

# International Production Networks in Asia: Rivalry or Riches

## Introduction

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The economic crisis of 1997 called East Asia's economic miracle into question and generated widespread criticism of the region's distinctive developmental models. The startling rapidity with which problems in one Asian economy were transmitted to others in part reflects similar weaknesses across countries: overvalued exchange rates, a run-up of unhedged, short-term, foreign debt, underdeveloped domestic financial intermediaries and weak regulatory oversight. In our view, contagion also reflected a deeper underlying fact about the region's economic development. Over the last two decades, driven neither by high politics as in the EU nor by formal trade agreement as in NAFTA, the economies in East Asia have become closely integrated at the level of production organization.

The massive literature on Asia's economic integration, most of it focusing on trade patterns and the investment and trade behavior of multinational corporations, has by and large missed this deeper level of industrial integration. Arms-length trade, foreign direct investment, and even intra-firm trade do not fully capture the organizational structure of the region's major growth industries and markets. In electronics, textiles and apparel, autos, and other sectors, firms in the region are increasingly linked across borders in complex and ongoing relationships that extend beyond the boundary of the firm and span the entire value-chain in the given activity. The architecture of these "cross-border production networks," the way that technology, know-how, resources and control flow across them, and their implications for competition and cooperation in the region, are the subject of this book.

By a lead firm's "cross-border production network" (CPN) we mean the inter- and intra-firm relationships through which the firm organizes the entire range of its business activities: from research and development, product definition and design, to supply of inputs, manufacturing (or production of a service), distribution, and support services. We thus include the entire network of cross-border relationships between a lead firm and its own affiliates and subsidiaries, but also its subcontractors, suppliers, service providers, or other firms participating in cooperative arrangements, such as standards-setting or R&D consortia. Choosing the CPN as the unit of analysis captures the cross-border operations of the lead firm itself, but also the proliferation of non-equity, non-arms-length, inter-firm relationships in which significant value is added outside the lead-firm.

The value of studying CPNs is that they closely mirror the rapidly changing division of labor in the Asia-Pacific. In the electronics sector that is the subject of this book, CPNs are not simply constructed to access cheap factor inputs (resources or labor) or to gain access to expanding markets, two of the principle explanations for foreign direct investment. Although those factors may have motivated initial investment, CPNs are increasingly designed to both foster and exploit the region's highly heterogeneous *technological capabilities*. *Indeed, a central theme of our work is that CPNs are assembled to access locational advantages at each network node associated with the increasingly specialized technology, skills and know-how that are resident there.*

The origins of those specialized capabilities are multiple, and include both technology transfers from multinationals and increasing investment in process and product development on the part of firms in the region. However, the development of local technological capabilities has also been a primary objective of government industrial policies. The study of CPNs thus inevitably raises the question of the role of the state in fostering the region's rapid industrial transformation and its particular pattern of economic integration.

A second theme of our work is that CPNs come in many national flavors. Even when we control for industry or product, the relationships that comprise a CPN can be arranged in a variety of ways, as can the accompanying flows of technology, know-how, resources and control. Some of these differences must be traced to characteristics of the lead firm in the CPN; individual firm strategies matter. However, the empirical chapters that follow argue that the cross-border production networks emanating from the United States, Japan, Korea, Taiwan, and Singapore exhibit substantial differences that are ultimately rooted in national systems of production and innovation.

A third major theme of this book is that the organization of CPNs has important competitive consequences, particularly in technology-intensive sectors such as electronics. The electronics industry encompasses a range of different segments. But for an increasingly wide array of electronics products, the definition of standards is a critical element of competition, product life-cycles are short and technological change is not only extraordinarily rapid but subject to periodic trajectory-disrupting innovations. In such "high-tech commodity" markets, cost competitiveness must be combined with product differentiation and speed to market. As Michael Borrus and Dieter Ernst show in chapters 2 and 3, network forms of organization are an important explanation for the competitive resurgence of U.S. electronics producers vis-a-vis their Japanese competitors. CPN's also explain Taiwan's success in the electronics sector (Ernst, Chapter 5) and help us understand why Singapore has prospered by positioning itself as the high value-added node for Southeast Asia's electronics (Poh Kam Wong, Chapter 6).

The fourth major theme of our work is that despite these competitive consequences of network organization, we have not seen convergence on a single organizational form; differences rooted in national origin have persisted. Indeed, the enduring differences in network character help to explain why some of the region's economies and industries have been able to adapt more rapidly than others to the stresses caused by the crises of 1997. It is conceivable that continued globalization and the sheer passage of time could

de-couple CPNs from their national origins. The crises of 1997 may well act as a catalyst for a new wave of foreign direct investment and for corporate restructuring and significant policy reforms throughout the region that would force greater convergence. To date, however, the strong convergence predicted by many theorists of globalization has not occurred. Indeed, national differences endure over time despite operational convergence in some areas of CPN organization and behavior, as Ernst and Ravenhill suggest in the concluding chapter.

We chose electronics as the focus of our analysis on both methodological and substantive grounds. Our focus on electronics raises questions of the applicability to other sectors. It should be emphasized however that the electronics industry itself represents a microcosmos of sectoral differences: it covers a broad range of product markets that include truly high-tech products like microprocessors as well as fairly conventional mass-produced commodities like appliances and general-purpose computer memory. By focusing on the electronics industry, we are thus able to capture a great variety of sectoral characteristics that shape different approaches to the organization of CPNs.

Controlling for a broad industry sector also offers obvious advantages in conducting cross-national comparisons. Moreover, investment and trade in electronics dominates Asia's trade and investment flows in manufactures, and as Paolo Guerrieri shows in his chapter on intra-regional trade flows, electronics has been an important factor in regional integration. Moreover, we expect that industrial practices characteristic of electronics are likely to diffuse to other sectors, just as cross-border network practices initially visible in the textile-apparel complex subsequently diffused and were later modified and deepened in the region's electronics industry.

### **CPNs: A New Form of Competition and Market Organization?**

To get at the new forms of market organization that are emerging in Asia and how they differ from traditional corporate forms, it is useful to consider an extreme case: the cross-border network controlled by U.S.-owned Cisco Systems, the leading supplier of routers, switches and hubs for corporate communications networks. Were Cisco to be organized like a traditional, vertically-integrated, multi-divisional producer of communications equipment-like the pre-Lucent Western Electric, Germany's Siemens or Japan's NEC-almost everything from the R&D at central corporate laboratories to product design, engineering, manufacturing, distribution and service would be done by one affiliate or another, most located in the country of origin. The bulk of the underlying technologies, components, parts, software and subsystems would be produced internally. The finished product would be sold directly to customers and control would be hierarchical and centralized.

In reality, Cisco looks nothing like this model. Cisco does no R&D in the conventional sense of a central corporate lab. It does do new product definition and software development at its headquarters in Silicon Valley. But the bulk of more conventional R&D and significant development work on some products is done through technology and product development alliances with key suppliers such as chip, design and software firms. Similarly, Cisco does none of its own volume manufacturing (although it does assemble pro-

totypes and some low-volume, high-value models). Rather, the products are assembled entirely by independent 'turnkey' contract manufacturers in California and Asia from components and manufacturing services (e.g., board-stuffing, PCB design) that flow from a variety of independent suppliers throughout Asia (including Taiwan, Korea, Japan, Singapore, Thailand, and Malaysia) and the U.S. These suppliers are bound to Cisco through a variety of contractual arrangements, however they do not typically involve an equity stake. Several independent companies in California produce to Cisco's technical specifications (i.e., its product standards), adding value in the form of products or services that interface in some fashion with Cisco's products. The final product is sold directly to customers but also through a variety of third-party channels including value-added resellers and systems integrators. Third-party suppliers very frequently undertake after-sales service.

