Chapter 8

A Dynamic Model of Technological Trading

When Do the Firms add Value to the Emerging Networks?

Abstract: Information asymmetry, problems of appropriability, human capital specificity, and evolutionary firm-specific path-dependence, act as formidable impediments to trading of technology in the global markets. American firms respond to these barriers by aggressively investing into the proprietary technologies. They are also on constant vigil for newly emergent technology options, on which full increasing returns might not have been yet appropriated. Japanese firms, on the other hand, let the American firms evaluate the true tradable value of the newly emergent options, and generate revenues on bringing in locally traded options to the mainstream global markets. While such a process offers super-normal advantage to the American firms in acquiring worldwide assets, Japanese firms seek super-normal gains on financing and strategic support services.

Introduction

Assembly of the sophisticated market know-how is a dominant theme in the studies of international development. For instance, Olson (1982: 176) noted, "the poor nations now can borrow the technologies of more developed nations, some of which will be readily adaptable to their own environments, and improve their techniques of production very rapidly…. The nations of continental Europe and Japan were far behind the United States technologically at the end of World War II, but they borrowed American technology, grew far faster than the United States, and very nearly caught up with the United States in both technology and per capita income in less than twenty-five years." The incremental rents from effective trading can significantly boost the cultural incentives for innovation, and further economic development. Franke, Hofstede and Bond (1991: 165) report, "Cultural values, measured from Western and Eastern perspectives, are factors in economic performance that explain more than half the cross-national variance in economic growth over 2 periods for samples of 18 and 20 nations. Performance seems facilitated by Confucian dynamism, stressing thrift, perseverance, and hierarchical relatedness, but not traditions impeding innovation." Once the firms become proficient in the sophisticated know-how, they might add incremental value to the generic technological inputs available internationally. In this regard, Bruderer and Singh (1996: 1323) highlight the "the capacity for organizational learning as a 'genetic' trait that is itself subject to Darwinian selection. A population of organizational forms that has capacity of learning will discover a viable organizational form much more quickly than a population of their inert counterparts. This is true in spite of the selection process being strictly Darwinian: even when the acquired traits are not heritable, selection will favor the capacity to acquire traits."

The case of how Coca-Cola Co. is contesting its lost market share back from PepsiCo is notable. PepsiCo "owns 10% of Britvic (a company that distributes soft drinks, especially fruit juices, to Britain's public houses) and tried to take over the rest of the distributor [in 1995]. The European Commission scotched the deal on antitrust grounds." Coca-Cola Co. announced a deal in June 1996 for a 100% acquisition of the British beverage bottler, CCSB, for $1.85 billion. Coca-Cola had previously raised its equity stake in CCSB to 49%, and the British beverage giant Cadbury-Schweppes owned the residual 51%. When the European Commission raised an alarm, Coca-Cola highlighted its global experiences: "In the Philippines, Pepsi at one time sold three times Coke's volume. Then Coke took over its own distribution using an anchor bottler. Today Coca-Cola outsells Pepsi in the Philippines by a healthy margin of 3-to-1." (Forbes, 1996: 184) Cadbury stood to receive $1billion in cash, 11 times Cadbury's share of the CCSB's earnings in 1995, from the sale. Cadbury emphatically submitted that it "wants to use the money to reduce debt (mostly arising from the $1.7 billion spent buying the 74% of Dr. Pepper it did not already own) and also to make acquisitions in the confectionery and chocolate markets." (Forbes, 1996: 186) The British government fully endorsed the case of Cadbury in the European Commission.

In the US, Coca-Cola with a Wharton Graduate at its helm then set a target of 50% domestic market share in 2001, up from 43% in 1995 (Forbes, 1996: 251). In 1996 the restaurant fountain sales accounted for 22% of the US carbonated soft drinks market. With its share at 43.1%, as against 31% for PepsiCo., and 14.8% for Dr. Pepper, Coca-Cola projected a 7% annual growth until 2001 on its current US sales of $5.3 billion, against an industry average of 3.5% (Financial Times, June 4, 1997). It offered the US franchisees of McDonald one-time gifts of 200-600 gallons of soft drink syrup sufficient for 30,000-90,000 drinks per restaurant, if they served only the Coca-Cola products. Coca-Cola gained an exclusive contract for 1,800 restaurants owned and operated by McDonald's. Another 9,500 franchises supplemented Coke with the products of Cadbury Schweppes. A vast brand range such as Dr. Pepper, 7 UP, Canada Dry, Schweppes, A&W and Sunkist gave Cadbury No. 2 position in the US fountain market.

The gains from technological trading are thus a function of two forces: (1) the proficiency of motivating the vendors to patronize the firm-specific technological services, and (2) the costs of vendors locking into the non-tradable organizational trajectories. This report evaluates the first force, and recommends the second for further academic research.

Motivating the Vendors to Patronize the Firm-specific Services

At the end of World War II, the US reform agencies set up the 'Training within Industries' Program in Japan, which over the subsequent years trained more than ten million Japanese managers, supervisors, and workers, in scientific procedures, systematic methods improvement, and team relationship dynamics. Over the subsequent years, Japanese firms enjoyed a rapid development in the vehicle line and models using increasingly complex and diverse imported engineering platforms. Japanese networks were struck at the low-volume low-price end of the market, generating wafer-thin margins. The firms sought team-based on-the-job learning, wide span of job rotation, and continuous change in operating procedures, machinery, as well as product designs, both within the firm as well as across a tiered network of firm-specific suppliers.

Recognizing the super-normal productivity of these initiatives, traditionally Japanese firms were reluctant multinationals. Their overseas investments were pre-dominantly joint ventures into the Asian region, in which the host nation partners had a majority equity stake.

