Chapter 3

A Dynamic Model of Organizational Learning

When Do the Firms Discover Emerging Technological Know-how?

Abstract: Learning-oriented innovation process generates an idiosyncratic and tacit organizational path that competes with those outside the firm-specific network. Therefore, with the creation of each new competing network, services offered by the firms to the customers yield only decreasing returns. The model shows that the high-performing characteristics of the Japanese firms derive from the innovative trading of technological inputs specialized to the leading global networks. A comparative analysis of the American firms highlights that the assembly of components, sub-systems, and services of the newly emergent vendors boosts the learning effectiveness. The forces conditioning the timing and intensity of technological growth are presented.

Introduction

The study of organizational learning has gained a significant prominence over the last two decades. Argyris (1993: 9) explains that the "Single-loop learning is appropriate for the routine, repetitive issues -- it helps get everyday job done. Double-loop learning is more relevant for the complex, non-programmable issues -- it assures that there will be another day in the future of the organization." The principal organizational challenge for the management lies in the fact, "that the reasoning processes people use for double-loop learning are actually counterproductive to such learning; that people are unaware of the counterproductive features of their own actions but usually quite aware of such features in others; that the lack of awareness exists in all subjects, and hence, may be due to a program in people's heads of which they must necessarily be unaware."

This work highlights how an over-confidence in the efficiency properties of their organizational systems has impeded the learning effectiveness of the Japanese firms over the recent years. In the late 1980s, in an influential work on the performance of the US auto industry for the MIT Commission on Industrial Productivity (1989: 27-29, 42), Womack concluded,

> "The American producers can not be faulted for failing to keep up in the R&D race… Remarkably, by 1985 Nissan, Toyota, and Honda were outpatenting General Motors, Ford, and Chrysler in the United States while spending much smaller sums on R&D in aggregate…. A Japanese product development group with a given amount of personnel can develop twice as many products in a third less time than the Americans or the Europeans… More ominously, most of the Japanese firms are able to build their own proprietary technology. Honda, to take a leading example, has made a public commitment to a '300 percent improvement in manufacturing productivity' by 1990, using machinery built by its wholly-owned and highly secretive subsidiary, Honda Engineering Ltd."

Mansfield (1989: 190) analyzed the diffusion of industrial robots among about 200 leading firms in the US and Japan. The diffusion in Japan was super-normal not only across but also within firms: "Based on the detailed data we obtained from the Japanese firms concerning the distribution of robots by rate of return, it appears that, if they had applied the same hurdle rates as their American rivals, their robot utilization would have dropped by 50 percent or more." The higher hurdle rates allowed the American firms to become focussed in their initiatives, but also precipitated resource heterogeneity. Zenger and Hesterly (1997: 211) report that in the US, "60% of manufacturing employees in 1979, but only 45.7% in 1991, worked in firms with 1,000 or more employees. Data from Country Business Patterns reveal a similar, although less dramatic, trend for average establishment size: a decline from 16.3 employees in 1981 to 14.4 employees in 1987." Between 1958 and 1978, both the richest and the poorest 20% people in the US had nearly doubled their annual incomes. But between 1979 and 1995, the richest people enjoyed significantly higher income growth than the poorest people. The inflation-corrected income of the richest 20% US families grew by 26%, and that of the poorest 20% US families fell by 9%. The inflation-corrected earnings of the highest 10% paid workers rose by about 10.7%, and that of the lowest 10% paid workers fell by about 9.6% (Financial Times, 1997: 18).

Dyer (1996) studied the case of Chrysler over the late 1980s and early 1990s. Historically, Chrysler had a multidivisional structure. Each product line division was functionally organized. All auto components were designed and engineered by these divisions. The bids were invited from the outside suppliers for manufacturing the components to the specified designs. The lowest cost bidder was given the contract. For the components that needed customization to the new proprietary technical standards, the bargaining power of Chrysler was low and the purchase costs high. Under these conditions, Chrysler sought to internalize the production of problem components. On the whole, there emerged significant delays, quality problems, and escalating costs of the product development. By the late 1970s, Chrysler was on the verge of bankruptcy, and had to rely on the credit guarantees from the US government for keeping afloat. About the same time, Mitsubishi Motors in Japan was also on the verge of bankruptcy. The lead shareholders of Mitsubishi Motors approached Chrysler for equity and technical support. Chrysler agreed to the offer, with an expectation that such an alliance might help learn mechanisms for upgrading the employee participation, and improving the quality of the newly designed low-priced K cars. Though Mitsubishi Motors enjoyed a revolutionary growth in its competitive advantage, Chrysler found itself again on the verge of second bankruptcy despite the tremendous success of its K cars and the popular recreational minivans introduced in 1983. Chrysler then sought to benchmark Honda Motor's product development and manufacturing operations in the US. Honda had gained the top most share of the US market among all the Japanese auto firms. Honda's performance had been especially startling because Honda was earlier a motorcycle maker, with no base in the auto manufacturing. In 1987, Chrysler decided to acquire American Motors Corporation (AMC) as a further learning alternative. AMC had a strong history of a high rate of new product introduction. But over the recent years, it had been besieged with a cutthroat competition from the General Motors and Ford -- who were seeking to increasingly focus on its mainstay of the truck business to combat rapid penetration of the Japanese firms into the car segment. AMC's proprietary jeep operations nevertheless were profitable. In the fourth quarter of 1989, Chrysler reported a record loss of $664 million, and unveiled a Supplier Cost Reduction Effort (SCORE). Under SCORE, the suppliers were actively encouraged to develop parts that could be flexibly used across multiple product lines. The simplified production and after-sales servicing offered substantial benefits, encouraging Chrysler to offer its suppliers a reward of $20,000 for each component part removed from the complete assembly system. In 1992, Chrysler hired Robert Eaton, who at his previous job at the General Motors had successfully introduced teamwork into the European division, as its new Chief Executive Officer. Chrysler sold all non-automotive operations, and decentralized the responsibility for teamwork with the supplier groups. By 1994, the annual cost reductions per supplier had reached 5%. The suggestions by one supplier, Magna, alone saved $75.5 million in total costs. The new products were lighter and less complex, with fewer defects, safety hazards, and warranty claims. Chrysler's average profit per vehicle grew from $250 in 1989 to a record (for all the US assemblers) $2,110 in 1994. The average new vehicle development time fell from 234 weeks to 160 weeks, and the cost of new vehicle development fell by 20-40%.

