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**LEFT FOR DEAD:  
ASIAN PRODUCTION NETWORKS  
AND THE REVIVAL OF US ELECTRONICS**

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**MITJP 96-24**

Center for International Studies  
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## **Left for Dead: Asian Production Networks and the Revival of US Electronics<sup>1</sup>**

### **I: Evolution in Electronics: Global Competition and the Persistence of National Identity**

International competition in electronics has always been a story about market rivalry between firms with distinctive national identities: U.S. firms confronted Japanese or German firms. Each acted in ways characteristic of their national point of origin. Market outcomes were a function of how well the strategies and organizational traits originating in one domestic market generated competitive advantage in other national markets.<sup>2</sup> A specific understanding of the international economy grounded that story-line, one in which sovereign nations trade and invest with each other. The understanding has been a constant for at least half a century, even through the shift in principal agency from national firms trading on the basis of local factors to so-called multinational corporations (MNCs) who invested abroad but retained a characteristic identity with their national point of origin.

An account of the evolution of recent competition in electronics within this tradition of discourse would go something like this. From the early 1970s until the mid-1980s, Japanese producers were ascendant in electronics. In short order, they had taken over consumer electronics, gained leading world market shares in semiconductor chips, materials and equipment, and looked entirely capable of repeating the feat in computers, office systems (e.g., copiers, faxes), and customer telecommunications equipment. So worried were US policy-makers and industrialists that the avowedly laissez-faire Reagan Administration took the unprecedented step of using interventionist industrial policy to support the domestic microelectronics industry.<sup>3</sup> If the rapid rates of attrition of U.S.

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<sup>1</sup>This chapter is drawn in part from a larger work in progress on global competition in electronics. See, Michael Borrus, *Punctuated Equilibria in Electronics: Microsystems, Standards' Competitions, and Asian Production Networks*, forthcoming, 1996.

<sup>2</sup>See, for example, Michael Porter's extensive comparative analysis of domestic competitive factors in, *The Competitive Advantage of Nations*, (London: MacMillan, 1990)

<sup>3</sup>The government's support took two forms -- direct financial support of \$100 million per year to the industry's manufacturing technology consortium, Sematech -- or half of Sematech's annual budget -- and

market share had continued, US firms would have joined their European counterparts as significant players only in niches and on the margin of mass global markets.

What a difference a decade made. By 1994, US producers of silicon chips and semiconductor materials and equipment were again flourishing, having regained the dominant world position. US producers of office, communications and computer systems had reasserted product and technical leadership, with especially the latter retaining clear market dominance. As computer technology began to pervade consumer electronics, those same producers even looked to be reviving defunct US consumer fortunes. By contrast, with few exceptions, their once formidable Japanese competition appeared disorganized, dismayed and decidedly on the defensive. Indeed, US industry leaders were so certain of continued success that many dismissed the Japanese giants as competitive dinosaurs, ill-adapted to the raucous, fast, changeable, idea-intensive electronics markets of the future.<sup>4</sup>

As argued below, however, the recent success of US-owned firms has rested in significant part upon extensive inter-firm relationships with Asian-based producers. Those cross-boarder ties permitted US-owned firms to exploit the growing technical sophistication and competitive strength of indigenous firms initially in Taiwan, Singapore and Korea, and later throughout Southeast Asia and along the coastal provinces of Mainland China. Those proliferating cross-boarder links suggest that the future success of US firms is increasingly bound up with non-US partners. They hint at a very different kind of international economy, one whose emblem is globalization and in which cross-border, inter-firm relationships blur the easy identity of nations and firms. Must they therefore also call into question the continued utility of an account of competition that stresses rivalry between identifiable national industries?

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negotiation of the US-Japan Semiconductor Trade Agreement (STA). For details, see Michael Borrus, *Competing for Control: America's Stake in Microelectronics*, (NY: Ballinger, 1988).

<sup>4</sup>This position is argued explicitly by industry consultant William F. Finan and his academic collaborator Jeffrey Frey in their *Nihon no Gijyutsu ga Abunai: Kenshō, Haiteku Sangyō no Suitai* [Japan's Crisis in Electronics: Failure of the Vision] (Tokyo: Nikkei Press, 1994).

The international economy has changed for sure. Economic interconnections have clearly expanded across geographic distance and between firms and nations. The terms of market competition have been altered irrevocably in most sectors as a combination of new technologies, markets, and players have entered the economic fray. Those facts are not in issue; but their patterns and significance most surely are. Without a doubt, capital, intermediate inputs, technologies, know-how and corporate best practices, flow more rapidly across national boundaries than ever before. But, as argued below, those global movements have not globally diffused location-specific advantages or leveled national distinctions. They have not eviscerated consequential national differences in corporate behavior. Ownership continues to matter in understanding international competition, though in an era of global markets, investment and competition, the ways in which ownership is significant have shifted ground.

Even in an industry like electronics, dominated by multinational corporations (MNCs) – MNCs that are, moreover, entangled in a growing web of joint development and production arrangements -- an analytic that distinguishes between US-, Japan-, and Asia-based industries still makes sense. The analysis here presumes that the international market dynamic in most high-tech industries can still be effectively analyzed as a competition between firms operating out of largely national home bases.<sup>5</sup> By ‘home base’ I mean the national market in which the majority of a firm’s assets, employment and sales reside, and from which corporate control is exercised (especially control over strategy formation, corporate re-organization, new product development, finance and distribution). In most cases the home base is also the predominant locus of corporate ownership.

By that definition, very few high-tech MNCs are globally footloose. Indeed, 2/3-3/4 of the assets, employment and sales of most MNCs, and an overwhelming percentage

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<sup>5</sup>Applying and exploring the limits of this method are principle goals of BRIE research supported by the Alfred P. Sloan Foundation. That research is elaborated in a forthcoming BRIE book on national technology trajectories with contributions by Benedicte Callon, Keith Dardon, Ulrike Hodges, Tim Sturgeon, Jay Tate, Michael Borrus, David Soskice, and John Zysman.

of their best-compensated and highest-skilled jobs, are still in a home base.<sup>6</sup> Of the world's top 50 MNCs of all national origins, who might be expected to be the most non-national of MNCs, almost all fall in the 60-90% range of assets within the home country.<sup>7</sup> Equally significant, almost all MNC firms still explicitly exercise control from their home country of origin.<sup>8</sup>

Given those facts, this paper's analytic sees firm strategies as still systematically shaped by the logic of competition in the home market base. Domestic institutions shape a national market logic or system of production<sup>9</sup>-- i.e., characteristic ways of doing business and distinctive trajectories of technology development that are the basis of product differentiation on international markets.<sup>10</sup> For high-tech industries, the principle domestic institutional variables include 1) the structure of the industry in question and of its domestic market (e.g. oligopolistic, keiretsu, lead customers); 2) technology, trade and industrial policies and the political system that implements them; 3) the capital and labor

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<sup>6</sup> See the discussion in Laura Tyson, "They Are Not US," The American Prospect, (Winter, 1991), p.37ff. See also, Yao-Su Hu, "Global Corporations Are National Firms with International Operations", California Management Review, Winter, 1992, p.107ff. Of course, the debate addressed by these articles was popularly launched by Robert Reich in "Who is Us?" Harvard Business Review, (Jan.-Feb., 1990) p.53ff. More generally, the recent collection by Dennis Encarnation, ed., *Does Ownership Matter?* (NY and London: Oxford University Press, 1995) supports the persistence of important differences among multinational firms based on national origin.

<sup>7</sup> See "A Survey of Multinationals" The Economist, March 27, 1993, p.6-7, citing United Nations data. The major exceptions are oil companies (because oil fields tend to be located abroad) and small country multinationals like Nestle, Unilever and ABB (because their markets are located abroad) -- and the latter would fall into the 60-90% range if Europe was treated as their home base. By that measure, the most non-oil MNC is IBM, with about 50% of assets outside of the U.S. But because half of its assets are still concentrated in the U.S., even IBM can be said to have the U.S. as its home base.

<sup>8</sup> This conclusion is easily reached from industry conversations and even a quick perusal of the annual reports of the 1000 largest US and 1000 largest non-US firms. More generally, the evidence in John Dunning's comprehensive work on MNCs supports this conclusion, *Multinationals, Technology, and Competitiveness*, (London: Unwin Hyman, 1988), as does Michael Porter's work, *supra*.

