coherent sets of production activities). As the market for contract manufacturing services has widened, it has become easier for both customer and contractor firms to reduce interdependence by *volume spreading* (e.g., keeping each other's business at or below 20% of volume). From the perspective of the brand name firms, well defined standards and the general nature of the key assets allow opportunism to be disciplined through competitive switching. Since 1985, many new contract manufacturers have become active and existing ones have grown, on average, much faster than the electronics industry as a whole. In the American-led electronics industry, no customer firm is "locked" into a "bilateral" trading relationship with any contractor, (or *vice-versa*) because contract manufacturers have developed a merchant character through volume spreading. So even though the frequency and (market) uncertainty of the transactions are high, innovating firms have little incentive to build internal manufacturing capacity.

## 6. NETWORK THEORIES OF THE FIRM: WHERE THE TURNKEY MODEL FITS

Network theorists (e.g., Powell, 1991) do not argue, as I do, that network forms of organization can function without the build up of specific assets. Instead, they argue that there are mitigating factors (e.g., trust, social norms) that allow external economies to persist in the face of asset specificity. Asset specificity need not lead to integration (vertical or horizontal) over time and therefore to the ever increasing size and scope of firms because trust, reputation, and mutual dependence dampen opportunistic behavior.

Granovetter (1985) has enjoined Williamson at the most basic level, drawing on Marx and Weber to argue that economic life is a *social* process, the structure of which is certainly not governed solely by efficiency considerations. Culture, the social fabric that binds groups

of people together in daily life, can create sets of shared goals and expectations that limit economic behavior to generally accepted norms and dampen the self-interested behavior of individuals in the group. Economic relations, then, are "embedded" in social relations, not *vice-versa* as neoclassical economists would have it. Perfectly efficient firm and market structures are not required for economic systems to function and, therefore, what we observe empirically cannot be assumed to reflect optimum efficiency. The implications of this approach for industry organization is that social relationships can (and usually do) create relationships of power and norms of behavior (e.g., trust, reciprocity, reputation, peer pressure, etc.) that reduce the threat of opportunism, Williamson's driving force for the accretion of production functions within the modern corporation.

> "I suggest here that small firms in a market setting may persist ... because a dense network of social relations is overlaid on the business relations connecting such firms and reduces pressures for integration" (Granovetter, 1985:507).

Granovetter goes on to suggest that large, vertically integrated firms tend to arise when supporting social relationships are not in place to generate "standards of behavior" between firms. Where such social relationships are in place, the pressure for firms to integrate is reduced. Most of the literature on production networks has followed Granovetter's (1985) lead in arguing that shared goals and expectations, built through social and spatial proximity and especially through *long term contracting relationships* between firms, can substitute for the authority structure of the integrated firm, explaining why *ongoing thick linkages* are more commonly observed in economic life than neoclassical economic theory suggests, even in the much altered form that it is offered by Williamson.[18]

Other authors have taken a more "economistic" approach to cooperation and trust than Granovetter. Using Williamson's transaction cost framework, they argue that trust-based inter-firm relationships lower transaction costs without internalization. Jarillo (1988),

[18] In his work with Ouchi, Williamson recognizes that in certain "clan" cultures (e.g., Japan), social controls (e.g., trust) can support elaborate informal governance structures that soften the structure of bureaucratic authority relations within the firm (Williamson and Ouchi, 1981:360-363). Oddly, the authors do not extend this insight to relationships *between* firms, assigning the distinction between clan and bureaucratic authority to a difference in internal management style.

turning over the coin of "opportunism" minted by Williamson, argues that the main reason transaction costs arise is because of lack of trust. This version of trust retains transaction cost as the determining factor of organizational form, and therefore possible assumptions about maximally efficient outcomes. Beyond a nod to repeated interaction, the question of how trust is generated in the first place is simply not asked. The argument is simply that trust can lower transaction costs to the point where externalization is a more efficient outcome than internalization (Thorelli, 1986; Johanson and Mattson, 1987; Powell, 1987; Jarillo, 1988; Lorenz, 1988). If opportunism creates "friction" in markets, then trust can act as a transactional "lubricant."