Internet software producer Netscape Communications' product development and distribution relationships show a similar pattern. Product development is done in conjunction with a variety of independent development partners such as SUN, Real Audio, Adobe, NEC Systems Laboratory and others in Asia, who develop "plug-in" packages of software functionality (e.g., JavaScript applets, authoring tools, audio and video players) designed to work seamlessly with Netscape's browser-server products; without these products, the Netscape software would not be fully functional. The software is distributed directly to customers and through a variety of independent channels including OEM's like Netcom and Concentric, on-line service providers like Earthlink and Singapore's Pacific Internet, specialized retailers such as EggHead Software, local systems integrators and value-added resellers like Hong Kong's EDI Shop or Germany's Softlens, who provide Web set-up and services, and mass marketers such as Costco. The relationships that define the division of labor in Netscape's cross-border production network are mostly at odds with the traditional, vertically-integrated form of business enterprise; Netscape controls none of its partners through ownership, fiat or resource allocation.

These limiting cases suggest that the new CPN's emerging in Asian electronics include not only increasingly far-flung intra-firm networks that have been extensively analyzed in the literature on foreign direct investment in the region, but a wide variety of new inter-firm relationships as well. These include supplier, buyer and customer networks, but also producer networks, in which competing producers pool development and production capacities, standards coalitions among firms seeking to "lock-in" proprietary product, architectural or interface standards, technology cooperation networks and other strategic alliances. The external relationships that comprise a given firm's CPN include short-term supply contracts that approximate pure, arms-length market relations. For example, procurement of some commodity subassemblies and components, where technical leadership can shift abruptly among suppliers between (and even within) product generations, is more likely to be short-term and market-based. However, we are particularly interested in CPNs that depart from this model, and in which traditionally core competencies, such as manufacturing or R&D, are conducted outside the lead firm on the basis of more stable, long-term alliances requiring more intimate involvement and greater trust.

Although there is no simple measure for the development of these new CPNs, one important indicator of the new organizational forms that are emerging is the increasing trend toward the outsourcing of production itself. Since the 1970s, it has been established practice for "brand name" companies in the garment, footwear, furniture, and toy industries to depend on CPNs for essentially all of their manufacturing requirements. By contrast, the outsourcing of core manufacturing functions did not begin in earnest in the electronics industry until the mid-1980s. However, the trend has increased dramatically in the 1990s and shows no sign of abating. The scale and pace of these developments is suggested indirectly by the rapid growth of the contract manufacturing-production services segment of the industry, which has grown over the last decade from marginal revenues to \$40 billion in 1995. Outsourcing of supply and assembly to firms like SCI Systems and Solec-tron now involves 10-20 per cent of total product-level electronics manufacturing, (up from less than 5 per cent in 1982) and 40-50 per cent of highly volatile electronics industry segments, such as PCs and modems.

Conversely, vertically integrated assemblers like IBM, Hewlett-Packard, and Apple have disposed of captive production facilities and moved toward the new CPN model for a number of product lines. By 1994, 50 per cent of HP's 20 million circuit boards and 11 per cent of its 4.5 million final products were being assembled by contract manufacturers, as was fully 50 per cent of Apple's production. Some of the newest and most successful systems companies own no volume manufacturing at all, including Dell (PCs), Silicon Graphics (workstations), Cisco Systems (networking), Diebold (automatic teller machines), Digital Microwave (communications), Telebit (modems), LAM Research (equipment), and Octel (communications).

The emergence of contract production and CPNs in consumer durable sectors such as electronics and now, perhaps automobiles as well, turns the phenomenon from one confined to labor-intensive low or middle skill products in mature sectors to the most innovative and rapidly expanding sectors of the advanced industrial economies. Asia's well-developed local production and supply capabilities and their relatively open, "merchant" character, have put in place an infrastructure for global production strategies that drastically reduce the need for capital investment in production facilities by final electronic systems producers. Such organizational developments call into question a number of existing approaches to foreign direct investment and modern theories of the firm.

### **Theoretical Considerations: Explaining the Network Form**

As John Stopford has observed, the emergence of cross-border production networks shifts organizational focus "from the legal entity known as the firm to the contractual network of firms tied together by mutual long-term interest." (Stopford, 1994, p. 21). Such network forms of industrial organization have generated an extensive literature. How does that literature fare in explaining the new, loosely-coupled organizational forms that we see in the electronics industry in the Asia-Pacific?

The literature on networks can be roughly grouped into two traditions of discourse. One, anchored initially in business schools and subsequently in the microeconomics of organizations, centers on the attempt to explain the form and functioning of modern industrial

enterprise, including particularly tendencies to vertical integration (hierarchies) and disintegration (markets). Functional in explanatory form, these theories explain institutional design by reference to its implications for efficiency. The second, rooted in sociology and, secondarily in economic geography and comparative politics, elaborates the structure, characteristics and functioning of networks as a distinctive form of social organization.

The first tradition elaborates the rise of the large, vertically integrated, multidivisional, corporation and the global spread of its modern MNC variants, and details their governance and operations. In the nineteenth century the introduction of new production, transport and communications technologies vastly increased productivity, output and ability to reach distant markets. The form of the modern corporation grew out of the need to manage the complex coordination problems posed by large-scale industrial production and marketing. Improving control over an increasingly complex and diverse production chain meant housing as many of those activities within the purview of the corporate administrative hierarchy as possible. In-house production meant lower transaction costs, much faster throughput, and greater economies of scale and scope.

Global market opportunities, declining transport and communications costs, and changing national policies eventually extended the reach of the modern corporation, first through trade and then direct investment. The seemingly organic development and inexorable cross-border reach of the modern corporation, in turn, spawned variations on the ideal-typical form-e.g., affiliates with autonomous local ties, cross-border joint ventures, varied forms of outsourcing and contracting-and a lucrative cottage industry seeking to outline their determinants. John Dunning's "eclectic paradigm" (introduced originally in the mid-1970s) synthesized those determinants. Dunning argued that firms will locate wherever optimal for exploiting their defensible competitive advantages, choosing direct ownership whenever market transactions would fail to realize the full value of those advantages, for example with intangible assets like technological know-how.

An important strand of this literature stylized economic history into formal theory by developing and elaborating Ronald Coase's hypothesis that transaction costs were key determinants of the optimal form of industrial organization. Following Coase, Oliver Williamson and others hypothesized that modern industrial organization arose because it minimized transaction costs. Because transactions involving significant irreversible investment are subject to the hold-up problem, they are best handled by hierarchy. By contrast, we would expect a tendency to vertical disintegration and a return to market forms of organization where the costs of transacting and contracting fall. For example, Milgrom and Roberts have suggested that flexible machine tools and programmable, multi-task production equipment have obviated the hold-up problem by permitting firms to produce a variety of outputs efficiently in small batches.

The difficulties of operationalizing the transactions cost approach-and even identifying the meaning of "transaction costs" precisely-are notorious and well known. However, we wish to underscore two further difficulties with the transactions costs approach. As the literature on international supply-chain management suggests, it is by no means obvious

that the costs of coordinating a large, geographically dispersed network of independent suppliers is lower than vertical integration. In industries such as disk drives, several leading firms remain vertically integrated even as their operations have become geographically dispersed throughout Asia.

Rather, the higher transactions costs of managing a network of inter-firm relations must be offset by other advantages, such as economies of scale, flexibility, access to information, and the ability to focus resources on core competencies. For example, an investment by Cisco Systems in wholly-owned assembly facilities that replaced its reliance on contract assemblers would reduce the transactions costs it currently incurs in coordinating with those assemblers. But it would also impose new costs (currently incurred by its contractors) associated with monitoring technical trends in assembly to keep facilities state-of-the-art. For Cisco Systems, investment in assembly capacity is likely to have much less payoff than expenditure of similar resources in broadening its product's technical capabilities and evolving its product standards in ways that lock-in customers.

