THE NEW GLOBAL SUPPLY-BASE:

NEW CHALLENGES FOR LOCAL SUPPLIERS IN EAST ASIA

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The central argument of this paper is that changes emanating from the advanced industrial economies, particularly the United States, have begun substantially to alter the prospects for supplier-oriented industrial upgrading in East Asia. A key finding of our research is that American and European lead firms have recently become more dependent on a set of “global suppliers” based in the West, even as they have increased their direct involvement in Asian production and Asian markets. These lead firms are increasingly relying on large suppliers and contract manufacturers from within their own societies to support their global operations. These global suppliers have in turn experienced rapid growth and global expansion, and have become influential global actors.
The views expressed herein are the author’s responsibility and do not necessarily reflect those of the MIT Industrial Performance Center or the Massachusetts Institute of Technology.
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Chapter 2
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Timothy J. Sturgeon  Richard K. Lester¹

I. Introduction

In the 1970s and 1980s, the newly industrialized economies (NIEs) of East Asia moved along high growth trajectories. A combination of prudent and stable macroeconomic policies, the targeting of specific sectors for development, and country-specific industrial and social structures enabled the absorption of key technologies and the accumulation of the skills required for industrial upgrading and growth (Amsden, 1989; Wade, 1990; World Bank, 1993; MacIntyre, 1994; Evans, 1995). In South Korea it was the chaebol, large-scale conglomerates with privileged access to state-provided capital; in Taiwan (China) and Hong Kong (China) development was driven by small and medium scale enterprises (SMEs) that were largely financed with private or family capital; in Singapore the state played a key role in encouraging foreign direct investment (FDI) by multinational enterprises, and by fostering the development of SMEs to serve them. Industries in these countries upgraded by building links to international markets and to the necessary sources of technology, expertise, managerial experience, and capital in the advanced countries. As Guillén (2001) has shown, country-specific links between domestic structures and national policies produced different growth trajectories among the Asian NIEs.

¹ Acknowledgements: The preparation of this paper has benefited greatly from the ongoing work of the Globalization Study team at the MIT Industrial Performance Center (IPC). The authors are grateful to Sara Jane McCaffrey for providing invaluable research assistance. Qualitative field research was conducted in Southeast Asia by Raphael Bonoan, Douglas Fuller, and Vincent Sawansawat. Suzanne Berger made many important contributions throughout. The authors would like also to thank the other participants in the IPC Globalization Study, including Akintunde Akinwande, Dan Breznitz, Brian Hanson, Donald Lessard, Richard Locke, Teresa Lynch, Mike Piore, Charles Sodini, and Edward Steinfeld for valuable discussions. Shahid Yusuf and Simon Evenett of the World Bank were helpful and patient during the paper’s preparation. Helpful comments were also provided by the participants in the East Asia’s Future Economy Conference, organized jointly by the Development Economic Research Group of the World Bank and the Asia Pacific Policy Program of the Kennedy School of Government at Harvard University on October 1-2, 2001. The comments of Dennis Encarnation were especially valuable. All errors and omissions are the sole responsibility of the authors.
Less well understood is that each of these growth trajectories was also influenced by the industrial structures of the advanced countries with whom the NIEs were interacting. It is commonly observed that the rapid growth of the NIEs required trade openness in the West. This is indeed a necessary condition for export-oriented development. But the development paths pursued in the Asian NIEs were also influenced and enabled by the competitive strategies of American, European, and Japanese firms, which *inter alia* involved establishing local operations in the NIEs, identifying local firms as suppliers, transferring skills and technologies to them, investing in them, and buying from them. The NIEs exploited these strategies to establish and upgrade a critical set of domestic technological and industrial capabilities. In this paper we refer to this process as “supplier-oriented industrial upgrading”—developing a supply base tuned to serving advanced economy lead firms as a key mechanism of industrial upgrading. Both firms and government policy makers tend to view supplier-oriented industrial upgrading as a stepwise learning process, beginning with manufacturing services only, perhaps in an export processing zone, then gradually progressing to manufacturing plus design, and culminating with developing country firms having the capability to design, manufacture, and sell their own branded products on world markets.

Today, however, lead firms based in the West are reorganizing production networks in ways that still lead them to want to engage with the newly industrialized and emerging economies of East Asia, but with different understandings about how global value chains should be organized and what roles local firms should play in them. The central argument of this paper is that changes emanating from the advanced industrial economies, particularly the United States, have begun to substantially alter the prospects for supplier-oriented industrial upgrading in East Asia. A key finding of our research is that American and European lead firms have recently become more dependent on a set of “global suppliers” based in the West, even as they have increased their direct involvement in Asian production and Asian markets. These lead firms are increasingly relying on large suppliers and contract manufacturers from within their own societies to support their global operations. These global suppliers have in turn experienced rapid growth and global expansion, and have become influential global actors. In the electronics sector, where the global suppliers are most highly developed, industry consultants estimate that the $90 billion of business that went to contract manufacturers in 2000 accounted for 13% of total market for world circuit board assembly, product-level electronics manufacturing and
associated services. We argue that, in the key manufacturing sectors of electronics and motor vehicles, the rapid rise of global suppliers based in the United States and Europe presents an important new challenge to the supplier-oriented industrial upgrading paths that Asian economies have pursued in the past. Not only do these global suppliers offer stiff competition to established Asian suppliers and allow lead firms to bypass the painstaking process of bringing new suppliers on stream, but they also provide lead firms with a strategic alternative to relying on a group of Asian suppliers who appear to be focused on becoming, sooner or later, competitors to the lead firms in product markets.

The paper is organized as follows. Section II introduces the notion of supplier-oriented industrial upgrading. Sections III and IV document the rise of global suppliers in the electronics and motor vehicle industries. Section V draws on evidence from our field research to argue that the threshold requirements for supplier participation in global value chains rose sharply in the 1990s. For East Asian firms, an especially challenging requirement is for participating suppliers to increase the geographical scope of their operations. Section VI outlines some of the risks and uncertainties introduced by the emergence of the global supplier model for both the lead firms and the global suppliers. Section VII briefly discusses the changing architecture of Japanese production networks in East Asia and their impact on development. Finally, some policy implications of the evidence presented in the paper for the economies of East Asia are explored in Section VIII.

Some of the empirical evidence presented in the paper has been drawn from more than 400 field interviews conducted during the period 1999-2003 by a team of researchers at MIT’s Industrial Performance Center (IPC) as part of the IPC’s ongoing Globalization Study. Other

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2 For the past four years (1999-2003), a team of 24 researchers from MIT’s Industrial Performance Center (IPC) has been investigating the confluence of globalization and industry reorganization in several sectors, including electronics, motor vehicles, software, and textile/apparel. Field research for the IPC Globalization Study has consisted of semi-structured qualitative interviews with company personnel and relevant individuals from government agencies, labor unions, and academia. In-person interviews and plant tours have been conducted in Canada, mainland China, France, Germany, Indonesia, Ireland, Israel, Italy, Japan, Korea, Malaysia, Mexico, the Philippines, Singapore, Spain, Taiwan (China), Thailand, Romania, and the United States. By the end of 2002, more than 350 interviews had been conducted. 108 of these interviews were conducted in the electronics industry, 72 were conducted in the textile/apparel industry, and 61 were conducted in the motor vehicle industry. Sponsors of the IPC Globalization Study include the Chinese National Federation of Industries, The Fujitsu Research Institute, the Volkswagen Foundation, and the Alfred P. Sloan Foundation. For more information about the IPC Globalization Study, including our methodology and detailed research findings, see http://globalization.mit.edu.
data were collected during the course of the World Bank’s Project on East Asia’s Economic Future.

II. A New Focus on Supplier-oriented Development Strategies for Industrial Upgrading in East Asia

By the late 1990s the debate over the relative roles of macroeconomic (i.e., fiscal and monetary) policies and micro-level industrial policies in driving development in East Asia, summarized in the World Bank’s 1993 volume *The East Asian Miracle*, had begun to run out of steam. There were two main reasons for this. The first was the careful work of authors such as Evans (1995) and Guillèn (2001) showing that both had been important and that macroeconomic and industrial policies have in fact been effectively combined and coordinated in a variety of ways in different countries. The most important lesson of this work was less about the effectiveness of one set of policies relative to the other, and more about the need to build up the capacity of states to act effectively in a variety of realms through the nurturing of a competent, professionalized, politically insulated bureaucracy with effective but transparent links to a country’s business elite. The second factor was the growing strength of the World Trade Organization (WTO). The traditional debate about whether development strategies such as infant industry protection and technical assistance followed by trade liberalization and export promotion were effective or not was becoming less relevant as more of these policies became “actionable” (illegal) under WTO rules.

Attention accordingly began to shift to the role of global production networks in stimulating and sustaining industrial upgrading in Asian societies (Gereffi 1994, 1999; Lee and Chen, 2000; Encarnation, 1999; Tachiki, 1999; Shimokawa, 1999; Dolan and Humphrey, 2000; Kaplinsky, 2000). The demands made by advanced economy firms on local enterprises tended to be above and beyond what is required for the local market, and it was this gap that stimulated the rapid advance of supply-base capabilities in East Asia (Keesing and Lall, 1992). Through their roles as suppliers of parts and products and as purchasers of specialized process equipment, local firms gained access to important product and process know-how without violating WTO rules. As the case of hard disk drives in Singapore illustrates (McKendrick et al 2000), East Asian economic development has been strongly influenced by the strategies of advanced economy firms in specific industries. Rovenhill (1995), Ernst (1997), Dedrick and Kraemer (1998), Borrus
et al (2000) and others noted that production networks emanating from different advanced economies have had different characteristics, and in particular, that the “openness” of US networks, that is, the willingness of lead firms from the United States to install local management and ratchet up their demands on local firms, speeded the upgrading process in East Asian locations such as Hong Kong, Singapore, South Korea, and Taiwan. These insights led Dedrick and Kraemer (1998) to argue that encouraging and facilitating local firms’ participation in global production networks was the only effective policy tool left for developing countries.

The intensifying global trend towards economic liberalization and the declining appeal of autarkic development policies that sought to wall off domestic industries until “national champions” were strong enough to compete with foreign rivals have brought new attention to policies that seek to develop the capabilities of local firms as suppliers to lead firms from advanced economies. But advocates of the “supplier-oriented” approach to industrial upgrading have often failed to account fully for the fundamental organizational changes now taking place in the industries that have been key to the creation of cross-border production networks, of the new actors that have arisen within them, and of the new demands being placed on suppliers as a result.

In the conventional supplier-oriented model of economic development, domestic suppliers continuously upgrade their capabilities either by serving the needs of the local affiliates of multinational firms or by supplying lead firms in advanced countries from a distance. In both cases, if the model is extended further, the expectation is that the local firms will leverage their experience by building up design competencies of their own. These design capabilities not only provide new sources of revenue, but eventually enable the firms to develop their own lines of branded products, and perhaps even emerge as direct competitors to advanced economy lead firms. The upgrading process can proceed in stepwise fashion, beginning with simple assembly, where labor is applied to components and designs supplied by foreign buyers; followed by the supply of complete products with locally sourced components manufactured to specifications provided by foreign buyers (the so-called original equipment manufacturing (OEM) relationship); followed by the addition of post-conceptual design services to the manufacturing function, a combination known as original design manufacturing (ODM). Once design competencies are well established, the supplier can begin to conceptualize, develop, and manufacture finished products, first for sale under the brand labels of its customers, and later to
be marketed under its own brand name. At that point the local firm becomes what is sometimes referred to as an “original brand manufacturer” (OBM). In this fully-blown version of the supplier-oriented upgrading path, the local firm eventually steps fully out of the supplier role to become a lead firm in its own right.

The supplier-oriented upgrading path, though straightforward in concept, is often far from smooth in practice, especially if it is to be followed to its ultimate conclusion. At each stage along the way, difficult problems have had to be addressed by the companies involved. One price of entry into cross-border networks, especially for suppliers whose operations are tightly coupled to customers in advanced economies, has been a heightened vulnerability to rapid changes in customer strategy. Thus, for example, when Compaq adopted a new strategy of marketing a complete desktop PC system for under $1,000 in 1997—a strategy that was quickly followed by competitors—many small PC manufacturers in Taiwan (China) were forced to close. Those that remained were able to survive only by rapidly shifting production to mainland China.

The development of in-house product design capabilities allows for the capture of more of the final price of the product, and can also provide some protection against uncertainties in the business environment by enabling more rapid response to shifts in demand. In fact, many Asian firms have successfully made the shift from OEM to ODM status (although, as Table 1 suggests, many more have not done so.)