Over time, the productivity of the overseas transplants was often discovered to be at par, or even above, the domestic levels. These transplants evidenced only partial adoption of the known high-performance Japanese practices, such as the just-in-time system, the flexible automation, or the single assembly line. Recognizing opportunities for adding value, Japanese firms began seeking to boost their share of equity in the overseas ventures from minority, usually 26%, to 50%, and then 74% or even 100%, aimed at a unified managerial control. They implemented a central coordination at the headquarters for identifying the drivers of transplant productivity, and actively rotated Japanese expatriates between the overseas and various domestic plants. Three major regionally specialized techniques were identified. The Asian region had a distinctive labor-supporting cell system, the European region deployed semi-autonomous teams, and the US used multiple assembly lines varying by the distinct product models.

Abo (1997: 16, 18), Director of the Japanese Multinational Enterprise Study Group, observed that the new integrated assembly system was “called ‘autonomous completing lines’ as the team members working at a divided line have a kind of ‘autonomy’ and responsibility to complete a set of linked assembly processes with some buffer… compared with the case of ‘unlimited responsibility’ including ‘kaizen activities’ (continuous improvement) for one whole final line.” This U-shaped cell system “can be said an ‘ultimate Japanese system’ in terms of extremely large variety-small lot production system where almost all processes are done by manual works of super wider multi-skilled workers without using automated lines (various micro and mechanical electronic machines are effectively used but in many cases existing robots and conveyors were removed away). Such representative factories are those of NEC Saitama (mobile telephone), Toshiba Fuchu (computer assembly), Sony Koda (handy VCR camera), Casio Yamagata (digital watch), and so on."

Recognizing the productivity of Asian transplants, Japanese firms diffused the cell-based system to Europe using a semi-autonomous team structure. The American auto assemblers were scaling back their UK direct investments, and considerable surplus of the specialized workforce and vendors was available. Supported by Japan, the share of foreign direct investments in the UK manufacturing value-added jumped from 20% in 1990 to more than 25% in 1997. The value-added/ hour grew @ 3.75% during the 1986-95, compared to just 2.8% during the 1973-85. British National Institute of Economic and Social Research (1997: 9) reports, "Almost a third of the productivity growth in UK manufacturing industry since the mid-1980s can be ascribed to the 'ripple-through' effects of changes in work practices… In many cases, supplier companies have been encouraged to take on new cost control and self-improvement techniques. This has been driven primarily by the move to just-in-time production…"

In Germany, economy minister, Robert Schmidt, had set up a state-funded National Board of Efficiency (RKW) in 1921. Carl Friedrich von Siemens – the head of Siemens industrial group – was appointed as the first President of the RKW. After extensive discussions with engineers, unions, and corporate managers, Siemens concluded, "All Germans agree that our present production is too small and therefore too expensive." (Guillen, 1994: 114) An emphasis was laid on adopting the American mass production methods. By 1930, more than 200 committees, with about 4,000 members, were operating under the support of RKW. These committees codified the American methods and trained German workforce in a variety of industries. The critical elements introduced in Germany included the product and process standardization, job analysis and division, time-and-motion studies, mechanization, as well as the piecework systems. The industries that benefited from the training initiatives included the building materials, paper, footwear, mining and metal processing, machine construction and tools, electric equipment and automotive. The training domains were quite diverse encompassing all the support functions such as extraction, logistics as well as packaging. The RKW also conducted nearly 80,000 psychological tests every year to enhance the workforce proficiency. After the end of the World War II, under the US-sponsored Marshall Plan, the RKW was restructured into the German Productivity Center. The Center emphasized "working meaningfully – living satisfied" (*Sinnvoller arbeiten – zufrieden leben*) as its mission.

Throughout the late 1950s and early 1960s, German firms moved into a variety of diverse industrial activities. Though such initiatives helped German firms to boost the premium luxury image of their products, German auto assemblers stood at the bottom of the international competition on key parameters such as the unit vehicle costs, product development times, and process quality. German engineering vendor groups also experienced a similar situation. Rather than letting Japanese firms acquire their operations, the German firms began a phase of rapid foreign direct investment over the early 1990s. By the mid-1990s, both German auto assemblers as well as German engineering groups realized sharp growth in their sales and profits. The dividends had been substantially boosted, on confidence that higher dividend pay-out is sustainable in the foreseeable future. German auto assemblers renewed their initiatives of moving further upscale, motivating the British firm Vickers to put up its prestigious luxury car division, Rolls-Royce Motor Cars, up for auction in November 1997. Volkswagen, whose manufacturing power was primarily focused on the lower-end vehicles, showed an early interest seeking sole bidding rights. BMW, who was a core supplier of premium engines to the Rolls Royce, soon made public its intentions to wage a bidding contest. Its key competitor and German leader, Daimler-Benz, was in the process of building up the Maybach, the principal alternative to Rolls-Royce models in the international market. Still BMW's bid of Sterling 340 million far lagged the Volkswagen's upgraded offer of Sterling 430 million. BMW maintained that the difference was more than made up by the proprietary eight and twelve-cylinder engines supplied by it to run

Rolls Royce vehicles. Ferdinand Piech, chairman of Volkswagen, countered that it was quite easy to reengineer the vehicles to use Volkswagen's engines. He noted, "the change of engines could boost sales as the motors would be built by Cosworth, the specialist racing engine subsidiary of Vickers… If Vickers also sold Cosworth to [Volkswagen], it would be expanded to build engines and do foundry work for [Volkswagen's] executive car subsidiary, Audi, which is facing production bottlenecks… Colsworth engines already power several sporty Ford models, as well as some Rolls-Royce vehicles." (Financial Times, 1998: 17)