While I do not disagree with this argument, mine is different. Trust, reputation, and long term relationships are not the only way to buoy external economies. As industries grow and the capabilities of the supply base[19] deepens, it is possible for assets to become *less* specific over time, leading to increased possibilities for outsourcing relationships to be maintained without an intensely relational character, as long as the firms providing the industry with external capacity maintain a merchant character through volume spreading. New possibilities are opened up for the spatial organization of production as well, because innovating firms can tap distant production networks without FDI (Sturgeon, 1997a). If asset specificity is lowered through standardization and the use of information technology, and interdependence is mitigated though volume spreading, production systems based on external economies can thrive without the temporal sluggishness and geographic inertia exhibited by production systems based on long-term, trust-based relationships.

To create trust in market relationships takes time. This truism has been stressed by many network theorists. Thorelli (1988) defines the network relationship as *any* long-term relationship. Time is needed to operationalize economic actors' "hope for future business" which can act as a disciplinary mechanism in ongoing contracting relationships (Richardson,

[19] The term "supply base" was coined by Michael Borrus at BRIE to describe the "resident domestic capability to supply the component, machinery, materials and control technologies, and the associated know-how, that producers use to develop and manufacture products" (Borrus, 1993, p. 7).

1975; Powell, 1990). Repeated interaction is the key to creating the network in the first instance, and because setting up such relationships is costly and time consuming, the ability to change partners becomes constrained over time (Johanson and Mattsson, 1987). What differentiates trust-based relationships from market relationships based strictly on price or on authority (as when a smaller firm acts as a "captive" supplier to a much larger one) is the *mutual dependence* that builds up between firms and the relinquishing of a certain degree of autonomy by each party (Richardson, 1975; Thorelli, 1988).[20] Once firms in a network have adapted to one another, "strong bonds" are created that allow them to *better adapt to ongoing change* (Powell, 1987, 1990; Jarillo, 1988) within a stable network structure. The process of building up such interdependent relationships is a cumulative one that takes time (Johanson and Mattsson, 1987; Jarillo, 1988; Lorenz, 1988, 1992). The image that has been created by much of the this literature is one of *relational networks,* a moniker that clearly differentiates the network relationship from the atomized market relationships of the Marshallian firm.

Here, the network is held up as an alternate governance structure to the integrated firm and deemed more adaptable to change, therefore providing better economic performance in highly competitive or volatile markets (Powell, 1990; Cooke and Morgan, 1992).[21] Interpersonal experience garnered through long-term relationships renders information more reliable in network settings,[22] resulting in a more innovative environment than that within the modern corporation, which suffers from a chilling effect on innovation due to empire building and "information impactedness" (Powell, 1987).

However, since the ability to make and break network relationships are constrained in the relational network, the structure of the overall network architecture becomes somewhat

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[20] This distinction has led some network theorists to argue that production networks can be relatively egalitarian systems (Piore and Sabel, 1984; Powell, 1990).

[21] My own view is that production networks provide better performance in some instances. We need to take a *systemic view* of the firm by recognizing that industry organization is a strategic decision in each instance. Strategic considerations include, but are not limited to cost. Other important considerations are speed (e.g., time to market); quality; market access (for inputs or for outputs); access to specific technology, routines, and labor markets; and the need to engage in or adapt to the creation of new markets, often in conjunction with lead users. Any of these considerations can render the network strategy more or less desirable in specific cases.

[22] A point that directly contradicts Williamson, who argues that firm hierarchies provide better information than the market (Williamson, 1981).

rigid. Dore (1986), in his study of the textile industry in Japan, referred to this ironic character of relational networks as "flexible rigidities." Relational networks are rigid in that the trust required to enter the system takes a long time to build up. Behavior within the network is tightly constrained; large deviations from generally accepted behavior risks exclusion from the network, an action that could easily spell economic death for the offending firm. Once the relational network is in place, however, a great deal of adaptability exists *within* the system because its elements (firms) can be quickly redeployed as environmental conditions change (e.g., from oil shocks, protectionism abroad, etc.).