In a review of the individual-level leadership behavior, House and Aditya (1997: 418) concluded, "traits have a stronger influence on leader behaviors when the situational characteristics permit the expression of individual dispositions… Thus, the behavioral manifestation of traits is stronger in weak situations and weaker in strong situations. These conclusions need to be qualified with the caveat that they apply to leaders of task-oriented work units or task-oriented organizations, and that they are based pre-dominantly on the study of American males." The strengthening of the global linkages thus played a critical role in the transformation of Chrysler's firm-specific system into an exchange-oriented network.

Thus, a firm might further its organizational profitability through: (1) learning from the experiences of the diverse global cultural systems, and (2) trading of the know-how overseas for further reengineering and development by the global human capital. This work investigates the evidence on the first force, and recommends the second for further research.

Factors Conditioning the Learning from Cultural Diversity

During the late 1980s and early 1990s, Japanese firms experienced considerable maturity in their domestic operations. But by January 1997, all the nine full-line Japanese auto assemblers had realized remarkable growth in their domestic production volumes. As is evident from Table 3.1, Japanese auto assemblers enjoyed a stronger growth in the high volume car business. The exceptions were Mitsubishi Motors, Mazda, Isuzu, and to some extent Daihatsu. Mitsubishi was the principal Japanese affiliate of Chrysler, Mazda was the principal Japanese affiliate of Ford, and Isuzu of General Motors. Further Daihatsu was a principal affiliate of Toyota. Japan, led by the principal firms, boosted the share of the US auto market to 23% in February 1997, up from 20.6% in February 1996. The share of the US auto assemblers dropped from 75.7% to 72.7%. The share of General Motors fell from 32.5% to 30.5% (The Wall Street Journal, 1997).

Table 3.1: Japanese Domestic Auto Production Volume in January 1997
(Percentage growth over the January 1996 levels given in brackets)

	Cars		Trucks	
Toyota	262862	(34.9%)	51093	(13.6%)
Nissan	123394	(13.2%)	16195	(-9.5%)
Mitsubishi	73013	(9.0%)	35368	(14.0%)
Honda	85572	(37.7%)	12314	(15.8%)
Suzuki	52628	(6.0%)	16262	(-2.7%)
Mazda	49591	(2.8%)	16277	(28.6%)
Daihatsu	33437	(23.1%)	16234	(24.4%)
Fuji Heavy	27555	(23.7%)	6433	(-26.2%)
Isuzu	1118	(-76.7%)	25924	(26.7%)

Source: Japan Automobile Manufacturers Association (1997)

Thus, the super-normal Japanese performance had three core dimensions: (1) competitive learning of the principal Japanese firms, (2) complementary learning of the US-affiliated firms, and (3) supplementary learning of the subsidiary Japanese firms from the international channels.

1) Competitive learning of the principal Japanese firms: Toyota has been the most reputed Japanese assembler for the competitive nature of its organizational learning. Toyota originated as an offshoot of a Japanese textile firm, named Toyoda Loom, during the early 1930s. Toyota had very limited capital base, and was up against a generously capitalized early mover Nissan Motors.

Toyota used wooden frames, and the services of the local tool operators, for manufacturing modest numbers of small trucks. In the meantime, Honda acquired machinery for making steel-based auto components. Honda's initiatives were catalyzed by the decision of the Japanese government to ban the assembly of imported semi-knocked down steel components by the General Motors and Ford in Japan. Toyota bought Honda's machinery after the World War II, and began marketing small cars for use as yellow taxis. Toyota made an increasing use of the specialized steel components, and rapidly contested the leadership of the Japanese auto market from Nissan over the 1960s. In the meantime, Honda researched the successful racing cars, and developed powerful engines. Honda rapidly diversified from its early Post-war motorcycle operations to the car business over the 1970s. It gained the largest share of the Japanese auto firms in the US, and led the moves into the highly popular recreational vehicles during the late 1980s. By 1996, the fast growing recreational segment comprised 30% of the Japanese auto vehicle market, and Honda had 13% share in that segment. Honda's spacious Step WGN vehicle, priced at $16,000, was a special hit in Japan. Toyota's volume share of the Japanese auto market fell for the first time since 1980, to less than 40% in 1996. Poor volume performance of Toyota derived from an enhanced focus on the more profitable luxury vehicles, such as Lexus and midsize Camry sedan. These vehicles were primarily specialized to the preferences of the American customers. Windom, the Japanese version of Lexux, got only a lukewarm response from the Japanese customers at the hefty price of $30,086. On the whole, Toyota accumulated a record free cash reserve of $23 billion in 1996. In a bid to regain its Japanese volume share, Toyota introduced recreational minivans Noah and Ipsum, priced at $18,391 and $16,696 respectively. Toyota backed their launch in Japan with a $1 million a day 'carpet-bombing campaign' during September 1996. By 1997, Toyota had regained a more than 40% share of the Japanese market, and re-established its technological leadership.