Volkswagen in the meantime constructed new plants in East Germany, Slovakia and Hungary, using pre-dominantly local vendor support, and modernized the mother plants in its German Wolfsburg base. In Germany, material inputs accounted for up to two thirds of total vehicle cost. Volkswagen sought maximum possible concessions from the German suppliers, and gave added purchase contracts to the overseas vendors under the leadership of Jose Ignacio Lopez. The German courts barred Lopez, who earlier headed the GM's worldwide purchasing, from using the GM's manufacturing designs. Yet with the introduction of unusually simple work methods, German workforce adopted a flexible "working time shareholding system" to use the enhanced productivity for leisurely time-off. Between 1993 and 1996, the Volkswagen's, as did the BMW's, output per employee surged by a third. Even the market leader, Daimler-Benz, adopted an unusually flexible basic engineering platform for its luxury limousines. It produced a great variety of models with sharply reduced product development times, and introduced a wider range of more popular vehicles such as sports cars, off-road vehicles, and even nippy commuter runabouts. Profits per unit on the new 1995 models of its E class vehicles jumped by DM 3,350 compared to the older ones. The profits per unit on the 1998 models of its premium S Class limousine were DM 8,000 greater than those on the earlier models (Financial Times, 1998: 13).

Hypothesis Formulation

Traditionally, Japanese auto assemblers used general-purpose platforms, which required an expensive re-programming specialized to each application, and used the black-box components designed-in specifically for their pre-programmed product standards. Over the 1980s, Japanese suppliers set up several joint ventures and strategic alliances in the US to better service the Japanese assembler expectations for international prominence. American suppliers were motivated to set up model 21st century lines for manufacturing the latest components, using customized artificial intelligence support systems. Japanese electronic firms serviced an increasing share of the electronic-based parts and components in the next generation auto vehicles. By the late 1980s Japanese auto assemblers were making substantial investments into the computerized information systems, linking distributors, factories, as well as the vendors. Using novel computerized systems that could perform multiple tasks, significant savings in the labor cost of complex assembly and quality assurance of disintegrated component units were realized. A greater variety of intermediate inputs, offering diverse services, were added to a vehicle of the same size, without any increase in the total cost. Consequently, the assemblers realized super-normal growth in profits, and grew out of the historical profit-less state.

Japanese youth -- deeply enthused with the global learning opportunities -- began delaying the courtship and marriage, the birth rates in Japan began falling, and the overall population was aging. Youth showed visible dissatisfaction with the risks of *karoshii* (lit. death due to overwork). Japanese auto assemblers were the primary targets of the demands for obliterating 3-D (Dangerous, Dirty, and Demanding) activities from the shop floor. Saved efforts were directed into the special-purpose projects, for including the electronic products, imported from the dedicated overseas vendors, as standard options in the Japanese vehicles. Based on his field visits, Abo (1997) reported that Japanese firms in their Asian subsidiaries were making a wide range of electronic products, including consumer home appliances, business equipment, and component assemblies. The variety, scale, and sophistication, of these products far exceeded that of Japan's subsidiaries in the West, where even the largest of plants made just 1000-2000 pieces/shift of the color televisions and microwave ovens. Japanese firms increasingly sought to export the accumulated base of redundant domestic machinery and intermediate components to the local plants. Besides the exports of varied historical product designs, Japanese firms also exploited the opportunities to export technical services. These services were targeted to help local transplants re-engineer the local know-how, making it compatible to the path-dependent Japanese technology. Repairs and maintenance servicing of these path-dependent bases accumulating in the transplants generated further export revenues.

Lieberman, Lau and Williams (1990) investigated the super-normal productivity growth of the Big-3 Japanese auto assemblers (Toyota, Nissan, and Honda) compared to that of the Big-3 American auto assemblers (GM, Ford, and Chrysler). During the 1950s, scale economies drove the Japanese edge in productivity growth. From 1960s to late 1980s, the differences in labor efficiency dominated the productivity differentials. Lieberman and Asaba (1997) found that by the end of 1970s, Japanese auto sector had gained overall productivity edge over the US auto-sector. During the 1970s, both auto assemblers and their supplier networks enjoyed a significant reduction in the inventory levels in Japan. But in the US, only the assemblers and not the suppliers had cut their inventory levels. Thus, the overseas vendors enhanced the flexibility of Japanese firms in higher value-adding inputs. Therefore it is proposed that:

Hypothesis: Technological Trading and Creative Linkages

The more a firm purchases from the outside vendors, the greater the productivity.

Operational Measures

For inducing foreign firms to directly invest into the training of Japanese workforce, Japanese government allocated liberal fiscal expenditures to the construction projects. These public welfare projects were financed through special construction bonds, primarily subscribed by the post offices using the saving funds received from the consumers under compulsory fiscal rules. The government also injected multi-billion dollars of prime funds into the financial sector as perpetual non-repayable bonds. Under these conditions, experienced Japanese workers moved to set up creative service enterprises after the retirement. These enterprises were typically one person operations, but were critically supported with the family labor especially during the weekends. Besides working part time on computing the gains from diffusing their savings into the global portfolios, the entrepreneurs prospected a variety of dedicated networking opportunities. For instance, the weekend flights from Tokyo to Seoul round the year were booked fully by the first-line Japanese supervisors on the verge of retirement. The initial contacts generated promising consulting contracts, typically involving transfer of older machinery and component designs from the over-capitalized Japanese corporations. The overseas clients were offered repayment deals, whereby they traded a dominant proportion of their output, under buy-back arrangements with guaranteed yen-based, to the local distribution contacts.