<sup>9</sup> My colleague Stephen Cohen coined the concept of national market logics in Borrus, Cohen, et.al, "Globalization and Production," BRIE Working Papers, #45 (Berkeley: BRIE, 1991).

<sup>10</sup> For a discussion of this concept of technology trajectories see Michael Borrus, "The Regional Architecture of Global Electronics: Trajectories, Linkages and Access to Technology" and the sources cited there, in Peter Gourevitch and Paolo Guierrieri, eds., *New Challenges to International Cooperation: Adjustment of Firms, Policies, and Organizations to Global Competition*, (San Diego: UCSD, 1993).

market structures that condition access to those factor inputs; and 4) the local supply base which enables access to technology factor inputs.<sup>11</sup>

Those variables create a fabric of possibilities, a pattern of constraint and opportunity that confronts firms as they choose strategies, making some choices more likely (or less risky) and foreclosing others. Consider, for example, how U.S. antitrust enforcement denies to US firms the use of market-sharing arrangements that are routinely adopted in Japan and parts of Europe. Or consider how Japan's life-time employment system encouraged corporate strategies built on in-house training and up-skilling of technical employees. Or how 'guanxi' networks permit smaller Taiwanese family 'firms' to stably deal in high-risk international ventures.<sup>12</sup>

As such examples suggest, the home base's pattern of constraint and opportunity channels, in characteristic directions, corporate strategies and behavior and, through them, technology development. For example, a well developed venture capital market, highly flexible labor market, leading-edge military and computer industry demand, and competitive industry structure characterized by easy entry and exit, all shaped a US-based semiconductor industry with characteristic strategies and technologies based on radical product innovation.<sup>13</sup> By contrast, keiretsu-dominated capital and distribution, inflexible labor markets, price-sensitive consumer demand, and a panoply of industrial and trade policies, shaped a Japanese semiconductor industry with equally characteristic strategies and technologies based, in contrast to the US pattern, on incremental manufacturing innovation.

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<sup>11</sup>For one effort to elucidate some of these variables -- the state, and the legal, labor relations and financial systems -- as part of a formal analytic explaining national economic development, see John Zysman, "How Institutions Create Historically Rooted Trajectories of Growth," (Berkeley, BRIE, October, 1993) draft manuscript. Some of the variables described above are similar to those used by Michael Porter, *Competitive Advantage*, *supra*, however, to different ends in a decidedly different, albeit complementary, analytic.

<sup>12</sup>On the 'guanxi' network concept see Gary G. Hamilton, "Competition and Organization: A Reexamination of Chinese Business Practices," paper prepared for the IGCC Conference *The China Circle: Regional Consequences of Evolving Relations Among the PRC, Taiwan, and Hong Kong-Macao*, Hong Kong, December 8-10, 1994

<sup>13</sup>For a fuller discussion of this US-Japan comparison, see Bornus, *Competing for Control*, *supra*, at chapters 4 and 5.



Of course, a broad range of contingent choices is always available within any given pattern of constraint and opportunity. Strategies can and do differ among firms facing similar constraints, not least because they start with different resources and actively respond to what their competitors are doing. Nor are firms inflexibly bound to the home base's particular mix of possibilities. They can seek external opportunities or devise ways around national constraints. As the argument below suggests, U.S. firms did exactly that by creating their Asian-based production networks. In the real world of commerce, then, the home-base institutions that shape a national system of production are less independent variables in a formal analytic than systemic constraints tending to push strategies in particular directions, but without determining them.

That inherent openness of the analytic permits revision over time as evidence accrues to challenge the hypotheses it generates. Indeed, this paper suggests that regional and sub-regional production systems in electronics may be gradually supplanting national ones. This would be an unintended consequence of the Asian-based production network strategy of US firms, the sub-regional production networks it helped to spawn throughout Asia under the control of indigenous Asian capital, and the parallel regional response of Japanese firms. As argued, below, such networks start-out as an extra-territorial extension across national borders of a home-base market logic; but the extension is almost inevitably likely to alter the logic over time. Were such developments to diminish considerably the significance of the national home-base, they would require revision of the approach adopted here.

Until then, however, the overall working hypothesis is that for most firms the national market logic dominates international market strategies. This holds especially for the dominant Japanese electronics firms and even for the US-based MNCs who adjusted to high-tech competition by constructing production networks outside the U.S. The several competitive shifts that lie behind the recent American re-ascendance in electronics demonstrate this quite well. Consider first the shift involving the domestic Japanese economy after 1990, from economic miracle to economic basket case.

The bursting of the domestic Japanese asset bubble, the attendant, lengthy recession in the Japanese economy, and multiple endaka (dramatic yen appreciation), did much to undermine the international competitive position of Japanese electronics firms. Far more than Japanese firms were willing to admit even to themselves, Japan's electronics success in the 1970s and 80s was driven by rapid growth in the sheltered domestic market. Rapid domestic growth afforded the stable demand to reach scale economies, the launch market for several generations of consumer and office systems, premium prices to subsidize price competition on foreign markets, cheap capital for continuous reinvestment, and not least, quality- and feature-conscious consumers who rewarded corporate strategies built on incremental product revisions.<sup>14</sup> Cheap capital ended when the asset bubble burst, provoking Japan's longest post-war recession. Enduring recession put an end, at least temporarily, to the domestic economy's ability to support firm strategies premised on rapid growth, and to the willingness of retailers blindly to support the producer-controlled pricing structure.<sup>15</sup> Combined with successive endaka, the economic problems made Japanese firms increasingly vulnerable to price competition both at home and abroad -- something exploited at least as well by Korean and Taiwanese firms as by American.

That Japan's domestic economic problems could so profoundly influence the international competitive performance of Japanese-owned firms is one strong piece of evidence that ownership and a national home base still matter. The competitive shifts that account for the resurgence of US market and technical leadership offer further evidence. Two competitive shifts are of paramount importance there -- one in the market and one in production organization -- and both have strong roots in a domestic home base. The market shift encompassed both a transformation of the character of electronic

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<sup>14</sup>For a fuller analysis, see Borrus, *Competing for Control*, *supra*. The domestic market served as a launch market during the late 1970s-1980s for, among other products, the VCR, Camcorder, Walkman, hand-held TV, fax machine, portable copier, and notebook PC.

<sup>15</sup>On the latter point, see Ichiro Uchida, "Restructuring of the Japanese Economy" in Eileen Doherty, ed., *Japanese Investment in Asia: International Production Strategies in a Rapidly Changing World*, (U.C. Berkeley: Berkeley Roundtable on the International Economy, 1995).

systems products and a resulting sea-change in the industry's principal business strategies. Specifically, new electronics product-markets have begun to converge on a common technological foundation of networkable, 'open', microprocessor-based systems (of which, the PC is emblematic).<sup>16</sup> Such new product markets are characterized by a predominant form of market rivalry, namely competitions to set defacto market standards. Over the last half decade, the domestic U.S. market has been the principle launch market for such new products and the principle terrain on which the resulting standards competitions have been fought. With just a few exceptions -- e.g., Nintendo in video games, Sony in 8mm video camcorders -- U.S. firms defined the products, set and controlled the standards initially in their home market, and, achieved dominant world market positions as US choices became global standards.

The organizational shift was, however, just as significant and in its own way permitted the new product-market strategies to succeed. The shift in U.S. firm production organization was the move away from traditional integration to network forms of organization, specifically, international production networks centered in Asia.<sup>17</sup> By a firm's *international* production network I mean the organization, across national borders, of the relationships (intra and increasingly inter-firm) through which the firm conducts research and development, product definition and design, procurement, manufacturing, distribution, and support services. . As a first approximation, such networks comprise a lead firm, its subsidiaries and affiliates, its subcontractors and suppliers, its distribution channels and sources of value-added product or service features, its joint ventures, R&D

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<sup>16</sup>By 'open', I mean that key product specifications, especially the interface specifications which permit interoperability with the operating system or system hardware, are published or licensed and thus available to independent designers of systems or software who can produce complementary or competing products.

<sup>17</sup> For one elaboration of the concept of international production networks, see Dieter Ernst "Networks, Market Structure and Technology Diffusion: A Conceptual Framework and Some Empirical Evidence," report prepared for the OECD, Paris, 1992. More generally, on network forms of organization see Walter Powell's classic, "Neither Market Nor Hierarchy: Network Forms of Organization," *Research in Organizational Behavior*, v.12, 1990, p.295-336. The electronics case strongly confirms Powell's argument that the network form is not some intermediate mix of market or hierarchy. Indeed, far from being the optimal organizational poles, markets and hierarchies can be fruitfully thought of as specific forms of networks, with network relations being mediated in the former by price signals and buyer-seller transactions and in the latter by command signals and power relations.

alliances and other cooperative arrangements (like standards consortia). In contrast to traditional forms of corporate organization, such networks boost a proliferation of non-equity, non-arms-length, cross-border, inter-firm relationships in which significant value is added outside the lead firm and entire business functions may be outsourced.