While I agree that the "internal" structure of production networks based on long-term relationships may well be more adaptable than the governance structures of integrated firms, substantial rigidities may exist *if the overall architecture of the network is itself resistant to change*. The "porosity" (i.e., ease and speed of information flow) within the confines of the network may be high, just as it is within the integrated firm, but the perimeter of the network may be "unporous" to linkages with economic actors outside the network, creating a barrier to the free flow of information analogous to that of the legal boundary of the large integrated firm.

As long as the line of argument about adaptability remains at the level of *existing structures*, the image that is created of both the production network and the integrated firm remains static. In practice, we can observe that *systems of industrial organization are in a constant state of flux.* Both the integrated firm and the network must continually redefine their boundaries as conditions change. This means that the question of adaptability must be raised to the level of the overall architecture of the system.

In the electronics industry, American-led production networks contain suppliers that are becoming increasingly capable (i.e., offering turnkey production services that include all process engineering and component purchasing services) and independent, operating as merchant suppliers to a wide range of customer firms. This type of production network is very permeable, allowing customer firms to easily connect and disconnect from an ever

broadening palette of potential suppliers that possess a wide variety of technical and geographically-specific attributes. The result is a highly adaptable system characterized by fluid relationships, geographic flexibility, low costs, rapid technological diffusion, and powerful external economies of speed, scale, and scope.

In contrast to the model of the *relational network* offered by much of the network literature, I offer a different network model, the *turnkey network.* The turnkey production network is characterized by relatively low barriers to entry and exit, rendering its perimeter highly porous. Walter Powell (1990) has offered a schematic comparison of the Marshallian firm (which he labels as "market"), the modern corporation (which he labels as "hierarchy"), and the relational network (which he labels as "network"). In Table 2, I present an elaborated version of this schematic, relabeling Powell's "network" organizational form as "relational network" and adding my own category of "turnkey network" as a way to build a new network model in contrast to the relational model put forward by most network theorists.

Table 2. Stylized Comparison of Forms of Economic Organization; Comparing the Turnkey Network to the Relational Network.

| | Forms | | | |
|---|---|---|---|---|
| Key Features | Market | Hierarchy | *Relational Network* | *Turnkey Network* |
| Normative Basis | Contract-Property Rights | Employment Relationship | Complementary Strengths | *Functional Specialization* |
| Means of Communication | Prices | Routines | Relational | *"Thinly Relational" Prices, codified transactions* |
| *Volume of information and goods flowing across linkage* | *Low* | *Not applicable* | *High* | *Medium* |
| *Degree of interdependence* | *Low* | *High* | *High* | *Medium to Low* |
| Methods of Conflict Resolution | Haggling- resort to courts for enforcement | Administrative fiat-Supervision | Norms of reciprocity-Reputational concerns | *Competitive switching, multiple partners* |
| Degree of Flexibility | High | Low | Medium | *High* |
| *Degree of adaptability within system* | *High* | *Low* | *High* | *High* |

| | | | | |
|---|---|---|---|---|
| *Degree of adaptability of overall system architecture* | *High* | *Low* | *Low* | *High* |
| Amount of commitment among the parties | Low | Medium to High | Medium to High | *Medium to Low* |
| Tone or Climate | Precision and/or Suspicion | Formal, bureaucratic | Open-ended, mutual benefits | *Precision, competitive, pragmatic* |
| Actor Preferences or Choices | Independent | Dependent | Interdependent | *Limited dependency* |
| Mixing of Forms | Repeat transactions Contracts as hierarchical documents | Informal organization Market-like features: profit centers, transfer pricing | Status Hierarchies Multiple Partners Formal rules | *Tight linkages and long term relationships Buffer capacity* |
| *Spatial Aspect* | *Clustered or Dispersed* | *Dispersed* | *Clustered* | *Clustered and dispersed, linked nodes* |

Source: Adapted from Powell (1990:300). Italic entries added to original.