2) Complementary learning of the US-affiliated firms: A total imitation of the established American know-how offered limited competitive benefits to any Japanese firm. Suzuki Motors demonstrated the most revolutionary development of the complementary linkages. Suzuki Motors originated as an offshoot of Suzuki Loom Works, which had started in 1909 as a maker of the textile weaving equipment. Suzuki Loom had diversified into the war-related products over the Pre-war period, but lost its operations by the end of the World War II. In 1952, Suzuki began motorizing the bicycles using a 36cc engine. It soon developed a motorcycle in 1954, and used a more powerful 360cc engine for diversifying into the minicar market with Suzulight model vehicle in 1955. By 1961, Suzuki had also introduced a small Suzulight truck. But with the entry of Honda into the car segment, Suzuki's minicar production dropped by a third between 1970 and 1974. In 1975, Suzuki began transferring its idle machinery capacity to the minority joint ventures in Taiwan, Thailand, and Malaysia, for the assembly of motor vehicles. Suzuki's overseas motor cycle sales grew rapidly, even as the domestic sales had begun falling sharply. In 1981, Suzuki sold 5% of its equity to General Motors for cash, and received a preferential arrangement for technical assistance. In 1983, Suzuki entered the subcompact car market with a Swift model. Most of the Swift subcompacts carried General Motor's private labels Chevy Spring and GEO Metro, and were sold by the General Motors in the US through its own distribution networks. In 1986, Suzuki entered into a joint venture with the General Motors, to form a Canadian subsidiary, named CAMI Automotive Inc. Simultaneously, Suzuki commissioned a 100% owned plant in California for making a recreational sports-utility model named 'Samurai.' The 1988 US Consumer Report identified a possible rollover risk during the test drive of Samurai. In 1989, the top US executives of the Suzuki plant quit due to the irreconcilable differences in philosophy, which eventually culminated into Suzuki being asked to pay a product liability of $90 million in 1995. The Jury found Suzuki to be negligent in the paralysis of a lady driver from the rolling over of her Samurai model. The US sales of Suzuki fell

sharply following the accident in the late 1980s. Suzuki's European joint venture in Spain also failed to realize the expected market performance. But thereafter, the interactions with the emerging markets helped Suzuki establish its prominent reputation for design and quality. In 1991, Suzuki collaborated with C. Itoh General Trading Company of Japan to start a joint venture in Hungary for making the Swift model vehicles. In 1994, Suzuki introduced the cheapest Japanese vehicle named Alto Van, priced at $5000, and a creative miniwagon, into the Japanese market. These products were an instant hit. In 1996, Suzuki acquired 12% equity in the car-making operations of a Chinese government agency. It sought full equity in its earlier minority joint venture with the Indian government. Indian venture had raised its share of the domestic market to nearly 80%, even after the 1991 liberalization of the entry for all the global assemblers.

<u>3) Supplementary learning from the international channels:</u> With the liberalization of the Indian market, multinationals actively sought local expertise. The exports/ production ratio of machine tools in India fell from a peak of 20% in 1990 to a low of 2.3% in 1995. In the total domestic production of India, the share of 160 export-oriented small-scale units fell to 16%. The share of two large-scale public sector machine tool producers, HMT and Praga who used their output internally, dropped to 31%. The share of 300 mid-sized technocratic private firms, supplying to the lead domestic and multinational assemblers, grew rapidly to 20%. The global demand for the machine tools had dropped from $39 billion in 1991 to $26.5 billion in 1994. With new innovative offerings, the demand jumped to $36 billion in 1995. Asia as a whole catered to 38% of this demand. An area of special interest was the tools supporting the electronics and software products, which contributed 20% to the retail value of Japanese vehicles in 1995, up from 5% in 1970. In 1995, Japan was the largest exporter of machine tools, ahead of Germany and the third placed US. These nations, along with Italy, Switzerland, Taiwan, and the UK, gained more than 80% of the machine tool export market. On the whole, the world exports of machine tools surged from $14.5 billion in 1993 to $21.7 billion in 1995 (Export Import Bank of India, 1997).

The improved information processing technology helped Japanese assemblers discover new learning opportunities. Isuzu secured the assistance of General Motors, and designed an aluminum-based direct fuel injection system for diesel engines. Compared to the traditional diesel engines, the new system saved 25% in engine weight, and 30% in engine size. The diesel engines equipped with the new system yielded a mileage of more than 20 kilometers/liter – double compared to a similar size 3000cc petrol-engine. On account of a higher cost of diesel fuel in Japan, the diesel engines were used in only 3% of the contemporary Japanese vehicles. Isuzu, nevertheless, gained an instant supply contract from the General Motor's German subsidiary Opel. Toyota, in the meantime, devoted a record budget to the research and development expenditures. These helped Toyota discover a direct fuel injection system, which could be commercialized in the diesel engines after at least two years of further research. The diesel engines based on this system were expected to have substantially less noise and greater mileage than the conventional diesel engines. Still Toyota did not expect to commercialize the new system in the petrol-engines (Financial Times, 1997: 24).

Hypothesis Formulation

The firms boost the productivity of their resources, and competitive advantage of their network organization, through assembly of the learning researched and developed by alternative players. Table 3.2 presents the average annual data on the resource productivity and competitive advantage of the Big Three US assemblers, over the three five year periods between 1976 and 1990. The analysis evaluates the productivity of manpower resource, competitive advantage offered by a complementary networking of the material power, and the learning value of the supplementary service initiatives. **Resource productivity** is measured as the $ gross profit/ employee. **Competitive advantage** is measured as the value of firm's sales as percentage of the total production of motor vehicles in the US, Germany and Japan. **Manpower** is measured as the labor cost/sales, **material power** as the (gross profit – labor)/sales, and **services** as the (selling, general and administrative costs)/sales. The raw data were obtained from COMPUSTAT.