In the meantime, American firms developed innovative left-hand drive vehicles for the Japanese market. Japanese government had traditionally blamed the American attempts to push right-hand drive domestic vehicles into Japan, as the key factor in limited foreign share of Japanese motor vehicle market. Still even the modified models made little progress at the Japanese distributorships. The new studies of Japanese government figured a credible link between the continued low imports of American vehicles, typically of a size larger than the Japanese ones, and the narrow Japanese lanes and small Japanese garages. Japanese assemblers -- who had moved into the larger vehicle segment using extensive technical lab facilities in the US -- relocated radio antennas from front to the side panels. Their large vehicle offerings were an instant hit in Japan, and the exports of these redesigned vehicles to the US at premium luxury prices were viewed as the most expeditious solution to the prolonged domestic recession.

General Motors licensed the auto parts and assembly know-how to the Korean conglomerate Daewoo Motors Co. Daewoo initiated an ambitious program to export 110,000 units of autos in Eastern Europe alone – more than double its auto sales in the US and Western Europe. It bid $1.1 billion for the acquisition of 100% equity in the sole local automaker AvtoZaz, compared to the GM's bid of just $23 million. Daewoo's valuation of the market potential was unusual, for the cumulative foreign direct investments into Ukraine since the 1991 liberalization had been just $1.4 billion. Daewoo presented a complementary $500 million project, seeking exclusive rights for construction of the mobile phone network in Ukraine. GM was approached to be a partner in the AvtoZaz plant, and share the responsibility for developing the Daewoo-brand products. Thus, Daewoo's gained an impressive reputation in the Central Asian region. The Wall Street Journal (1997: A 14) reported, "In tiny and isolated Uzbekistan, for instance, Daewoo's electronics and automotive units have spent more than $1 billion in the past four years, earning generous tax exemptions, the protection against import tariffs levied against competitors, and even soft credits from state banks to consumers who purchase locally made Daewoo products. The preferential treatment has earned the Central Asian republic the nickname 'Daewoostan.'" These experiences suggest a need to correct for the **reputation-effect** in evaluating the productivity contribution of purchases from the outside vendors.

Test of the Hypothesis

The gross productivity is measured as the number of vehicle unit manufactured/ employee. To get actual productivity, it is corrected (1) upwards, if the vehicles have a more valuable design complexity, and (2) downwards, if the vehicles use higher quality purchased inputs. The impact of super-normal design complexity may be termed as '**human-effect**,' and measured as (sales value - purchase costs)/employee. The impact of super-normal input quality may be termed as '**trading-effect**,' and measured as (sales value - cost of goods manufactured)/employee.

Sample and Data Source: The analysis focuses on the performance of Japan's largest consumer electronics group, Matsushita. Firm-level annual data on the three core members of the group -- Matsushita Electrical Industries, Matsushita Electronics, and Victor Co. of Japan -- are used. The group boosts its productivity by researching the complex firm-specific applications of high quality technological inputs. Alternatively, business equipment firms seek complex designs for more cost-effective servicing of Matsushita. The better the quality of inputs (trading-effect) used by the business equipment firms, the greater the potential design improvements (human-effect). The quality of inputs is augmented by the generic technologies, such as semiconductors. The greater the demand for design flexibility in the electronics sector (human-effect), the greater the incentives for securing the latest generic know-how from overseas (trading-effect). These propositions are investigated using data on Japan's three comparable mid-sized business equipment firms. These firms are Ricoh, Canon, and Oki Industries. The electronics sector data are measured as the aggregate of three Matsushita group members, three business equipment firms, and five major semiconductor firms. The original data in yen were obtained from the NIKKEI NEEDS database, using the assistance of Takahiro Fujimoto at the University of Tokyo. These data were translated from varying accounting years to a calendar year basis, and converted into US$ to help evaluate the global productivity implications. The aggregate annual data on human-effect and trading-effect for each of the three corporate groupings are in Table 8.1(a).

The quality of technological inputs traded by Matsushita group (trading-effect) improved rapidly until 1988, but deteriorated thereafter. As such, the ability of Matsushita group to develop complex firm-specific applications (human-effect) also peaked in 1988, and there were increased pressures to simplify the designs for keeping up with the more generic technological input quality thereafter. The business equipment firms eventually responded by trading more generic technological inputs in 1990. The improved trading-effect after 1990 facilitated more specialized servicing of the customers (human-effect). The demand for complex services of electronics firms (human-effect) peaked in 1990. In 1990, there was a discontinuity in the use of highly co-specialized technological inputs, and the firms began using more popular flexible inputs in the electronics sector. On the whole, flexibility of electronic inputs had a most significant growth impact on the trading-effect of the business equipment group, and on the human-effect of the overall electronics sector. Matsushita group experienced the least growth in both elements.

Table 8.1(a): Changing Cost-effectiveness of Generic Resources for Japanese Electronics

	Consumer Electronics		**Business Equipment**		**Electronics Industry**	
	Trading-effect	Human-effect	Trading-effect	Human-effect	Trading-effect	Human-effect
1985	60802	84852	41701	56503	44672	76245
1986	78045	113674	48705	71189	58599	103758
1987	96831	140158	67086	94698	76026	130306
1988	127102	177116	90630	113140	102305	165526
1989	125438	169061	96602	127634	106576	166194
1990	122657	161799	95031	126312	106530	163347
1991	126959	170656	97823	131377	109518	173088
1992	117883	167586	99154	149672	103966	178950
1993	122314	178109	114087	174426	111886	199335

Matsushita group sought productivity by enhancing its **purchases** of the generic technological inputs. More complex applications were **designed** for specialized customer needs. The productivity gains were limited by the cost of building **reputation** for firm-specific designs in the market. Reputation motivated the business equipment firms to support the Matsushita group through similar firm-specific initiatives. The purchase cost is measured as the aggregate cost of intermediate inputs and royalties on licensed know-how. The design cost is measured as the aggregate overheads in manufacturing and general administration. The reputation cost is measured as the aggregate costs of the advertising, sales and distribution. Table 8.1(b) presents the significance of purchase, design, and reputation costs for the two groups over time.