Table 1. Interaction of East Asian manufacturing firms with foreign customers and suppliers, by sector (2000)\(^3\)

<table>
<thead>
<tr>
<th></th>
<th>All sectors</th>
<th>Apparel</th>
<th>Consumer Goods</th>
<th>Electronics</th>
<th>Vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ASEAN 4 (n=58)</td>
<td>China (n=310)</td>
<td>ASEAN 4 (n=18)</td>
<td>China (n=63)</td>
<td>ASEAN 4 (n=40)</td>
</tr>
<tr>
<td>Firm supplying parts designed in-house to foreign customers (as % of total)</td>
<td>28%</td>
<td>15%</td>
<td>29%</td>
<td>13%</td>
<td>40%</td>
</tr>
<tr>
<td>Firms supplying design and R&amp;D services to foreign customers (as % of total)</td>
<td>19%</td>
<td>7%</td>
<td>10%</td>
<td>4%</td>
<td>40%</td>
</tr>
</tbody>
</table>


\(^3\) The data in the table were obtained from a survey conducted by the World Bank in early 2001. More details on the survey are given in Appendix A.
The transition from ODM to brand-name production has been more problematical. There are certainly success stories among Asian brand-name producers. Firms like VTech and Fang Brothers in Hong Kong (China), Samsung in South Korea, Creative Labs in Singapore, and Acer in Taiwan (China) have developed brands for Western markets as well as for markets in Asia, and the OBM model has been influential throughout the region, especially in Taiwan (China), where Acer, the flagship firm of the Taiwan (Chinese) computer industry, had seemed to make the transition successfully (Dedrick and Kraemer, 1998). Some of the challenges and attractions of brand-name production were explained by the head of a Hong Kong (China) firm that produces both brand-name goods and OEM products for clients:

> With a label, you take on a series of challenges. It’s a baby to continuously enhance. If you work only OEM, if you work only for others, you’re taking commands from them. You’re on the hand-me-down side. You’re not in the decision-making seat.

But in the course of our interviews we encountered numerous firms that had retreated from a brand-name strategy back to an ODM or OEM focus, and our fieldwork in Taiwan (China) and elsewhere suggested that for many firms the OEM→ODM→OBM upgrading path had stalled at the ODM phase. Even Acer struggled and ultimately failed to establish a significant presence in the US market, and Fang Brothers has sold off its chain of retail outlets in the United States.

These problems have several causes. For would-be OBM manufacturers, the importing, sales, marketing, and distribution functions associated with brand-name products are entirely new and very different from their deep competencies in manufacturing and design. In our interviews many Asian NIC firms mentioned the high cost of penetrating advanced economy markets, especially at the retail level. Second, lead firms from the West continue to enjoy substantial design and marketing advantages resulting from their proximity to advanced country markets and lead users. While some Asian manufacturers have gained a great deal of expertise in post-architectural, detailed design, advanced economy lead firms appear to have a strong advantage in the realm of new product creation and conceptual design that allows them to continue to set product strategy and drive the broad trajectory of market development. Third,
Asian brand-name manufacturers that have retained OEM and ODM operations have had difficulty reassuring their customers that the customers' intellectual property and quality of service would not be compromised as they develop their own branded products, and have sometimes seen their preferred supplier status slip away when they have a measure of success with their own brands. Acer chairman Stan Shih recently acknowledged the problems that Acer’s own-brand operations had created for its contract manufacturing business: “In many cases we were in the final list [as a contract manufacturer], but . . . when they made a decision, they picked our competitors in Taiwan (China).”\(^5\) The latter, “pure play” OEM/ODM suppliers who had not developed an own-brand business such as Quanta and Hon Hai, were seen as less of a competitive threat to lead firms, and have seen their business grow accordingly.

Like other companies that have struggled with the OBM strategy, Acer appears to be re-focusing on its OEM and ODM businesses. (According to its latest corporate restructuring plan the company will divest its contract manufacturing operations from its brand-name business.\(^6\)) However, the OEM/ODM strategy, important as it has been for industrial upgrading in the region, now itself faces new questions. Indeed, one of the biggest challenges to the supplier-oriented upgrading approach in East Asia may turn out to be the emergence of a new class of highly sophisticated pure-play suppliers, mostly US-based, who are capable of supporting the manufacturing needs of US and European lead firms in Asia and around the world.

The supplier-oriented model of economic development has generally assumed that lead firms will continue to seek out or develop distinct supply bases in multiple locations, and that to achieve these objectives they will support the upgrading efforts of local firms. But our interviews with managers at dozens of lead firms and suppliers in the electronics and motor vehicle industries have cast doubt on both assumptions. This research has revealed a growing preference on the part of lead firms to expect considerably more from their suppliers, both functionally and in terms of geographic scope. The new requirements go well beyond excellent manufacturing performance and low costs, which are today perceived as being widely available and commodified. Today, suppliers must provide an independent process development capability, and an ability to perform a wide range of value-added functions associated with the

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manufacturing process, including help with product and component design, component sourcing, inventory management, testing, packaging, and outbound logistics.

Lead firms are also demanding that suppliers have the ability to support the lead firm’s operations and market-serving activities around the world. Getting the right part or process in the right place at the right time—as well as at the right cost and with a minimum of inventories in process and in transit—is critical. Even slightly out-of-date components, products, and processes quickly lose their utility and value. As the market and operational scope of many lead firms has become truly global, suppliers are being selected on the basis of their ability to provide global support. Such suppliers have the scale and scope to coordinate component sourcing and inventory management at a global level. Finally, as we have noted, lead firms have become less willing to use actual or potential competitors as suppliers, especially as globally operating “pure-play” suppliers have appeared on the scene as an alternative.

As we shall show in the following sections, these new requirements pose difficult challenges to the larger, established suppliers in the Asian NICs. The new requirements are also raising the barriers to market entry for smaller and/or younger suppliers throughout the region now seeking to participate in global value chains. On a larger scale, the emergence of a global supply base serving lead firms in the West raises questions about the long-term viability of the supplier-oriented upgrading model, and suggests a need to rethink at least some of the economic development policies that countries in the region have been pursuing. We take up these questions in the following sections.

III. Electronics: the Rise of Global Contract Manufacturers

Historically, most American electronics firms have purchased electronic components and assembled them in-house into sub-systems and final products of their own design. For transnational firms, a mix of on- and offshore assembly plants was used. Since manufacturing processes were quite labor-intensive, plants assembling high volume, price-sensitive products were often located in low labor cost areas, especially Mexico’s northern border region and in East Asia. In the 1960s Japanese firms began licensing local firms in Taiwan (China), Hong Kong (China), and Korea, initially to produce transistor radios and, later, hand-held calculators.

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6 Ibid.
Beginning in the 1960s, American (and later, European) semiconductor firms moved labor-intensive chip assembly processes to low-wage locations in East Asia, especially Singapore, Hong Kong (China), Malaysia, and Thailand (Scott, 1987). The attraction was low labor costs, and, for American firms, tariff exemptions that allowed them to pay duties only on the value that had been added through the assembly process, not on the semiconductor chips themselves. Once the semiconductors were assembled in Asia, they were shipped back to the United States and Europe, where they were sold to brand-name electronics companies and assembled into final products. For a time, nearly all semiconductor wafer fabrication, circuit-board assembly, and product-level assembly stayed in the United States, Northern Europe, and Japan. For circuit-board assembly, domestic contract manufacturers were used as “shock absorbers” during times of peak demand, when brand-name companies’ internal capacity was fully utilized, but not as a serious alternative to in-house manufacturing. In electronics, the typical contract manufacturing arrangement during the 1970s was for the brand-name firms to provide labor contractors—then known as “board stuffers”—with kits of components from their own inventories on a consignment basis. The contractors then supplied the labor needed to assemble the customer-supplied kits. Some overseas firms, in locations that included Hong Kong (China), Singapore, and Taiwan (China), also stepped into the board stuffer role.

In the 1980s, American brand-name electronics firms operating in high volume, price-sensitive market segments, such as disk drives and personal computers, began following the semiconductor industry offshore as a way to tap low-cost labor in Asia, either by establishing local subsidiaries or tapping the growing capability of Asian producers, especially in Taiwan (China). In the late 1980s, as progress towards European unification continued, American electronics companies moved the assembly of some products destined for the European market to Scotland and Wales to increase value-added within Europe. Scotland and Wales were most often chosen because of their relatively low labor and engineering costs, a well-trained English-speaking workforce, and aggressive efforts by local economic development agencies to attract foreign direct investment in electronics. IBM, for example, set up its largest European personal computer assembly facility in Greenock, Scotland.

Over time significant numbers of local contract manufacturers assembling circuit-boards for the affiliates of American brand-name electronics firms emerged, especially in the United States, Mexico, Scotland, Wales, Singapore, and Taiwan (China). Drawing on components from
nearby semiconductor assembly plants, both brand-name firms and their contract manufacturers, especially those located in Asia, began sourcing the bulk of their components locally. The local availability of components allowed brand-name firms to ask their Asian contractors to begin buying components on a turn-key basis, that is, with financing provided by the supplier.

In the early 1990s, some brand-name electronics firms in the United States moved beyond the tactical use of their contractors as providers of overflow capacity and began to use the most capable of them for more strategic purposes. The advantages included: manufacturing close to end markets or with low-cost labor; subjecting internal operations to market forces; keeping abreast of fast moving assembly technologies; and focusing their own activities on increasingly challenging “core competencies” such as product definition, design, sales and marketing. As the contract manufacturers grew in size, additional cost advantages accrued from scale economies derived from the pooling of manufacturing capacity and component purchasing. Lead firms also discovered that there were dynamic advantages to moving manufacturing further out-of-house: they could ramp production levels up and down more quickly and with less cost at contractor facilities than with in-house manufacturing. This proved to be an important asset in the face of a highly volatile and contentious market environment. Today, production outsourcing in electronics has become a widely accepted practice for both large and small brand-name electronics firms based in the United States, and increasingly, Europe.

More recently, globally-operating lead firms have been consolidating their contract manufacturing relationships by giving a larger share of their manufacturing to a smaller group of large, technologically-sophisticated contract manufacturers, nearly all of them of North American origin. Brand-name electronics firms are demanding that their contractors have a “global presence” as a way of streamlining the management of their outsourcing relationships. As a result, North American contract manufacturers have themselves been aggressively internationalizing since the mid-1990s.

During the past decade, global suppliers in the electronics industry have experienced rapid revenue growth, top-level consolidation, and geographic expansion. In the 1990s, established North American electronics firms in the computer and networking sectors, such as IBM, Nortel, Apple Computer, 3Com, Hewlett Packard, Maxtor, and Lucent, rapidly moved toward outsourcing their circuit-board and product-level assembly, notably by selling off much of their domestic and offshore production facilities to the five largest contract manufacturers
(CMs). Many newer North American electronics companies such as Sun Microsystems, EMC, Juniper Networks, Sycamore Networks, Cisco Systems, JDS Uniphase, and Network Appliance, outsourced most of their production from the outset, and their rapid growth during the late 1990s further fueled growth of the largest electronics CMs.

All of the top five CMs are based in North America. They consist of Solectron, based in Milpitas, CA; Flextronics International, incorporated in Singapore but managed from its San Jose, CA, headquarters; Sanmina/SCI, based in San Jose; Celestica, based in Toronto, Canada; and Jabil Circuit, based in St. Petersberg, FL. These five firms collectively grew at an average annual rate of 36% per year between 1994 and 2001 (see Table 2).

<table>
<thead>
<tr>
<th>COMPANY</th>
<th>1994</th>
<th>2001</th>
<th>Average Annual Growth Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solectron</td>
<td>1,641,617</td>
<td>18,692,000</td>
<td>42%</td>
</tr>
<tr>
<td>Flextronics</td>
<td>210,700</td>
<td>12,110,000</td>
<td>78%</td>
</tr>
<tr>
<td>Sanmina/SCI</td>
<td>2,363,581</td>
<td>11,248,651</td>
<td>25%</td>
</tr>
<tr>
<td>Celestica</td>
<td>1,989,000</td>
<td>10,004,000</td>
<td>26%</td>
</tr>
<tr>
<td>Jabil Circuit</td>
<td>404,056</td>
<td>4,331,000</td>
<td>40%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>6,608,954</td>
<td>56,385,651</td>
<td>36%</td>
</tr>
</tbody>
</table>

* All Celestica revenues in 1994 were from IBM.

Source: Company annual and quarterly reports.

