5

Information Infrastructure

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Information flows are a key element in a knowledge-based society. Indeed, in the 1990s rapid advances in the Internet and telephony led to talk of an infobahn (information superhighway). For many firms, investors, and policy makers it proved to be a fast track to a crash. Japan, especially Japanese electronic firms, were caught up in this, mostly with varying degrees of nonsuccess.

This chapter is in two parts. The first looks at telecom operators and equipment makers as one of the pillars of the knowledge-based economy. The second looks at Japan's electronics industry, especially its involvement in information technology.

Part A Telecommunications

Telecommunications is an essential part of creating a knowledge-based society. Indeed, it is advances in telecommunications—particularly wireless telephony and the Internet—that are, with personal computers, the most visible aspects of the IT revolution.

This part begins with overviews of the first phases of the deregulation of telecom services and of mobile telephony. The subsequent split-up of Nippon Telegraph and Telephone Corporation is then analyzed. Attention next turns to the Internet, including the spread of Asymmetrical Digital Subscriber Line (ADSL) as the dominant broadband technology in Japan and the rapid spread of broadband in Asia. Access to the Internet by mobile phones and some newer technologies are then explored. Part A concludes with a presentation of lessons of particular importance for government policy makers.

Japan Deregulates

The Japanese telecommunications market was formally opened for new entry under the terms of the Telecommunications Business Act and the NTT Act of April 1985. This means Japan was one of the first countries, along with the United States and the United Kingdom, to privatize and liberalize its telecom industry. Under the NTT Act, the state telecom monopoly was privatized and transformed into NTT (Nippon Telegraph and Telephone Corporation, Nippon Denshin Denwa KK in Japanese). This was just after the United Kingdom's 1984 privatization of British Telecom (now called BT Group plc) and the 1984 break-up in the United States of American Telephone & Telegraph (from 1994, simply AT&T Corporation; being acquired by SBC Communications Inc. in 2005).

Privatization was part of a larger process of government administrative reform begun in 1980. A special commission was established in January 1981, chaired by Toshi Doko, at the time head of Japan's most important business organization, Keidanren. The commission, Rinji Gyosei Chosakai, issued a series of reports beginning in July

Box 5.1. *Telecom Terminology*

The connection between switching offices and individual users historically is termed the "local loop" or "subscriber loop" by the industry. It has also come to be called the "last mile" (or, from the users' perspective, the "first mile"). The connection can be by wire or wireless. A local loop that is a fixed line is also called a local line.

"Fixed line" refers to a telephone line that is physical—such as a copper wire or fiber-optic cable. Mobile phones use wireless connections.

Spectrum refers to the range electromagnetic wavelengths used in wireless communications. To avoid interference between users, the right to use specific wavelengths is usually subject to government license and regulation.

1981. The July 1982 report raised the possibility of not just privatizing but also splitting up NTT (a topic discussed later).

NTT shares were not sold by the government until April 1987. After a series of sales, including sales to NTT, the government owned 33.7% of the stock as of September 2005. The original intention had been for the government to sell its shares more quickly, but the collapse of the Japanese stock market in the early 1990s led to a hiatus.

Deregulation had important effects in Japan. In 1985, three companies, called New Common Carriers (NCCs), entered the long distance telephone business, and began service in 1987. These were Daini Denden In (DDI), Japan Telecom (JT), and Nihon Kosoku Tsuhin (Teleway). They concentrated on routes with heavy traffic, for example, between Tokyo and Osaka. Competition led to the cost of using trunk (long-distance) lines falling dramatically—as much as 80% between Tokyo and Osaka from 1985 to 2000.

However, it was impractical to build local networks paralleling the existing NTT lines, so the NCCs had to rely on NTT's local loop to reach users. As a result, the cost of access to the network did not fall to any significant degree. On the contrary, it went up at one point, from 7 yen to 10 yen per three minutes. In an environment with little competitive pressure, NTT had little incentive to reduce prices. Inadequate competition in local service is not unique to Japan. Similar situations existed in many other Organization for Economic Co-operation and Development (OECD) countries. Even in the United States, established companies have continued to control the last mile between the switches and fixed-line telephone subscribers.

Mobile Phones

In the 1980s, equipment suppliers and operating companies in the larger countries were developing mobile phone standards for their domestic markets. NTT's mobile phone subsidiary, NTT DoCoMo Inc., led development of a digital standard for Japan called PDC (personal digital cellular).

DoCoMo was, and still is, the dominant mobile phone service provider in Japan. After deregulation, two firms sought to compete with it. One, IDO (Nihon Ido Tsushin, Ltd.), chose to use the DoCoMo technology, but the other, DDI chose a technology from the U.S. company Motorola Inc.

Equipment Supplier Relationships

During the postwar period and through the 1980s there was a close relationship between NTT and certain Japanese telecom equipment makers. Six in particular

Box 5.2. *Mobile Telecom Providers in Japan*

There are four mobile telecom providers in Japan. As data for March 2005 show, the dominant provider is a subsidiary of NTT.