The purchases of the Matsushita group matured in 1987, as did its firm-specific design costs and the reputation costs. While the purchases picked up immediately, and grew consistently through 1991, the firm-specific design costs fell through 1990 and the reputation costs fell throughout. The purchases of the business equipment firms were quite volatile. The use of more specialized inputs increased the purchase costs in 1986. The firms responded by searching new generic inputs in 1987, but an increased customization of these inputs enhanced the purchase costs in 1988. The firms again searched additional generic inputs in 1989, which again became more customized over 1990 and 1991. The firms consequently put sustained priorities on using generic inputs over 1992 and 1993. In 1986, the firms sought to add value to the specialized inputs through more complex designs. To facilitate the use of more generic inputs, the designing was simplified over 1987 and 1988. As the vendors customized their technologies to these simplified designs, the firms sought to upgrade the complexity over the subsequent period.

Table 8.1(b): Changing Cost-effectiveness of Firm-specific Designs for Japanese Electronics

	Consumer Electronics Group			**Business Equipment Firms**		
	Design	Purchase	Reputation	Design	Purchase	Reputation
1985	12.6%	70.6%	9.0%	22.0%	64.5%	5.1%
1986	13.3%	70.7%	9.3%	24.1%	66.0%	5.1%
1987	13.9%	69.8%	9.9%	23.4%	64.5%	4.7%
1988	13.2%	70.5%	9.2%	20.6%	67.1%	4.6%
1989	12.6%	71.0%	9.0%	21.3%	64.1%	4.6%
1990	12.2%	71.7%	8.7%	21.7%	64.8%	4.8%
1991	12.4%	72.4%	8.3%	21.5%	67.0%	4.3%
1992	14.0%	71.9%	8.4%	24.8%	64.3%	3.9%
1993	14.2%	72.3%	8.2%	26.6%	63.0%	3.6%

Matsushita group boosted proficiency of vendor-designed inputs by **subcontracting** its path-dependent firm-specific designs to the vendors for reengineering. Additional gains in productivity could be realized through **learning** of the processes used by the vendors to develop popular designs. The international **diffusion** of firm-specific designs could facilitate constant servicing inquiries from the high potential vendors. The super-normal productivity growth of the Matsushita group might motivate the business equipment firms to also pursue a similar strategy. Subcontract power is measured as the aggregate of sales to and purchases from the corporate affiliates. Learning power is measured as the balance of sales to the corporate affiliates, net of purchases from these affiliates. Diffusion power is measured as the value of exports. Table 8.1(c) presents annual data on the subcontract, learning, and diffusion power of the two groups.

The subcontract power of the Matsushita group grew throughout the period, except for a marginal fall in 1989. The learning power surged through 1987, but fell radically thereafter, and turned negative in 1993. There was consequently a sustained rise in the diffusion of firm-specific designs, except for a marginal fall in 1992. The experiences of Matsushita group encouraged the business equipment firms to rapidly try catching up in the subcontract power. The catch-up process was dominated by sustained growth in the learning power as well as diffusion power.

Table 8.1(c): Changing Cost-effectiveness of Network Assembly for Japanese Electronics

	Consumer Electronics Group			**Business Equipment Firms**		
	Subcontract	Learning	Diffusion	Subcontract	Learning	Diffusion
1985	20272	3832	7045	5192	2867	2991
1986	27321	4779	8479	7216	3834	3862
1987	30930	5652	8586	9305	4661	5022
1988	39114	3581	12402	12141	6233	6412
1989	38028	2247	12417	13225	6897	6889
1990	39927	2393	13154	14257	7044	7202
1991	45199	2277	15532	17237	7604	8499
1992	45267	871	15488	18840	7754	9278
1993	49236	-31	16815	21548	8353	10185

Investigating the Correction Factor for Reputation-effect

Given its strong pre-existing market reputation, Matsushita could sustain its operational productivity through research and development of its own proprietary firm-specific designs. Creating reputation for the human capital effectiveness in the trading of popular inputs could further the overall productivity. Table 8.2(a) presents the regression of design, purchase and reputation costs on the trading-effect and human-effect. The data are for nine years, each for three members of the Matsushita group. The intercepts yield the **productivity-effect** of specialized firm-specific trajectory. The t-values are in brackets.

The path-dependent Matsushita group trajectory limited the incentives to invest in design costs and purchase costs, and generated greater costs of building reputation [see the productivity-effect, in reference with Table 8.1(a)]. As such neither trading-effect nor human-effect had any stable effects on the design, purchase, or reputation costs. Design costs were the dominating force in the reengineering of the firm-specific inputs using the traded inputs. Reputation costs dominated the extent of market specialization of the Matsushita's trajectory.