In the latter part of the 1990s, the outsourcing trend began to spread to most of the major European communications infrastructure suppliers as well, especially Ericsson and Alcatel, and to a lesser degree Nokia and Siemens. In 1997 Ericsson made a decisive series of moves, first by outsourcing production to Solectron, Flextronics, and SCI, and then by selling its principal domestic production facilities in Karlskorna, Sweden, to Flextronics and a plant in Brazil to Solectron (Dunn, 1997). Solectron established a local presence in Sweden as well, but shifted the bulk of Ericsson’s circuit-board assembly to its existing network of plants in France, Germany, and Scotland (Jonas, 1997). In 2000, Ericsson shifted the remainder of its cell phone production to these American CMs, and sold its US production facilities to SCI (Electronics Weekly, 2000).

In the past two years even a few Japanese electronics firms have tested the waters. In December 2000 NEC, whose cell phone handset business was doing poorly in the midst of a
fierce shakeout, announced that it was selling its cell phone production facilities in England and Mexico to Solectron, while keeping facilities in Japan and China (Bloomberg News, 2000). In October 2000, Sony announced that it was selling two underutilized Asian facilities to Solectron, one in Miyagi, Japan, and a second in Kaohsiung, Taiwan (China) (Levine, 2000). In January 2002, NEC announced the sale of two of its advanced manufacturing facilities in Miyagi and Yamanashi, Japan, to Celestica. About 1,200 highly-skilled NEC manufacturing specialists and related support staff became Celestica employees. As part of the deal, Celestica assumed supply chain management, sub-assembly, final assembly, integration, and testing responsibilities for a broad range of NEC’s optical backbone and broadband access equipment. The companies expect the deal to generate revenue of approximately US$2.5 billion for Celestica over a five-year period. According to Kaoru Yano, Senior Vice President of NEC and Company Deputy President of NEC Networks:

NEC’s growing partnership with Celestica will allow us to improve our competitive positioning by further leveraging our leading-edge R&D, product development and manufacturing expertise with Celestica’s global manufacturing capabilities and supply chain management expertise. Through the alliance with Celestica, NEC intends to improve price competitiveness, production lead-times and supply chain flexibility to optimize overall manufacturing efficiency. NEC also chose to work with Celestica based on its reputation for providing global, advanced manufacturing capabilities and cost-effective supply chain solutions for the world’s best communications and information technology companies.

As we have already mentioned, most of the growth in electronics contract manufacturing has taken place in the very top tier of firms. Electronic Trend Publications (2000) estimates that the top five CMs had captured 38% of the electronics contract manufacturing market by 1999, and expects this share to grow to 65% in 2003. This rapid expansion, fueled by the acquisition of competitors and customer facilities as well as organic expansion in existing and newly established facilities, was aided by the US stock market run up in the late 1990s, which concentrated 90% of the market capitalization in the top five CMs.

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7 In 2001 SCI was acquired by Sanmina.
8 The design and development functions currently performed by NEC Miyagi will remain with NEC and NEC Miyagi will continue as a developer of optical transmission systems. The development and manufacturing of optical devices and optical submarine cable systems at NEC Yamanashi’s Otsuki Plant will also remain with NEC.
Each of the largest electronics contract manufacturers has established a global network of plants that consist of 1) low-product-mix, high-volume production sites, mostly in Asia, Mexico, and East Europe; 2) high-product-mix, medium-to-high volume production sites in the United States, Canada, Western Europe, and now Japan; 3) engineering-heavy “new product introduction” centers, often located near an important customer’s design activities; and 4) facilities that perform final assembly and product configuration to order and/or provide after-sales repair service, often located near major transportation hubs, such as Memphis, Tennessee and Amsterdam. All have large-scale investments for high volume production in East Asia, especially in South East Asia and increasingly in China.

The rapid geographic expansion of these firms is worth noting in some detail. Celestica, which spun off from IBM in 1996, began with two production locations, a large complex near Toronto, Canada and a small facility in upstate New York, since closed. Today, after completing 29 acquisitions, Celestica operates nearly 50 facilities in North America, South America, Europe, and Asia and generates annual revenues in excess of $11B (see Figure 1). In Asia, the company established or acquired facilities in Dongguan, Suzhou (2), Shanghai, Xiamen, and Hong Kong (China), China; Parit Buntar, Kulim, and Johor Baru (3), Malaysia; Bintan and Batam, Indonesia; and Singapore (3). Other high volume production sites were established in Kladno and Rajecko, Czech Republic; Guadalajara, Querétaro, and Monterrey (2), Mexico; and Hortolandia and Guarulhos, Brazil.

Figure 1. Celestica’s Global Footprint, 2001
Another striking example of rapid geographic expansion is the largest electronics CM, Solectron, which was concentrated in a single campus in Silicon Valley until 1991, when its key customers, including Sun Microsystems, Hewlett Packard, and IBM, began to demand global manufacturing and process engineering support. Within ten years, the company’s footprint had expanded to nearly 50 facilities worldwide (see Table 3). Today this network consists of global and regional headquarters, both high and low mix manufacturing facilities, materials purchasing and management centers, new product introduction centers, after-sales repair service centers for products manufactured by Solectron and others, and technology centers to develop advanced process and component packaging technologies.

As mentioned previously, estimates by Technology Forecasters, IDC, and Prudential Financial all peg the CM penetration of the total available market for circuit board and product-level electronics manufacturing in 2000 at roughly 13%. A recent Bear Stearns survey of brand name electronics firms concluded that the rate and size of outsourcing agreements will continue to increase, with 85% of the firms interviewed planning on further increases in production outsourcing. As a group, the branded electronics firms in the survey expected to outsource 73% of total production needs on average, and 40% stated their intention ultimately to outsource 90% to 100% of final product manufacturing. The CEO of Flextronics has stated publicly that he expects annual revenues at his company to reach the $100 billion range in the next 5-10 years.

In some instances the expansion of North American CMs in East Asia has come about through the acquisition of established regional firms, such as Solectron’s acquisition of NatSteel Electronics (Singapore) and Ocean Electronics (Hong Kong (China)) in the late 1990s. In the future, the North American CMs may compete directly with the largest indigenous electronics contract manufacturers in East Asia, and may already be constraining the growth of Asian-owned firms. Given the importance of the electronics industry in East Asia’s industrial upgrading, the question of how much business indigenous East Asian electronics suppliers will capture in the ongoing shift from in-house to outsourced production is an important one for the future of economic development in the region. Chapter 3 explores this question further and, in particular, examines not only the strengths of the CMs, but also the risks they face.
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Source: Solectron

HQ: global and regional headquarters; Mfg: manufacturing facilities; Mat: materials purchasing and management centers; NPI: new product introduction centers; Serv: after-sales repair service centers; Tech: process technology centers.
IV. Motor Vehicles: the Rise of the Mega-Suppliers

The interest in producing motor vehicles close to final markets has always been strong, though the motivations have changed over time. Prior to the advent of mass production in 1910, automobiles were luxury products and the need for customization required proximity to pools of well-heeled customers. When mass production lowered the cost of the automobile to the point where mass markets developed, final assembly moved close to final markets to reduce transport costs. In the 1930s, overcoming trade barriers erected by national governments become the main motivation for offshore production. Automakers were forced to establish local production or forgo participation in the most promising emerging markets of the day. By 1928 Ford and GM were assembling vehicles in 24 countries, including Japan, India, Malaysia, and Brazil. Ten years later both companies were operating large-scale integrated “transplant” facilities in Europe. When trade barriers were extended to automotive parts, automakers moved to integrate offshore production and source parts locally to the extent possible. Both tariff and non-tariff barriers to trade in finished vehicles—or the threat thereof—continue to be a key motivation for the growth of offshore production today.

The number of automakers willing and able to compete in the arena of international production increased markedly in the 1980s, but competition for American automakers in the developing world had already begun in the late 1950s, when European producers had recovered sufficiently from World War II to begin investing in Latin America, South Africa, and Australia. During the 1960s and 1970s a regional pattern emerged. Most new offshore assembly plants established by American and European automakers were located in Latin America and most offshore plants by Japanese firms were located in Asia. There were exceptions to this pattern, namely GM’s and Ford’s investments in Taiwan (China), and a few small Japanese investments in Brazil, Peru, and Ecuador. In the 1980s, the remarkable successes of the Japanese automakers’ export strategy in the United States at the direct expense of the American Big Three sparked a political backlash,

9 Investments by Japanese automakers, however, tended to be of a very different character than those of American and European firms. American and European firms tended to build larger, more integrated plants, whereas Japanese plants relied heavily on the assembly of vehicle “kits” sourced from home factories. Japanese investments were highly conservative, in that assembly plant investments remained scaled to the actual, not potential, size of the local market – something that is still true today. Still, in places where Japanese automakers faced no competition from more aggressive investors, such as the ASEAN countries of Thailand, Indonesia, and Malaysia, they were able to capture the lion’s share of these markets, especially in countries where local content rules became more stringent over time (Doner, 1991).
which resulted in the setting of “voluntary” limits to continued market share expansion via exports. In response to these quotas, Japanese automakers embarked on a wave of plant construction in the United States (Kenney and Florida, 1993). By 1995 Japanese automakers were manufacturing two thirds of the passenger vehicles they sold in the United States locally. A similar dynamic led to a wave of Japanese transplants in Europe, beginning with Nissan’s plant in the U.K. in 1986. By 1995 Japanese automakers were manufacturing nearly one third of the passenger vehicles they sold in Europe locally.

In the 1980s American and European automakers, under increasing competitive pressure from the rather sudden appearance of fierce new competition from Asia, began importing finished vehicles into their home markets from operations in lower-cost peripheral locations (e.g., Canada, Mexico, Spain, and East Europe) within the context of regional trade agreements such as the North American Free Trade Agreement (NAFTA) and the European Union.

During the 1990s there was a wave of new assembly and supplier plant construction in emerging markets such as China, India, Thailand, Vietnam, Brazil, Mexico, and East Europe. These new investments were driven by increased competition and market saturation at home, the opening of new spaces for investment following the end of the Cold War, host country requirements for local content and production, and an effort by automakers to cut costs within the context of regional trade arrangements such as NAFTA and the European Union.

The idea that emerging markets, particularly in Asia, would be the locus of rapid economic growth in the medium term stimulated a huge wave of new investment in Asia during the 1990s, particularly in China and ASEAN. Industry consultants projected that Asia and Eastern Europe would have the highest rates of production growth, with Asia outside of Japan generating 55% of the world’s new production. Developing countries, taken together, were projected to account for 80% of all new production (Sturgeon and Florida, forthcoming). The Asian financial crisis brought the investment boom to an abrupt end, and many of the motor vehicle investment projects in Asia were scaled back or put on hold. Still, the long-term projections for the development of the motor vehicle market in large Asian countries such as India and China remain very positive. In an interview with IPC researchers in 2000, the manager of a German automotive parts supplier in China asserted that 50 million cars would be sold annually in China by 2050, 3.5 times the size of the current US market.
As the number of production locations multiplied during the 1990s, automakers sought to streamline operations on a global scale, particularly in the arena of vehicle design and component sourcing. Most automakers today are seeking to place a greater number of car models on fewer under-body platforms, allowing for greater commonalization and reusability of parts while retaining the ability to adapt specific vehicle models to local tastes and driving conditions. Such strategies call for global sourcing, tighter coordination of worldwide design efforts, and in cases where platform design activities have become geographically dispersed over time (i.e., in American firms), consolidation of project management in core locations and the formation of international design teams. At the same time, the need to respond to unique market requirements has created pressure to localize body design, prompting highly centralized automakers (i.e., Japanese firms) to set up regional design studios to cater to local tastes. Since the benefits of global platforms can only be reaped when they are used and reused across a broad product line, there has been a wave of consolidation in the industry as large players acquire small, specialty producers. Efforts to create global platforms, often thought to have begun with the ‘world car’ strategies of the 1980s, in fact long predate this, and can be traced as far back Ford’s failed “1928 Plan,” which aimed to supply Model As to the world from three giant River-Rouge style plants in Detroit, Canada, and England. The current trend, however, includes an entirely new feature: the formation of a global supply-base.

The recent round of globalization in the motor vehicle industry has helped to change the nature of relationships between automakers and their largest suppliers. First-tier suppliers are moving to module design, second tier component sourcing, and the provision of local content in the context of emerging markets. The growing need to provide automakers with modules on a worldwide basis is driving a wave of consolidation and geographic expansion among first-tier suppliers, just as it has in the electronics industry. For suppliers that serve multiple automakers, the geographic scale of operations can surpass that of any single customer. In the long run it may well be suppliers, not automakers, that generate the vast majority of the industry's future foreign direct investment (FDI)—and the associated economic and social benefits (e.g. employment).