Million subscribers	% share	Company
48.8	56	NTT DoCoMo
19.5	22	KDDI
15.0	17	Vodafone
3.6	4	Tsuka

DoCoMo is, in its own words, "the world's leading mobile communications company." It was formed in 1991 as an NTT subsidiary to combine NTT's various mobile operations, including maritime and paging. "The company offers a wide variety of leading-edge mobile multimedia services, including i-mode, [introduced in 1999], which provides e-mail and Internet access to over 44 million subscribers as the world's most popular mobile Internet service, and FOMA [Freedom of Mobile Multimedia Access], launched in 2001 as the world's first 3G [third-generation] mobile service based on W-CDMA [Wideband Code Division Multiple Access]." The company has wholly owned subsidiaries in Europe and North America, but most of its customers are in Japan. (Quotes are from the "About NTT DoCoMo" section of the company's English press releases in the first half of 2005.)

KDDI is the result of the October 2000 merger of KDD, DDI, and IDO (Nihon Ido Tsushin, Ltd.). KDD (Kokusai Denshin Denwa) was the government-owned, monopoly international telecom provider before deregulation. DDI established a subsidiary, Kansai Cellular, to provide mobile telecom service in western Japan (the Osaka-Kobe-Kyoto region) in June 1987. In 1992 Nissan Motor Co. Ltd. joined DDI in the mobile telecom business.

Vodafone (Japan) is 97.7% owned by London-based Vodafone Group plc. Vodafone entered the Japanese mobile phone market in 1990 by partnering with JT in the J-Phone group. By 2001 Vodafone had a 67% ownership interest in, and thus control of, JT. In August 2003 JT announced the sale of its fixed-line business to an affiliate of Ripplewood Holdings LLC. The fixed-line business, and the name Japan Telecom, was acquired by Softbank in 2004.

Tsuka provides only PDC service and is not engaged in 3G.

were called the "*denden* family." These were Fujitsu Ltd., Hitachi Ltd., Mitsubishi Electric Corp., NEC Corp., Oki Electric Industry Co. Ltd., and Toshiba Corp.

Development of telephony technology and standards was under the leadership of NTT, with its world-class laboratory. Once the technology was established, it was up to the manufactures that participated in the joint effort to produce the equipment. Because of the influence of the government, and NTT's desire to promote its own standards, the firms concentrated on the large domestic market. Although they were interested in expanding into foreign markets, the burden of pursuing two different technology standards at the same time was considered too great.

The same sorts of relationships were found in the United States and Europe at the time: each telephone operating company (state-owned except in the United States) had a stable of primarily domestic suppliers. In the United States, the near-monopoly phone company (American Telephone & Telegraph Inc.) even owned its principal equipment maker (Western Electric) until 1984.

However, especially in the United States after the 1984 break-up of AT&T, equipment markets became more open, except in Japan. There, the *denden* family remained largely closed to outsiders. Even other Japanese firms, such as Sony Corp., were unable to compete in the domestic market because of NTT's (including DoCoMo's) relationships with its long-standing principal suppliers.

A New Approach

European countries took a new approach with respect to second-generation mobile phones. Realizing that Europe would be at a disadvantage because of fragmented markets, in the late 1980s the European Commission for Post and Telecommunications created the Group Special Mobile (GSM) with the authority to establish a common standard and thus create a unified market in Europe. A key decision was to make it a digital standard, the same decision made by NTT in developing its PDC standard. This leap-frogged the United States, which was using an analog standard. The result was also called GSM (for global system for mobile communications). This is a very clear example of the important role governments can play.

Two Scandinavian companies particularly profited from this because of their ability first to influence the GSM standard and then to promote it in other countries. These were Nokia Corp. and Telefon AB LM Ericsson. By the end of 1996, GSM was used in 105 countries by over 200 telephone companies. Japanese makers of both handsets and network equipment were largely left out. Motorola remained committed to its technology and also lost ground in global markets.

It should be noted that it is not clear that the results for Japanese firms and Motorola could have been different. The tradition in advanced countries was for national champions to supply the domestic market. Europe's innovation was to unify its market so European companies could achieve greater economies of scale and mobile phone users would have a larger roaming area.

Splitting Up NTT

The 1996 Telecommunication Act in the United States had a sweeping effect on the telecom policies of OECD members, particularly regarding local-loop unbundling. Very quickly, OECD countries, including Japan, followed suit. However, actual unbundling proved more difficult to implement than writing the laws. Incumbent companies had many ways to procrastinate, frustrate, and even refuse in spite of efforts by regulators.

The other important provision that was included in Japan's 1997 revision of its telecom law was splitting NTT operations into NTT West and NTT East (regional local-service fixed-line operators) and NTT Communications (long distance). The division became effective in July 1999. This was not a true break-up, because all three companies remained in one group under a newly established NTT holding company. This outcome was a political compromise.