As this example suggests, the analysis of the determinants of institutional form must shift away from the narrow focus on transaction costs to the broader competitive environment in which firms operate. Although it is difficult if not impossible to generalize across all electronics segments, several fundamental changes in the industry help account for the adoption of network forms of organization.

In the past, two stylized types of competitive strategies could be distinguished within the industry. For consumer electronics and components, competition centered primarily on cost reduction, with non-price competition reserved for a few, high value-added market niches, such as high-end audio equipment. In the computer industry, by contrast, the focus of competition was on product differentiation based on innovative product designs and market segmentation.

Today, however, a wide range of electronics products have become "high-tech commodities:" they combine the characteristics of mass production with extremely short product life cycles and highly volatile market demand. As a result, firms must combine product innovation and differentiation, and the learning and acquisition of specialized capabilities that implies, with high volumes, speed-to-market, competitive pricing, and the ability to penetrate new and uncharted markets. Mass production implies large investment thresholds to reap economies of scale, while short product life-cycles imply the rapid depreciation of plant, equipment and R&D. The problems of squaring this strategic circle are compounded by periodic trajectory-disrupting innovations, so that leadership positions cannot be taken for granted.

These market conditions create pressures to move from partial globalization, characterized by a loose patchwork of stand-alone affiliates, joint ventures, and suppliers, to systemic globalization: the effort by a firm to network its own operations and inter-firm relationships worldwide, across both functions and locations. The demand both for scale and for closer, faster, and more cost-effective interactions between different stages of the

value chain have been a driving force in shifting core functions, like production, outside the boundaries of the firm into networks.

Our second criticism of the transaction cost approach to networks and vertical disintegration centers on the presumed efficiency gains from these organizational choices. This approach skips some of the more provocative chapters in the economic history of the modern corporation. Chandler's vibrant histories show that the quest for rents and market power via increased throughput and speed of coordination were more important in explaining hierarchy than the traditional emphasis on scale economies or efficiency. The chapters in this volume similarly point to these often-overlooked dimensions of organizational choice. Like hierarchies, CPNs not only promise to improve efficiency, but can permit lead firms to sustain quasi-monopoly positions, generate market power through specialization, and raise entry barriers; these considerations are of particular concern for developing countries' integration into CPNs.

Indeed, the cases suggest that competition in electronics in the era of CPNs is increasingly about developing and sustaining monopoly niches, whether through ownership and control of a de facto standard or by maintaining a differentiated product through the ability to add performance, functionality, features or to improve costs faster than competitors. Profitability in electronics is almost purely a function of a firm's position in the resulting market structure; high where quasi-monopoly position can be maintained; weak and volatile everywhere else. Contrary to conventional wisdom, we find that electronics is not a simple story about firms finding profits by moving up a hypothetical value chain that starts in low value-added components and assembly and ends with services and content. As Intel demonstrates in components and Matsushita's recent desultory experience with MCA suggests in content-creation, profits can be made or lost at any point in the value-chain. In electronics, then, CPNs are self-conscious efforts to structure markets in ways that increase profits by removing direct competitors, creating differentiation, erecting entry barriers and, most significantly, assembling capabilities that other forms of business organization cannot match.

The second discursive tradition, with its emphasis on networks as unique forms of social organization, provides some tonic to the over-drawn dichotomy between markets and hierarchies. As Walter Powell has argued, the history of modern commerce is a story of enterprises with loose and permeable boundaries-e.g., guilds, trading companies, family associations-which do not fit neatly on a spectrum of organizational forms bounded by markets and hierarchies (Powell, 1990, p. 298). Standard operating forms in a range of modern industries including construction, publishing, architecture, filmmaking and media have always fit uneasily into the market/hierarchy dichotomy. Nor is it entirely satisfying to say that these industries incorporate elements of both market and hierarchy; rather, Powell argues, they define a qualitatively different type of organization in which neither price signals nor command capture key relationships (Powell, 1990, p. 380).

In particular, this second tradition views economic interactions as 'embedded' in broader social relationships based on trust, reciprocity, and shared expectations that overcome opportunistic behavior and permit coordination. The literature emphasizes how such

forms of coordination are especially useful under conditions of high uncertainty, for mutual learning, and for adjusting rapidly to shifts in the environment, all features associated with the markets of concern here. The more complex the global market environment-the more subject to competitive ambiguity and rapid technical or market shifts-the more likely firms are to benefit from the trust and reciprocity of socially-embedded networks.

The central problem with the sociological approach to networks has to do with the international rather than localized setting in which industries now operate. While it is possible to identify the discrete social institutions that support trust and reciprocity in Northern Italian manufacturing, for example, what is the social foundation for such networks in the Asia-Pacific? Much of the literature on industrial districts and social networks has focused on an analysis of micro-interactions within a particular localized cluster. Yet, local clusters of knowledge creation can no longer exist in isolation: they are rapidly becoming internationalized, either through acquisitions or through the increasing power of global customers. They are also prone to the challenge of "ubiquification," a term coined by Peter Maskell to describe the erosion of existing knowledge clusters through information technology and globalization (Maskell, 1996).

One answer, as we will spell out in somewhat more detail below, is the transnationalization of ethnic social networks, particularly within the Chinese Diaspora. However, it would be entirely impossible for Chinese firms-or firms of any nationality-to build CPNs in the electronics industry that are ethnically self-contained. Key technologies continue to be dominated by Japanese and American firms, and end-markets for products are everywhere. Moreover, as Michael Borras argues, American firms have been particularly adept at linking into Chinese networks, an outcome difficult to explain on the basis of sociological embeddedness. Thus while we do not discount the role of transnational ethnic ties as the basis for the success of some Chinese enterprises, their importance in the overall structure of major industries in the Asia-Pacific has been exaggerated; because of the significant role played by American, Japanese, Korean and increasingly European firms, they cannot capture the full range of social ties that may be germane in understanding the development of the CPN form in the Asia-Pacific.

Rather, the case studies identify a different way in which embeddedness matters; foreign firms are increasingly tapping into local concentrations of technological and production capability that have in turn been fostered under conditions of social and political "embeddedness." Access to resources outside the firm is a key motive for building CPN's. It is also a principle reason why location decisions by firms tend to cluster where they can benefit from strong externalities generated by local networks, like supportive infrastructures, specialized suppliers, skilled labor, supportive government institutions, and above all, technological know-how.

As illustrated by the chapters on Taiwan and Singapore, CPNs incorporate and are linked to local capability clusters that have emerged out of both local social ties and policy-induced linkages among local firms, universities, government agencies, research institutions and other public and quasi-public entities. The fact that CPNs both extend and incorporate these local networks underlines the conceptual ambiguity in the concept of

"globalization:" the most globalized firms depend heavily on capacities that benefit from local agglomeration economies.

Networks provide an especially effective means for tapping into locally developed technological capabilities. Among the most significant of external resources for most firms is the specialized know-how embodied in other firms or locations. The extensive literature on the spread of inter-organizational partnerships thus emphasizes the central role of technological learning through such network connections. But while technological know-how is increasingly exploited on a global basis through such partnerships, its generation remains to a substantial degree national and local. The studies in this volume confirm patterns of increasing local and regional technical specialization as globalization proceeds. Indeed, a central theme of our work is that CPNs are assembled to access locational advantages at each network node associated with the increasingly specialized technology, skills and know-how that are resident there.