As in electronics production, the outsourcing trend in the motor vehicle sector has been strongest among American firms. The structure of the motor vehicle industry in the United States, and the characteristics of the jobs within it, have changed radically since 1986, when long-time rough employment parity between the assembly and parts sectors began to diverge
(see Figure 2). Since the 1980s the supply sector has been the main source of job growth in the United States automotive industry, adding 220,900 jobs since 1982, compared with only 25,300 jobs in assembly.

**Figure 2. The Deverticalization of the US Motor Vehicle Industry; Assembly and Parts Employment, 1958-2000 (’000 jobs)**

In the realm of vehicle manufacturing, automakers are performing far fewer functions within their assembly facilities than they have in the past. Vehicle assembly lines have been streamlined; integrated “feeder” lines building up sub-assemblies such as seats, cockpits, and climate control systems within vehicle assembly facilities have all but disappeared. Assembly workers now bolt together a greater number of large sub-assemblies of individual components, known as “modules,” that have been pre-assembled off-site by suppliers. Modules arrive fully assembled on the loading docks of final assembly plants, ready to be attached to vehicles as they move down the line. The result is more production workers in supplier plants and fewer in final assembly plants.
Modularity. Modularity has already been mentioned in the context of final assembly, but it has important consequences for the scope of supplier activities as well. As automakers do less within their assembly plants, suppliers have an opportunity to do more. For example, vehicle doors can be delivered with the glass, fabric, interior panels, handles, and mirrors pre-assembled. Dashboards can be delivered complete with polymers, wood, displays, lights, and switches. One manager interviewed during our research estimated that 75% of vehicle value can be accounted for by only fifteen modules. Important modules are suspension (supplied as “corners”); doors; headliners (which can come with grip handles, lighting, wiring, sunroof, sun visors, and trim pre-assembled); heating, ventilation, and air conditioning (HVAC) units; seats; dashboards; and drive trains (i.e. engines, transmissions, and axles). A continuation of the trend toward modules would mean that suppliers would provide automakers with groups of related modules, in what might be called “module systems.” For example, seats, interior trim, the headliner, dashboard, and cockpit module could be supplied as a complete “interior system.” Figure 3 provides a graphic representation of the trend from discrete parts to modules and then module systems.¹⁰

The drive toward modularity is associated with supply-base consolidation, as first-tier suppliers buy second-tier suppliers to gain the broader range of capabilities needed to supply modules and systems. TRW’s recent acquisitions, for example, have given the company the capability to deliver all aspects of occupant restraint systems. Modularity creates natural “break-points” in the value chain, and makes the outsourcing and/or relocation of module design and production more feasible. But modularity can also be pursued largely as an in-house strategy, as at Volkswagen, where internal subsidiaries have moved beyond the manufacture of parts to the assembly of modules and systems that are delivered to streamlined assembly plants.

¹⁰ It is important to note that some modules comprise contiguous sub-assemblies, while others do not. For example, seats and HVAC units comprise physically contiguous sub-assemblies, while vehicle electronics or occupant safety can consist of a variety of physically discrete components that work together to make up a functional system. Contiguous sub-assemblies provide the key benefit of assembly-line simplification, while non-contiguous systems do not. Sourcing non-contiguous modules from a single supplier provides opportunity for automakers to pass the responsibility for system integration to suppliers. For example, an electronics supplier such as Bosch, Delphi, Siemens Automotive, or Visteon can take responsibility for ensuring that engine controls work properly with temperature, pressure, r.p.m., and other sensors that provide information to the control unit. In other instances, sourcing non-contiguous modules is a way for automakers to pass warranty responsibility for entire aspects of vehicle quality—such as engine and transmission sealing or occupant restraint—on to suppliers. This is not to imply that industry nomenclature in the area of modules and systems has been standardized; some automakers refer to contiguous sub-assemblies as “modules” and functionally related non-contiguous parts as “systems.”
Because larger modules are more difficult and expensive to ship over long distances and are also more likely to be “sequenced” (i.e., coordinated tightly with the final assembly process), the adoption of modular assembly processes is associated with the co-location of assembly plants and supply plants. In-line sequencing has accelerated the adoption of “just-in time” parts delivery, where modules are delivered according to the sequence of cars moving down the assembly line. A key motivation for in-line-sequencing is color matching. Mirrors, interior panels, seats, dashboards, carpets, door handles, and bumpers all have to match or accent the body color, and thus must be tightly sequenced with the colors of vehicles on the final assembly line.

Globalization is occurring at the same time as increased outsourcing and the move to sourcing modules and systems, and so many suppliers are taking a larger role in the globalization process. Companies like Bosch, Johnson Controls, Lear, Magna, Siemens Automotive, TRW, Yazaki, and others have become the preferred suppliers for automakers around the world. Many
first tier suppliers have responded by embarking on a wave of vertical integration (through mergers, acquisitions, and joint-ventures) and geographic expansion to gain the ability to deliver parts and modules on a global basis. The entry of GM’s and Ford’s former component divisions into the merchant market for vehicle components, modules, and systems has, almost overnight, created the world’s two largest, most diversified, and geographically extensive automotive suppliers.

Unlike the global contract manufacturers in electronics, global suppliers in the motor vehicle industry have emerged from Japan and Europe as well as North America. Still, the trends toward rapid growth, geographic expansion, and consolidation are most pronounced among suppliers based in North America. Bosch and Siemens Automotive, both based in Germany, have tended to remain more focused on their core activities, but since their focus has long been electrical and electronic systems for vehicles, their growth has been in part due to the increased electronic content in vehicles, and in part to increased sales to Japanese and especially American automakers. Major European suppliers are experimenting with a modular approach, however, especially with their American customers. In 2000, Siemens Automotive acquired another German firm, VDO, which added cockpit instrumentation capability to Siemens’ climate control and interior plastics capability. This has allowed the firm to bid on completely built-up dashboard modules.

To illustrate the radical pace of change in the motor vehicle supply-base, we consider the case the German tire manufacturer Continental AG in some detail. Continental has long specialized in tires for the retail market and had already established a global manufacturing presence in tires by the early 1990s. As late as 1995, Continental was still concentrated in the retail tires market, and ranked 52nd in the world in terms of direct sales to automakers. That year, the company established Continental Automotive Systems Group, and began acquiring

11 The integral nature of product architecture in motor vehicles makes it harder for lead firms in the industry to switch suppliers, so they tend to bring their suppliers with them when they set up international operations, while the more standard interfaces and production processes in electronics have allowed contract manufacturers from North America to surge ahead and more easily win business from lead firms of many nationalities.

12 Continental established a global manufacturing presence in tires largely through acquisition. In 1979, the company acquired the European assets of Uniroyal (USA), a deal that included plants in Belgium, the UK, France, and Germany. In 1985 Semperit Reifen AG (Germany) was acquired, adding plants in Austria and Ireland (since closed). In 1987, Continental acquired General Tire (USA), including four plants in the USA, two in Mexico (since sold), and a series of joint venture operations in Asia, Africa, and South America. In 1991 a joint venture agreement
automotive suppliers with a wide variety of competencies and geographic attributes, such as TBA Belting (UK) and ITT Brake and Chassis (USA). The latter acquisition, which was valued at nearly $2B, added 23 plants and 10,000 employees. To round out the company’s global footprint, Continental made a series of additional acquisitions in Argentina, Brazil, Slovakia, Romania, Mexico, and South Africa. In 2001, Continental acquired Temic Microelectronic GmbH, a medium-sized ($900M in revenues) German automotive electronics firm with 3,000 employees and nine manufacturing facilities in Germany, and also a small, newly established global footprint, including 2,800 workers at factories in Mexico, Hungary, the Philippines, China, and Brazil, and two technical centers, one at its headquarters in Germany and a new center in Auburn Hills, MI, just north of Detroit. Continental’s product strategy is threefold: to leverage competence in synthetic rubber by entering markets for power transmission belts and other rubber parts for motor vehicles; to develop integrated modules from the tire inward, including assembled wheels, brakes, and suspension parts; and to enter the high growth area of vehicle electronics. Today Continental’s automotive divisions operate 140 facilities in 36 countries and employ 64,000. Development centers are located in Detroit and Germany. By 2000 Continental had jumped to number 12 in the global ranking of sales to automakers (see Table 4.)

As Tables 4 and 5 show, most of the largest and most rapidly growing suppliers providing auto parts and modules are based in North America. Consider the example of Lear. The company's focus is on automotive interior modules and systems, which are used in vehicles bearing the nameplates of GM, Suzuki, Hyundai, Isuzu, Jaguar, Mazda, Opel, Ford, VW, Porsche, Mercedes, Chrysler, Saab, Subaru, Fiat, Daewoo, Renault, Toyota, Mitsubishi, Honda, Audi, BMW, Peugeot, Nissan, Volvo, and Rover, among others. Headquartered in Southfield, MI, Lear has grown to 120,000 employees working at more than 200 locations in 33 countries. Lear rose from the world's 13th largest automotive supplier in 1995 to the fifth largest in 2000, with record sales of $14.1 billion.

As already mentioned, the spin-off of the internal parts divisions of General Motors and Ford in the late 1990s created the world’s two largest and most diversified automotive parts suppliers, with capabilities to supply complete modules and with global operations from the outset. For example, Visteon has system and module capabilities in chassis, climate, electronics,
glass and lighting, interior, exterior trim, and power-train. The company currently operates 42 facilities in the US and Canada; 29 in West Europe; 22 in Asia, nine in Mexico, six in East Europe, and four in South America. In East Asia, Visteon operates plants in Nanchang, Changchun, and Shanghai (3), China; Japan (5); the Philippines, South Korea (5); Taiwan (China); and Thailand (2). (Three other plants are located in India.) System and module engineering work is carried out in Japan, Germany (3), England (3), and the United States (4).

Though outsourcing is an industry-wide phenomenon, our research has also identified significant variations in the speed, extent, and nature of deverticalization among automakers. GM and Ford, long among the most vertically integrated automakers, have been aggressively outsourcing to cut costs and reduce overhead, both by increasing their use of outside suppliers and, as noted, by moving to spin off their internal parts subsidiaries as independent “merchant” firms. Even so, sourcing is still fairly traditional at GM and Ford, which have globally centralized and notoriously predatory purchasing organizations. In the resulting atmosphere of price pressure and mistrust, suppliers are only slowly and irregularly gaining influence over design. There is some experimentation with pre-selection of suppliers and involvement prior to project approval where suppliers are asked to bid on the parts they would like to design and produce, but the drive toward lowest-cost sourcing and ongoing cost reduction is still very strong. As a result, there is tension between the purchasing organization, which pushes for lower costs, and manufacturing, which pushes for modularity, local content, and co-location. DaimlerChrysler’s Chrysler Division, by contrast, has long sourced as much as 70% of the value of its vehicles from outside suppliers. Chrysler’s relationship with suppliers is far more consultative than GM or Ford, and the company has asked suppliers to perform a significant amount of module design and engineering work.

(http://www.conti-online.com/). In 1992, the company acquired the Swedish tire producer Nivis Tyre.
Table 4. Top Fifteen Motor Vehicle Parts Supplier, 1995 and 2000 Rank by Home Region and Country, 1995-2000 Compound Annual Growth Rate

<table>
<thead>
<tr>
<th>Home Country/Region</th>
<th>Company</th>
<th>World Rank 1995</th>
<th>World Rank 2000</th>
<th>95 World OEM Sales, $M</th>
<th>00 World OEM Sales, $M</th>
<th>CAGR 95-2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>North American</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA</td>
<td>Delphi</td>
<td>1</td>
<td>1</td>
<td>26,400</td>
<td>29,100</td>
<td>2%</td>
</tr>
<tr>
<td>USA</td>
<td>Visteon</td>
<td>6</td>
<td>3</td>
<td>9,200</td>
<td>19,500</td>
<td>16%</td>
</tr>
<tr>
<td>USA</td>
<td>Lear</td>
<td>13</td>
<td>5</td>
<td>4,707</td>
<td>14,100</td>
<td>25%</td>
</tr>
<tr>
<td>USA</td>
<td>Johnson Controls</td>
<td>15</td>
<td>6</td>
<td>4,420</td>
<td>11,869</td>
<td>22%</td>
</tr>
<tr>
<td>USA</td>
<td>TRW</td>
<td>7</td>
<td>7</td>
<td>6,100</td>
<td>11,000</td>
<td>13%</td>
</tr>
<tr>
<td>Canada</td>
<td>Magna</td>
<td>19</td>
<td>8</td>
<td>3,223</td>
<td>10,099</td>
<td>26%</td>
</tr>
<tr>
<td>USA</td>
<td>Arvin Industries</td>
<td>32</td>
<td>13</td>
<td>1,792</td>
<td>5,153</td>
<td>24%</td>
</tr>
<tr>
<td>USA</td>
<td>Dupont Auto</td>
<td>18</td>
<td>14</td>
<td>3,500</td>
<td>5,100</td>
<td>8%</td>
</tr>
<tr>
<td>Average North American</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>Denso</td>
<td>2</td>
<td>4</td>
<td>15,000</td>
<td>16,392</td>
<td>2%</td>
</tr>
<tr>
<td>Japan</td>
<td>Aisin World</td>
<td>5</td>
<td>9</td>
<td>11,587</td>
<td>8,301</td>
<td>-6%</td>
</tr>
<tr>
<td>Japan</td>
<td>Yazaki</td>
<td>10</td>
<td>11</td>
<td>5,000</td>
<td>6,000</td>
<td>4%</td>
</tr>
<tr>
<td>Average Japanese</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0%</td>
</tr>
<tr>
<td>European</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>Robert Bosch</td>
<td>3</td>
<td>2</td>
<td>14,200</td>
<td>20,550</td>
<td>8%</td>
</tr>
<tr>
<td>Germany</td>
<td>Continental</td>
<td>52</td>
<td>12</td>
<td>800</td>
<td>5,500</td>
<td>47%</td>
</tr>
<tr>
<td>France</td>
<td>Valeo</td>
<td>11</td>
<td>10</td>
<td>5,000</td>
<td>8,200</td>
<td>10%</td>
</tr>
<tr>
<td>Average European</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>22%</td>
</tr>
<tr>
<td>Average top 15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>14%</td>
</tr>
</tbody>
</table>