The data indicate that the resource productivity of all the three firms grew at a diminishing rate over the late 1980s. General Motors experienced the most sluggish resource productivity, and its competitive advantage fell from 23.5% in the early 1980s to 20.0% in the late 1980s. Ford and Chrysler enjoyed faster growth in resource productivity, and partially regained their early 1980s competitive advantage losses over the late 1980s. Over the 1980s, all the three firms – in particular Ford and Chrysler – experienced a falling cost-effectiveness of manpower. To sustain growth in resource productivity, General Motors, with the highest manpower costs, raised its emphasis on material power to match the Ford's levels. Chrysler, with the least manpower costs, found its material power fall to the Ford's levels. The escalating cost of manpower led all the three firms to raise their service priorities during the early 1980s. Nevertheless, Chrysler, with the least service-based learning, dramatically transformed from the least to the most productive American auto assembler. Therefore, with the growth in their own material power, General Motors and Ford cut service-based learning over the late 1980s. Chrysler, that recognized the significance of service-based learning to compensate its falling material power, maintained the lead resource productivity position. Ford, with comparable manpower and material costs but lower services-based learning, closely followed in the resource productivity levels. General Motors, with the highest manpower costs, lagged far behind. Its services-based learning was oriented towards costly material power, which was constrained in the capability for further boosting the resource productivity or competitive advantage.

Table 3.2: Performance of the Big 3 US Auto Assemblers

Firm	Year	Resource Productivity	Competitive Advantage	Manpower	Material power	Services
GM	1976-80	11834	23.4%	31.8%	51.9%	9.0%
	1980-85	15967	23.5%	30.2%	54.3%	11.2%
	1986-90	21212	20.0%	28.1%	57.2%	7.9%
Ford	1976-80	8538	15.4%	30.3%	59.1%	7.7%

	1980-85	15313	14.0%	28.4%	58.5%	10.3%
	1986-90	40281	14.7%	20.7%	61.8%	6.0%
Chrysler	1976-80	4045	5.4%	26.6%	68.1%	7.5%
	1980-85	24168	4.7%	23.7%	60.9%	8.8%
	1986-90	46057	5.2%	20.4%	59.4%	11.1%

On the whole, American firms experienced a falling cost-effectiveness of manpower. To sustain their competitive advantage, American firms sought higher cost materials. For instance, American assemblers actively used the panels made from plastic costing 80 cents per pound, for specialty car bodies that had a production run of just up to 150,000 units. The conventional steel material had a cost of only 35 cents per pound. The defect rate in plastic panels was 5%, compared to near zero levels in the steel panels. The plastic panels offered a weight saving of merely 2-21% over the conventional steel panels (Automotive News, 1997). Despite their significantly lower human resource productivity, the plastic panels offered opportunities for an enhanced corporate-level competitive advantage.

The labor-intensive technical advancement is termed as ‘research-effect.’ **Research-effect** is measured as ‘annual (labor cost/sales) of a firm – (average annual labor cost/average annual sales) of the firm over the decade of 1976-85.’ The learning about the assembly value of costly materials is termed as ‘development-effect.’ **Design-effect** is measured as ‘annual labor cost/sales of a firm – annual material cost/sales of the firm.’ The data include annual observations for the Big-3 US firms, over the period 1976-85.

In Table 3.3(a), resource productivity and competitive advantage are regressed on the research-effect and design-effect. The intercepts yield the constant **market-effect**. The t-values are in brackets. The market offered a resource productivity level of $21141, which was greater than the average realized by any of the three American assemblers. Further, the market offered a competitive advantage of 41.8% to each of the three assemblers, which implied aggregate American assembler revenues exceeding the motor vehicle production value for the US, Germany and Japan combined. Technical advancement research-effect had a negative impact on resource productivity and competitive advantage. Design of systems for using new costlier materials boosted competitive advantage, but did not yield significant resource productivity growth.

Table 3.3(a): Marketing Effectiveness of the Big-3 US Auto Assemblers

	Resource Productivity	Competitive Advantage
Market-effect	21141 (4.055)	0.418 (14.853)
Research-effect	-153285 (-3.775)	-0.831 (-3.791)
Design-effect	24695 (1.494)	0.890 (9.974)
R sq.	0.348	0.788

The firms work with the outside vendors to improve the costing of new materials, such as through redesign and reengineering. The impact of such initiatives is termed as 'corporate-effect.' **Corporate-effect** is measured as the 'annual labor cost/sales for a firm – annual (labor cost/sales), averaged over General Motors, Ford, and Chrysler.' The implied cost-effectiveness of employing the higher skilled manpower is termed as leadership-effect. **Leadership-effect** is measured as the '(average annual labor cost/average annual sales) of a firm over the decade 1976-85 – annual (labor cost/ sales), averaged over General Motors, Ford and Chrysler.'

In Table 3.3(b), resource productivity and competitive advantage are regressed on the corporate-effect and leadership-effect. The intercepts yield the constant **organization-effect** of marketing the acquired resources. The t-values are in brackets. The organization offered a resource productivity of $13,554, which was about two-thirds of that offered by the market. Further, the organization offered a competitive advantage of 17.5%. While in aggregate this exceeded the actual aggregate competitive advantage of the three American assemblers, the level was less than half that offered by the market. The firm-specific redesign initiatives limited the human resource productivity, but generated a positive competitive advantage. The leadership in human capital increased the resource productivity as well as competitive advantage.