In sum, new forms of CPNs are emerging that are only partly explained by reference to existing literatures on foreign investment or networks. CPN's are not motivated only by cheap factor costs or market access, although particular relations within a CPN may well be influenced by the need to surmount barriers to trade and investment. They are not confined to particular segments of an industry's value-chain like supply of components or manufacturing. Nor are they confined to a limited number of routine relational forms like outsourcing or joint ventures.

Nor is possible to explain CPNs solely with reference to changes in transactions costs or to social embeddedness. Rather, they represent efforts to develop new forms of organization that provide greater flexibility, responsiveness, risk-sharing as well as efficiency under conditions of high market and technological uncertainty. CPNs embody efforts to develop relationships to exploit complementary assets held by other firms, for example, to develop something new that no partner could as effectively alone (within given constraints of time and cost) or because rationalization around areas of core competence requires contracting-out non-core functions. Most significantly, CPNs exploit locational advantages by organizing a division of labor across borders that re-assembles the industry value-chain through specialization at each node. To understand their distinctive form in Asia, therefore, requires an understanding of developments at each of those nodes.

### **Enabling Conditions: Asia's Development and the Emergence of CPNs**

CPNs emerged in a dense and highly elaborated form in Asia because the region's economic development occurred in phases that created unusually heterogeneous production capabilities and thus a high degree of intra-regional complementarity. Asia's long-term growth can be seen in terms of four developmental tiers. Japan occupies the first tier. Industrialization began in the 19th century, accelerated under military auspices during the late 1930s, and reached the advanced country frontier in the middle of the post-war era through self-conscious policies of technological catch-up, a large domestic market, and access to the American market for exports. The second tier consists of the newly industrializing countries (NICs): Taiwan, Singapore, Hong Kong and Korea. The so-called "Four Tigers" approached the advanced industrial frontier in some industry segments using

strategies of extensive technological borrowing and export-led growth, in the case of Singapore, with a dominant role for foreign investment.

The third tier of later-industrializers includes the major Southeast Asian countries of Malaysia, Thailand, the Philippines, and Indonesia. These countries began to emulate the first generation of NICs in the 1970s by pursuing more outward-oriented development strategies; Malaysia and Thailand relied heavily on insertion into the networks created by Japanese, US, Korean, European, Taiwanese and other overseas Chinese multinational corporations. To date, however, the extent of indigenous technological capacity in the "ASEAN four" remains substantially lower than in the four NICs.

The fourth tier is occupied by China, Southeast Asia's late-late developers, particularly Vietnam and perhaps in the future India as well. China could in theory deepen the more inward-looking, dirigist strategies it has long pursued, and despite extensive reforms, some elements of such a strategy remain visible. Over the last decade, however, the trend is clearly toward a deeper incorporation into the region's trade and investment networks, with China already drawing foreign direct investment away from countries in the third tier.

This tiered pattern of development created complementary capabilities across countries that were highly conducive to the emergence of regional production networks; indeed, the broad development history just sketched is mirrored in the evolution of cross-national production networks in the region. To stylize a complex history, the beginnings of CPNs in electronics can be traced to the 1960s, when American and Japanese multinational firms established (or in some cases re-established) their presence in a number of Asian locations. These investments took two basic forms. Outward-processing investments, which located first in Hong Kong and spread to Taiwan, Korea and Singapore in the 1960s, established production units or contracted-out for narrowly defined activities that were intensive in the use of low-cost (and initially, relatively low-skilled) labor. Simple electronic components and semiconductor packaging and testing are examples. Local value-added was largely limited to the wage bill, with little local sourcing; initial investments in these activities were often located in export-processing zones with few linkages to the local economy. By contrast, import-substituting investments, particularly in consumer electronics products in which the Japanese enjoyed advantages, established branch plants to circumvent tariff protection and to gain access to local markets; fans, air conditioners and refrigerators are examples.

Partly in response to the opportunities spawned by these investments, indigenous firms emerged and developed to produce components and subassemblies or to provide services. During the 1970s and 1980s, affiliates of U.S. firms increasingly relied on local, and gradually regional, suppliers for specialized inputs. Backed in Korea, Taiwan and Singapore by industry-specific industrial policies of various sorts, local firms strove to extend their range of production and to integrate forward and backward from their initial point in the production chain.

Product cycle and "flying geese" models predicted that the development of local capabilities would ultimately displace the multinationals in both home and foreign markets. Multinationals would cede low-end market segments to their lower-cost competitors and move on to new products. In some cases, such as black and white televisions, such a process did occur. In a surprisingly large number of other segments, however, such a seamless transition did not take place; rather, a more complementary form of organization emerged. MNC affiliates continued to invest in production facilities, but relied on local and regional suppliers for a greater range of inputs, processes and manufacturing steps. At the same time, the division of labor within Asia became more dense as suppliers from the second tier (e.g., Singapore, Hong Kong, Taiwan and Korea) began to export to other Asian production sites, and finally extended their own operations into less developed parts of Asia (e.g., Malaysia, Indonesia, Thailand, Southern China).

As the region's technological capabilities and labor skills deepened still further in the 1980s and 1990s, some MNCs focused increasingly on core competencies at home and the distinctive CPNs outlined above began to emerge. So developed had Asia's manufacturing capabilities become that the supply portion of the value-chain for some firms centered almost entirely in Asia. Moreover, production was no longer confined to wholly-owned subsidiaries; rather, production itself was out-sourced. The American firms which pursued this strategy concentrated almost entirely on product definition, development, and marketing. The very management of complex supply chains had itself become a core competence, and some firms like Compaq even specialized in it. Production intermediaries such as Solectron built lucrative businesses by developing their own CPNs, packaging Asian supply capabilities with their own skills and providing full-service turnkey manufacturing capabilities to MNC customers. As Ernst shows in his chapter on Taiwan, a number of Asian firms entered this segment of the market as well.

It is important to underscore that the stylized history just sketched should not imply a linear, "stages" model nor a uniform pace to the developments across segments. The developments leading to more articulated CPNs overlap in particular countries and even in the experiences of individual MNCs; the emergence of new organizational forms did not necessarily replace existing ones. Rather, several forms co-exist, representing in part different corporate production strategies.

### **Distinctions at the Point of Origin**

More importantly, the structure and operation of CPNs in the region bore the imprint not only of their lead firm, but also of the lead firm's home country. Globalization has not eviscerated the analytic significance of national distinctions based on ownership and origin. American networks show modal characteristics that contrast with equally distinctive production networks under the control of Japanese, Taiwanese, Korean and other Asian firms.

Moreover, the chapters that follow strongly suggest that these differences are competitively consequential. Differences in organizational form help explain why U.S. electronics firms have prospered over the last decade, indigenous Asian firms became significant players in a number of industry segments, and Japanese firms, whatever their previous

successes and continuing strengths, saw a shrinkage in their market share over the last decade.

The following tables provide a typology of the major networks operating in the region—American, Japanese, Taiwanese, Singaporean and Korean—based on the findings of the case studies. We have chosen to emphasize only those differential characteristics that seem to explain differences in competitive performance and market outcomes.

First, it is important to underscore that there are differences in the product mixes in which countries specialize. For example, U.S. firms have a more pronounced presence in industrial electronics, Japanese firms still play a critical role in consumer products, as do Korean firms, while Taiwanese and Singaporean firms have established a strong specialization in PC electronics, including peripherals and components. However, there is no clear reason why these sectoral differences would necessarily produce diverse organizational forms; the case studies suggest strongly that even when we control for industry segment, the organization of production still differs in significant ways.

In the tables that follow, "accessibility" is an indicator of the openness of the network to outsiders and the willingness to develop relations beyond a limited set of partners. "Permanence" refers to the time-frame characterizing relationships among firms in the network, and whether the network involves relatively short-term relationships or longer-term ones built on trust and "repeat play." Together, as Table 1.1 implies, these factors help to explain the relative ability of the different networks to adjust to rapid market and technological shifts. In our view, the ability to adjust rapidly is perhaps the crucial performance variable in contemporary electronics markets.