Table 5. Top Fifteen Motor Vehicle Parts Suppliers, Share of Sales in North America, 1995 and 2000

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>North American</td>
<td>Delphi</td>
<td>21,800</td>
<td>23,600</td>
<td>83%</td>
<td>81%</td>
</tr>
<tr>
<td>USA</td>
<td>Visteon</td>
<td>8,140</td>
<td>14,400</td>
<td>88%</td>
<td>74%</td>
</tr>
<tr>
<td>USA</td>
<td>Lear</td>
<td>3,373</td>
<td>8,600</td>
<td>72%</td>
<td>61%</td>
</tr>
<tr>
<td>USA</td>
<td>Johnson Controls</td>
<td>3,257</td>
<td>7,596</td>
<td>74%</td>
<td>64%</td>
</tr>
<tr>
<td>USA</td>
<td>TRW</td>
<td>3,300</td>
<td>5,610</td>
<td>54%</td>
<td>51%</td>
</tr>
<tr>
<td>Canada</td>
<td>Magna</td>
<td>2,579</td>
<td>6,111</td>
<td>80%</td>
<td>61%</td>
</tr>
<tr>
<td>USA</td>
<td>Arvin Industries</td>
<td>892</td>
<td>3,252</td>
<td>50%</td>
<td>63%</td>
</tr>
<tr>
<td>USA</td>
<td>DuPont Auto</td>
<td>2,500</td>
<td>2,550</td>
<td>71%</td>
<td>50%</td>
</tr>
<tr>
<td>Average North American</td>
<td></td>
<td>5,730</td>
<td>8,965</td>
<td>72%</td>
<td>63%</td>
</tr>
</tbody>
</table>

Japanese

| Japan        | Denso            | 2,300                   | 3,803                   | 15%                        | 23%                        |
| Japan        | Aisin World      | 563                     | 664                     | 5%                         | 8%                         |
| Japan        | Yazaki           | 1,600                   | 2,400                   | 32%                        | 40%                        |
| Average Japanese |           | 1,488                   | 2,289                   | 17%                        | 24%                        |

European

| Germany      | Robert Bosch    | 1,576                   | 6,200                   | 11%                        | 30%                        |
| Germany      | Continental     | 350                     | 1,650                   | 44%                        | 30%                        |
| France       | Valeo           | 600                     | 2,246                   | 12%                        | 27%                        |
| Average European |         | 842                     | 3,365                   | 22%                        | 29%                        |

Source: Automotive News, 1996; Crain’s Detroit Business, 2001

Japanese automakers are well known for their extensive reliance on multi-tiered supplier networks and high outsourcing levels. The nature of Japanese supplier networks tends to be more “captive” than those that have been developed by American and European firms, that is, Japanese suppliers tend to be more dominated by their largest customer. For example, Japan’s largest supplier, Denso, a Toyota Group company, generated half of its revenues from Toyota in 1997, and none from Toyota’s arch rival, Nissan. Such captive relationships inhibit the build up of external scale economies, and engender financial and technological dependence of suppliers on their largest customers. On the other hand, the integral nature of product architecture in motor vehicles may well favor this kind of tight integration between lead firms and their suppliers, as the continued superior performance of firms such as Toyota may attest. In this hierarchical
system, it is not surprising that the trends toward modularity and the outsourcing of component
design and engineering are much weaker among Japanese automakers. As mentioned above,
Volkswagen has pursued modularity and final assembly plant simplification largely as an in-
house strategy, although its plants outside of Germany appear to be making much greater use of
external suppliers. Premium European brands such as BMW and Mercedes have outsourced very
little of their component design and engineering.

**Prospects for local suppliers in East Asia.** Global suppliers in the motor vehicle industry most
often establish production facilities in developing countries at the behest of their customers who
have set up final assembly plants and are trying to meet local content requirements. While
suppliers are hard pressed to establish plants in all of the locations where their customers operate,
they are only willing to invest in certain countries, especially those where there are multiple
automakers present and where lower operating costs raise the possibility of large scale exporting.
China is seen as such a location, as are smaller countries with dynamic vehicle markets and the
possibility of raising quality levels to world standards without too much trouble, such as
Thailand. What is clear is that having a plant in each East Asian country makes no economic
sense to suppliers and that trade liberalization will very likely lead to dramatic consolidation.

The rise of suppliers with global reach and the technical sophistication necessary to
design and produce complex modules and sub-systems is making supplier-oriented industrial
upgrading in the motor vehicle industry increasingly difficult. To paraphrase a manager of a
Taiwan (China)ese automotive parts producer interviewed by IPC researchers:

> Despite lower operating costs than Western suppliers we cannot win business in ASEAN
outside of our home economy because we are not present in the industry’s design centers.
In China, we suffer from the additional problem of not being part of the local supply
base. We have not been asked to follow our American customer to new locations such as
India. They prefer to work with American suppliers worldwide. In general, it is difficult
for Taiwan (China)ese firms to get into the American supplier networks because all Big 3
design is done in Detroit. To supply Ford, a company needs to have at least an office in
Detroit and in some cases, manufacturing facilities there too. If we were in Detroit, we
could get assembly drawings and make bids on parts. We have more or less given up on
building business with the Big 3. This is a critical problem because the local market is
slow growing. Only by expanding regionally, especially into China, will we be able to attain better scale economies. But the [vehicle] platforms must be the same. In Asia, relationships between firms are different: they tend to be long-term and firms take care of each other.

The ongoing globalization of the motor vehicle industry and the new role of suppliers in supporting the increasingly integrated global operations of automakers has important implications for supplier-oriented development in East Asia. The potential for local sourcing in the motor vehicle sector is high because of the large number, size, and weight of components and materials. With tariffs on imported parts, locally operating suppliers have a huge advantage. For example, a manager at a global automotive parts supplier in China interviewed by IPC researchers stated a willingness to pay local suppliers a price equivalent to the worldwide price plus tariffs and transportation costs. What is clear is that local content, when it is provided, will come from the affiliates of global suppliers; a lack of technical competence has generally confined locally owned suppliers to simple, standardized, and slow changing components such as bearings where there is a wider market that supports adequate scale economies.

Local suppliers in Asian NICs have gained little design responsibility. As a manager of a German automotive parts producer in China interviewed by IPC researchers put it: “Design responsibility remains in Germany.” According to a local supplier interviewed in Taiwan (China) by IPC researchers, “Ford does not allow changes in the ‘hot’ or critical points of cars, such as gear boxes, engine, chassis but only ‘soft point’ changes, e.g., front and back end styling.” The result is a somewhat loose technological relationship between the actors in the offshore supply chain while tight linkages are forged and maintained in the advanced economies. This puts a ceiling on the engineering capabilities that can be developed at suppliers based in emerging economies. As a manager at an American-owned auto parts firm interviewed in China by IPC researchers stated: “The auto industry in China is a ‘veneered industry’—while it appears that Chinese firms are major suppliers to assemblers, all are propped up by huge amounts of

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13Note: The direct quotes included in this paper are intended to provide a window into the attitudes and desires of industry participants that might not be otherwise available. They are not meant as statements of fact or accurate predictors of outcomes. Many of the statements are highly controversial and are meant to highlight important issues and areas of tension. These are individual opinions with which the authors may or may not agree. Manager and company names have been excluded to protect the confidentiality of the research subjects.
imports.” Another manager at a foreign invested manufacturer of fuel system components and wire harnesses in China interviewed by IPC researchers stated:

We use only 5 or 6 local suppliers and local content is only around 2%. Even for relatively simple products like wire harnesses 85% of materials is imported from places like Japan and Korea. Because of customs duties, transportation costs, “harassment” at customs, etc., these materials are very expensive. Automakers do not even buy all their steel in China because they cannot get the necessary quantities at the right quality. [The lack of] true local sourcing is the biggest impediment to growth of the industry in China. China hasn’t done enough to allow its basic industries to survive. If the raw materials sectors do not develop, Chinese firms that do not have access to a global supply system will die after WTO is implemented. First-tier suppliers are pressuring their material suppliers to move to China. We have given many of our suppliers an ultimatum: by a certain year, they must either establish facilities in China or provide the company with imported material at a “domestic” price— the price they could achieve if they were located in China and not paying customs duties, transport costs, etc. Material suppliers, though, are reluctant to move to China because they are not sure they can reach critical economies of scale and because there is a shortage of basic commodity inputs in China. Material suppliers are particularly sensitive to commodity prices and quality because as one moves further up the supply chain in wire harnesses, materials become far more important than labor in determining total costs.

The result of these tensions is that the supply chains that are emerging in developing countries are increasingly foreign-owned and very “thin.” Core design activities remain concentrated in advanced economies, and many parts and materials continue to be imported. Trade, market, and investment liberalization will cause a further thinning as specific activities consolidate in particular places and export either regionally or globally. Some of the respondents interviewed in the Chinese motor vehicle industry by IPC researchers believed that foreign automakers have no intention of manufacturing locally when China joins the WTO and drops its import restrictions. This view sees current operations as loss leaders that provide foreign automakers with a means to develop brand recognition and distribution and service networks for vehicles that they will later import.

Thun (2001) suggests two alternative strategies for local motor vehicle parts suppliers facing these difficulties. The first calls for local suppliers to join forces with global suppliers, either through mergers, joint ventures, or alliances. Local suppliers can offer global suppliers additional production locations and help in the creation of “complementarity schemes,” where vehicle components are exchanged within a region to offset tariffs and concentrate production to
build up scale economies. The second strategy would require local suppliers to serve global suppliers at a lower tier, supplying local content. But as local content rules are phased out, many parts will be produced on a regional basis to increase scale economies, undermining the rationale for regional complementarity schemes and putting further pressure on local firms. This pressure may force local suppliers from smaller Asian countries to invest in regional production centers, where they will either come into direct competition with global suppliers, or if the second tier option is followed, with local suppliers following the same strategy. A third option, of course, is to exit the business entirely.

V. Old and New Requirements for Suppliers in Global Production Networks: Drivers, Responses, and Outcomes

The evidence presented in the previous two sections points to the emergence of a new organizational structure underpinning the global value chains in two key manufacturing industries. The rise of this global supply-base can best be understood in terms of drivers, responses, and outcomes. First, the ‘deverticalization’ of value chains has been driven by increased levels of international competition, rising competence in the supply-base, and a belief among lead firm managers in the West in the doctrine of “core competence” (Prahalad and Hamel, 1990). Second, the ascendancy of the WTO and the strengthening of regional trading blocs in North America and Europe is driving high volume production to low cost sites within the blocs (i.e., Mexico and East Europe) and to the largest countries of Asia (i.e., China and India). This trend towards the regional organization of production has been reinforced by the rising demand in end-user markets for rapid response, build-to-order, and configure-to-order performance on the supply side. At the same time, deverticalization has been enabled by the increased use of information and communications technologies throughout the supply chain, but particularly in the design process and in supply-chain management.