Table 8.2(a): Productivity of Path-dependent Japanese Consumer Electronics Operations

	Design Costs	Purchase Costs	Reputation Costs
Productivity-effect	0.1199 (4.276)	0.6613 (12.014)	0.1079 (5.034)
Trading-effect	-21.0×10^{-7} (-1.663)	8.8×10^{-7} (0.349)	-1.6×10^{-7} (-0.159)
Human-effect	15.3×10^{-7} (1.875)	-5.6×10^{-7} (-0.348)	0.9×10^{-7} (0.142)
R square	0.145	0.005	0.001

The less reputed business equipment firms help Matsushita improve its productivity through the specialized diffusion of their own learning. Table 2(b) presents the analysis for the three business equipment firms. The path-developing business equipment trajectory nearly doubled the productivity of design costs from 11.99% to 20.47%, but limited the productivity of purchases from 66.13% to 64.72%, and that of building reputation from 10.79% to 6.17% [see the average of Table 8.1(a) data, in reference with productivity-effect]. Trading-effect cut the purely customer-oriented design costs, and the human-effect sustained the incentives for adding firm-specific designs to the popularly traded inputs. Design costs were the dominating force in the reengineering of firm-specific trajectory, while the purchases dominated its market specialization.

Table 8.2(b): Productivity of Path-developing Japanese Business Equipment Operations

	Design Costs	Purchase Costs	Reputation Costs
Productivity-effect	0.2047 (7.562)	0.6472 (10.584)	0.0617 (3.858)
Trading-effect	-32.0×10^{-7} (-2.589)	11.1×10^{-7} (0.395)	3.8×10^{-7} (0.511)
Human-effect	21.3×10^{-7} (2.717)	-7.3×10^{-7} (-0.412)	-3.2×10^{-7} (-0.684)
R square	0.237	0.007	0.039

Matsushita groups clear the pressures for entropy in its market reputation by acquiring direct equity stakes in the firms marketing the less productive generic products. The institution of the firm-specific intellectual property rights on these generic products substantially enhances the productivity. Table 8.3(a) presents the regression of subcontract, learning and diffusion power on trading-effect and human-effect. The intercepts yield the **productivity-effect** of firm-specific intellectual property rights. The t-values are in brackets.

The firm-specific intellectual property rights limited the productivity of subcontract, learning as well as diffusion power [compare Table 8.1(b) with productivity-effect]. The enhanced trading-effect curtailed the learning power. The human-effect boosted the subcontract, learning as well as diffusion power.

Table 8.3(a): Productivity of Path-promoting Japanese Intellectual Property Rights

	Subcontract Power	Learning Power	Diffusion Power
Productivity-effect	17065.78 (4.683)	2137.81 (7.310)	5856.95 (4.704)
Trading-effect	-0.0726 (-0.474)	-0.0609 (-4.960)	-0.0529 (-1.011)
Human-effect	0.4392 (2.393)	0.0741 (5.029)	0.1462 (2.331)
R square	0.381	0.529	0.272

Given the high-powered initiatives of the principal Matsushita group for creating new agents internationally, the business equipment firms gain a productivity advantage using a less dominant principal-hood. Table 8.3(b) presents the regression of subcontract, learning, and diffusion power on the trading-effect and human-effect, for the business equipment firms. The firm-specific path-generalizing trajectory of the business equipment firms led a significant reduction in subcontract, learning as well as diffusion power [see Table 8.1(b), in reference with productivity-effect]. Enhanced trading-effect added to the subcontract, learning as well as diffusion power. Consequential human-effect contributed to a net positive growth in learning power (8.15% - 7.11%), and limited the need for diffusion power (5.69% - 7.82%). There was only a marginal reduction in the discovery of new subcontract power (11.17% - 11.68%).

Table 8.3(b): Productivity of Path-Generalizing Japanese Intellectual Property Rights

	Subcontract Power	Learning Power	Diffusion Power
Productivity-effect	1342.67 (1.419)	264.20 (0.825)	71.35 (0.121)
Trading-effect	0.1117 (4.585)	0.0815 (9.872)	0.0569 (3.756)
Human-effect	-0.1168 (-4.188)	-0.0711 (-7.535)	-0.0782 (-4.509)
R square	0.518	0.816	0.493

When Do the Firms add Value to the Emerging Networks?

A weak trading-effect limits the subcontract power. The firms rely on the human-effect to generate maximum learning out of the available subcontract options. The diffusion of the augmented firm-specific know-how improves the market information about the world-class technology standards, and encourages the vendors with better quality technological services to enter as potential agents in the market for corporate control. These dynamic propositions are tested using the case of emerging global market for auto vendors in India. As of 1993, more than 104 European, 54 Japanese, 29 American and 20 Korean auto firms had forged technical link-ups with various Indian part makers. Fiat of Italy, with $50 billion of annual worldwide revenues, earmarked $1 billion of its 1997-2002 investments for joint ventures in India. It encouraged some 20 of its lead worldwide vendors to form learning-oriented joint ventures with the technically proficient Indian suppliers in a variety of component areas. These included suspension springs (Rejna with Coventry of India), instrument clusters (Brazilian Udo with IIL), brake systems (Lucas Girling with Brakes India), clutches (Valeo with Amalgamation Repco), door latches and window regulators (Valeo with Rockwell India), air conditioners (Magneti Marelli with Sanden Vikas), wiring harness (Cavis with Tarapur Cables), seats (Lear Seat with Vijayjyot), trim items (Pianfei with Vijayjyot), steering systems (TRW with Rane Madras), instrument penals (Reydel with Bright Bros), fuel tanks (Cornaglia with Spectra), rubber items (Saiag with Goldseal), as well as drive shafts (GKN-BTB with Invel). Active exports of surplus home machinery to Indian partners, and licensing fee for training them in firm-specific intellectual properties, offered prospects of fully locking-in the high quality vendor services. With the Indian services valued at 32% of the total production value, Fiat made an ambitious plan to upgrade its conventional Uno model into a world car model of Palio, assembled in India. With a new South American plant already commissioned in a record-breaking 18 months, Fiat also targeted a deluxe model of 999cc petrol-driven Uno, and a premium 1700cc Uno, in India by the end 1997.