The move to such production networks based in Asia during the 1980s, had three significant consequences for U.S. firms. U.S. firms were able to relieve the constraining threat of competitive dependence on Japanese firms for a wide range of component technologies and manufacturing capabilities because their Asian production networks became a competitive supply base alternative to Japanese producers.<sup>18</sup> Simultaneously, the networks helped to lower production costs and turnaround times while keeping pace with rapid technological progress. Finally, the networks spawned Asian-based direct competitors to Japanese firms in several of their stronghold markets (e.g., memory chips, consumer electronics, and displays).

Taken together, the market and organizational shifts enabled US firms to pioneer a new form of competition in electronics, one that grew out of the distinctively American market environment and was adapted to overseas opportunities. Each of the US-owned enterprises that pioneered the shifts and dominated market outcomes is by and large a new type of firm competing in a new type of way in the international economy. It's 'core asset' is the intellectual property and know-how associated with setting, maintaining and continuously evolving a de-facto market standard, a process that requires perpetual improvements in product features, functionality, performance, costs and quality. It's core managerial skill is orchestrating the continuously changing sets of external relationships and melding them with the relatively more stable core of internal activities in order to access relevant technologies, design, develop, and manufacture the products, and get them from product concept to order fulfillment in minimal time. Although a few vertically integrated firms like HP and Motorola play this game, most of

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<sup>18</sup>The next section defines the concept of supply base.

the successful players are fleet-footed US firms like Sun Microsystems, Cisco Systems, 3Com, Intel, Netscape, Microsoft.

Compare, for example, a firm such as Cisco Systems, leading supplier of routers, switches and hubs for corporate communications networks, with the network equipment business of the pre-divestiture ATT and its international counterpart, ITT. Everything from the R&D at central corporate laboratories to product design, engineering, manufacturing, distribution and service was done by one ATT/ITT affiliate or another, usually located somewhere in the U.S. for ATT or Europe for ITT. The vast bulk of the underlying technologies, components, parts, software and subsystems were produced internally by the two companies. The finished product was “sold” direct to local phone companies. Control was hierarchical and centralized in the U.S. ATT was the epitome of the hierarchically managed, vertically integrated, multidivisional corporation. ITT was the epitome of the modern corporation’s multinational extension to other markets.

By contrast, much of Cisco’s R&D is done at its corporate headquarters in Silicon Valley, but a portion is also done through technology development alliances with key suppliers such as chip companies and software vendors. Associated engineering is done in Cisco affiliates in Japan and California, but sometimes also by lead vendors. The products are assembled in California, and Japan 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. and sometimes Europe. These suppliers are bound to Cisco through a variety of non-equity contractual arrangements. Cisco’s Japanese “subsidiary”, however, which is responsible for customizing the products for the Japanese market, is “owned” by Cisco and 14 major Japanese electronics companies (each with an equity stake), that together form a formidable coalition aimed at making Cisco’s “owned” but open protocols the standard for corporate communications in Japan.

Several independent companies in California, Asia and Europe (including most of its Japanese partners) produce to Cisco's standard, adding value in the form of products or services that interface in some fashion with Cisco's products—and without which Cisco's products would not be complete because they could not fully perform core functions (a significant difference from the more traditional model of behavior in which a firm might sell into the Bell System in competition with Western Electric, but the customer did not need the outsider product to have a complete system). The final product is sold direct to customers but also through a variety of third-party channels including value-added resellers and systems integrators. After-sales service is very frequently undertaken by third-party suppliers.

As the example suggests, the new form of competition is no longer confined largely to equity investments and outsourcing in the manufacturing stage of production. It now extends throughout the value chain and to an increasing variety of non-equity, but not arms-length relations. Consider, for example, Internet software producer Netscape Communications' product development and distribution relationships: Product development is done in conjunction with a variety of independent development partners such as SUN, Macromedia, Real Audio, Streamworks and others 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—and without which the product would not be fully functional. The software is distributed direct to customers and through a variety of independent channels including on-line service providers such as Compuserve and AOL, traditional carriers such as Pacific Bell, specialized retailers such as EggHead Software, value-added resellers who provide Web set-up services, and mass marketers such as Costco.

As the examples suggest, this new form of competition has left no part of the information technology and electronics sector untouched: It holds true as much for Microsoft as for hardware vendors such as Cisco, as much for large-scale systems builders such as HP as for integrators such as Anderson Consulting -- and as much for

standard-followers such as Compaq as for standard-holders such as Netscape. For these firms, in important ways, their US home base was more significant in the last ten years of increasing global competition than it had been earlier in the era of clearly defined national industries. Indeed, even discounting supportive US trade and technology policies, the *global* leadership of US firms was rebuilt on a *domestic* foundation --the American market's characteristic logic of competitive ferment, and its leadership both in the networking of microcomputer-based systems and in the design, product definition, and systems architecture capabilities that created the new standards. Key attributes of the new network form of production organization reflected unique characteristics of the domestic US environment. Indeed, while most firms in the industry gravitated toward a network model in response to similar global market conditions, those models differed by ownership and control: As we argue below, the distinctively American model contrasts with equally distinctive production networks under the control of Japanese, Taiwanese and other indigenous Asian capital/ -- though for reasons explored below, those alternative network models were competitively less effective than the American in the last round of market rivalry.

The rest of this paper takes a closer look at the shift in production organization, the way it created an alternative supply base in Asia, and the role it played in the resurgence by US firms to product and technical leadership in electronics. The next section describes the historical development of US direct investment in electronics in Asia over the past three decades, comparing it to Japanese investment and contrasting the consequences. The following section then examines the indigenous complement to US firm strategies in Asia, namely the emerging networked production capabilities under the control of especially Taiwanese and Singapore capital. The concluding section develops a production network typology to examine the respective positions of US, Japanese, and Taiwanese electronics firms, and draws conclusions about whether national ownership will continue to matter in global electronics markets.

## II: US FDI and the Creation of a Regional Supply Base

By the end of the 1970s, US electronics firms were almost completely dependent on Japanese competitors for supply of the underlying component technologies (e.g., tuners, picture tubes, recording heads, miniature motors) necessary to produce consumer electronics products.<sup>19</sup> In most cases, thorough-going technology dependence was a first step toward market exit. It meant that US firms were far enough removed from the technological state of the art to impede new product development, and that their principal competitors could dictate time-to-market, product cost and feature quality. Under those circumstances, profits were minimal -- if any were to be had at all. Consequently, by 1980 most major US firms had exited the consumer segment of the market and remaining players like GE and RCA survived largely by putting their brands on Japanese OEM production. A few short years later, even RCA and GE, who had created most of the consumer electronic technologies that Japanese firms perfected, left the business.

The loss of consumer electronics' high-volume demand eroded the US *supply base* for the other segments of the electronics industry, and threatened them with an equally, competitively constraining *architecture of supply*.<sup>20</sup> The supply base is the local capability to supply the component, machinery, materials and control technologies (e.g., software), and the associated know-how, that producers use to develop and manufacture products. The architecture of supply is the structure of the markets and other organized interactions (e.g., joint development) through which the underlying technologies reach producers. In effect, US producers of industrial electronics (e.g., computers, communications) were in danger of becoming dependent on their Japanese competitors for memory chips, displays, precision components, and a wealth of the other essential

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<sup>19</sup>See the discussion of sequential increasing supply dependence in consumer electronics in Consumer Electronics Sector Working Group, *MIT Commission on Industrial Productivity*, "The Decline of U.S. Consumer Electronics Manufacturing: History, Hypotheses, Remedies," December, 1988.

<sup>20</sup>For an extended discussion of the supply base and architecture of supply concepts, see Michael Borrus, "The Regional Architecture of Global Electronics," *supra*.



technologies (and associated manufacturing skills) that went into electronic systems.<sup>21</sup>

The only alternative to increasing dependence on a closed oligopoly of rivals was to make the supply architecture more open and competitive: In conjunction with government policies and local private investors in Asia, US firms gradually turned their Asian production networks into a flexible supply base alternative to Japanese firms.