These drivers have led to the emergence of lead firms with little if any in-house manufacturing and the rapid expansion, growing financial strength, and increasing competence of the largest external suppliers of core manufacturing services, which in a self-reinforcing dynamic of “industry co-evolution” has fueled further outsourcing by lead firms and more consolidation within the supply sector (Sturgeon and Lee, 2001). An important outcome of this process has been the growing requirement for greater involvement by suppliers early in the
design process, which has strengthened the competitive position of suppliers who are able to co-
locate and coordinate engineering and production activities with those of their customers at a
global level. These changes are raising the threshold of performance for supplier firms in several
areas, including design and engineering, sourcing, the effective use of ICT, and the ability to
operate in and coordinate between multiple locations. In the following paragraphs we discuss
several of these developments in more detail with an emphasis on the new requirements they
raise for suppliers, paying particular attention to the implications for supplier firms in East Asia.

Deverticalization

The deverticalization of firm structures is at least partly a response to the increased
volatility of the markets in which the firms are operating. Shorter product life cycles, the
complexity and high cost of new product introductions, and unforgiving end-user and capital
markets are combining to impose new pressures on all areas of the firm, from R&D to
manufacturing to marketing and sales. In response to these pressures, and to offload risk, firms in
a wide range of sectors and locations have sought to outsource ‘non-core’ functions, especially
those, like manufacturing, that are associated with large scale fixed capital. Outsourcing has been
especially prominent in competitive and fast-moving industries like electronics, motor vehicles,
and textile/apparel (Quinn and Hilmer, 1994; Fine, 1999).

Lead firms have focused on the areas and functions that they believe to be essential to the
creation and maintenance of competitive advantage, especially product innovation, marketing,
and other activities related to brand development, and have increasingly come to rely upon
specialized suppliers to provide “non-core” functions. The belief is that by divesting non-core
functions, lead firms can more quickly reap value from innovations while spreading risk in
volatile markets (Venkatesan, 1992). Firms that develop, market, and sell electronic hardware,
cars, and clothing have turned to suppliers for production and, increasingly, post-architectural
(i.e., detailed) design services. By tapping the competencies of suppliers, lead firms are able to
maintain substantial market presence without the fixed costs and risk of building and supporting
a vertically integrated corporate organization (Sturgeon, 2000, 2002). Among the advantages
claimed for these production networks are that they are more adaptable than an integrated firm
would be, and that they are capable of providing better economic performance in highly
competitive and volatile markets (Powell, 1990; Cooke and Morgan, 1993).
**Design and engineering.**

Lead firms in the advanced economies are asking their suppliers to take on more responsibility for the design and engineering of products and sub-systems. Suppliers are increasingly being chosen and brought into the development process before products are fully designed. By doing so, the lead firm is able to spread risk and reduce costs. When suppliers participate in prototype development, moreover, they typically improve their performance in design for manufacturability and in implementing subsequent engineering change orders. Product redesign for different markets is also easier and quicker if the suppliers are actively involved from the outset.

One of the keys to achieving heavy supplier involvement in early development activity is the promise of future business. Small numbers of suppliers or even sole sourcing has become common for specific product models and generic product platforms. Conversely, situations in which a new supplier is brought on board after volume production has begun are becoming increasingly rare. In industries such as motor vehicles, where models remain in production for 2-5 years, business is won and lost by suppliers in large blocks and for long periods. The lead firms try to reduce supplier market power in various ways (by using different suppliers for different models and types, for example), but a supplier for a successful model can gain a great deal of leverage.

Design and engineering competencies have been aggressively pursued by many Asian suppliers (although, as Table 1 above shows, many more remain at the OEM stage). Leading Asian suppliers in the electronics, motor vehicle, and textile/apparel industries now offer a full range of design and engineering services. Advanced Taiwan (China)ese notebook computer ODMs and Hong Kong (China) garment producers, for example, provide their customers with completely designed finished products, as well as products that are made-to-specification and co-designed.

However, few Asian suppliers are yet able to provide design services that are co-located with those of their customers. One manager at an American-based global motor vehicle parts supplier observed that: “Co-location of design with our customers’ vehicle development is important because the design interface is very complex and technology changes very quickly. Face-to-face meetings are still needed to resolve design issues.” Continuing advances in
broadband communications and information technologies may make long-distance concurrent engineering between lead firms and suppliers a more viable alternative to co-location, but to the extent that co-location remains important or becomes more so, suppliers with design facilities located near their customers will have an advantage.

**Information and communications technology.**

The increasing use of advanced information and communications technologies (ICT) has accelerated the possibilities for effective integration in geographically and organizationally dispersed value chains. Firms carrying out functions at different points along a value chain have a greater ability to exchange data so as to achieve high degrees of conformance with specifications and tight coordination of productive activities. In the past, achieving such conformance and coordination required firms to locate the relevant functions within their own vertically-integrated organizations or within tightly controlled networks of subordinate suppliers. The promise of ITC is that codifiable specifications and standard interfaces will make it possible to coordinate activities through market-based exchanges among autonomous organizations.

So far, the contribution of ICT has been most important in supply chain management and in product and component design and manufacturing. Specific applications in the supply chain management area include enterprise resource planning (ERP) systems, business-to-business (B2B) e-commerce marketplaces, and electronic data interchange (EDI). The application of digital technology to the product and component design process involves tools such as electronic design automation (EDA), computer aided engineering (CAE), and computer aided design (CAD). These technologies, when combined with computer aided manufacturing (CAM) systems embedded in numerically controlled (NC) and robotic production equipment, allow complex product specifications to be handed off to outside suppliers. Using these tools, suppliers can create fully computer-integrated manufacturing (CIM) environments to track product quality and inventory, and shorten design/production cycles.

New information and communications technologies enable lead firms to ask much more of established suppliers in terms of rapid response, design collaboration, lower costs, and close monitoring. It is not unusual for lead firms to exert great pressure on their suppliers to adopt the latest ICT to improve quality, facilitate the tracking of in-process inventory, and streamline the order/reorder process.
Whether new ICT systems raise or lower barriers to entry is an open question. Leading edge ITC systems are expensive and often must be adapted to the specific requirements of the firms that use them. Successful adoption of ICT requires competent vendors and specialized personnel to build and operate the new systems, and also frequently requires user firms to adapt their organizational routines to accommodate them. ICT systems typically have short lifecycles and must be continually upgraded to remain compatible with customer systems and changing industry standards. Staying on this treadmill of ongoing capital spending, learning, and organizational change is only possible at considerable effort and expense. Leading Asian merchant manufacturers and suppliers such as Taiwan (China) Semiconductor and Li & Fung are among the most sophisticated users of ICT to be found anywhere, and in our field research we came across many firms that had adopted the latest information technologies. Examples include semiconductor foundries, PC and peripheral producers, and textile/apparel suppliers based in Taiwan (China); electronic component suppliers based in Singapore; and textile/apparel suppliers in Hong Kong (China). But many smaller firms in East Asia, especially from the less developed economies in the region, are struggling to keep up. One indication of the general situation with respect to ICT adoption is provided by Table 6, which reports the (very low) rates of Internet usage by manufacturers in China and the four ASEAN economies of Indonesia, Philippines, Thailand, and Malaysia.14

Table 6. Internet Use by ASEAN 4 and Chinese Manufacturing Firms

<table>
<thead>
<tr>
<th></th>
<th>ASEAN 4</th>
<th>China</th>
</tr>
</thead>
<tbody>
<tr>
<td>% communicating with clients via Internet</td>
<td>24%</td>
<td>6%</td>
</tr>
<tr>
<td>% communicating with suppliers via Internet</td>
<td>15%</td>
<td>5%</td>
</tr>
<tr>
<td>Orders via Internet or e-mail:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% in 1999</td>
<td>10%</td>
<td>2%</td>
</tr>
<tr>
<td>% in 2000</td>
<td>14%</td>
<td>4%</td>
</tr>
<tr>
<td>% in 2005 (estimated)</td>
<td>23%</td>
<td>6%</td>
</tr>
</tbody>
</table>


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14 About 24% of the ASEAN firms also reported that they participated in an electronic data interchange (EDI) network.
It is also important to note that ITC systems, especially for supply-chain management, are relatively new and still rapidly evolving. Vendors have emerged from various fields (manufacturing automation, enterprise computing, etc.), business models are often untested and experimental, standards battles are in full swing, and merger and acquisition activity among IT vendors is proceeding at a rapid pace—and, since the bursting of the dot com bubble in the US, some have gone out of business. Moreover, the vendors and standards used in different industries are often very different. Our interviews suggest that, given the rapidly changing technology and standards, user firms may derive advantage from being located near the nexus of IT innovation. In places such as Silicon Valley, users and vendors have set up informal and formal working groups intended to set standards and develop better applications (Sturgeon, 2003). Although all have sales offices around the world, the leading IT vendors in the supply-chain management field are based in Germany (SAP), the Netherlands (BAAN), California (Ariba, Oracle, and, PeopleSoft) and Colorado (J.D. Edwards). None of the major vendors are based in Asia, which may be a disadvantage for Asian suppliers.

**Global Suppliers**

As lead firms have outsourced more of the manufacturing, sourcing, and logistics functions that were previously carried out in-house, their preference for dealing with suppliers with international reach has grown. The reasons are several. First, the lead firms are in many cases marketing their products globally, and require engineering, manufacturing, and logistics support in multiple locations. Second, the lead firms often seek to economize on development costs by creating global product platforms that share and re-use many common parts, modules, and subsystems. Partnering with a small number of suppliers, or even a single supplier, enables lead firms to exploit these economies of scope more fully, while also avoiding the cost of re-qualifying new suppliers for each new market. Third, cost pressures require purchasing organizations to scan the world for low-cost, high quality parts, and to the degree that suppliers are taking on these responsibilities, they too must have global sourcing capabilities. Fourth, suppliers based in protected final markets can combine global sourcing with local sourcing and subassembly to help lead firms meet local content requirements. Fifth, as already discussed, the preference for key suppliers to take on a more active role early in the development process requires these suppliers to be able to co-locate at least some of their own design activities with
the design facilities of their customers. Some lead firms have given their key suppliers an ultimatum: provide support on a global basis or lose the business entirely. Managers at three global automotive suppliers made essentially the same point during separate interviews with IPC researchers:

The industry began to change 5-10 years ago. Today it is a requirement to serve platforms – it is part of the bid. If a supplier doesn’t have a global strategy, it can’t bid. New projects are no longer seen as an opportunity to expand globally—instead, a supplier must have a global base in place to even make a bid. This forces suppliers to have a global supply system in place.

Suppliers must support assemblers as a sole source for global products lines to support commonalization. We must supply the same part, with the same quality and price, in every location. If [the automaker] says to go to Argentina, we must go or lose existing, not just potential, business. Logistics are becoming a key competitive advantage; we must have the ability to move production to where customer's facilities are.

We want our plants to be present where vehicles are produced. Sometimes customers ask us to locate near offshore assembly plants to provide local content. . . . We will follow our customer's strategy by establishing local engineering operations in large emerging markets only, such as Korea, Mexico and Brazil.

Providing this kind of support involves coordinating flows of components, sub-assemblies, and products across production networks that often span several countries or even continents. It also requires setting up design operations close to the design centers of the lead firms. As a result of the popularity of outsourcing among American and European lead firms, the great majority of the suppliers that have risen to this challenge so far have originated from the North America and Europe, where the lead firms have the bulk of their design activities, where there is a deep pool of management talent with long experience in international operations, and where capital is available to finance global expansion. The pressure to expand has been met partly by internal growth but even more by aggressive merger and acquisition activity. Acquisitions of competitors in similar lines of business have yielded sudden jumps in geographic coverage. Acquisition of firms with upstream or downstream capabilities have broadened the range of products and services on offer. (Frequently, acquisitions have served both purposes
Finally, acquisitions of customer facilities have also helped suppliers to win new business while at the same time expanding their geographic and functional scope.15

The rise of regional production systems under trade arrangements such as NAFTA and the EU has strengthened the hand of global suppliers in several ways. First, the drive to serve advanced economies from proximate low-labor-cost locations such as Mexico and East Europe, for both tariff and speed-of-response reasons, has reduced the competitiveness of suppliers serving advanced economy markets solely from Asian locations. Some Asian suppliers in the electronics and textile/apparel sector have responded by opening plants in places like Mexico and Central America, but most have not. For global lead firms and suppliers, fragmented national production systems are being replaced by regional systems that allow increases in scale economies in plants serving regional markets. This regional strategy is nested within a global strategy that seeks to commonalize and reuse as many design elements as possible among regions. Suppliers that do not or cannot put a global/regional system in place to match the strategy of the lead firms in their industry, either because they are too small or are concentrated in a single region, may find long-term success elusive. For Asia, the increased popularity of the regional/global model has meant the consolidation of production in China, and more global suppliers are scaling back existing investments in South East Asia and building up very large-scale operations in China. In the words of the president of Manufacturing Services Limited, a medium-sized electronics contract manufacturer based in Concord, Massachusetts, “We want to consolidate [the Malaysia and Singapore operations] in China…we want to supersize our China operation. They have a great pool of available labor.” (Serant, 2001).