NTT of course wanted to remain an integrated company. The advisory body to the Ministry of Post and Telecommunications (MPT) was split regarding a break-up, and the Social Democratic Party (SDP), part of the ruling coalition at the time, was publicly opposed. Moreover, the MPT minister was a member of the SDP. Thus, those favoring substantive reforms faced powerful opposition. Those opposing a split argued it would result in overall inefficiency, an inability to provide uniform service, and a weakening of research and development (R&D) capacity.

From the viewpoint of competition policy, it is unclear if the division achieved any meaningful purpose. NTT operating companies are required to get approval from the holding company on strategic decisions such as their annual business plans, large investments, appointments of senior managers, mergers, acquisitions, and R&D.

Each operating company formed a small empire in one segment of the telecom market, and competition did not follow. There is no incentive for the holding company to encourage competition among the operating companies. The telephone tariff and interconnection fees are the same for both NTT West and NTT East, in spite of the difference in their financial performances.

Another Attempt at Local-Loop Competition

As of mid-2005, the dual structure of Japanese IT infrastructure tariffs, namely expensive access to the telephone network and cheap Internet, is being challenged by another bold attempt by Softbank Corp. to break into fixed-line service. In November 2004, Softbank announced it would apply for approval to commence fixed-line service at a discounted tariff. The monopoly control of fixed lines has been the source of power for the entire NTT group.

In December 2004, JT, now owned by Softbank, started a service called "*otoku* line," which means bonus line. This is meant to pose a direct challenge to the monthly, fixed base price, and NTT countered by reducing the base rate. In other words, within seven years of mandatory opening of the local loop, the telecom sector will have moved from pure monopoly to full-scale competition.

The role of the government policy to ensure effective competition has never been as crucial as it is now in the telecom sector. Softbank has not built its own local loop, but instead leases lines from NTT.

Connecting to the Internet

The value of information technology is fully exploited when individual computers are connected and information can be exchanged on a large scale. In the early years, such connections were made largely through the public telephone network. Large firms often leased telephone lines from telecom operators as part of private networks, but these were not physically distinct from the public network. Within buildings or on campuses, an organization might have its own switches and phone lines. Satellites and microwaves offered opportunities for large firms with geographically dispersed operations an opportunity to bypass the telephone company to transmit data, although microwaves are limited to line-of-sight situations.

In the first few years after the Internet became available for commercial use, most customers used the public network to reach an Internet access point. This is called a "dial-up" connection because users dialed the telephone number of the access point. Using telephone lines to access the Internet has two important implications.

First, an issue in all countries is speed. Initially, dial-up could provide speeds of only a few thousand bits per second. Eventually this increased to about 55 thousand as a theoretical maximum, but actual speeds are slower, especially for "uploads"—sending data from an individual computer into the system.

Second, an issue in Japan and Europe, but less so in the United States, is cost. In Japan and continental European countries, local calls are metered, that is, charged by their duration. In the United States and Australia, they generally are not. Thus, in those two places, once connected, it did not matter how long the user stayed connected. This flat rate was very conducive to the use of the Internet, as many users preferred to be "always on" (that is, continually connected).

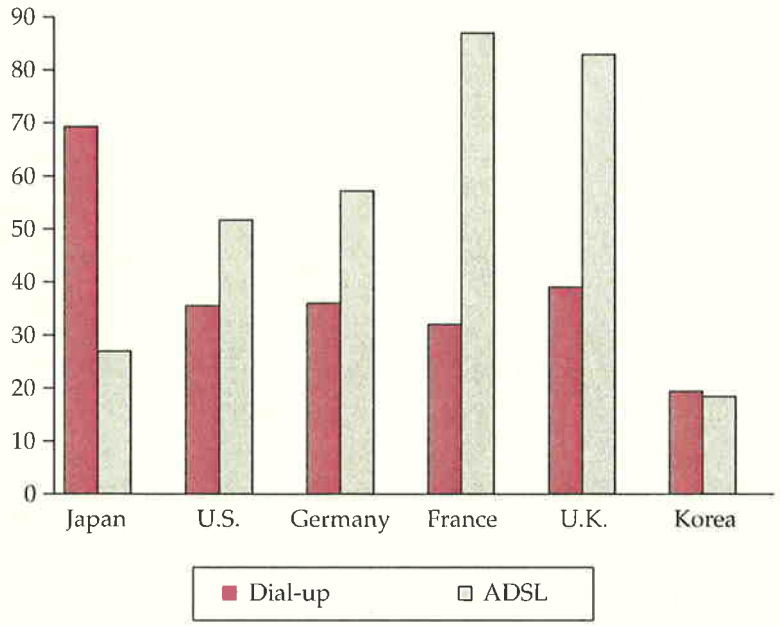
Box 5.3. *ADSL, ISDN, and Other Telecom Acronyms*

ADSL is a transmission system that uses the copper twisted-pair access network used by voice telephones. As the name implies, it is digital. The data rate from the network to the subscriber is faster than from the subscriber to the network. Note that ADSL is a specific type of DSL, and what is commonly referred to as DSL in the United States is not ADSL.