**Table 1.1: Ability to Adjust to Market/Technology Shifts Accessibility Tendency**

	<b>Open</b>	<b>Closed</b>
<b>Permanence</b>	<u>Fast</u>	<u>Moderate</u>
<b>Fluid</b>	US, Taiwan	Korea
<b>Long-term</b>	<u>Moderate</u>	<u>Slow</u>
	Singapore	Japan

"Governance" captures the extent of control exercised by headquarters or the lead network firm over affiliates and local network partners. The case studies spend a significant effort unraveling the question of control because of its implications for where value is captured, the existence of barriers to entry, and the developmental consequences networks have for the developing countries in the region. Indicators of control include in the first instance the preference for vertical integration over more loosely-coupled network forms, but also the role of headquarters in directing personnel, sourcing and other key managerial decisions of affiliates and network partners. Control over both product and process technology and the willingness to transfer competencies constitute core elements of the governance structure. Thus, as a control indicator, the "supply base" variable is intended to capture the tendency for the lead firm to prefer domestic and affiliated part-

ners over anyone who can meet price, quality and delivery constraints. Taken together, as in Table 1.2, these variables help to explain the degree to which the different CPN forms exploit local technological and business capabilities throughout the region. In our view, the ability to exploit local specializations is a second crucial performance variable in electronics markets.

**Table 1.2: Exploitation of Asian Value-added Supply Base**

	<b>Unaffiliated</b>	<b>Affiliated</b>
<b>Governance</b> <b>Decentralized</b>	<u>High</u> US	<u>Moderate</u> Taiwan
<b>Centralized</b>	<u>Moderate</u> Singapore	<u>Low</u> Korea/Japan

Table 1.3 summarizes all of these features.

**Table 1.3: Typology of Electronics Production Networks in Asia**

<b>Characteristic</b>	<b>US-Owned</b>	<b>Japanese-Owned</b>	<b>Taiwanese-Owned</b>	<b>Korean-Owned</b>	<b>Singapore-Owned</b>
<b>Product Mix</b>	Sophisticated industrial electronics	Consumer and low-end components, commodity industrial	PC electronics	Consumer, some components	Disk Drive and PC electronics
<b>Accessibility</b>	Open	Closed	Open	Closed	Open
<b>Permanence</b>	Fluid	Long-term	Fluid	Long-term	Long-term
<b>Ability to Adjust to Market/Tech Shifts</b>	Fast	Slow	Moderate	Slow	Moderate
<b>Governance</b>	Decentralized	Centralized	Centralized	Centralized	Centralized
<b>Supply Base Preference</b>	Anyone meeting price, quality, delivery constraints	Domestic and Local-Affiliated	Domestic and Local-Chinese	Domestic	Local Chinese
<b>Exploitation of Intra-Asia Value-Added</b>	Maximizes local Asian value-added	Maximizes Japanese value-added at home and locally; minimizes rest of Asia value-added	Maximizes Taiwanese value-added but exploits local Chinese value-added where necessary	Maximizes domestic Korean value-added	Maximizes high domestic and low local-Asian value-added

The U.S. networks produce (and in some cases design and develop) increasingly sophisticated industrial electronics like hard disk drives, PCs, InkJet Printers, and telecommunications products. Geographically, American investments are concentrated in the NICs, especially Singapore, but increasingly reach into the rest of Asia; for example, China is emerging as a separate regional focus for American CPN activity. However, the networks of American firms rely on an open, competitive supply architecture in which Japanese, Taiwanese, Singapore, and Korean firms, as well as other American firms based in the region, provide significant value-added. The U.S. networks are more likely to exploit a complementary division of labor in which American firms specialize in 'soft' competencies (definition, architecture, design, standards and marketing) and Asian firms specialize in hard competencies (components, manufacturing stages and design/development thereof). By increasing technical specialization throughout the production process, the Asian contribution to final output is maximized.

With respect to control, the U.S. networks decentralize significant decisions to affiliates or partners. As Borrus argues in his chapter on the United States, the setting, maintenance and evolution of de facto standards set in the domestic U.S. launch market was the principle instrument used by U.S. firms to preserve control over their inter-firm networks. As long as U.S. firms maintained that role in the division of labor by defining the product and technology trajectory, customers were locked-in to their standards and it was extremely difficult for other firms in the network to challenge for the lead. U.S. networks could be highly decentralized precisely because ownership of standards enabled devolution of responsibility to network partners without fear of losing control.

The Japanese networks, like the Korean, still mostly produce consumer audio-visual electronics, appliances, and components. Over the last few years, however, unlike the Koreans, the Japanese networks have rapidly expanded production of commodity industrial electronics products like hard disc drives. Although Japanese networks span the region geographically, and Korean firms have begun to invest abroad aggressively in the last half-decade, both still rely on a largely domestic and affiliated supply base with surprisingly little value-added by other Asian producers. The division of labor across the network is more likely to be one in which domestic operations produce high-value, high-end products using sophisticated processes while off-shore affiliations produce comparatively lower-value, low-end products using simpler processes. As a result, indigenous Asian (i.e., not Japanese/Korean) contribution is minimized, although, given relative levels of development, the Korean networks are much more dependent on partnerships, particularly with respect to core technologies.

In terms of internal organization, Japanese and Korean networks have tended to be relatively closed to outsiders, more centralized, and structured on stable, long-term business and traditional keiretsu or chaebol relationships. The Ernst and Kim chapters on Japan and Korea show that with control residing in their domestic-based manufacturing and core-component technologies, any significant devolution of responsibility to outsider partners risked creating a direct competitor; Japanese and Korean networks were thus centralized to avoid that outcome. More recently, as Japanese-affiliated local production has deepened (i.e., favored domestic suppliers have followed lead assemblers offshore),

their networks (again, unlike the Koreans) have become more open and less centralized—though the contrast to the U.S. degree of openness and decentralization is still quite stark.

In contrast to the American model, the Japanese and Korean CPNs are closed, cautious, centralized, long-term and stable. Y.S. Kim's work suggests that Korean networks are likelier than their Japanese counterparts to engage in short-term, opportunistic behavior. However, in general we find that the organizational structure of both Japanese and Korean networks results in cautious decision-making that has periodically proven costly in the region's rapidly changing electronics markets.

The emerging Taiwanese and Singaporean networks in Asian electronics take still a different form, incorporating elements of both the American and Japanese/Korean model while combining them in distinctive ways. With respect to products, the Taiwanese electronics industry has become heavily specialized in the PC business and related peripherals and components. Singapore's industry has established itself as a hub for the manufacture of a number of computer peripherals, such as disk drives, as well as components, but with an increasing move toward the high-end of these product categories. The Taiwanese network relationships extend into Southeast Asia, but are increasingly China-centered. Ironically, they may end up with a China base as their global center, using demand and technical know-how in the China market to achieve world-class scale, costs and innovation. Singapore firms have concentrated their reach in Southeast Asia, particularly in proximate regions such as the "growth triangle" with Batam Island (Indonesia) and Southern Malaysia. Less elaborately, Singaporean firms have, with government assistance, also forged ties with Chinese authorities and businesses.

Much like the Japanese and Koreans, Taiwanese and Singaporean networks retain in the home base high value-added products manufactured with more advanced processes, and off-shore to cheaper production locations lower value-added products and simpler processes. However, like the Americans, these networks also seek to exploit a highly competitive supply base. Taiwanese networks, in particular, have self-consciously exploited indigenous specializations through local partners, typically other Chinese firms.