For established East Asian manufacturing firms, the requirement for global reach may be the most challenging of all the performance requirements associated with the emerging supply base. According to a manager at one global motor vehicle parts supplier interviewed by IPC researchers: “Supplier logistics need to be synchronized with [lead firms], and many local

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15For example, Sanmina, an electronics contract manufacturer based in San Jose acquired Nortel’s Wireless Electro-Mechanical Subsystem Assembly (EMSS) in August, 1999. This deal included inventory, production equipment, and 230 employees in manufacturing facilities in Calgary, Canada and Chateaudun, France, as well as a small engineering design group located in Guyancourt, France, outside Paris. Both the Calgary and Chateaudun facilities were located adjacent to Nortel’s wireless system design houses, allowing the production facilities, now owned by Sanmina, to remain poised to quickly bring new products into production. The acquisition provided Sanmina with new locations in Canada and France, locations that can support not only Nortel but its other customers, as well as new expertise in radio-frequency (RF) electronics manufacturing.
suppliers do not have the capability to do this.” Except for the Japanese, few East Asian suppliers have expanded geographically outside East Asia. Most have lacked access to the capital that would enable the aggressive merger and acquisition strategies needed to build an international position. Many East Asian firms are still controlled by their founders or the founders’ family members. Other, publicly held firms are listed on thinly capitalized local exchanges that lack the liquidity of US and European public equity markets. Most of these firms, too, have lacked access to the managerial expertise needed to operate successfully outside Asia. Of 100 ASEAN 4 manufacturing firms responding to the World Bank’s 2001 survey, only 16% reported employing managers with any foreign work experience.

VI. Risks and Uncertainties of the Global Supplier Model

The organizational and technological changes we have described in the previous sections are still emerging, and many questions have been raised about their sustainability. Some of the strongest doubts about the global supplier strategy were expressed during our interviews with Japanese lead firms in the electronics sector, but our research at lead firms in the US and Europe also revealed conflicts and confusion over the desirability of increased outsourcing. Some of these concerns are of long standing, but have grown more acute as the pace of outsourcing and supply base consolidation has accelerated. There are fears of the loss of innovative capacity as production-related activities migrate to global suppliers, of the leakage of proprietary information to competitors through shared suppliers, of the creation of competitors if suppliers choose to move into the production of final products, and more generally, of the increased market power of the largest suppliers. There are also concerns about the feasibility of product design modularization in cases where unanticipated or complex interdependences between the components of the product lead to greatly increased coordination and transaction costs. There are also examples of outsourcing leading to additional effort. In some lead firms we observed the emergence of ‘shadow’ engineering organizations, whose ostensible role in monitoring cost and quality and maintaining the ability to switch suppliers has expanded into large-scale duplication of supplier engineering work.

Lead firm reliance on a one or just a few external suppliers, or sometimes even a single plant, when coupled with the reduced inventories associated with just-in-time delivery practices, has significantly increased the vulnerability of lead firm operations to disruption from external...
work stoppages, accidents, or natural disasters. When key supply plants go off-line, the whole system can go down.

Other questions have been raised about the sustainability of the suppliers’ business model itself. Some global suppliers report difficulties in finding a way to get lead firms to pay for the additional engineering, component purchasing, and logistics support they are providing, leading to very low or negative profit margins. Moreover, the rapid international expansion of supplier firms, often driven by acquisition of companies in different institutional settings with dissimilar corporate governance systems, industrial relations practices, product and process technologies, and ICT systems, may be re-creating, or even exacerbating, the operational inefficiencies that outsourcing was (in part) intended to remedy in the first place.

The separation of product strategy and design from manufacturing also raised concerns, especially at Japanese electronics firms, where there is a strong tradition of using what is learned on the shop floor to inform and improve product design, that outsourcing would undermine innovation in the long run. Whether product innovation can be sustained in the face of high levels of outsourcing remains to be seen. Similarly, there were concerns that process innovation would suffer when so much production is in supplier firms with fewer capabilities in and funding for R&D.

The current global economic downturn presents one more challenge to these global supply networks, which owe much of their growth to the long, uninterrupted economic expansion of the 1990s, and whose stability in recessionary conditions is only now being tested. It also remains to be seen whether this pattern of deverticalization and global-scale organization will be affected by the September 11 terrorist attacks and their aftermath. The pattern is real, and has considerable momentum. Even so, a caution against assumptions of irreversibility and inevitability is appropriate, especially at the present juncture. Research on these questions is continuing at the MIT Industrial Performance Center.

VII. Japanese Supply Chains in East Asia

Japanese firms have had a major impact on industrial upgrading throughout East Asia. The flows of technology, investment, and training resources from Japan to other East Asian countries have been substantial, and today Japanese firms are sourcing throughout the region on
a large scale. Supplier-oriented upgrading in East Asia based on linkages with Japanese firms has taken two distinct, though sometimes overlapping forms.

The first has occurred through the acquisition by developing country suppliers, often through licensing or joint ventures, of process technologies for the manufacture of inputs and components that had become highly competitive, standardized, and unprofitable for Japanese producers. Japanese firms, pursuing the ‘flying geese’ strategy of letting older, less profitable industries migrate to their developing neighbors, have systematically developed suppliers in East Asia for inputs that were becoming commodities and/or were subject to great demand volatility. The logic of the flying geese strategy is to create a ‘shock absorbing’ supply base outside Japan capable of meeting the variable portions of world demand. This is achieved by offloading process technologies for product categories where commoditization results in intense price competition and low profit margins. With an alternative source of supply for low-value items in place, higher-value components and inputs, and many of the final products using these components, can continue to be produced in Japan. 16

In the 1970s and 1980s, Japanese firms began to transfer synthetic textile and steel production technology to firms in Taiwan and Korea. In the 1980s, process technology for the production of computer memory chips, or DRAMs, was transferred to Korean firms. 17 In the mid-1990s, Japanese firms began to transfer process technology for flat panel displays to Korean and Taiwanese firms (Akinwande, et. al. 2001). In this way, an important path to industrial upgrading in Korea and Taiwan served simultaneously (and, from the Japanese perspective, more importantly) as a strategy for promoting industrial transformation in Japan. Technical progress in developing countries based on the flying geese model has been widely documented (see, for example, Encarnacion, 1999). Amsden (1989) referred to it as “apprenticeship,” the acquisition of foreign technology through licensing and technical assistance programs, and differentiated it

16 American and European firms have also licensed process technology to firms in East Asia, but these moves have often been motivated by short term tactical considerations (usually the generation of cash in times of trouble) rather than strategic ones. In some cases, however, Western firms have taken a more strategic approach. The development of a supply-base in Taiwan for low-cost desktop and notebook personal computers by American computers firms such as Compaq and Dell is a case in point.

17 Taiwanese firms also acquired DRAM technology from the Japanese, and also from European producers, but have met with very limited success.
from “imitation,” the copying of foreign technology through tactics such as reverse engineering, a method that has also been widely used in the Asian NICs.\(^\text{18}\)

For developing countries, the risk of upgrading via the flying geese model comes down to one of low profitability due to technological lag. Since the technology that has been transferred has invariably been one or more generations behind the leading edge, countries that have relied on this strategy for development today find themselves on the ‘bleeding edge’ of many markets, stuck in low-profit and volatile sectors like low-cost PCs, computer monitors, scanners, power suppliers, batteries, keyboards, DRAMs, and mass market apparel and footwear products. More profitable product segments, such as high-end computers and servers, communications equipment, software, logic semiconductors, and high fashion apparel and footwear, continue to be primarily pursued by American, European, and Japanese firms working closely with advanced users, who are concentrated in the advanced economies.

The second variant of industrial upgrading that has been based on linkages with Japanese firms is that of foreign direct investment. Japanese firms have a long history of FDI in East Asia, and Japanese investment has in the past been widely dispersed throughout the region—much more so than US-originated FDI (Mason and Encarnation, 1995). Until the mid-1980s these investments, which were concentrated in consumer and white goods, consumer electronics, and automobiles, were established mainly to serve protected local markets. Over time, Japanese firms gained a strong foothold in all but the most protected markets in East Asia. In East Asian countries other than Korea, for example, Japanese motor vehicle firms have a market share that exceeds 90% (Doner, 1991; Sturgeon and Florida, 1999). The appreciation of the yen in the mid-1980s accelerated Japanese investment in South East Asia, and some production platforms were

\(^{18}\) Amsden (1989, p.110) argued that the acquisition of advanced production equipment has been a major avenue for industrial upgrading in East Asia. Productivity increases are drawn from the world “technology shelf” through imports of foreign technology embodied in advanced production equipment. Operating advanced production equipment at scale economies sufficient to minimize unit costs, and learning to use it more efficiently than foreign rivals, enhances competitiveness on world markets. As long as profits from increased output are invested in new equipment that embodies the latest technology, growth can be maintained. Increased output results in greater scale economies and expands the opportunities for learning-by-doing, improving efficiency and increasing wages, and driving growth in the domestic market. While the state can do a lot to initiate this process, effective application of new technology depends on what happens on the shop floor, which according to Amsden helps to explain the importance of managers over entrepreneurs in countries like South Korea, which have pursued this manufacturing-led approach to industrial upgrading.
upgraded and expanded to serve export markets in the West.\textsuperscript{19} But the cross-border networks led by Japanese firms have tended to rely on internal subsidiaries and on Japanese suppliers, and, given the scale of investment, the opportunities for local firms to upgrade their competencies via supply relationships have consequently been very limited.\textsuperscript{20} To the extent that local firms were included, it was usually in the smallest and least promising markets such as the Philippines and Vietnam, where they were used as final assemblers and retailers who would work under license, source all components from Japanese firms, and absorb the risk of distributing and selling finished products in small and uncertain markets. In a few cases where the network relationships were of long standing and the local supplier’s capabilities were high, local firms were sometimes tapped to serve the export market. But such firms were never part of the core of the production network, and were particularly vulnerable to changes in lead firm strategy.

The experience of a Philippines-based independent consumer electronics contract manufacturer is a case in point. The firm started out in 1965 as a television distributor for a major Japanese consumer electronics company, and, following the introduction of tariff barriers for fully assembled sets, began assembling televisions for the local market under license in 1971. By 1994, production at this dedicated facility had increased to 12,000 units per month. In 1977 the company began assembling televisions under license for a second Japanese consumer electronics firm, initially for the local market, and then, beginning in 1993, for export. In 1994 the company built a one million unit per year plant in an export-processing zone. Production at this plant quickly rose to 40,000 units per month. The license agreements required the company to source components from its Japanese partner’s subsidiaries, some of which were located in Japan and Singapore, and also allowed the company to provide after-sales service, marketing, and distribution in the Philippines.

As the company grew, it added a plastic injection molding division, which was spun off as an independent company in 1994. Its strategy was eventually to develop its own original brand

\textsuperscript{19} Japanese export platforms in South East Asia were not as extensive as they might have been, because Japanese firms began at the same time to make very large investments within or adjacent to Western markets (Abo, 1994; Curry, 2000 and forthcoming).

\textsuperscript{20} Some analysts have contrasted the closed Japanese production networks in Asia with the relatively open character of networks led by North American – and to a lesser extent European – firms, which they argue have created more opportunities for East Asian firms to upgrade their capabilities. (See Borrus et all, 2000; Ravenhill, 1995; Ernst, 1997.) On the captive, hierarchical character of Japanese-led production networks, see Sturgeon (1999), Schonberger (1982), Dore (1986), Sayer et al (1986), Aoki (1987), Sako (1989), Womack et al (1990), and Gilson and Roe (1993).
of products in addition to its contract manufacturing and distribution business. After the Asian financial crisis, however, the first Japanese electronics customer began to shift its export production to its plant in Malaysia, and production at the dedicated plant declined from 12,000 to 2000 units per month; orders ceased completely at the end of 2001. By 1998 the second customer had also withdrawn all its orders. The second plant has been able to survive by serving a new customer, a Taiwanese producer of monitors.

Management believes that its television business is unlikely to recover because the global market is saturated and television manufacturers are focusing on high-value TV sets whose large size and weight leads to a preference for assembly close to final markets. The company is trying to diversify into broadband communications services, real estate development, corporate financial services, food, and agriculture businesses, but the future is uncertain. The injection molding unit did develop new business in beer crates and motorcycle, refrigerator, and water cooler parts, but management has found that many of the Japanese firms producing these products locally prefer to rely on their own suppliers, which have followed them to the Philippines.