Recognizing the emergent diffusion option, Toyota approached a technically renowned Indian engineering group of Kirloskar for a 50-50 joint venture with $340 million 100% equity capital base in the Fall of 1997, with an ambitious commissioning time of 2 years. Kirloskar noted, “This is something we are learning from the Japanese… least external dependence will enable us to begin production early by completing the project in the shortest time possible." As the discussions progressed, Toyota motivated Kirloskar to accept just 30% share in the project, and reserved an option to involve its group affiliate Daihatsu as equity partner in future. Instead of its popular Carolla model, Toyota sought to diffuse a 10-seater Kijang sports-utility model, designed and assembled by its Thai subsidiary, to India. The diffused Kijang was to be assembled using almost all “parts and components from the Indian market with least dependence on the Japanese companies.” Previously, Toyota’s light commercial vehicle project with another prestigious Indian group DCM during the late 1980s had been a total failure when a “good portion of parts were imported from Japan.” Toyota noted, “We have analyzed the Indian component manufacturers and their ability to deliver against deadlines,” and Kirloskar elaborated, “although the capital cost on the diesel engine Kijang would be costlier for the Indian market conditions, there would be great demand for the vehicle considering the operating cost” of locally designed parts (Times of India, June 2, 1997).

Sample and Data Source: The super-normal capital cost of Fiat and Toyota’s designs is well illustrated by the fact that Indian auto assembly market is currently dominated by Suzuki’s 50% joint venture with the Indian government, Maruti Udyog Ltd. Even with escalating competition from the more prominent international assemblers, Maruti actually boosted its share of the Indian car market to 77.3% by mid 1990s. Suzuki at the time was suffering from deep losses on its other global operations, and was generating only marginal profits on its home operations. Appreciative of the learning opportunity, it first motivated its Indian collaborator to let it increase its share of the equity from minority 40% to 50% “in the true spirit of equal partnership” under collective

Japanese tradition. Then in 1997 it demanded a 74% or even 100% stake in the $37 million venture, so that it could raise $418 million of low cost debt capital from the global market for further learning. Table 8.4 presents the data on the auto components business of the Indian firms that had at least $3 million of auto component sales in the fiscal year 1994-95 (April 1, 1994 – March 31, 1995). The data are for thirty largest suppliers who reported Maruti to be their foremost customer (termed **agents**), and the thirty largest suppliers who reported Maruti to be a secondary customer (termed **independents**). The data are from the Automotive Component Manufacturers Association of India (1996), a publication made available by John Paul MacDuffie. The data highlight that the agents had lower sales, lower export intensity, and lower firm-specific experience, than the independents.

Table 8.4: Characteristics of the Network Assembled by Suzuki in India

Type of Network	Aggregate sales in million $	Aggregate exports in million $	Exports/ sales	Aggregate employee	Average Year of founding	Aggregate sales/ Indian auto component industry sales
Agents	400.784	16.490	4.11%	18,591	1975	18.47%
Independents	680.286	47.405	6.97%	29,451	1965	31.35%

Independents had a more broad-based skill base, and were more attractive options:

(a) Flexible Knowledge: 16 of the 30 agents had their main plant in the North, especially Delhi, Haryana and Uttar Pradesh (with some units situated in Punjab, Himachal Pradesh, and Rajasthan), in close proximity with the Maruti's factory. 5 were from the Western region, comprising Maharashtra and Gujarat states, the bases of Indian multipurpose vehicle makers TELCO and Mahindra & Mahindra. 9 were from Southern region, encompassing Karnataka and Tamil Nadu states, the bases of software revolution. Of the 30 independents, 12 were from in the North, 10 in the South, 7 in the West, and 1 in the East (the state of West Bengal).

(b) Tradable Knowledge: 15 of the agents had technical collaborations with the foreign corporations: 11 with Japanese, 3 with Spanish, and 1 with British. 2 of the Japanese collaborations generated additional alliance with the European (German and Swiss) vendors, and

1 of the Spanish collaboration generated additional alliance with an American vendor. 14 of the independents had foreign technical collaboration. 4 chose the Japanese option, and 2 of these also had a German alliance. 5 had the sole German collaboration, 2 had the sole British option, 1 had multiple European options, and 2 availed of the American option.

(c) Productive Knowledge: 9 of the agents had original equipment manufacturing (OEM) export contracts: 3 in the US, 4 in Europe, 1 in Japan, and 1 worldwide. 14 of the independents had such contracts: 3 in the US, 4 in Europe, 2 in Japan, 5 worldwide, 1 in Iran, and 1 in Egypt. The independents with Iranian and Egyptian contracts had technical collaboration with Japanese and German firms, but most others had no foreign technical collaboration.

The learning potential was particularly strong given that the Indian auto parts sector required Research & Development costs of just 0.6% of sales, compared to a high 6% committed in Japan. To begin with, Suzuki could investigate the domains where the agents were diffusing their **unique** know-how to the international market, and request additional employees for a more intensive learning of how the **flexible** know-how could be adapted to the Suzuki's firm-specific trajectory. **Uniqueness-effect** is measured as "exports in million US$ of the agent – aggregate exports of the agents/number of agents in sample." **Flexibility-effect** is measured as "exports in million US$ of the agent * Dummy = 1 if the agent has no locked-in foreign technical collaboration." In Table 8.5(a), year of founding, sales value and number of employees data for the agents are regressed on uniqueness-effect and flexibility-effect. The intercept reflects the constant **servicing-effect** of Suzuki. The t-values are in brackets.