Instead of "thickly relational" interactions between firms, as in the relational network, turnkey contracting allows for looser, "thinly relational" interactions because the supplier specifies its own processes, purchases its own inputs, and retains an autonomous financial stance *vis-a-vis,* its customers. In the turnkey network, supplier firms take a "full service" stance toward their customers, providing turnkey production services that require very little support or input (beyond design specifications) from customer firms. The result is less frequent and intense interaction than in relational networks, reduced interdependence, and a lesser need for spatial propinquity, all of which are enabled by the use of highly formalized inter-firm linkages (i.e., low asset specificity, highly codifiable transactions, standard nomenclatures). However, transactions may be very frequent and important to both parties in the turnkey relationship, with a high volume of money and goods flowing across the link. As in the perfectly competitive Marshallian market, the disciplining mechanism in the turnkey network is simply for either party to the conflict to change partners.

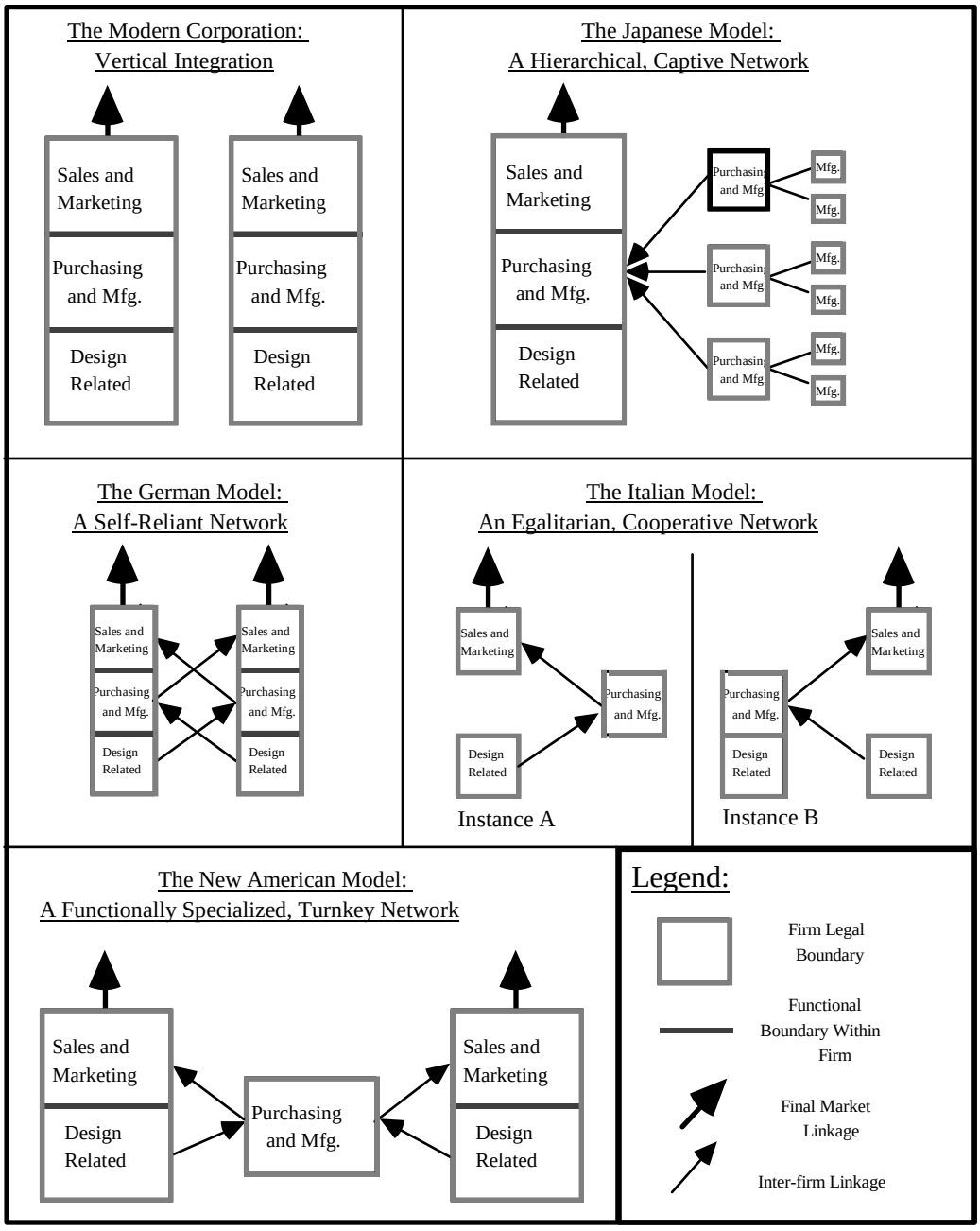
Some of the inspiration for network theory has been provided by nationally-specific models of industrial organization that rely extensively on external economies. These models have been largely derived from research on the industrial systems of Japan, Germany, and