The recent experience of this Philippines manufacturer is far from unique. Japanese production networks throughout East Asia have been undergoing a process of rationalization. As a local supplier to both the Ford and Nissan joint-ventures in Taiwan noted in an interview with IPC researchers, “Japanese firms have slowed investment in new capacity, rationalized production in SE Asia, increased investment in China, scaled back internal capacity, and outsourced more activities, including engineering.” The combination of the protracted economic downturn in Japan, the continuing weakness of other Asian economies, the lowering of tariff barriers for finished products in the region, and the saturation of markets for some products in smaller East Asian countries, is leading to the centralization of production at a smaller number of locations in order to eliminate excess capacity and to exploit economies of scale. In many cases this has meant a new focus on production in China at the expense of other East Asian locations. For local suppliers elsewhere in East Asia, therefore, the prospects for upgrading through links with Japanese lead firms do not seem significantly more favorable than they have been in the past.

In a sense, the new preference of Western lead firms to use Western suppliers on a global basis simply brings these production networks more in line with those led by Japanese firms.
While FDI of this type can do much to create jobs and train workers in advanced technical and business processes, its contribution to the development of a vibrant locally-owned supply base and thus to the strategy of supplier-oriented industrial upgrading is less evident.

**VIII. Policy Implications of the New Global Supply-base for East Asia’s Future Development**

Throughout East Asia, many manufacturing firms have moved along the industrial learning curve by mastering contract manufacturing under the tutelage of some of the world’s most advanced lead firms, who have in turn marketed the products under their own brands. In the electronics and automobile sectors on which our research has focused, East Asian managers described learning how to make products well with help from their early customers and then improving their products by selling to ever more demanding buyers. A company’s capabilities as a manufacturer are proven, in effect, by its clientele. The fact remains, however, that in this common scenario, the manufacturer captures only part (and often relatively little) of the final price of the good, remains at the beck and call of the buyer, and is vulnerable to competition from lower cost competitors who threaten to take the business away. While this is true for many suppliers in all economies, the problem is made acute in places such as East Asia where a great many suppliers are not co-located with their customers or with their final markets and so have little opportunity to move beyond this highly subordinate stance.

The concentration of lead firms in advanced economies and the increased demands they are imposing on their suppliers means that many Asian firms are dealing with fewer and stronger customers than they faced in the past. This is not a situation in which the Asian suppliers are inevitably the losers. If the evidence in Table 7 is anything to go by, some larger Asian suppliers still appear to hold their own in negotiations with their customers. While it is difficult to conceptualize and to measure power relations in supply chains, the levels of profitability and return on capital of the suppliers compared with those of the lead firms—often their customers—show the suppliers capturing a comparable share of the rewards in the system. The suppliers compared in this table stand out, however, not only for producing at low cost, but for having recruited and nurtured well-educated managers, engineers, and technicians who can work in partnership with customers. These firms have innovative design capabilities that allow them to offer new model design suggestions to customers (ODM) as well as work to their clients' specifications (OEM). They have implemented major changes in their business structures and
adopted advanced ICT systems that allow them to coordinate widely dispersed activities in different countries. Like the Taiwan (China) chip foundries and electronics contract manufacturers, some East Asian firms have aggressively exploited the possibilities of deverticalization and so have achieved some success in capturing the business that is being hived off by formerly vertically-integrated firms.

The suppliers in Table 7 are exceptional. The resources that they have deployed for each of these advances are well beyond the reach of most small Asian suppliers. In the early days of the Asian miracle, even rather small firms might be linked up to large international customers, who in turn provided many of the services and inputs the firms needed in order to produce to specifications and gradually upgrade their capabilities. Today, however, there are fewer such supports for the small firm. The international customers are looking for suppliers who are already able to make the products—not for firms that can be brought up to the needed level of performance.

For Asian manufacturers today, moving away from old-style OEM is a precondition for enhancing the value they create, for protecting their share of the market against competitors—both rivals elsewhere in the region and global suppliers based in the West—and, more broadly, for contributing to the continued economic development of their home societies. We do not reject supplier-oriented approaches to industrial upgrading, but have pointed out that there are new actors and new requirements that pose challenges to any notion of an unproblematic or inevitable OEM→ODM→OBM upgrading path. There are a variety of ways in which firms can balance or replace OEM production with new higher-value activities, and the scope for industrial upgrading in the Malaysian context is explored in Chapter 3. One route is to acquire or create a brand and sell some or all of the firm’s production under the brand name. We have already discussed the pitfalls of competing directly with customers in end markets, but there are approaches, such as selling products or selling in markets that customers are not interested in, that can avoid conflict. A second approach is to continue to make products or components that will be sold under another label, but to develop internal capabilities sufficient to invest these products with design and functional features allowing them to command higher prices and to raise the barriers to the entry of competitors, the classic ODM route. A third is to specialize in process-specific technologies that enable the firm to provide high-quality, low-priced manufacturing and manufacturing-related services for a number of (increasingly
demanding) brand-name customers, some of whom may themselves have shed those functions entirely; essentially the OEM route with an emphasis on continuous improvement. A fourth is to move to the second tier of the supply-base, providing domestic content for the local affiliates of global suppliers. The fifth and perhaps most radical option for Asian firms is to follow the same strategy of those lead firms in the West which have shed the manufacturing function entirely, and tap the resources of the increasingly ubiquitous global supply-base, which has in many ways commodified the manufacturing process. This will prove challenging in many Asian societies which have for so long based their industrial upgrading and industrial policies on the initial establishment of excellence in manufacturing. As we have stressed in this paper, each of these routes to upgrading poses formidable technological and managerial challenges, but the key point is that industrial upgrading is an unending process that requires constant attention and investment in time, money, and human effort.

What concrete steps can East Asian governments take to strengthen the capabilities of their domestic suppliers to participate successfully in emerging global production networks? The most important policies are those whose outcomes benefit all sectors of the economy: macroeconomic stability; transparent and efficient capital markets; confidence in public institutions; protection of individual rights under rule of law; and a strong foundation of education and training. Beyond these general measures, however, additional steps can be taken to address the specific capabilities of the supply-base. The details will depend on the stage of development of the country, the strength of its public institutions, the particular capabilities of both government and industry, and the prevailing attitudes towards the role of government in the economy. But while the particular prescriptions will vary from one country to another, the empirical evidence on supplier-oriented industrial upgrading presented in this paper points towards several important general lessons.
Table 7. Comparing Lead Firm and Contractor Profitability

<table>
<thead>
<tr>
<th>Firms</th>
<th>Country</th>
<th>Sectors</th>
<th>Profit growth 5-year average</th>
<th>Return on Shares</th>
<th>Sales growth 4-year average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johnson Electric Black &amp; Decker</td>
<td>Hong Kong (China) US</td>
<td>Micro-motors Tools</td>
<td>19%</td>
<td>15%</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Laptop maker Laptop lead firm</td>
<td>11% **</td>
<td>57%</td>
<td>73%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tools</td>
<td>10%</td>
<td>13%*</td>
<td>-1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Retailer</td>
<td>9%</td>
<td>58%</td>
<td>45%</td>
</tr>
<tr>
<td>Hon Hai</td>
<td>Taiwan (China) US</td>
<td>Tools</td>
<td>7%</td>
<td>23%</td>
<td>23%</td>
</tr>
<tr>
<td>Intel</td>
<td></td>
<td>Retailer</td>
<td>8%</td>
<td>18%</td>
<td>25%</td>
</tr>
<tr>
<td>TSMC</td>
<td>Taiwan (China) US</td>
<td>Microprocessors</td>
<td>11%</td>
<td>33%</td>
<td>57%</td>
</tr>
<tr>
<td>Philips</td>
<td></td>
<td></td>
<td>34%</td>
<td>32%</td>
<td>24%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0%</td>
<td>38%</td>
<td>28%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>44%</td>
<td>10%</td>
<td>6%</td>
</tr>
<tr>
<td>Hung Hing</td>
<td>Hong Kong (China)</td>
<td>Printing Press</td>
<td>16%</td>
<td>21%</td>
<td>16%</td>
</tr>
<tr>
<td>Bertelsmann</td>
<td></td>
<td></td>
<td>7%</td>
<td>21%</td>
<td>6%</td>
</tr>
<tr>
<td>Li &amp; Fung</td>
<td>Hong Kong (China) US</td>
<td>Trading Retailer</td>
<td>3%</td>
<td>49%</td>
<td>25%</td>
</tr>
<tr>
<td>The Limited</td>
<td></td>
<td></td>
<td>8%</td>
<td>35%</td>
<td>6%</td>
</tr>
</tbody>
</table>

Source: Boillot and Michelon, 2001, p.142. The authors' sources were Reuters, CLSA Global Emerging Markets, Rapports annuels de l'année, 1999.
*Median value
**Four year average

First, as noted above, there is more than one upgrading path. The best approach will vary from one industry to another; moreover, even in the same industry different firms may choose different paths depending on their internal capabilities, the regional environment in which they operate, and the particular overseas market or markets they are serving. Government policies that do not acknowledge the range of upgrading possibilities for domestic suppliers, that presume that all firms will follow the same path or, worse, that attempt to dictate such a path, are likely to fail.
Equally important, however, is to recognize that remaining at the same level of competence is not a viable option. This is the second key lesson for policy-makers. The process of upgrading is unending; there is no threshold of adequacy. Taken on its own, the strategy of pursuing low cost labor wherever it is to be found, a strategy which many Asian manufacturers have pursued, is not a viable approach in anything other than the short term. Cost and quality will remain important to customers, but performance in these dimensions is increasingly becoming a commodity and will not be enough to yield attractive margins. Providing innovative design content, production flexibility, and the ability to dependably deliver the right product at the right time and in the right place are gaining in importance, as are the international sourcing and logistic capabilities on which these service enhancements are based. Even as the competitiveness of lead firms in Western markets is increasingly determined by the efficiency of their supply chains, these lead firms are electing to outsource more of the key supply chain functions, and this continued deverticalization will certainly put ongoing pressure on suppliers—from East Asia and elsewhere—to continuously upgrade their capabilities and their geographic reach.

Third, the innovations that fuel new generations of products and processes grow both out of new ideas that a society develops on its own and those it finds in other countries and adapts and develops for its own purposes. Even an advanced economy like the United States, with its vast domestic research and development infrastructure, still needs mechanisms to monitor science and technology in leading centers abroad and to pull the most promising new developments into its own industries. East Asian nations need to enhance those institutions that enable them to tap into the most promising technologies developed abroad. In new areas of technology in which firms wish to advance, there may be much to be gained by recruiting international experts with experiences in leading-edge firms. Immigration and housing policies can often be effective in aiding the recruitment efforts of domestic corporations. Governments should also look for opportunities to strengthen links with leading research universities overseas, including universities elsewhere in the region.

The importance of information technology to the effort to upgrade supplier performance has been a pervasive theme of this paper and is a fourth key lesson for policymakers. We have commented on the central role of information technology in the design, manufacture, and delivery of the service-enhanced products demanded by customers in advanced economies. For
the emerging economies of East Asia, participating successfully in global value chains will require stronger domestic capabilities to exploit advanced technologies of information generation, storage, and communication. Notwithstanding the deflation of the IT bubble in the US and elsewhere, electronic commerce is rapidly becoming a *sine qua non* for small and medium-sized manufacturing enterprises throughout East Asia to compete effectively in global markets. The technologies of electronic commerce, combined with the computerization and codification of both the design and manufacturing processes, are accelerating the possibilities for effective integration in geographically and organizationally dispersed value chains. While great strides have been made, it is important to note that the process of codification that supports this sort of “value chain modularity” is, in many ways, in its infancy. There are of course vast areas of knowledge and information that remain uncodified and some are extremely difficult to codify for technical reasons. Furthermore, the ongoing processes of technological change and innovation can render existing standards obsolete, restarting the clock on the process of codification (David, 1995; Storper, 1995). Indeed, internalizing such realms of tacit knowledge, and packaging them as services for a wide range of customers, remains one of the most promising routes for industrial upgrading.

Related to this is a fifth important lesson. The cultivation of vertically integrated ‘national champions’ cannot any longer serve as a primary goal of industrial development policies. It is, rather, the development of key supply chain capabilities that should be the objective of these policies. The presumption that such capabilities should be combined within vertically integrated corporate structures is not consistent with the emerging pattern of global value chains, and may actually inhibit the acquisition of knowledge and technology on which both domestic upgrading and international competitiveness depend.

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21 For more on the concept of value chain modularity see Baldwin and Clark (2000); Schilling and Steensma (2001); Sturgeon, (2002, 2003); Dolan and Humphrey (forthcoming); and Gereffi, Humphrey and Sturgeon (forthcoming).
References


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