Table 3.3(b): Organizational Effectiveness of the Big-3 US Auto Assemblers

	Resource Productivity	Competitive Advantage
Organization-effect	13554 (9.255)	0.175 (17.759)
Corporate-effect	-137063 (-2.890)	0.947 (2.961)
Leadership-effect	134734 (2.822)	1.386 (4.304)

R sq.	0.295	0.642

To summarize, it is hypothesized that:

Hypothesis: Organizational Learning and Manufacturing Reactions

The less a firm owns the visible assets, the greater the technological investment.

Operational Measures

Conventionally, human capital is expected to generate super-normal returns and economic growth. Table 3.4 presents the growth rates in the domestic income for Japan, Germany and the US, and for market (industrially advanced), emerging, and transitional (East European) economies. The data give the actual growth rate for 1995 and 1996, and the predicted growth rate for 1997, estimated by the International Monetary Fund (1997: 5) in its World Outlook.

Table 3.4: Percentage Annual Growth in Gross Domestic Product, 1995-1997

	1995	1996	1997 Expected
Japan	1.4%	3.6%	2.2%
Germany	1.9%	1.4%	2.3%
US	2.0%	2.4%	3.0%
Market Economies	2.0%	2.2%	2.6%
Emerging Economies	6.0%	6.5%	6.6%
Transitional Economies	-0.8%	0.1%	3.0%

The expected future growth rates of the emerging and transitional economies exceeded that of the market economies. In 1996, the emerging and transitional economies received a net $61.9 billion in short-term overseas credit. In 1997, their outstanding short-term overseas credit fell by a net $12.2 billion, and was to fall by another $17 billion in 1998. The foreign bank credit declined from $107 billion in 1996, to $4 billion in 1997, and was expected to be $12 billion in 1998. The net foreign private non-bank credit, primarily bonds, was expected to drop from $80 billion in 1997, to $60 billion in 1998. The foreign equity investments, primarily direct, were $148 billion in 1997, and were expected to be $149.5 billion in 1998 (Institute of International Finance, 1998: 6). On the whole, the coordination of the emerging and transitional market investments constituted a significant element of the market economies' services. Therefore, there is a need to correct for the **globalization-effect** while testing the proposed hypothesis.

Test of the Hypothesis

The visible assets impose a fixed cost obligation, and make the firms liable to bear escalating costs of transacting with the principal institutions. The analysis investigates the manufacturing, services, and transaction costs, of the Big Three American auto assemblers, over the period 1976-85. **Manufacturing cost** is measured as the '($ value of machinery at the beginning of the year + $ value of machinery at the end of the year)/2'. **Services cost** is measured as the '($ value of administrative, marketing and selling expenses during the year)'. **Transaction cost** is measured as the '(Sales – labor cost – cost of intermediate purchased inputs – services cost)'.

The firms could minimize the risk perception of the principal institutions by evidencing a super-normal productivity through the exploitation of invisible opportunities. The resulting gains in the marketing power of the firm are termed as competitive-effect. **Competitive-effect** is measured as the 'Incremental market effectiveness, evaluated as the residuals of the resource productivity in Table 3.3(a) – Incremental organizational effectiveness, evaluated as the corresponding residuals of the resource productivity in Table 3.3(b).' The development of invisible opportunities could allow the firms to better exploit the co-specialized visible assets owned by the outside firms also. The resulting gains in the competitive power of the firm are termed as complementary-effect. **Complementary-effect** is measured as the 'Incremental market flexibility, evaluated as the residuals of the competitive advantage equation in Table 3.3(a) – Incremental organizational flexibility, evaluated as the corresponding residuals of the competitive advantage equation in Table 3.3(b).'

Table 3.5 presents the results of the regression of the three costs on the competitive-effect and the complementary-effect. The intercepts yield the constant **supplementary-effect** of the visible market opportunities. The t-values are in brackets. The visible market opportunities played a significant role in adding to the manufacturing, services and the transaction costs. The competitive development of the invisible market opportunities helped save all the three costs. The complementary exploitation of the market resources obviated the necessity of co-specialized manufacturing or servicing commitments, and tended to further reduce the transaction costs.

Table 3.5: Changes in the Cost-effectiveness of Big-3 US Auto Assemblers

	Manufacturing Cost	Services Cost	Transaction Cost
Supplementary-effect	5869 (10.469)	3933 (11.247)	1732 (5.547)
Competitive-effect	-1.469 (-4.528)	-1.071 (-5.317)	-0.738 (-4.103)
Complementary-effect	20683 (1.239)	9176 (0.885)	-14067 (-1.520)
R sq.	0.439	0.532	0.527

To the extent, the visible assets of the firms have no co-specialized links with the emergent vendor assets, the firms could use service-based learning to upgrade their manufacturing assets, and thereby obviate the escalating transaction costs. The upgrading cost of manufacturing, termed the **manufacturing-effect**, is measured as the residuals of manufacturing cost equation in Table 3.5. The incremental services cost, termed **services-effect,** is measured as the residuals of services cost equation in Table 3.5. **Transaction-effect** is measured as the residuals of transaction cost equation in Table 3.5. Below, manufacturing-effect is regressed on the services-effect and transaction-effect. Services-based learning significantly enhanced the manufacturing investments, and obviated any persistent detrimental impact of the escalating transaction costs on the manufacturing reengineering.