The transformation from cheap labor affiliates to alternative supply base occurred in three stages -- an initial stage from the late 1960s to late 1970s during which US firms established their presence through foreign direct investments, a second stage in which their Asian affiliates developed extensive local relationships in the shadow of the dollar appreciation from 1980-1985, and a third stage from the late 1980s-early 1990s, when the technical capabilities in their regional production networks were significantly upgraded and local affiliates were assigned global product responsibilities. The US progression from simple assembly affiliate to technologically able Asian production network contrasts sharply with the development pattern of Japanese investments in the region over the same time period. A brief review of key developments in each of the three stages will highlight the differences.<sup>22</sup>

From the late 1960s, after an earlier round of market access investments by a few large US MNCs, (notably IBM, GE and RCA), most US firms sought not market access but cheap production locations in Asia. US investment was led by US chip-makers, then consumer electronics and calculator producers, and finally, toward the end of the 1970s, producers of industrial electronic systems like computers and peripherals. Most of the U.S. investments in this first stage established local assembly affiliates. Cheap but disciplined Asian labor permitted US firms to compete on price back home and in Europe.

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<sup>21</sup>For the broad range of major component technologies involved, see the discussion in Bornus, *Ibid*.

<sup>22</sup>The characterization of US fdi is based on the BRIE US Electronics FDI database, compiled from public sources and maintained by Greg Linden., and supplemented by industry conversations. The characterization of Japanese electronics fdi in Asia which follows is consistent with, and in part draws on data and detail in the chapters by Dennis Encarnation, Satoshi Ohoka, Yasunori Baba, and Dieter Ernst, in Doherty, ed., *Japanese Production Networks*, *supra*. See especially also, Ken-ichi Takayasu and Yukiko Ishizaki, *The Changing International Division of Labor of Japanese Electronics Industry in Asia and Its Impact on the Japanese Economy*, *RIM, Pacific Business and Industries*, Vol.1, #27, 1995, p.2-21.

Right from the start, then, the Asian affiliates of US electronics firms were established as part of a multinational production network to serve advanced country markets. By contrast, most Japanese investment into Asia in this period, led by consumer electronics and appliance makers, is aimed at serving nascent local markets behind tariff walls. Japanese investment is often turnkey, with knock-down kits exported from Japan for local final assembly and sale in the local affiliate's domestic market. While the Japanese and US investments in this first stage are both oriented to simple assembly and superficially appear similar, the vastly different markets being served pulled their respective investments in divergent directions.

Consider the resulting logic of sunk investment for the two sets of firms. Because their Asian affiliates were integrated into a production operation serving advanced country markets, US firms upgraded their Asian investments in line with the pace of development of the lead market being served, the US market. In essence, they upgraded in line with US rather than local product cycles. By contrast, Japanese firms were led to upgrade the technological capacities of their Asian investments only at the slower pace necessary to serve lagging local markets. As local US affiliates became more sophisticated through several rounds of reinvestment, a division of labor premised on increasing local technical specialization developed throughout the US firms' global production operations. Local needs began to diverge from those elsewhere in the US firm's overall operations and affiliates sought out, and where necessary, trained local partners to meet them.

To be sure, the growth of local autonomy and relationships was constrained by overall corporate strategies (e.g. where economies of scale dictated a global rather than local sourcing arrangement), but over time US investments still led to greater technology transfer and increasing technological capabilities for locals. By contrast, stuck in developing market product cycles, off-shore Japanese affiliates benefited from no such incentives to upgrade and no need to develop local supply relationships. Japanese firms served the domestic and US markets wholly from home. Whatever their lagging Asian affiliates needed could be easily supplied from Japan. As local Asian markets demanded

the marginally more sophisticated goods whose product cycles had already peaked in the advanced countries, the entire production capability for those could also be transferred from Japan. Overall, less technology was transferred, and even that remained locked up within the Japanese firm's more limited circle of relations.

Thus, during the second stage (1980-1985) US-owned assembly platforms were upgraded and enhanced technically to include more value-added, e.g., from assembly to test in chips, from hand to automation assembly techniques, from simple assembly of printed circuit boards to more complex subsystems and final assembly in industrial electronics. As they gained more autonomy, US affiliates began to source more parts and components locally (e.g., a range of mechanical parts, monitors, discrete chips and even power supplies). As US affiliates developed and as the US industry exited the consumer segment, local electronics producers in places like Taiwan shifted to concentrate more and more of their own investment (and their government's attentions) on industrial electronics.<sup>23</sup> As these developments occurred, the contour began to appear of an ever more elaborate and deepening technical division of labor between U.S. and Asian-based operations, bound together in production networks serving US firms' advanced country markets. In essence, a new supply base was being created in Asia under the control of US and local, but not Japanese capital.

By contrast, the pattern of Japanese investment led to a dual production structure under the control of Japanese firms and premised on traditional product cycles -- sophisticated products were produced at home with sophisticated processes to serve advanced country markets, while lower-end products were produced with simple processes in regional affiliates to serve local Asian markets. Both sets of operations

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<sup>23</sup> On the progression from consumer to industrial electronics in Taiwan, see Chung Chin, "The Changing Pattern of Division of Labor Across the Straits: Macro Overview and Sectoral Analysis on the Electronics Industry," Chung Hua Institution of Economic Research, Taipei, September; and Scott Callon, "Different Paths: The Rise of Taiwan and Singapore in the Global Personal Computer Industry," *Japan Development Bank Discussion Paper Series*, #9494, August, 1994. More generally, on the development of Taiwan's information technology industry, see Kenneth L. Kraemer and Jason Dedrick, "Entrepreneurship, Flexibility and Policy Coordination: Taiwan's Information Technology Industry," (Irvine: Center for Research on Information Technology and Organizations, 1995).

sourced from a common supply base, located largely in Japan and controlled, directly or indirectly, by Japan's major electronics companies. Where Japanese companies responded to government or commercial pressures to localize, they did so from within their established supply base -- that is, by transplanting the operation of an affiliated domestic Japanese supplier -- not by sourcing locally from the emerging Asian supply base. In short, the Japanese production networks boasted redundant investment and remained relatively closed, even as the US networks became more open and specialized.

These trends were fully elaborated during the third stage, from 1985-early 1990s. At home, US firms focused scarce corporate resources more intensely on new product definition and the associated skills (e.g., design, architectures, software) necessary to create, maintain and evolve de-facto market standards. In turn, they upgraded their Asian affiliates, giving them greater responsibility for hardware value-added and manufacturing, and significantly increased local sourcing of components, parts, and subassemblies. They even contracted-out design and manufacture of some boards and components. Thus, during this period, the Asian affiliates of US firms continued to migrate from PCB to final assembly with increased automation; to increase both component production and final system value-added; and to assume global responsibility for higher value-added systems (e.g., from monochrome desktops to color notebook PCs). Their production networks extended to more and more capable local Asian producers who became increasingly skilled suppliers of components, subassemblies and, in some cases, entire systems. Even in areas like memory chips and displays where Japanese firms remained important suppliers to US firms, there was sufficient competition from other Asian sources (e.g., Korea in memory chips) or sufficient political pressure to keep the supply architecture open.

Leading US producers of PCs like Apple illustrate well these developments.<sup>24</sup> Apple Computer Singapore (ACS) opened a PCB assembly plant for the Apple II PC in

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<sup>24</sup>Based on press accounts, company annual reports and SEC 10K filings as compiled by Greg Linden in the BRIE Asia FDI Database. See Linden, "Apple Computer East Asian Manufacturing Affiliates," November 7, 1994, unpublished summary.