### **Convergence, Competitive Outcomes and the Diffusion of CPNs**

The distinctive features of networks just outlined mirror in important ways the domestic competitive environments and political-economic systems of the home country of the lead firm in the network. The case studies seek to draw these links more closely, showing how patterns of regulation and industrial organization are extended transnationally through CPNs. For example, Korea's highly dirigist industrial policy, with a particular emphasis on channeling preferential credit to the heavy and chemical industries, contributed to the emergence of the distinctive chaebol form of business organization, a highly concentrated industrial structure, and a lesser role for small and medium-sized firms. In Taiwan, by contrast, the ruling Kuomintang initially feared concentrations of Taiwanese business power and relied to a greater extent on state-owned enterprises. The resulting industrial organization was less concentrated, and although large Taiwanese groups did emerge, they were complemented by a dense network of geographically dispersed small and medium-sized enterprises.

The important theoretical point is that these organizational forms do not always reflect optimal adaptations to the market environment at some subsequent point in time. Lead firms from all countries have invested abroad and formed CPNs in order to complement their domestic activities by exploiting location-specific advantages within the region, but they have varied in their capacity to do so. The U.S. network form helped U.S. firms regain leadership in electronics markets over the past decade, partly by re-constituting the architecture of supply to reduce dependence on Japanese rivals. Their own characteristic form helped both Taiwanese and Singaporean firms to keep abreast of the remarkable pace of technological advance in digital electronics markets while operating with extraordinarily thin margins and, by and large, without the economies of scale in investment and production widely believed necessary to stay competitive. For both, as for the American CPNs, the turn to skilled but cheaper indigenous Asian suppliers not only helped to lower overall production costs, but fierce competition within the supply base helped to reduce turnaround times and encouraged specialization and diversity along the supply chain that more effectively tracked market shifts. Growing Asian technical capabilities within their CPNs freed U.S. firms to focus their efforts (and scarce resources) on new product definition, systems integration, software value-added and distribution. Japanese and Korean firms have been slower to exploit these advantages, with consequences both for their positions within existing markets and for their ability to move into new segments.

Moreover, the studies suggest that these national distinctions between CPNs are slow to disappear with time: there is no ineluctable convergence of the different CPN types around some new global norm. To be sure, the evolution of each network-in terms of architecture, function and role in international competition-has been strongly shaped by on-going interactions with other CPNs, by changes in the global strategies of the lead-firms, and by the force of competition leading to emulation of best practice. The studies provide clear instances of lead-firms learning and adopting the network practices of other CPN types, as when Japanese electronics firms emulated U.S. PC assemblers by establishing supply relations with Taiwanese firms (see the chapter on Taiwan). But the national distinctions that we highlight here are more enduring over time than convergence theory would allow.

Partly as a consequence of its competitive success, the CPN form or organization nonetheless does appear to be spreading. It is most highly developed in industries that produce goods made up of a large number of components requiring complex final assembly stages such as electronics, garments, and automobiles, and in regions such as Asia where heterogeneous production capabilities can be combined into unique packages of value-creation. But intimations of the form are visible in other regions, and they are likely to be spread geographically, if only by the global investment of firms that adopt them or that provide turnkey CPN services. There is, for example, some evidence that the form is spreading into Europe.

Technological changes are also facilitating the adoption of the loosely-coupled CPN form in other sectors. Digital electronics is transforming products and processes in a wide range of other goods and services industries, and the more pervasive these technologies

become, the more likely that CPN-like forms of corporate organization can become viable parts of corporate strategy. The spread of information technology has also had an effect on the adoption of the network form by enhancing the ability to transmit, process and store information across organizational boundaries. As Antonelli argues, "the vertical integration structure of knowledge, characteristic since the second world war, is being progressively replaced by the institutional creation of an information exchange market, based on real-time, on-line interaction between customers and producers," a structure conducive with, and supportive of, the network form of organization. As already noted, there is ample precedent for the cross-sectoral diffusion of such "best practice" models. CPNs have already diffused from the textile/apparel complex into electronics.

Finally, the chapters on Singapore, Taiwan and Malaysia all suggest that the CPN form will spread as much through the instigation of governments as of firms. The spatial location of investment, jobs, technology and competencies is a major focus of policy initiative throughout the developing countries of Asia. Particularly in the wake of the currency crises of 1997-8, governments in the region are redefining policy to increase their attractiveness as sites for investment and to promote their insertion into the new production networks we have described. They are doing so with varying degrees of sophistication and intent. Both Taiwan and Singapore have facilitated the regional expansion of their CPNs by providing infrastructure and services in Special Economic Zones in other countries, while simultaneously transforming both countries into higher-value, complementary nodes.

The spread of CPNs across regions, sectors and to new players within the region suggests a range of questions for a successor research agenda. Is the electronics story in Asia a stand-alone tale, or the precursor to upheaval in other sectors and regions? As CPNs spread across sectors and to other regions, will they produce similar decisive impacts on market competition and economic development? How will the CPN adapt to new terrain? Will it vary across regions as consequentially as by the point of origin of the lead-firm? The work here suggests that so long as technological change continues at current rates, the CPN form is likely to spread outward, and with significant variations as the network form is adapted both to the unique characteristics of different sectors and to the unique political-economies of different regions.

## **Implications for the Asia-Pacific Region**

Finally, our work has important implications for the burgeoning literature on regional integration in the Asia-Pacific. With a few important exceptions, that literature has tended to focus either on the political-legal process centered on Asia Pacific Economic Cooperation (APEC) or on underlying trade and investment flows. However, our analysis suggests that the region is increasingly organized and integrated at the level of corporate organization as well, and that the dynamics traced here have important implications for both the political economy of the region and the trade and investment policies of particular countries.

First, our analysis has important implications for the debate over closed vs. open regionalism. The growth of Japanese investment in Asia between the mid-1980s and the early

1990s, and the recent growth of the so-called overseas Chinese networks have generated fears of a closed economic bloc in Asia, if only an informal one. As we have seen, however, American firms have knit together their own cross-national production networks (CPNs) in the region, networks that closely link the U.S. and Asia. Critics of free trade and "runaway shops" see such investment as evidence of declining American competitiveness. However, virtually the opposite is the case; American investment networks in Asia took advantage of the region's increasing technological capabilities and production capacity and allowed the United States to maintain a leadership position in the industry.

Of course, so far, there has been very little over-lapping and rivalry between American and Japanese production networks in Asia: the Americans focused on PC-related products, while the Japanese focused on consumer electronics and appliances. This is now rapidly changing, as Japanese firms are shifting a variety of PC-related products to East Asia; they may now try to tap into the same set of regional supplier networks and capability clusters that, so far, have catered primarily to the needs of American firms. This implies that for the first time, American and Japanese firms will have to compete for the same supply sources in East Asia. It remains to be seen whether the networks remain open and whether American computer companies will be able to retain control over them as Japanese vendors finally begin to target them.

Just as important, however, the long-standing U.S. policy of maintaining an open market at home has played a key role in maintaining American advantage in exploiting the competitive potential of CPNs. As the chapter by Borrus suggests, exposure to international competition has pushed numerous U.S. industries, from finance to petrochemicals, to adopt new technologies quickly, making the U.S. the premier market for the launch of innovative new products; this was particularly true in electronics. A large, open market has allowed American firms to dominate product and standards definition in a range of products from business systems, to PCs, to a variety of communications equipment.