Manufacturing-effect = 0.000+1.494 Services-effect –0.196 Transaction-effect R^2:0.882
(0.000) (14.002) (-1.641)

The firms factor in the services-based learning in their organizational planning, and make incremental manufacturing investments. Further, they consider the potential market for supporting the services based learning, and thereby save on their manufacturing costs. The analysis of residuals of manufacturing-effect equation indicates that the three firms as a whole made significant super-normal manufacturing investments over 1976-80. These varied from the highs of $695 million in 1976 and $700 million in 1979, to the lows of $123 million in 1978 and $119 million in 1980. But over 1981-85, significant manufacturing cost savings were realized. These savings varied from the highs of $1038 million in 1981 and $595 million in 1985, to the lows of $204 million in 1983 and $27 million in 1984. On average, over 1976-85, Ford made annual super-normal manufacturing investment of $762.50 million. General Motors enjoyed incremental manufacturing cost savings of $471 million, and Chrysler of $291.50 million.

General Motors and Chrysler thus found the market services to be specialized with their assets, while Ford's mass manufacturing assets remained distinct. The market derived incremental rents through specialization with the invisible future programs of Ford. Further, Ford realized incremental productivity by investigating the invisible factors enabling General Motors to sustain its dominant competitive advantage, and Chrysler to sustain its resource productivity leadership. Table 3.6(a) presents the results of the regression of resource productivity on the research-effect and design-effect. The analysis is conducted for the period 1976-85 [same as that in Table 3.3(a)], and for the period 1986-93. The data comprise annual firm-level observations for the Big-3 US assemblers. The intercepts reflect the market-effect. The t-values are in brackets. The resource productivity of the visible market opportunities declined, and became negative, over the 1986-93. The effect of researching technical advancement became highly productive, while the effect of designing niche products became significantly negative over time.

Table 3.6(a): Productivity of Market-Specialized Know-how for the Big-3 US Assemblers

	1976-85	1986-93	test of Growth
Market-effect	21141 (4.055)	-95565 (-3.154)	-116707 (-3.796)
Research-effect	-153285 (-3.755)	466446 (2.453)	619731 (3.188)
Design-effect	24695 (1.494)	-311965 (-4.183)	-336659 (-4.407)
R sq.	0.348	0.479	

The firms derive incremental advantage by trading the corporate know-how to the subsidiary affiliates internationally, and thereby developing global leadership in each technological domain. Table 3.6(b) presents the results of the regression of the resource productivity on the corporate-effect and leadership-effect. The analysis is for the period 1976-85 [same as that in Table 3.3(b)], and for the period 1986-93. The data are firm-level annual observations for the Big-3 US assemblers. The intercepts yield the organization-effect. The t-values are in brackets. Organization had a proportionately increasing impact on productivity over time. The effect of corporate-specialized services became incrementally negative. The effect of developing sustainable global leadership was significantly positive, and constant, over time.

Table 3.6(b): Changing Sources of Productivity for the Big-3 US Assemblers

	1976-85	1986-93	test of Growth
Organization-effect	13554 (9.255)	23626 (8.147)	10072 (3.100)
Corporate-effect	-130763 (-2.890)	-647620 (-5.617)	-510557 (-4.095)
Leadership-effect	134734 (2.822)	102166 (1.136)	-32567 (-0.320)
R sq.	0.295	0.697	

Correction Factor for the Globalization-effect

Among the Big-3 firms, Chrysler has had the least international operations, and evidently suffered a significant competitive disadvantage despite the super-normal productivity of its resources. In May 1998, Germany's biggest industrial group, Diamler-Benz, offered 0.62 of its equity share in exchange for each share of Chrysler. This meant 35% ownership of the consolidated Diamler being offered to the erstwhile shareholders of Chrysler. Chrysler was valued at about $40 billion, which implied a 50% premium on Chrysler's stock value of $27 billion before the acquisition talks went public. The auto industry currently comprises of three major segments: cars, light trucks, and large trucks. Japanese firms currently dominate the car segment, and the American firms dominate the light truck segment. During the 1990s, Diamler bought Freightliner, the biggest large truck maker in the US, and then acquired Ford's Heavy trucks operations. With this, Germany gained the global leadership of the large truck market. The cars segment comprises of three sub-segments: ordinary cars, luxury cars, and recreational cars. Japanese firms traditionally dominate the low priced ordinary car segment, but have been recently expanding into the recreational car segment using integrative luxury image. German firms specialize in the high priced luxury car segment. American firms focus on the high growth value priced recreational car segment. The recreational cars include smart city cars, sport utility cars, and the people-carrier multi-purpose vehicles. Chrysler created the multi-purpose vehicle segment by integrating the sport utility cars with the light trucks to design glamorous minivans in 1983. The dominant share in this highly popular segment encouraged Chrysler to spin off its other defense and other ancillary business units by 1997.

In 1997, motor vehicles comprised 70.9% of the total $71.5 billion revenues of Diamler, with the rest accounted by the aerospace, financial services, rail-systems, and microelectronics. Chrysler's revenues of $61.9 billion derived solely from the motor vehicles. Chrysler sold 2.89 million vehicles worldwide in 1997, compared to just 1.33 million vehicles of Diamler. Chrysler generated operating profits of $5.7 billion, with 121,000 employees, yielding a stellar resource productivity of $47,007/worker. Diamler generated operating profits of just $2.5 billion, with 300,068 employees, yielding a meager resource productivity of $8,331/worker. Diamler was the leader in the luxury saloon cars. With a maturing growth of this segment, it had sought to diversify into a variety of non-auto business areas over the 1980s. Financial Times (1998: 1) noted, "Daimler has largely abandoned attempts to expand outside the transport market after diversification earlier this decade into other business areas led to huge losses." As a first step towards new learning, Diamler commissioned its first-ever factory in the US during 1997, which was expected to make 60,000 sports utility cars during 1998. The construction of the factory was initiated in 1993, as a corrective response to an increasingly dismal performance. Until then, all manufacturing and developmental operations of Diamler had been concentrated only in Germany.