1981. By 1983 nine local companies were contract manufacturing PCBs for the Apple IIe and Lisa PCs. By 1985 ACS was upgraded to include final assembly of Apple IIes for the world market. From 1986-89, ACS was expanded and upgraded to begin some component design work. In 1990 ACS assumed final assembly responsibility for two of three new Macintosh PCs (and PCBs for the third) and designed (locally) and manufactured associated monitors. By then, essentially all components were sourced in Asia (except the US-fabbed microprocessor) -- ACS's 130 major suppliers included local firms like Gul Technologies and Tri-M (PCBs). ACS had also demonstrated that its growing technical prowess could pay competitive dividends in speeding time to market: It was able to move from designs to production roll-out in up to half the time of Apple's other facilities. By 1992, ACS assumed responsibility for final assembly for all Asia-Pacific markets, including Japan, was designing and supplying boards globally, manufacturing monitors and some peripherals, and designing chips. Over \$1 Billion was being procured annually through ACS. In 1993, ACS set up a design center for Macs for high-volume desk-top products -- Apple's only hardware design center outside the US. By 1994, ACS had become the center for distribution, logistics, sales and marketing for the Asia-Pacific region, and was assembling the MacClassic II, LC III and IV, mid-range Centris, and Quadra 800 for global distribution. Regional sourcing reached \$2 billion, half from Japan (LCD displays, peripherals, memory, hard disk drives), another quarter from Singapore, \$250-500 million in Taiwan for OEM desktops, monitors, PCBs, Powerbooks Digital Assistants, and chips. Korea's Goldstar also supplied monitors. By late 1994, ACS had begun to design the motherboard and tooling for, and assemble the multimedia system Mac LC 630 PC for worldwide export. Two new Mac products completely designed and manufactured at ACS were launched in 1995.

The value-added/local sourcing progression of other major US electronics players in Asia is broadly similar.<sup>25</sup> For example, Compaq Asia (hereafter: CAS for Compaq

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<sup>25</sup>For Compaq, see Linden, "Compaq East Asian Manufacturing Affiliates," November 7, 1994, unpublished summary; for Hewlett-Packard, see Linden, "Hewlett-Packard East Asian Manufacturing

Asia-Singapore) established its Singapore factory in 1986 for PCB assembly of components sourced from Asia (including Japan), for desktop PCs to be final assembled in the US. By 1994, after terminating an OEM relationship with Japan's Citizen Watch, CAS was designing and manufacturing all notebook and portable PCs for worldwide consumption, and all desktop PCs for the Asia-Pacific. Similarly, Hewlett-Packard's Singapore operations evolved from assembly of calculators in 1977 to global responsibility for portable printers and Pentium desk-top PCs and servers, with local manufacturing, process design, tooling development, and chip design. Motorola's Singapore operations evolved from simple PCB assembly of pagers and private radio systems destined for the US in 1983, to world-wide mandates for design, development and automated manufacture of double-sided six-layer PCBs, for design and development of integrated circuits for disk drives and other peripherals, for some R&D, and for sourcing of at least \$500 million of parts and components within the region. Similar kinds of stories could be told for ATT in telecommunications products, IBM and DEC in PCs and peripherals, Maxtor, Connor, Seagate, and Western Digital in hard disk drives, and for TI, Intel and National Semiconductor.

In sum, by the early 1990s, the division of labor between the US and Asia, and within Asia between affiliates and local producers, deepened significantly, and US firms effectively exploited increased technical specialization in Asia. In stark contrast, up through the end of 1993, Japanese firms still controlled their Asian affiliates' major decision-making and sourcing activities from Japan. More low-end process/product technology had been off-shored, including production of audio systems (cassette recorders, headphones, low-end tuners, etc.), under-20-inch televisions and some VCR models, cameras, calculators and appliances like microwave ovens. Local Asian content had risen toward 60%, but core technological inputs like magnetrons, chips and recording heads were exclusively sourced from Japan, and the 60% 'local' content was mostly

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Affiliates," November 9, 1994, unpublished summary; for Motorola, see Linden, "Motorola East Asian Manufacturing Affiliates," November 7, 1994, unpublished summary.

supplied by the off-shore branch plants of traditional domestic Japanese suppliers. Local design activities were invariably to tailor Japanese product concepts for local Asian markets, and global mandates for advanced products, let alone their design, development, and manufacture, were nowhere to be found outside of Japan. In contrast to US producers, for example, Japanese PC producers sourced displays, memory, some microprocessors, drives, power and mechanical components, plastics, and PCBs from Japan (or in the case of some low-end components, from off-shore affiliates), and did PCB and final assembly, and essentially all advanced design and development in Japan. In short, Japanese firms intensified rather than rationalized their dual production structure, and, by exclusion from their production networks, failed to benefit from increasing, cheaper, and faster technical capabilities in the rest of Asia.

### **III: Indigenous Networks – From Supply Base to Competitor?**

While Asia's indigenous electronics capabilities (excluding Japan) developed in close symbiosis with the strategies and activities of American MNC firms, they were driven by local private investment and supported by government policies. Outside of Korea (where the chaebol dominated domestic electronics development), resident ethnic Chinese investors played the principal, private entrepreneurial role in Taiwan and Hong Kong, Singapore and later in Malaysia, Indonesia, Thailand and along the Coastal provinces of the Mainland of China. First in the NICs and then in Southeast Asia, governments provided a panoply of fiscal and tax incentives, invested heavily in modern infrastructure, generic technology development, and the technical up-skilling of the work force, engaged in selective strategic trade interventions, and in some cases, even provided market intelligence and product development roadmaps.<sup>26</sup> The aims were both to plug

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<sup>26</sup> There were, of course, tremendous variations in the role played by state policy, and in the policies themselves, in the different countries of the region. In highlighting a few commonalities, I do not mean to slight those differences. The active role played in general by governments in the region has been explored in detail in a variety of scholarly works. See, e.g., Robert Wade, *Governing the Market: Economic Theory and the Role of Government in East Asian Industrialization*, (Princeton: Princeton University Press, 1990); Stephan Haggard, *Pathways from the Periphery: The Politics of Growth in the Newly Industrializing Countries*, (Ithaca: Cornell University Press, 1988). More recently, see the excellent

into the developing multinational production networks in the region, and to use them as a lever toward autonomous capabilities. The result, by the early 1990s, was burgeoning indigenous electronics production throughout the region, mainly under the control of indigenous capital.<sup>27</sup>

Outside of Korea's consumer electronics industry, advanced indigenous electronics activity is concentrated in the personal computer (PC) and PC-related product-markets. In turn, the nerve-centers of that activity in PC electronics are Taiwan and Singapore, the home bases for emerging Asia-Pacific MNCs like the former's ACER and the latter's Creative Technologies. As Table 1 shows, in 1994, Taiwanese firms held from significant to dominant world market shares in 14 PC-related product categories. Singapore, by contrast, a market about one-seventh Taiwan's size, produced about half of the world's hard disk drives, most of its multimedia sound cards, and growing percentages of computer printers, PC subassemblies and even finished PCs (about 5% world market share).<sup>28</sup>

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contributions in Andrew MacIntyre, ed., *Business and Government in Industrializing Asia*, (Ithaca: Cornell University Press, 1994).

<sup>27</sup> In focusing on Taiwanese and Singapore electronics capabilities, I am slighting the significant regional investment by the Korean Chaebol who emerged during this period as major, region-wide producers of consumer electronics and components. See, e.g., Martin D. Bloom, "Globalization and the Korean Electronics Industry," *Pacific Review*, v.6 #2, 1993.

<sup>28</sup> Callon, *ibid.*



**Table 1: Taiwan Firms' 1994 World Market Share (%) in PC-Related Products<sup>29</sup>**

Motherboard	80%
Mouse	80%
Scanner	61%
Monitor	56%
Keyboard	52%
Network Interface Card	34%
Graphics Card	32%
Switching Power Supply	31%
Notebook PC	28%
Video Card	24%
Terminal	22%
Network Hub	18%
Audio Card	11%
Desktop PC	8%
Source:Market Intelligence Center/III	

Of course, as argued earlier, the position of indigenous producers remains tied to the production networks of foreign multinationals. Table 2 gives some indication of this by examining the OEM relationships of major Taiwanese producers. In turn, however,

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<sup>29</sup> The Table is drawn from a presentation prepared by Tze-Chen (T.C.) Tu, Director of Taiwan's Market Intelligence Center (of the Institute for Information Industries), "Upgrading Taiwan's IT Industry -- New Challenges and the Role of International Cooperation," at the BRIE-Asia Foundation Conference, *Competing Production Networks in Asia: Host-Country Perspectives*, San Francisco, April 27-28, 1995.