FTTH is "fiber to the home." Although most trunk lines already are optical fiber, the local loop is largely copper cable. FTTH means to make the last mile fiber.

ISDN (Integrated Service of Digital Network) is an early digital telecom technology. NTT's experience with ISDN is analyzed in Box 5.4.

Figure 5.1. *Comparison of Prices Between Dial-Up and ADSL*



Note: ADSL prices are adjusted for 1 Mb/s.
Source: OECD, Telecommunication Outlook (2003).

In Japan, not only are local calls billed by length, but the per minute cost has been the most expensive among OECD countries. According to an OECD survey, as illustrated in Figure 5.1, in August 2002 the cost of using the Internet for 40 hours, including telephone and ISP (Internet service provider) charges, was almost twice as high in Japan as in New York City and in Germany. The cost of a dedicated (leased) line in Japan was even higher relative to other countries. The high cost of using the existing telephone infrastructure translated into high costs for using IT, as was often pointed out.

ADSL Provides Broadband

The story of ADSL in Japan is full of policy implications. NTT did not favor the technology, as it wanted to first establish a nationwide ISDN network, then move

Box 5.4. *ISDN: An Almost Forgotten Story*

From an early stage of Internet development, NTT knew that dial-up access would be inadequate in speed and that Japan would eventually need an entirely different network. NTT decided to first deploy a nationwide digital network, commonly referred to as ISDN, using technology developed by NTT. Then, by 2010, it planned to lay fiber-optic cable connecting all households and offices.

The strategy was ill-timed and unfortunate. The service came to market in 1988, but by 1995 it had only 510,000 subscribers. By the time the service was ready for dynamic take-up in the second half of the 1990s, there was a far more competitive service. This was ADSL. Although ISDN was initially marketed as broadband, it is in fact narrow band, with a transmission speed of only 64 Kb per second, more or less the same as analog dial-up. ADSL was capable of several hundred thousand bits per second, even at the time of its launching in 2000, and it improved quickly to a level of several million bits. Because ADSL could use the existing network, it was much less costly than ISDN, which had to be built from scratch.

Among OECD countries, only Japan and Germany pursued ISDN as a basic infrastructure for the Internet age. Subscribers have been shifting to ADSL, and at some point ISDN will quietly disappear.

Aware of the diversity of technology and its unpredictable nature, the OECD was critical of any government attempt to choose one technology out of many alternatives. The case of Japanese ISDN is a classical example that points to the danger of government involvement in selecting technology.

to fiber optics (see Box 5.4). To NTT, ADSL was nothing more than a distraction. In fact, it refused to cooperate with the new ventures trying to provide ADSL service using NTT's unbundled local loop.

The new entrants were, first, Tokyo Metallic then, later, Yahoo Broadband, a subsidiary of Softbank (run by Son Masayoshi). NTT used delaying tactics to prevent co-location until the end of 2000. (Co-location refers to placing equipment in a relay station, which is necessary for a telecom provider to use the local loop to reach users.) At that point Japan's Fair Trade Commission (JFTC) intervened and publicly warned that NTT risked violating the antimonopoly law. JFTC also warned NTT East and NTT West in December 2001 and in December 2003 regarding their ADSL practices.

Yahoo Broadband proceeded to introduce ADSL service in June 2001, and was spectacularly successful, adding 300 thousand new subscribers every month. NTT East and NTT West had begun offering ADSL earlier in the year, at ¥6,000 a month and a speed of 1.5 megabits/second (Mb/s). Yahoo charged ¥3,000 for a speed of 8 Mb/s. By 2002 the price was down to ¥2,400 ($20) plus ¥1,900 ($16) to NTT for use of the local loop. This is one of the lowest prices in the world, as shown in Figure 5.1.

Thus, for the first time in Japan, there was full-fledged competition in a telecom service. Although the Japanese government has had a reputation for a limited commitment to promoting competition, its action regarding ADSL is a thing to be admired. Today, this is widely referred to by Japanese telecom policy makers as a clear case of success.

Yahoo Broadband has been particularly aggressive in seeking market share. In early 2005 it had about 40%, followed by NTT with 35%. Smaller, but aggressive, newcomers such eAccess and Acca Networks are also advancing into the growing

market. This is a unique development: an entrenched near-monopoly has failed to control an important market niche. In contrast, in the United States and Europe, many attempts to get into ADSL by new entrants have been aborted by established telecoms.

Not only is the price of ADSL in Japan the lowest, the speed of connection is now well above 1 million bits per second. Some services promise more than 10 million, sufficient for high-definition television (HDTV) images. This is far speedier than connections in Europe, which are, for the most part, less than 1 million bits per second.