Table 3.7 presents performance data of Diamler, derived from COMPUSTAT. The earnings of Diamler's workers matured by 1991. The cost-effectiveness of material resources fell significantly in 1992, while the commitment to the services increased tremendously. An increased emphasis on the American learning, complemented with acquisition of substantial stakes in Brazil, encouraged Diamler refocus engineering resources into the development of innovative recreational vehicles, such as sport utility cars and smart city cars. Diamler's stock more than doubled in value over the next few years. As of May 1988, recognizing the significant future learning potential, the global market valued Diamler's stocks on a "1988 multiple of 6.9 times enterprise value/earnings before interest, tax and depreciation compared to a lowly 4.1 times for Chrysler." (Financial Times, 1998: 12).

Table 3.7: Organizational Performance of Diamler Benz

	$ Earnings/ employee	Material Costs/sales	Services Costs/sales
1989	37291	21.0%	49.5%
1990	47673	20.6%	49.9%
1991	51727	20.9%	49.9%
1992	52484	17.4%	53.9%
1993	52970	17.8%	54.3%

When Do the Firms Discover Emerging Technological Know-how?

German firms had strong historical strengths in the non-electrical mechanical sector, and over time developed specialized niche positions in the electric sector. These conditions offered abundant marketing opportunities for the Japanese firms by demonstrating a strategic commitment to learning. The data from OECD indicate that as of 1976, Japanese firms were about equally focused on the production of both electric machinery ($47.66 billion) and non-electric machinery ($46.34 billion). The parity was sustained until 1981, when the production in each sector was about $116 billion. Thereafter, the growth in the electric sector far outpaced that in the non-electric sector. On the whole, over 1976-90, Japan's non-electric machinery production grew at an exponential annualized rate of 11.29% (t-value = 13.47). In contrast, Japan's electric machinery production grew at an exponential annualized rate of 14.22% (t-value = 19.48). Table 3.8 presents data on the trade and the trade balance of Japan, each as a percentage of production, for the two sectors.

The trading of non-electric machinery rapidly grew from 18.88% of the production during the late 1970s, to 23.47% during the late 1980s. The trading of electric machinery matured at 25.33% of the production during the early 1980s, and thereafter dropped to 19.98% over the late 1980s. Initially, Japan gained a strong comparative advantage in the electric technology. By the late 1980s, the global services developed significant specialization with Japan's electric assets, and the augmented global market base sustained the comparative advantage of Japan's non-electric assets.

Table 3.8: Trading Effectiveness of Japanese Machinery Assets

	Non-electric Machinery		Electric Machinery	
	Trade	Balance of Trade	Trade	Balance of Trade
1976-80	18.88%	12.55%	22.79%	18.21%
1981-85	21.96%	16.07%	25.33%	20.98%
1986-90	23.47%	16.53%	19.98%	15.13%
Overall	22.26%	15.71%	21.76%	17.08%

The specialized international services helped sustain the exchange, marketing, manufacturing, and productivity of visible resources. The significance of manpower, termed **human-effect**, is measured as (cost of labor/production). The significance of material power, termed **trading-effect**, is measured as (cost of intermediate inputs/ production). Performance is evaluated on four parameters, (1) **exchange power**, measured as (exports + imports)/ production, (2) **marketing power**, measured as (exports – imports)/ production, (3) **manufacturing cost**, measured as (fixed investment/ production), and (4) **resource productivity**, measured as (operating surplus in the US$/employees). Table 3.9(a) presents the results of regression of each of the four parameters on the human-effect and trading-effect. The intercepts yield the constant **Japan-effect**. The t-values are in brackets.

Japan's exchange power derived almost fully from the marketing of its technological paradigm, and was conditioned on a high manufacturing cost of 49.7% of the production. A very strong resource productivity of $187,260 per worker was generated. The enhanced human and trading effectiveness discouraged the marketing power, and created incentives for exchanging the global machinery. The manufacturing costs were saved, but the resource productivity also fell.

Table 3.9(a): Impact of Marketing Technology on the Japanese Manufacturing Effectiveness

	Exchange Power	Marketing Power	Manufacturing Cost	Resource Productivity
Japan-effect	0.682 (4.608)	0.672 (3.837)	0.497 (6.924)	187260 (5.009)
Human-effect	-0.196 (-0.998)	-0.482 (-2.071)	-0.829 (-8.693)	-162750 (-3.279)
Trading-effect	-0.652 (-2.983)	-0.627 (-2.423)	-0.394 (-3.716)	-217902 (-3.950)
R sq.	0.265	0.267	0.764	0.486

Japanese firms limited the counter-productive implications of owning the visible overseas assets through reengineering of the previously owned assets. The improved engineering know-how enhanced the product value, and reduced the process costs. The **learning-effect,** reflecting adaptation to the globally marketed products, is measured as '(value-added in current prices)/production.' The **cost-effect** is measured as '(value-added in 1985 prices – value added in current prices)/ production.' In Table 9(b), each of the four performance parameters is regressed on the learning-effect and cost-effect. The intercepts yield the constant **history-effect** of the assets available for reengineering. The historical base of owned assets had a substantial detrimental impact on the resource productivity. Learning generated significant marketing power, without necessitating additional equipment imports. There was no sustained rise in manufacturing costs, and considerable growth in the resource productivity was realized. The improved cost-effectiveness motivated additional machinery imports. These enhanced manufacturing costs supported further growth in the resource productivity.