Suzuki's servicing reduced the firm-specific trajectory of the agents by more than 18 months, enhanced their sales by about a third, and their employee base by about a fourth (servicing-effect, compared to Table 8.4). Unique diffusion power of the agents promoted these effects. Flexibility of agent diffusion power limited the sales as well as number of employees.

Table 8.5(a): Diffusion Power of the Suzuki's Agents in India

	Year	Sales	Employee
Servicing-effect	1976.717 (907.246)	17.338 (7.310)	781.984 (9.124)
Uniqueness-effect	-7.191 (-2.545)	19.602 (6.373)	938.057 (8.440)
Flexibility-effect	-2.821 (-0.687)	-16.418 (3.676)	-669.672 (4.149)
R sq.	0.309	0.602	0.725

Suzuki gains pre-emptive learning over the contesting multinationals by motivating the agents with super-normal employee base to **recruit** additional agents. The gains are higher from the use of **tradable** knowledge, not yet specialized to the proprietary trajectories of the multinationals. **Recruitment-effect** is measured as "number of an agent's employees – aggregate number of agent employees/ number of agents in the sample." **Tradability-effect** is measured as "number of an agent employees * Dummy = 1 if the agent has no foreign OEM contract." Table 8.5(b) presents the regression of exports and sales of the agents on the recruitment-effect and tradability-effect. The intercepts yield the average **cost-effectiveness** of the agency operations. The t-values are in brackets.

Appreciation of Suzuki's principality added more than a sixth to the exports and a fifth to the overall sales of the agents (cost-effectiveness, compared with Table 8.4). Recruitment had a positive impact on the exports as well as sales. Tradability of agent know-how had a positive impact on exports, but no necessarily stronger impact on the overall sales.

Table 8.5(b): Option Value of the Suzuki's Agents in India

	Export	Sales
Cost-effectiveness	0.730 (5.780)	16.281 (5.980)
Recruitment-effect	0.0008 (6.370)	0.0178 (6.519)
Tradability-effect	0.0006 (2.186)	0.0101 (1.644)
R sq.	0.618	0.619

Conclusions and the Recommendations for Further Research

The diffusion of information about the motivational value of firm-specific services, helps enjoy new technical options over an expanded geographical landscape. As Bernstein (1994: 6) notes, "Sustained (that is to say, uninterrupted) economic growth requires continuing increases in investment expenditures that are large enough to make additions to productive capacity, create jobs, and expand output. Yet, in the absence of technical change, the rate of net investment will fall to zero as soon as the rate of increase in consumption (and hence in sales revenue) levels off. For consumption expenditures to rise consistently, there must be net investment to create jobs and maintain consumer income levels, or injections of spending from elsewhere in the economy such as government, foreign trade, and from major *resource discoveries or territorial expansion*. This is an essential paradox of capitalist growth and the reason why growth often takes the form of accelerations and pauses (or 'booms' and 'busts')." [Emphasis added]

Resource **discovery-effect** is measured as "sales of an agent in million US$ – aggregate sales of the agents/number of agents." Expanded **Territory-effect** is measured as "sales of an agent in million US$ * Dummy = 1 if the main plant is outside the Northern region of India." Table 8.6(a) is the regression of Year since founding and exports on discovery-effect and territory-effect. The intercepts yield the **investment-effect**. The t-values are in brackets.

Suzuki's networking motivated a more intensive use of the latent local know-how, amounting to nearly three years of added nation-specific know-how. The investments generated nearly 20% growth in exports (Table 8.4, compared with investment-effect). The discovery of new resource links significantly boosted the exports (i.e. foreign consumption). Expanded territory of acquired resources added to the customer-specific know-how, and limited the exports.

Table 8.6(a): Sustainability of the Suzuki's Agency Option in India

	Year	Exports
Investment-effect	1972.101 (790.074)	0.755 (5.794)
Discovery-effect	-0.168 (-1.423)	0.031 (5.103)
Territory-effect	0.720 (2.711)	-0.038 (-2.712)
R sq.	0.241	0.530

A more independent approach could allow the potential agents to discover technical change options through customized servicing of additional international assemblers. **Discovery-effect** is measured as "sales of an independent in million US$ – aggregate sales of independents/number of independents in the sample." **Customization-effect** is measured as "sales of an independent in million US$ * Dummy = 1 if the independent has a foreign OEM contract." Table 8.6(b) presents the regression of exports and number of employees for the independents on the discovery-effect and customization-effect. The intercepts yield the **independence-effect** of local vendors. The t-values are in brackets.

Independence-effect limited the exports by more than a third, and added just about 2% to the employees (compared to Table 8.4). Discovery of these independent agency options carried the potential for significant growth in exports as well as employment power of Suzuki. Motivating the independents to customize their original services to the Suzuki's equipment offered prospects for enhanced international revenues, without escalating human resource costs.

Table 8.6(b): Growth of the Suzuki's Agency Power in India

	Exports	Employee
Independence-effect	0.995 (3.478)	1015.676 (6.855)
Discovery-effect	0.049 (4.378)	22.608 (3.901)
Customization-effect	0.046 (3.496)	-2.696 (-0.392)
R sq.	0.757	0.452

To conclude, further research might investigate how the firms generate additional growth by diffusing information on the creative value of the independent human resources. The enhanced quality of assembly services obviates the dependency-promoting capital injections from the government institutions, and offer added surplus to the consumers for sustained demand.

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