Because of the rapid growth of Asian markets, U.S. trade policy has increasingly emphasized liberalizing trade and investment rules that allow American firms to operate more freely. For an important range of sectors and countries, however, this strategy pushes on an open door. The middle-income countries that have played a successful role in the new CPNs have already liberalized rules governing trade and investment, either by adopting free trade and investment policies across the board (as in Hong Kong, Singapore and increasingly Taiwan) or by adopting dualistic trade and investment policies in which the activities of key industries are freed, even as others remain sheltered; as Linden shows in his contribution, that was the model pursued in Malaysia. However, there is increasing evidence that those countries that have been slow to open up, such as Korea, or where there has been backsliding, as in Vietnam, have paid a high price by weakening their attractiveness as an investment site and reducing their participation in the networks we have outlined. The currency crises of 1997-8 has already given rise to a new wave of liberalization with respect both to trade and the rules governing foreign direct investment and we expect that this trend will continue.

Given the regional division of labor, APEC provides a natural forum for negotiating further liberalization and investment facilitation. However, the recent International Technology Agreement, which promises to eliminate trade barriers in a range of electronic products, shows that such regional developments can be used to wider effect, and need not conflict with multilateral goals. The agreement was primarily a U.S.-European creation, but European interest in the deal was heavily influenced by the rapid deepening of Asian electronics trade and investment.

The new Asian networks also help explain the growing significance of a number of new issues on the multilateral and regional trade policy agenda. Although the new Asian CPNs flourish in an environment of free trade and investment, they also require strong protection for intellectual property. Given the increasingly close links between investment and trade, and the significance of national industrial policies in shaping the nature of network relations at each node, it is also not surprising that national policies with respect to product standards and competition are also gaining increased attention. In addition, the Asian financial crisis has highlighted the fact that these networks flourished in the context of relative macroeconomic and exchange rate stability. Only time will tell whether they can flourish under conditions of financial market volatility.

Finally, the new CPNs also influence the key trans-Pacific relationships between the United States, China and Japan. Because of its size, Beijing believes it can exploit its large market to pursue an industrial strategy based on protection, restrictions on investment, forced technology transfer, and the creation of large industrial groups. China has also wielded its political influence to economic ends, playing U.S. firms' against their competitors and sanctioning government-to-government alliances that limit the participation of outsiders.

These strategies have reached their limits. As is shown in a parallel study to this project, China's attempt to foster national champions has generally been a failure; rather, it is the large number of relatively independent firms, including those integrated into the networks we have described, that have spearheaded China's export drive. The United States' bilateral trade deficit with China reflects in no small measure the offshore operations of overseas Chinese CPNs, and thus simply a shifting of exports from Taiwan and Hong Kong onto the mainland. The specter of a high technology, low-wage export powerhouse is thus exaggerated. Moreover, for China to continue to reap the benefits of foreign investment and the networks into which it is increasingly integrated, it will have to continue along its current reform path.

Japan's trade policies also constitute a regional policy problem. The chapter by Paolo Guerrieri shows that electronics trade in the region is still characterized by a marked triangular pattern, in which Japan's overseas investment produces for local consumption and for export to North American and European markets. The problems of Japan's structural surpluses are not unique to the United States; the China Circle and Southeast Asia remain heavily dependent on Japan as does Korea. Japan provides much of the capital equipment on which industrial production is based and continues to dominate certain high-technology components.

The economic crisis of 1997 is likely to exacerbate these problems. Japan's continuing recession has meant a declining ability to serve as a locomotive for the region, while reviving its temptation to refocus on exports. Indeed, despite a historically large domestic stimulus package announced in the Spring of 1998, Japan remains intransigent in maintaining much lower import levels than its wealth and size permit: It has told its neighbors not to expect Japan to substantially increase imports from them. For the United States, the crisis has led to a marked increase in current account deficits. In the short-run, these have been caused by a decline in exports to the region, rather than a surge of imports. However, the competitive devaluations in the region coupled with the reality that exporting to the U.S. market is the only recovery game in town, will, in short order, lead to ballooning U.S. imports from the region. The patterns outlined by Guerrieri will thus be reinforced.

The bilateral, sectoral strategy of dealing with Japan has yielded results by forcing dialogue on the range of anti-competitive practices that can hinder trade and investment. However, the closed and centralized nature of Japan's CPNs also raise the question of whether Japan's industrial organization is being exported to the region. Given the disadvantages we see in this form of organization, this should not be seen as a major current threat. However, were technology markets to stabilize, Japanese CPNs could well become a major source of competitive advantage and of trade friction.

Indeed, despite the current triumphalism in U.S. pronouncements on Asia and on Japan, we are quite hesitant to accord long-term competitive preference to the U.S. CPN form. Competitive success among the different CPN types is highly context-dependent. Both Borrus and Ernst outline scenarios under which the precise network characteristics that made Japanese firms vulnerable in the last round of market competition could be turned to competitive advantage under changed circumstances. We are prepared to hypothesize, however, that the loosely-coupled CPN form we have outlined is likely to be a better adaptive fit to the competitive circumstances of those sectors of the electronics industry which, like the PC industry, are characterized by market volatility, rapid technological change, and the need for global reach.

## References

Alstyne, M. van (1996) "The State of Network Organization: A Survey in Three Frameworks," Journal of Organizational Computing.

Antonelli, G. and De Liso, N. (eds) (1997) Economics of Structural and Technological Change, London and New York: Routledge.

Archibugi, D. and Michie, J. (1995) "The Globalisation of Technology: a New Taxonomy," Cambridge Journal of Economics, 19, 121-40.

Asia Pacific Research Group. "Router Market," Asia Market Trends, [<http://www.aprg.com/routers.html>]

Bergsten, C. and Nolans, M. (eds) (1993) Pacific Dynamism and the International System, Washington, D.C.: Institute for International Economics.

Bernard, M., and Ravenhill, J. (1995) "Beyond Product Cycles and Flying Geese: Regionalization, Hierarchy, and the Industrialization of East Asia," World Politics, 47, 2, 171-209.

Biggart, N. and Hamilton, G. (1993) "On the Limits of Firm-based Theory to Explain Business Networks: The Western Bias of Neoclassical Economics," in N. Nohria and R. Eccles (eds) Networks and Organization, Boston: Harvard University Business School Press.

Borras, M. and Cohen, S. (1998) "Why Now? A Transatlantic Initiative in Information Technology," in R. Steinberg and B. Stokes (eds) Partners or Competitors? The Prospects for U.S.-European Cooperation on Asian Trade, Boulder, CO: Rowman and Littlefield, forthcoming.

Borras, M. and Zysman, J. (1997) "Globalization with Borders: The Rise of Wintelism as the Future of Global Competition," Industry and Innovation, 4, 2, 141-66.

Cantwell, J. (1995) "The Globalization of Technology: What Remains of the Product Cycle Model?" Cambridge Journal of Economics, 19, 1, 155-74.

Chandler, A. (1962) Strategy and Structure: Chapters in the History of the Industrial Enterprise, Cambridge: MIT Press.

Chen, E.K.Y. and Drysdale, P. (1995) Corporate Links and Foreign Direct Investment in Asia and the Pacific, Canberra: Harper Educational Publishers.

Coase, R. (1937) "The Nature of the Firm," Economica, 4, 386-405.

Dobson, W. and Yue, C.S. (1997) Multinationals and East Asian Integration, Ottawa and Singapore: International Development Research Center, Canada, and Institute of Southeast Asian Studies.

Doner, R. (1993) "Japanese Foreign Investment and the Creation of a Pacific Asian Region," in J. Frankel and M. Kahler (eds) Regionalism and Rivalry, Chicago: University of Chicago Press.

Dunning, J. (1993) The Globalization of Business, New York: Routledge.

Encarnation, D. (1992) Rivals Beyond Trade, Ithaca: Cornell University Press.

Ernst, D. (1998) Globalization and Local Capabilities: Does Knowledge Migrate Within International Production Networks? Copenhagen: Copenhagen Business School Press, forthcoming.

--- (1998) "Catching-Up, Crisis and Industrial Upgrading. Evolutionary Aspects of Technological Learning in Korea,s Electronics Industry," Asia-Pacific Journal of Management, 15, 2.