Table 3.9(b): Impact of Reengineering on the Japanese Manufacturing Effectiveness

	Exchange Power	Marketing Power	Manufacturing Cost	Resource Productivity
History-effect	-0.019 (-0.269)	-0.064 (-0.738)	-0.053 (-0.820)	-58094 (-4.465)
Learning-effect	0.669 (3.415)	0.641 (2.645)	0.342 (1.875)	199660 (5.476)
Cost-effect	-0.132 (-2.802)	-0.171 (-2.940)	0.121 (2.770)	67530 (7.714)
R sq.	0.409	0.357	0.302	0.776

Conclusions and the Recommendations for Further Research

Japanese firms enjoyed super-normal growth by applying their networked endowments to the dominant international market paradigm. Over time, the increased isolation of their networked endowments from the emerging entrepreneurial developments limited sustained growth. A pre-dominant reliance on the dominant designs threatened a flexible development of dynamic electric know-how. **Dominant-effect**, reflecting the co-engineering of the machinery designs, is measured as the 'residuals of Table 3.9(a).' **Dynamic-effect**, reflecting newly emerging know-how, is measured as the 'residuals of Table 3.9(a) * [If electric machinery, then dummy = 1, else dummy = 0].' The exchange benefits of reengineering are termed as **exchange-effect**, measured as the residuals of exchange power equation in Table 3.9(b). Similarly, **marketing-effect** is measured as the residuals of marketing power equation, **manufacturing-effect** as the residuals of manufacturing cost equation, and **productivity-effect** as the residuals of resource productivity equation. In Table 3.10, each of these four reengineering benefits is regressed on the corresponding dominant-effect and dynamic-effect. The intercepts yield the constant **international-effect**, reflecting new invisible links. The t-values are in brackets. Japan could not make significant use of the newly visible options in the machinery technology. The dominant paradigm substantially augmented the marketing power, and enhanced the resource productivity. In contrast, the up-gradation to the dynamic electric know-how led to escalating manufacturing costs, and limited the resource productivity.

Table 3.10: Dominant Paradigm of Machine Technology and Japanese Network Assembly

	Exchange-effect	Marketing-effect	Manufacturing-effect	Productivity-effect
International-effect	0.001 (0.308)	0.002 (0.668)	0.000 (0.124)	-488 (-0.832)
Dominant-effect	1.037 (3.723)	1.063 (3.558)	-0.290 (-0.656)	0.606 (3.159)
Dynamic-effect	-0.344 (-1.148)	-0.509 (-1.413)	1.511 (2.690)	-0.570 (-2.346)
R sq.	0.691	0.520	0.323	0.274
Cumulative R sq.	0.817	0.691	0.527	0.837

Under these conditions, Japanese firms increasingly relied on the **diffusion** of the traditional machinery overseas to leverage the reengineering services of the global workforces. The **flexibility** of the resulting advanced technology offered significant potential savings in the manufacturing costs, and fostered a shift towards the higher value-adding services. Nohria and Gulati (1996: 128) surveyed 178 department heads in the 14 national subsidiaries of the largest Japanese consumer electronics firm and 78 department heads in the 8 national subsidiaries of a comparable European firm. The independent forces in the value-added by the three major innovations of each local manufacturing unit over the previous year, duly corrected for the leader skills and responsibility, are in Table 3.11. Local marketing and research initiatives generated significant innovative value across all the cases. The impact of the administratively influenced environment, resource capability, and manufacturing factors significantly varied across different cases. Japanese multinational had not yet diffused its learning advantage to all the units.

Table 3.11: Value-added by the Department Level Innovations in Consumer Electronics

Parameter	Operational Measure	Coefficient	Standard error
Environment	Intensity of competition and technological change experienced by the subsidiary in its local market	-0.01	0.34
Capability	Relative resource levels of the subsidiary	0.32	0.47
R&D	R&D function relative to administrative function	3.36	1.79
Manufacturing	Manufacturing function relative to administrative function	0.96	1.02
Marketing	Marketing function relative to administrative function	3.57	0.99
Europe	European firm relative to Japanese firm	-1.25	0.97

In the late 1980s, European Economic Commission (EEC) investigated the performance of Japanese firms in the dynamic access memory chips (D-Rams). The growth in the European market share of the Japanese firms from 25% in 1983 to more than 70% derived from the sales up to 60% below the production costs. In 1990, EEC regulated that the Japanese firms must sell D-Rams at a price that covers the full production cost and yields a minimum of 6.5% profit margin.

Japanese firms consequently lost an increasing share of their European market advantage to the Korean firms. EEC found that the Korean firms were selling at prices up to 24.7% below the production costs, and set minimum prices for the Korean firms also. In the meantime, European firms sought to sustain their competitiveness in the applications market through the use of higher value-adding logic chips designed by the American firms, such as Intel. Inevitably, EEC deleted the regulations in June 1995. Led by an intense competition, the worldwide prices of D-Ram slumped by 80% over the 1996. In future, innovative integration of logic and memory semiconductors will generate substantial growth. Still during 1996-2001, the usage of semiconductors is expected to grow by just 12% in Japan, 14% in Europe, 16% in the US, 20% in Asia, and 38% in the rest of the world (Financial Times, 1997: 4). As such, there is a need to conduct an overall strategic survey of the international technological capability, and tactical approach for a dynamic development of organizational learning. The stronger interactions with the rapidly emergent global units could help compensate for the limitations of firm-specific technological base. A creative assembly would boost the profitability of evolutionary organization, and enable further investments for revolutionary technological capability.

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