The appeal of ADSL to consumers is overwhelming. With the price so low, the speed so high, and the ability to be always on, subscription figures exploded in 2002 and 2003. They reached more than 14 million in June 2005. Combined with other broadband connections such as cable modem and optical fiber, broadband uptake relative to population is now higher in Japan than in the United States. Over 15% of Japanese have broadband access.

Effects of Competition

One consequence of the fierce competition is a low level of profitability for service providers. The broadband services are unprofitable or barely profitable. NTT does not release specific data, but Yahoo BB lost ¥97 billion in fiscal 2004. This raises some concern about whether the competitive environment is sustainable. Indeed, in August 2005 Yahoo BB was reported to be stopping its aggressive sales promotions and placing more emphasis on long-term profitability.

There is some question as to whether the high-speed Internet infrastructure is fully utilized. One good way to measure the level of broadband usage is to note that 330,000 pieces of music were downloaded in Japan in December 2004. This is about 1% of the global total of music downloads from iTunes. Although Japan boasts of being one the front-runners in broadband, its use is still very limited: most people use it only for sending e-mails and surfing the Web.

This reflects a lack of consensus on the right balance between protecting the intellectual property rights (IPRs) of content owners and encouraging dissemination. Copyright owners have been quite inflexible about allowing material to be sold at what most people feel is a reasonable price. The key is what is "reasonable": few consumers seem prepared to pay much, if anything. The peer-to-peer file transfer programs available make control of distribution almost impossible for IPR owners. This is a contentious legal issue in the United States as well.

The FTTH Alternative

It is noteworthy to take a look at the situation of FTTH. While ADSL spread far more quickly than any had foreseen, FTTH showed only modest growth until 2005. As of June 2005 the number of subscribers was almost 3.4 million, up from just 1 million in September 2004. Still, there were 14.1 million ADSL users. It is thus likely that FTTH uptake will substantially undershoot the original target set by the government, which was to connect 10 million households by March 2006. NTT's target as of mid-2005 is 30 million subscribers by 2010. Tokyo Electric Power Co. (Tepco) is another major provider.

The speed of ADSL, now up to 40 million bits per second, has diminished the advantage of fiber optics over ADSL. All the services that can be provided by FTTH can also be provided by ADSL, except access for areas remote from ADSL relay stations. However, FTTH is more convenient than ADSL for voice-over-Internet protocol (VOIP). This, combined with a marketing campaigns by providers, has contributed to the jump in acceptance.

Outside Japan, FTTH is considered too expensive to be a viable option. Globally, companies that invested massively in fiber-optic capacity have suffered serious losses. But, among some Japanese, the mentality of placing priority on technology and building physical infrastructure over providing good service at a reasonable price still persists.

The Rapid Spread of Broadband in Asia

While its policy makers are excited to see that broadband uptake is higher in Japan than any other major OECD countries, Japan still pales in comparison to the Republic of Korea; Taiwan, China; Hong Kong, China; and Singapore. Korea, in particular, has attracted a lot of attention, as it appears to have moved faster toward an information society than any other industrialized country. Telecommunications is one of the few areas in which relatively less developed countries have moved to the forefront of installing innovations ahead of more advanced countries. Partly this is because there is no large installed equipment base that has to be scrapped. It also reflects policy decisions and national self-images.

A close analysis of the Korean experience leads to the conclusion that it has been made possible through unique conditions, and it cannot be seen as a model for other countries. The following factors can explain the successful deployment of ADSL in Korea and other Asian countries.

First, all of them have very densely populated urban areas with many high-rise apartment buildings. This physical proximity provides an ideal condition for ADSL, the speed of which diminishes significantly beyond three kilometers from a relay station. If the population is sparsely spread, reaching homes becomes very costly. This is the case in virtually all of the United States and even most of Europe.

Second, the content is largely games, movies, and television programs, which are often circulated in infringement of copyrights. In some Asian countries, the government filters the news, and only an edited version is allowed on the air. This drives people to seek unfiltered versions over the Internet. In most OECD countries, by contrast, it is hard to create such widely popular uses: news is not censored and copyrights are more aggressively enforced.

Third, in many Asian countries, there has been government support for building broadband connections. A high broadband uptake is a matter of national pride rather than commercial concern. In fact, many of the firms that operate broadband networks are running deficits. Korea is subsidizing its film industry to advance Korean culture. Such content is first disseminated on broadband networks.

In light of all this, it is clear that the Asian countries leading in broadband uptake have supportive characteristics and backgrounds that do not necessarily apply or exist in other countries. Other than urban population density, Japan has few of the characteristics.

The Internet and Mobile Communications

Using mobile handsets for connecting to the Internet became possible when NTT DoCoMo introduced its i-mode service in 1999. Despite its overwhelming success in Japan, i-mode has made only modest inroads in Europe and the United States. In those markets, mobile phones are still used primarily for voice communication, with some text messaging. Japanese carriers and equipment vendors are making headway toward 3G offerings, which allows transmission of moving images.