--- (1998b) "Destroying or Upgrading the Engine of Growth? The Reshaping of the Electronics Industry in East Asia After the Crisis," Report prepared for the World Bank, Department of Industrial Economics and Strategy. Copenhagen: Copenhagen Business School.

--- (1997a ) ÑFrom Partial to Systemic Globalization: International Production Networks in the Electronics Industry," BRIE WP 98, Berkeley, CA: BRIE, University of California,Berkeley; San Diego: Graduate School of International Relations and Pacific Studies.

--- (1997b) ÑPartners for China Circle? The Asian Production Networks of Japanese Electronics Firms," BRIE WP 91, Berkeley, CA: BRIE.

--- (1994) ÑCarriers of Regionalization: The East Asian Production Networks of Japanese Electronics Firms," BRIE WP 73, Berkeley, CA: BRIE.

--- (1983) The Global Race in Microelectronics: Innovation and Corporate Strategies in a Period of Crisis, Frankfurt: Campus.

Ernst, D. and Guerrieri, P. (1998) ÑInternational Production Networks and Changing Trade Patterns in East Asia: The Case of the Electronics Industry," BRIE WP 101, Berkeley, CA: BRIE.

Ernst, D. and Lundvall, B.-A. (1998) ÑInformation Technology in the Learning Economy: Challenges for Developing Countries," in E. Reinert (ed.) Evolutionary Economics and Spatial Income Inequality, London: Edward Elgar.

Ernst, D. and O'Connor, D. (1992) "Competing in the Electronics Industry: The Experience of Newly Industrialising Economies," Paris, France: Development Centre of the Organisation for Economic Co-operation and Development.

Freeman, C. (1991) ÑNetworks of Innovation: A Synthesis of Research Issues," Research Policy 20: 499-514.

Funabashi, Y. (1995) Asia-Pacific Fusion: Japan's Role in APEC, Washington, D.C.: Institute for International Economics.

Gereffi, G. and Korzeniewicz, M. (eds) (1994) Commodity Chains and Global Competition, Wesport CT: Praeger.

Ghoshal, S. and Barlett, C. (1990) ÑThe Multinational Corporation as an Interorganizational Network," Academy of Management Review 15, 4: 603-25.

- Granovetter, M. (1985) "Economic Action and Social Structure: The Problem of Embeddedness," American Journal of Sociology 91, 3: 481-510.
- (1990) "The Old and the New Economic Sociology: A History and an Agenda," in R. Friedland and A.F. Robertson (eds) Beyond the Marketplace: Rethinking Economy and Society, New York: Aldine de Gruyter.
- Gungwu, W. (1991) China and the Overseas Chinese, Singapore: Times Academic Press.
- Hagedoorn, J. and Schakenraad, J. (1990) "Inter-firm Partnerships and Cooperative Strategies in Core Technologies," in C. Freeman and L. Soete (eds) New Exploration in the Economics of Technical Change, London: Pinter.
- Haggard, S. (1995) The Developing Nations and the Politics of Global Integration, Washington, D.C.: The Brookings Institution.
- Hamel, G. (1991) "Competition for Competence and Inter-partner Learning Within International Strategic Alliances," Strategic Management Journal, 12: 83-103.
- Hamilton, G. (ed.) (1996) Asian Business Networks, Berlin: Walter de Gruyter.
- Hatch, W. and Yamamura, K. (1997) A Looming Entry Barrier: Japan's Production Networks in Asia, Seattle, WA: National Bureau of Asian Research.
- Kao, J. (1993) "The Worldwide Web of Chinese Business," Harvard Business Review, March-April: 24-36.
- Katzenstein, P. (ed.) (1997) Network Power, Ithaca: Cornell University Press.
- Kogut, B. (1988) "Joint Ventures: Theoretical and Empirical Perspective," Strategic Management Journal, 9: 319-32.
- Kogut, B., and Zander, U. (1993) "Knowledge of the Firm and the Evolutionary Theory of the Multinational Corporation," Journal of International Business Studies, 24, 4: 625-45.
- Lawrence, R. (1996) Regionalism, Multilateralism and Deeper Integration, Washington, D.C.: The Brookings Institution.
- Levy, D. and Dunning, J. (1993) "International Production and Sourcing: Trends and Issues," STI Review, Paris: OECD.
- Lim, L. (1978) "Women Workers in Multinational Corporations: The Case of the Electronics Industry in Malaysia and Singapore," Michigan Occasional Papers in Women's Studies, 9. Ann Arbor: Women's Studies Program, University of Michigan.

- Mack, A. and Ravenhill, J. (eds) (1994) Pacific Cooperation: Building Economic and Security Regimes in the Asia-Pacific Region, Canberra: Allen and Unwin.
- Maskell, P. and Malmberg, A. (1995) "Localised Learning and Industrial Competitiveness," BRIE WP 80, Berkeley, CA: BRIE.
- Milgrom, P. and Roberts, J. (1990) "The Economics of Modern Manufacturing: Technology, Strategy and Organization," American Economic Review, 80, 3: 511-28.
- Naughton, B. (1997) The China Circle, Washington, D.C.: Brookings.
- Porter, M. (1990) The Competitive Advantage of Nations, New York: Free Press.
- Powell, W. (1990) "Neither Market Nor Hierarchy: Network Forms of Organization," Research in Organizational Behavior, 12: 295-336.
- Powell, W., and Brantley, P. (1992) "Competitive Cooperation in Biotechnology: Learning Through Networks?" in N. Nohria and R.G. Eccles (eds) Networks and Organizations: Structure, Form and Action, Boston: Harvard Business School Press.
- Powell, W., and Smith-Doerr, L. (1994) "Networks and Economic Life," in N. Smelser and R. Swedber (eds) The Handbook of Economic Sociology, Princeton: Princeton University Press.
- Stopford, J. (1996) "Building Regional Networks: Japanese Investments in Asia," Unpublished manuscript, London Business School.
- (ed.) (1994) Rejuvenating the Mature Business: The Competitive Challenge, Boston, MA: Harvard Business School Press.
- Sturgeon, T. (1998) "The Rise of the Global Locality," Ph.D. Dissertation, Berkeley, CA: University of California at Berkeley.
- Takayasu, K.-I. and Ishizaki, Y. (1995) "The Changing International Division of Labor of Japanese Electronics Industry in Asia and Its Impact on the Japanese Economy," RIM, Pacific Business and Industries, 1, 27: 2-21.
- Tilton, J. (1971) The International Diffusion of Technology; the Case of Semiconductors, Washington, D.C.: Brookings Institution.
- United Nations Conference on Trade and Development (1997) World Investment Report, Geneva: UNCTAD.
- United Nations Conference on Trade and Development, and International Chamber of Commerce (1998) "The Financial Crisis in Asia and Foreign Direct Investment," UNCTAD. [<http://www.unctad.org/en/pressref/bg9802en.htm>]

Vernon, R. (1971) Sovereignty at Bay: the Multinational Spread of U.S. Enterprises, New York: Basic Books, 1971.

Wade, R., and Veneroso, F. (1998) "The Asian Crisis: The High Debt Model Versus the Wall Street Treasury IMF Complex," New Left Review, 228: 3-22.

Williamson, O. (1985) The Economic Institutions of Capitalism: Firms, Markets and Relational Contracting, London: Macmillan.

--- (1993) "Transaction Cost Economics and Organization Theory," Industrial and Corporate Change, 2, 2: 107-56.

Zysman, J., Doherty, E. and Schwartz, A. (1997) "Tales from the Global Economy: Cross-National Production Networks and the Reorganization of the European Economy," Structural Change and Economic Dynamics, 8, 1: 45-85.