**Table 2: Taiwan Firms' 1994 OEM Relations in PC-Related Products (representative sample)<sup>30</sup>**

OEM Producer	Buyers	Products
Acer	Apple, Fujitsu, NEC, NCR, Data General, Siemens	Notebooks and/or monitors
Delta	Apple, Compaq, IBM	Power Supplies
Elite	DEC, IBM, NEC, Siemens	Motherboards
FIC	ATT, Dell, Unisys	Motherboards
Inventa	Apple, Compaq, Dell	PDA, Notebooks
Lite-on	Compaq, DEC, Dell	Power Supplies and/or Monitors
Tatung	Apple, Packard Bell, NEC	PCs and/or Motherboards, Monitors
Source: MIC/III and press accounts		

by leveraging their OEM relationships and overall world market shares, several indigenous Asian producers have emerged as increasingly autonomous forces in the electronics industry. Indeed, in the early 1990s, intense competition and growing needs for scale-intensive investment to stay in the game, forced a shake-out and consolidation among Taiwanese and Hong Kong-based electronics firms. In particular, several major Taiwanese MNCs have claimed growing shares of key product-markets and formed their own regional production networks. The resulting industry concentration is most visible in Taiwan's largest domestic product sectors, notably monitors, PCs and PCBs, where the top ten indigenous producers now account for over 70% of the market.<sup>31</sup> Leading producers include firms like ACER, the Formosa Plastics Group, and Tatung. ACER, for example, is Taiwan's largest PC firm, doing about \$2.3 Billion in 1994 and being the leading PC supplier outside of Japan in Asia, #2 in Latin America, and a rapidly growing

<sup>30</sup> *Ibid.*, supplemented by press reports.

<sup>31</sup> Chung Chin, "Changing Pattern," *ibid.*, at p.18,

#10 in the US.<sup>32</sup> ACER is the only Taiwanese firm with substantial backend distribution and marketing under its own brand in the US. It fully designs and develops its own systems, boards and many components including logic chips, and is moving into higher-end systems like servers. Similarly, Formosa Plastics Group, the principal holding arm of Taiwan's Wang family holdings and Taiwan's largest private enterprise, controls First International Computer (FIC), Everex Systems, and Nan Ya Plastics.<sup>33</sup> FIC (and its subsidiary Formosa Industrial Computer) is the world's largest contract PCB motherboard producer and, through Nan Ya Plastics the Group has expanded into production (not assembly) of PCBs, chips and even monochrome LCDs.

Taiwan-based MNCs like those ride herd on an extensive indigenous supply base of thousands of small and medium-sized design, component, parts, subassembly and assembly houses throughout the China Circle and extending into Southeast Asia.. Thus, for example, by the late 1980s, small firms (under 50 employees) accounted for about two-thirds of the electronics enterprises on Taiwan, roughly double their share a decade before when MNC consumer electronics firms dominated production.<sup>34</sup> These firms form an intricate sub-contracting structure of affiliated and family enterprises which comprise the local production network and supply base. The numerous small firms are aligned vertically with the few large scale enterprises and many trading companies that act as intermediaries for foreign MNC customers.<sup>35</sup> Designs and key components flow down from the large-scale enterprises; more labor-intensive production activities flow up along

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<sup>32</sup>*Ibid.*, see Linden, *supra*. See also, Pete Engardio, "For ACER, Breaking up is Smart to do," *Business Week*, July 4, 1994, p.82ff; and Louis Kraar, "Your next PC could be made in Taiwan," *Fortune*, August 8, 1994, p.90ff.

<sup>33</sup>*Ibid.*, see Linden, *supra*. See also, Pete Engardio, "A New High-Tech Dynasty?" *Business Week*, August 5, 1994, p.90ff.

<sup>34</sup>See the data in C.K. Paul Liu, Ying-Chuan Liu, and Hui-Lin Wu, "New Technologies, Industry and Trade – the Taiwan Experience," *Industry of Free China*, January/February, 1990, p.7ff.

<sup>35</sup>For elaboration on the following, see, e.g., G.S.Shieh, "Network Labor Process: The Subcontracting Networks in Manufacturing Industries of Taiwan," *Academia Sinica, Bulletin of the Institute of Ethnology*, #71, Spring, 1991; Brian Levy and Wen-Jeng Kuo, "The Strategic Orientation of Firms and the Performance of Korea and Taiwan in Frontier Industries: Lessons from Comparative Case Studies of Keyboard and Personal Computer Assembly," *World Development*, v.19,#4, 1990. I have also drawn on an excellent paper by one of my graduate students, Fu-mei Chen, "From Comparative Advantage to Competitive Advantage: A Case Study of Taiwan's Electronics Industry," unpublished manuscript, May 21, 1994.

the subcontract network leading to final assembly. Divisible production tasks (e.g., components and subassembly steps) can be farmed-out all the way down to family job shops and home-workers. Individual units within the network operate at small scale with minimal capital investment requirements, and link on the informal bases of *guanxi*, that is, kinship or friendship ties. The flexibility that results, mirroring the industrial district capabilities in Italy and parts of Germany, makes it possible to increase or decrease production scale on short notice, or to enter and exit niche product-market segments, all at minimal cost and with minimal fixed investments.<sup>36</sup>

Another significant competitive advantage of the indigenous network structure is what might be termed business 'speed', the ability to minimize the time it takes to move from design specification to production and then to market with a quality product. Industry estimates of Taiwanese network business speed peg the time from conception to execution at a fraction of that of larger MNCs burdened with formal organization and layered decision-making.<sup>37</sup> In some cases, indigenous networks can design and execute in less time than it takes the Japanese giants just to make a go-ahead decision.<sup>38</sup> For the Taiwanese design houses in particular, this capability is apparently built on a high-value-added foundation, macro-cell based design methodologies and libraries of already-characterized component functions that can be combined and altered to implement new concepts.<sup>39</sup> The rapid design capability then joins with the hyper-competition among subcontractors in the network to implement the new designs as fast as possible. Such speed advantages pack an enormous competitive punch in electronics markets where average product life cycles have roughly halved in the past five years -- one of the reasons

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<sup>36</sup>On European industrial districts, see the work on flexible specialization, notably, Michael Piore and Charles Sable, *The Second Industrial Divide: Possibilities for Prosperity*, (NY: Basic Books, 1984).

<sup>37</sup>Representative estimates range from Apple's judgment that its Singapore operation can move a new product into production in half the time of its other operations, to Ming Chien, Chairman of FIC, who estimates that motherboards can be completely changed out (with all attendant alterations to the rest of the system) in Taiwan in 2-3 weeks vs. up to a year in the US. On the former, see *Singapore Business Times*, 11/27/90 p.14; on the latter, see Callon, "Different Paths," *supra*.

<sup>38</sup>Kraar, "Your Next PC," *supra*, inferring from Dataquest estimates.

<sup>39</sup>See Callon, "Different Paths," *supra*, citing interviews in Singapore. Structured IC design approaches were pioneered in the US at Universities like Berkeley and CalTech, where many Asian engineers were formally trained.

Taiwanese suppliers in particular have a thriving ODM business as subcontract design houses for US and European MNCs.

Network speed is complemented by more traditional factor input advantages, notably the relative cost of skilled engineering and technical labor (especially designers), which, even in the maturing economies of Taiwan and Singapore, still costs less than a third of comparable US or Japanese labor. The best indigenous networks also run extremely lean in general, sales and administrative overheads where they match the best practices of MNC leaders like Hewlett-Packard (at about 10% of sales for microcomputers and printers), and are far superior to most advanced MNC performers (15%-upwards of 20% of sales).<sup>40</sup> Of course, such cost-minimization is inherent in the sub-contract structure of the especially the Taiwanese production networks where affiliates and family enterprises can be squeezed (if necessary, in time-honored sweat-shop manner).

Over the last half-decade, in response to steep rises in factor input costs in the NICs, and exacerbated by currency appreciation, the indigenous Asian production networks have become more and more regionalized. For example, Table 3 suggests the extent to which considerable PC-related production is now being carried on by Taiwanese MNCs within the region but outside of Taiwan. As the table suggests, production outside of Taiwan accounts for a growing share of total production under Taiwanese control, approaching one-quarter of the total in 1995.

**Table 3: Domestic vs. Off-shore Production Value of Taiwan's Electronics Industry, 1992-1995 (\$-Millions)<sup>41</sup>**

	1992	1993	1994	1995(est.)
Domestic Production	8391	9693	11579	13139
Offshore Production	973	1691	3003	4279
Offshore/Domestic(%)	11.60%	17.45%	25.93%	32.57%
Source: MIC/II				

<sup>40</sup>Based on industry discussions.

<sup>41</sup>Presentation by T.C. Tu, *supra*, n.30.