Italy. The basic organizational characteristics of the various models are well known, and I have summarized them conceptually in Figure 3 below.

I describe the production networks led by Japanese firms as *hierarchical, captive networks* because suppliers in the system are more likely to be highly dependent on one or a small number of key customer firms. Buyer-supplier relationships are often (but not always) formed between affiliates of the same industrial group. The qualification process for new suppliers can be extremely lengthy. Often, lead firms make equity investments in their suppliers and over time come to dominate them financially. The interdependence that arises in such system makes it much more difficult and costly to begin and end supplier relationships, leading to structural rigidities in the system, technological "cul-de-sacs," geographic inertia, and the development of redundant offshore production systems.

In Germany networks of small- and medium-sized firms interact through dense contracting relationships while jealously guarding their *self-reliant* stance in the marketplace by retaining a strong end-product focus. Generally speaking, most small and medium-sized German firms (known as the *mittlestand*) are willing to provide production services to other firms that need it if they have excess capacity, but few choose to forego developing and selling products under their own brand name and make production services their sole business, although there are some signs that such a *full service konzept* is becoming more popular (Markt and Technik, 1993, 1994). This end product focus has led even small German firms to remain remarkably vertically integrated. In the German model, vertical integration inhibits productive capacity from pooling in functionally specialized merchant suppliers and as a result external scale economies fail to build up.

Figure 3. Country-Specific Models of Production Networks; Where the Turnkey Model Fits




I refer to the Italian model as an *egalitarian, cooperative network* because of the close association that is required to maintain a very elaborate social division of labor. The firms in the network are functionally specialized, and change partners within the network easily. Like the turnkey model, flexible production equipment facilitates organizational flexibility and allows a wide variety of products to be produced for a variety of customers. But unlike the

turnkey network, the Italian model stresses long-term, trust-based relationships based on social and spatial propinquity that make the external boundary of the network impermeable to economic actors on the outside. Organizational flexibility within the industrial district is high, but because the relationships within it are idiosyncratic, the districts fails to develop as a node on a global-scale production network.

In an economy that is becoming increasingly integrated on a global scale, such "stand-alone" industrial districts can become isolated from the state of the art. The industrial clusters in turnkey production networks have many of the characteristics of the “Marshallian industrial districts” of the Italian model and the hierarchical model from Japan in that they depend on dense external economies, but with an important difference: they are not closed systems; they fulfill a specialized role within a larger, global-scale production network. In the electronics industry, for example, contract manufacturers providing a full range of leading edge production services have emerged in various geographic locations, particularly in established centers of the electronics industry such as Silicon Valley, Scotland, and Singapore. Taken as a group, the worldwide supply-base of contract manufacturers offer their customers a global-scale network of leading-edge manufacturing capacity for hire. By utilizing this network in a highly dynamic manner, some brand name firms, especially large systems firms with deep involvement in international markets, such as IBM, DEC, Sun Microsystems, Ericsson, and Hewlett Packard, have gained the ability to reconfigure the geography of their manufacturing operations on an ongoing basis without the costs, risks, and time commitments associated with setting up new offshore production facilities of their own.