Mobile phones have had profound effects, both economic and social. According to the OECD's *Communications Outlook*, in 2001, nearly $100 billion in revenue was generated from mobile phones in the United States and Japan, making it those countries' largest utility industry. In Japan, the number of mobile subscribers in August 2005 reached 88 million, a 6% increase over 2004. It is now generally believed the domestic market is close to saturation and future demand for handsets will be largely replacement. Globally, more than half of the population of OECD countries had mobile phones. In many developing countries with inadequate fixed-line telephone infrastructure, wireless systems can provide more cost-effective access to the modern information society.

New Telecom Technology

More or less simultaneously in the United States, Europe, and Japan, wireless local area networks (wireless LANs) began to attract attention as an option that is inexpensive and easy to use. The technology uses the existing copper or fiber network to reach connection points (stations), which are usually a small box or short stick. These stations use radio waves to connect with devices, usually computers, that have the appropriate card, thereby providing Internet access. By definition of being local, stations serve a radius of 100 meters or less, but this can be enough for a hotel, office, or coffee shop. This service is sometimes made available free to customers. For the provider of the station, the cost typically is about what a standard broadband connection costs an individual.

Finding appropriate spectrum is a major issue for wireless LANs. At the moment, one such technology, called WiFi, is using the spectrum also used by microwave ovens, 2.4 GHz. A much stronger signal, called WiMax, which has a range of up to 50 km, also is being tested. If the right frequency can be assigned, this technology has the potential to replace mobile phones entirely. In fact, in the United States, where mobile phones have been slower to penetrate than in Europe and Japan, wireless LAN is being far more seriously pursued.

Broadband over electric power lines (BPL) also is being developed. Tokyo Electric Power Co. (Tepco) is conducting a pilot test in a residential area of Tokyo. Equipment makers such as Mitsubishi Electric, Sony, and Matsushita are working together to create a common standard for Japan. It is expected that the government will approve the technology in 2006 if interference problems are resolved. Field tests are also under way in the United States, and BPL has been put to commercial use in Spain. The U.S. Federal Communications Commission is backing the technology, and in July 2005 International Business Machines Inc. (IBM) announced a partnership with a Houston, Texas, utility to develop broadband services.

All this points to the wide range of competing technologies and enormous magnitude of uncertainty that faces the telecom sector.

Conclusions

A review of the Japanese experience in telecommunications policy leads to a number of conclusions.

1. It is important to keep government policy technology-neutral. With such a wide range of technologies, both wired and wireless, it is impossible for the government to determine the most promising one. IT is unpredictable. Any attempt by a government to boost indigenous IT endangers interoperability and could isolate the domestic market from the rest of the world.

   This is not the same as abrogating regulatory responsibility in such areas as allocation of spectrum (wireless capacity), but this should be conducted in a manner neutral to any individual technology. In other words, governments should strive to create an environment where different approaches, both in terms of technology and business models, are encouraged.
2. Removing regulations does not automatically generate a healthy competitive environment. Incumbent players that own the infrastructure needed by newcomers can abuse their power, especially if they are monopolies or near-monopolies. Competition policy must play a role in ensuring a level playing field.

   In Japan, local fixed-line service remains in the grip of NTT. In contrast, although NTT's subsidiary DoCoMo dominates mobile communications, a competitive environment is emerging. For ADSL, newcomers created a new market with a new technology, with NTT playing aggressive catch-up. This suggests that the newer the field, and the less its infrastructure relies on the entrenched incumbent, the more likely there is to be competition in general, and successful newcomers in particular.

   Japanese consumers have reaped huge benefits from privatization and competition. In contrast, "success" for new service providers does not yet necessarily include profitability. The old monopoly has deeper pockets and thus greater staying power than virtually all of its would-be competitors, and is well-versed in the bureaucratic, regulatory games of simply outlasting the upstarts. Even with a sincere government policy to promote competition, the final outcome is in doubt. Thus, policy makers and regulators must remain vigilant, particularly regarding the last mile.
3. IPRs play a crucial role in advancing the information society. Digital content is easy to copy and duplicate. As telecommunications and broadcasting converge, content is expected to have greater influence over the nature of telecommunications. New IT infrastructure has been constructed with a speed unmatched by the tempo of content. Thus, Japan's infobahn looks like an empty highway.

   The copyright protection of music and video is not flexible and efficient enough to allow their liberal movement in Japan. This is a global problem. In developed countries, IPR often are in conflict with technologies that make disseminating music, games, and movies easy. Napster is an example. In 2004, a similar case was raised in Japan. At present, the legal risks associated with distributing video, software, and TV programs on demand are the biggest deterrents to the use of broadband. There is a need for a global consensus on the right balance between protecting IPRs and using and disseminating digital content.