Off-shore activity is concentrated in certain product segments, with about two-thirds of 'Taiwanese' production of keyboards, half of power supplies, and about a quarter of monitors and motherboards now taking place outside of Taiwan.<sup>42</sup> Before the Mainland became formally available, labor-intensive assembly of products like keyboards, low-end monitors and power supplies shifted off-shore to Malaysia and Thailand. Since the late 1980s, however, and given the cultural affinity, mainland China has been the preferred new investment site.

At least in the first instance, similar to the original motivation of many US MNCs, cheap labor for high-volumes seems to be a prime motivation. In labor-intensive assembly processes, official Taiwanese figures suggest cost savings of from 8% in monitor assembly to greater than 20% with keyboards and the mouse. Critically, most of these China investments are cooperative ventures, not wholly-owned subsidiaries, and they are not only being carried out by the largest producers. Chung Chin cites a 1994 study by Shu showing that of 38 Taiwanese monitor producers, 19 have established production relationships on the Mainland since the early 1990s, and 6 others were planning to do so.<sup>43</sup> In the resulting division of labor, 14" monochrome and color monitors are assembled on the Mainland or in other Asian locations, while Taiwanese production is upgraded to larger display sizes. Of the 4 million monitors produced off-shore in Taiwanese networks in 1993, half were assembled in China. The Mainland is increasingly also the site of other production activities. For example, in addition to color monitors, FIC's two Guangdong Province subsidiaries assemble PCBs and other components, and Mitac similarly does all of its semi-finished assembly (frames and PCBs) on the Mainland.<sup>44</sup> In all of these products, the combination of Taiwanese capital, production know-how, and OEM reputation with cheap Mainland labor and land, is making for an irresistible regional

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<sup>42</sup>For this and the following official figures, see Chung Chin, "Changing Patterns," *supra*, p.19-20, citing MIC/III data.

<sup>43</sup>This and the following, see Chung Chin, "Changing Patterns," *Ibid.*, at p.21-23.

<sup>44</sup>Engardio, *supra* n. 34, and Kraar, *supra* n.33.

extension of Taiwanese networks. And the lure of the Mainland's market provides the longer-term temptation.

#### IV: From Ownership to Control: The Future of Competition and the Prospects for Regional Identity

The emergence of competitive strategies in electronics premised on highly articulated inter-firm, cross-border production networks has not eviscerated the analytic significance of national distinctions based on ownership and origin. The evidence presented above suggests rather, and perhaps paradoxically, that those distinctions still have explanatory power: In Asia today, beneath the superficial similarity engendered by aggregate trade and investment data and macro-analyses, lie distinctly different electronics production networks under the control of US, Japanese and indigenous Asian multinationals. The differences have had competitive consequences; they help to explain why US firms prospered, indigenous Asian firms became significant players, and Japanese firms suffered in the last round of competition. Table 4 provides a comparative, albeit highly stylized typology of the different networks which is elaborated below.

**Table 4: Typology of Electronics Production Networks in Asia**

<b>Characteristic</b>	<b>US-Owned</b>	<b>Japanese-Owned</b>	<b>Taiwanese-Owned</b>
<b>Accessibility</b>	<b>Open</b>	<b>Closed</b>	<b>Insular</b>
<b>Responsiveness</b>	<b>Fast/Opportunistic</b>	<b>Cautious</b>	<b>Fast/Flexible</b>
<b>Governance</b>	<b>Decentralized</b>	<b>Centralized</b>	<b>Hierarchical</b>
<b>Permanence</b>	<b>Disposable</b>	<b>Long-term/stable</b>	<b>Fluid</b>
<b>Supply Base</b>	<b>Anyone meeting price, quality, delivery constraints</b>	<b>Domestic and Affiliated</b>	<b>Guanxi-preferenced</b>
<b>Product Mix</b>	<b>Sophisticated industrial electronics</b>	<b>Low-end, esp. consumer audio-visual</b>	<b>PC electronics</b>
<b>Division of Labor</b>	<b>Off-shores high value-added esp. in components, processes and manufacturing, and maximizes Asian value-added</b>	<b>High value-added product/processes at home, low off-shore, but minimizes Asian (i.e., non-Japanese) value-added</b>	<b>Off-shores low-end products/processes and exploits non-Taiwanese value-added there and where otherwise necessary</b>



The US networks tend to be open to outsiders, fast and opportunistic in implementation with significant decisions decentralized to affiliates or partners, and capable of changing contour (and partners) as needs change -- in an image: open, fast, opportunistic, decentralized and disposable. Their activities are centered in the NICs, especially Singapore, but increasingly reach into the rest of Asia and China. By contrast, the Japanese networks tend to be relatively closed to outsiders, more cautious to make and implement significant decisions which are almost always generated from Japan, and structured on stable, long-term business and keiretsu relationships -- that is, closed, cautious, centralized, long-term and stable. Despite the recent surge of Japanese investment into Asia, their networks are still most definitely centered in Japan.

The respective networks also rely on distinctively different supply bases, boast different product mixes, and, most significantly, constitute very different divisions of labor. The US networks rely on an open, competitive supply architecture in which Japanese, US, Taiwanese, Singapore, Korean and other Asian firms compete on cost, quality and time-to-market and, in some cases, provide significant value-added. By contrast, the Japanese networks rely on a largely domestic and affiliated supply base with little value-added by other Asian producers. The US networks produce (and in some cases design and develop) increasingly sophisticated industrial electronics like hard disk drives, PCs, InkJet Printers, and telecommunications products. The Japanese networks still mostly produce consumer audio-visual electronics and appliances. The US networks exploit a complementary division of labor in which US firms specialize in especially 'soft' competencies (definition, architecture, design -- standards areas) and Asian firms specialize in hard competencies (components, manufacturing stages and design/development thereof). By contrast, the Japanese networks exploit a division of labor with significant redundancies in which domestic Japanese operations produce high-value, high end products using sophisticated processes, and off-shore affiliations produce

low-value, low-end products.<sup>45</sup> The US networks exploit increasing technical specialization throughout the production process in which the Asian contribution is *maximized*; the Japanese networks exploit a value-added specialization between products in which the Asian (i.e., not Japanese) contribution is *minimized*.

By comparison, the emerging indigenous Asian networks like those of Taiwanese MNCs Acer, Mitac or the Formosa Plastics group, take still a different form. It is hardly surprising that on some dimensions they appear to emulate features of both the Japanese and US MNC approaches. However, the prevalence of distinctive characteristics of their own suggests that the indigenous Asian networks are a *sui generis* form of network organization, not a mere hybrid of US and Japanese ideal types.<sup>46</sup> Much like the Japanese, Taiwanese networks are difficult for outsiders to penetrate. They tend to be very hierarchically organized, though less reliant for decision-making on their point of origin than the Japanese. Much like the US, Taiwanese networks can move very fast in implementing decisions. Because they are much less constrained than the Americans by the need for legally-enforceable relations, they tend to be even more flexible in the kinds of relationships embodied and in the ability to shift contours as markets shift. Unlike either, Taiwanese networks are based on *guanxi* (rather than legal or *keiretsu*) ties which change fluidly as needs change but apparently without abandoning reciprocal obligations over the long-term. In short, the Taiwanese networks appear to be insular, fast, hierarchical, flexible and fluid. They tend to be centered in the China Circle with significant Southeast Asian investment as a hedge. Like the Americans, the Taiwanese networks seek to exploit a highly competitive supply base and concentrate on industrial electronics, albeit mostly PC-related. Much like the Japanese, Taiwanese 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

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<sup>45</sup>This is also a principal conclusion of Takayasu and Ishizaki, *supra*, who call this “intrafirm product-to-product division of labor,” at p.11ff.

processes. Unlike the Japanese, however, the Taiwanese networks also self-consciously leverage increasing technical specialization through local relationships for the off-shored products and processes. And unlike both, the Taiwanese network relationships are increasingly China-centered -- rather than using a NIC base as the regional center, Taiwanese networks may end up with a China base as their global center, using demand and technical know-how in the domestic China market to achieve world-class scale, costs and innovation.

As argued at the outset, these differences between US, Japanese and indigenous networks were competitively consequential in the last round of market battles in electronics. The US networks relieved the constraining threat of competitive dependence on Japanese rivals by re-constituting the architecture of supply in electronics. Simultaneously, the turn to skilled but cheaper Asian suppliers helped to lower overall production costs, fierce competition within the supply base helped to reduce turnaround times, and specialization and diversity within the network permitted US producers to keep better pace than Japanese rivals with rapid technological and market shifts. Growing Asian technical capabilities freed US firms to focus their efforts (and scarce resources) on new product definition, systems integration, software value-added and distribution. In the bargain, the US networks helped to spawn and sustain direct Asian competition to Japanese firms in several of their stronghold markets like memory chips, consumer electronics and displays. And while indigenous Asian network capabilities grew prodigiously, they did not directly challenge revived US leadership in the last round of competition.