## CONCLUSION: A WORLD CONVERGENCE OF ORGANIZATIONAL PARADIGMS?

What does the case study of this paper tell us about the current trajectory of capitalism? Firms and industrial systems that have historically been rooted in their respective national economies have become increasingly inter-linked as global-scale production networks have emerged. As competition between nationally-based production systems has become more pronounced, so too has the rate of organizational change as firms from one nationally-based system adapt to new competitive pressure from another by adopting, however imperfectly, the organizational characteristics that are perceived as providing competitive advantages for their rivals. Since nationally-rooted organizational characteristics cannot be imitated without being altered to fit their new context, powerful forces of innovation have been unleashed as attempts at imitation have been combined with home-grown organizational innovations to create new, more powerful approaches to organizing production.

Are organizational paradigms converging on a global basis? If we posit that the adaptation cycles described above are becoming shorter over time, we can then hypothesize that the changes we are seeing today will culminate, perhaps in the *very long run*, with the global industrial system converging around a more-or-less common organizational model. The process of convergence, if indeed it is occurring, may not be linear or unidirectional, but characterized by accelerating rounds of competition, adaptation, and transformation. National difference will persist to be sure, but over time, national production systems could well become more compatible with one another, further increasing global economic integration as global-scale linkages thicken in a self-reinforcing dynamic.

While it is certainly a compelling notion, it is impossible to say with certainty that convergence is occurring; instances of imitation and adaptation are not incompatible with persistent difference or even divergence. The question must be addressed with further research. What is important is that the framework that guides this research avoids the twin

pitfalls of over-abstraction (which tends to over-determine research findings) and relativism (which can devolve into simple description and list-making). This is indeed a fine line, but the following intellectual "signposts" have been useful for me. First, nationally- and regionally-specific social, political, and economic structures should be viewed as pre-existing conditions that effect outcomes. Firm-level strategic choices need to be placed in their historical and geographical contexts. Second, we need to recognize that firm-level strategic decisions can affect firm-level outcomes and, more importantly, that aggregated firm-level decisions can affect aggregate industry-level outcomes. Economic actors do have the agency to alter the conditions in which they find themselves.[23] Third, we need to accept, as neoclassical economics argues, that firm profitability is a positive evolutionary force (weak competition) while recognizing, as Schumpetarian thought does, that simple profitability cannot insulate the firm from radical innovations that alter the playing field (strong competition) as when entirely new markets are created or new organizational approaches are deployed (Storper and Walker, 1989). Low profitability can be tolerated by some firms in the network in exchange for lower risk and more stable market conditions (although negative profits over too long a period will likely have the expected evolutionary affect).

By thinking in terms of such wide historic sweeps and focusing on the geographic and technological context of the subject, we may be able to locate the modern corporation as a peculiarly American organizational innovation that spread more-or-less intact to Europe (Franko, 1979) but triggered organizational transformation in Japan, where the tenets of mass production were adapted to smaller markets (Sayer, 1986). The result was “lean production,” a system so productive that, in many important manufacturing industries (e.g., steel, autos, electronics), it triggered a competitive crisis among the leading industrial firms in the United States and Europe (Womack et. al. 1990). In a similar fashion, American electronics firms appear to have grafted some of the tenets of lean production (e.g., high levels of outsourcing,

[23] This point opens the door for policy making because firm managers can be prodded (e.g., through incentives) and directed (e.g., through regulation) to alter their aggregate decision-making patterns (Cooke and Morgan, 1992).

a focus on quality, low levels of work-in-progress inventories, etc.) to their own, lower-trust network environment. The result may be a new, more powerful organizational system that uses turnkey supply relationships to weave key geographic clusters into a global-scale production network that is highly adaptive to change both internally and externally.

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