4. The management of spectrum is a politically thorny issue for regulators. With more people using wireless services, spectrum is a scarce resource. There will be even more demand if radio frequency identification (RFID), which attaches a small IC to commodities, comes into widespread use. This is so even though RFID is being developed to use the limited frequencies more intensely. In October 2004, Softbank filed a lawsuit against the ministry in charge of spectrum allocation. The suit claims a right to acquire new spectrum for mobile telephones.

   It is essential that regulators distribute frequencies in the maximum interest of the public. The present allocation of spectrum use should be reviewed to see if control of some portions should be redistributed. The first step is to make publicly transparent the information as to who uses what spectrum and for what purpose. Many users were granted authorizations decades ago when capacity was abundant. Often it is politically difficult to take control back from them, but some mechanism for redistribution should be put in place.

   A revised law managing distribution and use of spectrum passed the Diet in July 2005. How it is implemented should be monitored closely. Policy makers must be aware that new technologies are being developed that allow many users to use the same frequency simultaneously without causing interference. Sooner or later, the existing regime of assigning specific frequencies to specific users for specific use will become unnecessary. Government handling of spectrum should not interfere with the development of such technology.
5. Effective corporate governance must be applied to government-controlled telecom providers. The government is, and always will be, NTT's largest shareholder. It is unclear how the government has played this role. The Ministry of Finance sends representative to the stockholders meetings, but apparently has remained reticent on management issues.

   In 2002 and 2003, after the IT bubble burst, NTT DoCoMo recorded nearly ¥1.5 trillion ($13.4 billion) in losses on investments in overseas mobile phone service companies. And, in 2001, NTT wrote off $4.5 billion related to the purchase of U.S. Web-hosting firm Verio. It still remains unclear who took responsibility for the losses.
6. Effective regulatory oversight must be applied to government-controlled telecom providers. With just under 34% of the stock, the Japanese government is by far NTT's largest holder. Under legal obligation to own more than a third of the company, the government will continue as the largest shareholder.

   This suggests there is a conflict of interest regarding the government's regulation of NTT, something the OECD pointed out in its review of Japan's regulator reforms in 2000. The Japanese government responded that it was the Ministry of Finance that was the shareholder, while the MPT was the regulator and policy maker. Thus, there is no conflict of interest.

   A good corporate governance system and an effective government regulatory system are particularly important because NTT has a very complex structure. Five subsidiaries operate under NTT Holdings. Cross-subsidization within and among them is highly probable, creating an unfair competitive advantage when NTT is confronted by competition. Arguably, the high fixed-line tariffs charged by NTT East and NTT West subsidize the lowest ADSL price in the world as NTT battles Yahoo Broadband.

NTT DoCoMo generates about two-thirds of NTT's profits, although its contribution fell to 63% for fiscal 2004. Much of this is plowed back into the development of 3G service. Consumer advocates argue that the profits should be returned to consumers by reducing tariffs, as they are obliged to pay increasingly expensive monthly bills to DoCoMo. But under the existing governance regime, there is no place for such voices to be heard.

Part B Losing Its Way: The Japanese Electronics Industry in the 1990s

The 1990s is understood to be the lost decade for Japan, and it was the electronics industry that most lost its way. Within electronics, it was information and communication technology that was most affected. How and why this happened, and what the experience means to the business strategies of Japanese firms, are the concern of Part B.

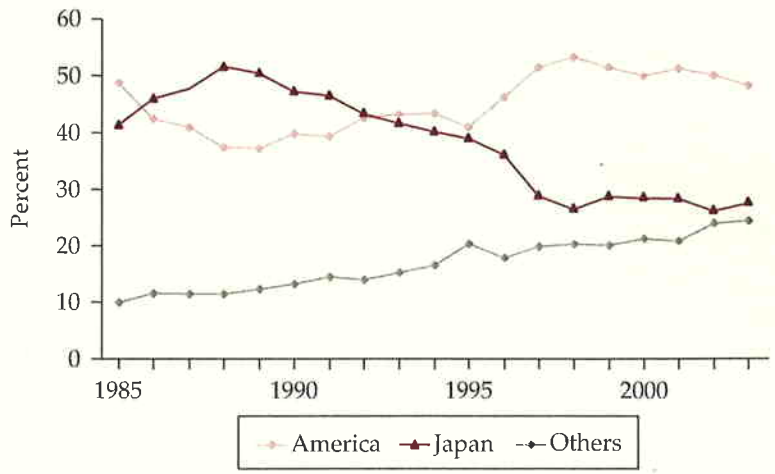
Japan's economy, one of the fastest growers during the 1980s, began to slow in the 1990s and, by the latter half of the decade, it had the lowest level of growth among G7 nations. This was due largely to the fact that key manufacturing sectors stopped growing.