National distinctions between electronics firms are likely to continue to be competitive differentiators for the foreseeable future. But the development of inter-firm, cross-border relationships does appear to have changed the significance of ownership and

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<sup>46</sup>Some commentators treat the Chinese capitalized networks as hybrid forms of organization. See, e.g., Dieter Ernst, "Hybrid Forms of Organization - the International Production Networks of Taiwanese Electronics Firms," (BRIE and IGCC, 1996, forthcoming).

origin-- perhaps even in ways that will eventually undermine their explanatory capacity. To see how requires detouring through the motives that lie behind the development of the network relationships. The electronics case suggests that firms are motivated by four principal goals in developing the new relational forms of competition.<sup>47</sup> Production networks are first an effort to develop forms of organization that provide greater flexibility, responsiveness, risk-sharing and efficiency under conditions of high market and technological uncertainty. Second, that uncertainty also provokes firms 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. Production networks are also an effort to achieve better access -- to foreign markets, technologies, investment opportunities and the like -- in 'global' markets that retain a panoply of formal and informal barriers to trade and investment.

Finally, the new relational forms are also principally about creating or removing market imperfections and raising or surmounting barriers to competitive entry. This is clearest in the case of standards coalitions, where the alliance network is aimed at generating (or challenging) a defacto market standard and customer lock-in. But competition in electronics 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 improve costs faster than competitors. Indeed, profitability in electronics is almost purely a function of the resulting market structure -- high where quasi-monopoly position can be maintained, essentially nonexistent everywhere else. That is why so-called value-chain analysis can be so misleading in evaluating this industry to the extent that it implies the need to find profits by moving up a hypothetical food chain that starts in components

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<sup>47</sup>I derive these solely from the electronics case, but there is broad support in the literature on strategic alliances which tends to emphasize the first three, where as the forth may be most significant at least in

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 won or lost at any point in the value-chain if the market is structured accordingly. While they may also fulfill the other motives suggested above, production networks are self-conscious efforts to structure markets in ways that increase profits by removing direct competitors, creating differentiability, erecting entry barriers and the like.

Whatever the precise mix of motives, in most cases what a firm needs -- and the resulting division of labor within its production network that embodies those needs and fulfills that mix -- derives in the first instance from what it lacks in its home environment. Or to put it in slightly different terms, the hypothesis is that the shape of a firm's international production network reflects its ability to exploit location-specific advantages at its point of origin and to fill-in complementary elements as necessary with relationships that exploit location-specific advantages elsewhere.<sup>48</sup> In turn, the shape and character of the resulting network reflect differences in the ability to control the relationships comprised by the network -- control that also derives initially from the point of origin. Thus, the setting, maintenance and evolution of de facto standards set in the domestic US launch market was the principle instrument used by U.S. firms to preserve control over their inter-firm networks. So long as U.S. firms maintained that role in the division of labor—by defining and executing an evolutionary path for improved performance-functionality-cost that kept customers locked-in to their standards—it was extremely difficult for other firms in the network to challenge for the lead. US networks could be highly decentralized because control over standards enabled devolution of responsibility for significant value-added to partners without fear of losing the ability to orchestrate the network. By contrast, with control residing in their domestic-based manufacturing and core-component technologies, any significant devolution of

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information technology markets. See, e.g., Mytelka.

<sup>48</sup> This is broadly consistent with work on the location decisions of multinationals. In addition to Porter and Dunning, *supra*, see John Cantwell, "The globalization of technology: What remains of the product cycle model?" *Cambridge Journal of Economics*, 1995, #19, p.155-174.

responsibility by Japanese firms over those competencies to outsider partners risked creating a direct competitor. Japanese networks had to be centralized to avoid that outcome.

The electronics case suggests that at the moment, for most firms, the point of origin will remain the principle source of control over their production networks. For most firms, control resides at home because that is where development of new product or process concepts, standards-setting and associated launch market opportunities are most developed, where local capacities and technical specialization are still exploited most fully, where, as argued in the introduction, the initial patterns of constraint and opportunity to which firms respond are first set. So long as the source of control over the shape and character of a firm's production network stems from its point of origin in the ways indicated, corporate nationality will continue to matter to market competition in electronics.

But will those sources of control remain largely national? As production networks become ever more articulated and cross more borders, it is easy to envision circumstances under which each of those sources of control migrates out from the point of origin to other places in the network. The ability of US firms to drive development of some process and manufacturing competencies out of their Asian affiliates provides one hint of what is possible. The competitive adjustment of Japanese firms provides still more: As Japanese firms respond to the relative success of US and indigenous Asian firms they are beginning to rationalize an Asia-regional network structure very different from that of US or indigenous producers.<sup>49</sup> That rationalization would turn the precise characteristics of Japan's Asia-based networks that created vulnerability over the last decade -- closed, cautious, centralized, long-term and stable -- into competitive strengths. Japanese firms could decide to accept slower domestic growth and the need to exploit technical capabilities in the rest of Asia as givens. They could decide to selectively

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<sup>49</sup> See the chapter by Dennis Tachiki in this volume.

incorporate indigenous Asian producers into the family and build stable, long-term, mutually advantageous ties focused on exploiting specific technological capabilities in other parts of Asia. They could decide to invest for the long-term. They could decide to drive their growth from Asia's: If Asia becomes a launch market for new product concepts -- and it's rapid growth and burgeoning wealth suggest that it must in some market segments -- Japanese firms might just then be better positioned to exploit the development.<sup>50</sup>

Just as big a competitive wild card is the growing indigenous electronics capability in the China Circle and Southeast Asia. A competitive indigenous producer scenario premised on regional rather than national origin, is easy enough to describe: The combination of Hong Kong-based financial and producer services, with Taiwan-based digital product and process design, Southeast Asian component specialization, highly skilled but cheap Mainland labor, and, of course, the Mainland market, provides a tantalizing scenario for regional dominance. The network characteristics identified above - - insulated from outside control, fast, hierarchical, flexible and fluid -- appear to be a compelling mix for exploiting the region's possibilities. And the sheer scale of production for the mainland and, from the mainland, for overseas markets would dwarf the leverage provided by any other regional market base. To this potent brew should be added the self-conscious developmental intent of local (not necessarily national) governments throughout the region to nurture indigenous capabilities.

The quite significant constraints on the emergence of such a scenario should not be underestimated, of course, for significant elements of control are likely to remain with US or Japanese firms for some time. Unlike the Americans, who have retained capability in most core component technologies and a significant though diminished position in capital

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<sup>50</sup>In fact, the opportunity to drive development out of Asia is already appearing in a set of significant potential product markets. These include broadcast media where firms like HongKong's TVB and Murdoch's Star TV are pioneering direct broadcast TV transmission, software where indigenous concepts could lead in new directions, and segments of the wireless communication markets where, for example, Motorola projects that China will pass the US to become its largest market for pagers in the next few years.

goods, the indigenous networks remain dependent on Japanese competitors for advanced manufacturing equipment and high value-added core components (e.g., for Taiwanese producers, \$500 million of LCD displays and \$3 Billion of memory chips in 1994). Even more of a constraint, however, is continuing dependence on the American networks for microprocessor architectures, advanced product concepts, and global distribution. It is likely that the burgeoning regional market can eventually help to break those constraints -- by providing the returns to invest to relieve core component dependence, the new product concepts that can become global standards, and leverage to develop indigenous brands and global distribution channels. Only then, perhaps, could we convincingly begin to talk about real regional, as distinct from national identity for firms operating in Asia. But such developments are likely to take time, perhaps even several decades. Until then, so long as a firm's point of origin remains the primary source of control over its network, ownership will continue to matter to competition in electronics.<sup>51</sup>

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<sup>51</sup>Even with the development of distinctive regional rather than national sources of control, I would not expect the Japanese, US and indigenous Asian networks to converge much. They will continue to be differentiated by the balance of regional emphasis in their operations: So long as Japanese, US, and indigenous firms continue to be driven by a very different balance among local linkages, strategies, industrial structures, and policy, local capital market and labor market influences, their network differences are likely to persist even if they converge in competitive purpose or in the geographic reach of operations.