The reasons were different for each sector. The steel industry, for example, managed to survive three difficult decades, beginning with the 1970s, by retaining quality advantages over new competitors and continuously slashing its workforce. Automobile companies expanded abroad to meet foreign demand, so production did not increase at home. These two sectors were, and have remained, the most competitive in the world. However, they did not contribute to the growth of the Japanese economy. Japanese consumer electronic brands, especially in audio-visual equipment and computer games, are still globally important, even dominant. But it is very rare to find a Japanese desktop computer outside Japan. The same is true for mobile telephone handsets. Less visible but no less important is the lack of a single operating system of Japanese make.

The rise and fall of the Japanese IT industry is encapsulated in the story of semiconductors, the basic building block of the sector.

Figure 5.2 shows how the market share for Japan peaked in 1988 at just over 50%, and then began to decline, falling below 30% in 1997. In contrast, the United

Figure 5.2. *Semiconductor Share in the World Market*



Source: Semiconductor Industry Association (SIA) statistics.

States began to recover share that had been lost to Japan in the 1980s. Although U.S. firms came back, it does not necessarily mean that all the chips (semiconductors) were produced in the United States. As a matter of fact, many were made by Asian manufacturers under U.S. labels.

Japan's experience in the 1990s stands in sharp contrast to the 1980s, when Japanese consumer electronic manufacturers overwhelmingly dominated the global markets in videotape recorders and color television sets. But these were analog technologies. In the United States, Motorola initially remained committed to an analog standard for mobile telephony and thus lost out to companies that successfully promoted the digital GSM standard.

But it was not simply being slow in shifting from analog to digital that caused the Japanese electronics industry to move off the technological frontier and fall from global leadership. Another reason was a lack of strategy. In particular, a lack of concentration and selection in the markets they contested, a lack of strategy regarding technical standards, and an overreliance on integrated design and manufacturing processes.

It is instructive to compare the automotive and electronics industries. Automobiles have undergone continuous but generally gradual improvement. This is the type of competition in which Japanese firms have excelled. But such an approach will not work in the IT sector. The innovations that have occurred in IT since the mid-1990s are of quite a different nature. They are more discontinuous and disruptive. As such, they are less amenable to the kaizen (continuous improvement) approach. They also are less compatible with the integrated design and manufacturing processes typical of large Japanese enterprises. These topics are developed more fully later.

Industry Structure and Strategy

To understand what has happened to the electronics and IT industries in Japan, it is necessary to understand their structure and strategy. Electronics and IT have been dominated by firms called *sogo-denki*, which translates as general electronics companies. These are listed in Table 5.1.

What characterizes these companies, even relatively small ones, is that they have had very broad ranges of products. This is the result of a "do as others do" (*yokonarabi* in Japanese) approach to business. Thus Hitachi, Toshiba, and Mitsubishi Electric produce practically everything that runs on electricity, ranging from refrigerators, washing machines, and air conditioners to atomic power generators and computers. Matsushita (Panasonic brand) and Sony are champions of home electronics. NEC and Fujitsu are somewhat more specialized in computers and communication equipment.

A "do as others do" strategy is not entirely without reason. If company A embarks on a project and B does not follow suit, then if the project is a success, B will find itself in an embarrassingly inferior position. If, on the other hand, B follows A, it remains equal relative to A. If the project fails, both A and B suffer, which B may find acceptable. So under a competitive environment where avoiding crushing defeat is more important than outperforming others, there is an advantage to "do as others do." This was in fact the case in Japan in the postwar period. But from a national viewpoint, this is not optimal. No firm can reach the critical mass necessary to command leadership in the global market.

Table 5.1. *Japan's* Sogo-Denki, *by Revenue, 2004 (Billion Yen)*

Parent 1985	*Company 2004*	*Consolidated 2004*	
3,026 (2)	2,597	9,027	Hitachi Ltd.[1]
3,424 (1)	4,146	8,713	Matsushita Electric Industrial Co. Ltd.
2,526 (3)	2,816	5,836	Toshiba Corp.
1,889 (4)	2,427	4,855	NEC Corp. (Nippon Denki)
1,292 (6)	2,846	4,763	Fujitsu Ltd.
1,858 (5)	2,022	3,411	Mitsubishi Electric Corp.
1,048 (7)	1,459	2,484	Sanyo Electric Co. Ltd.
Other major companies in electronics[2]			
1,071	2,895	7,496	Sony Corp.
n.a.	n.a.	3,468	Canon Inc.[3]
908	n.a.	2,800	Denso Corp.[4]
910	2,085	2,540	Sharp Corp.

Data are for fiscal years ending in March of the following calendar year.

Numbers in parentheses are 1985 ranking for parent companies. Hitachi, Toshiba, and Mitsubishi are the most diversified; NEC and Fujitsu are less diversified than the others.

1. Hitachi's parent company decrease reflects a policy of creating legally independent subsidiaries to operate various businesses.
2. As identified by NEEDS (Nikkei Electonic Economic Databank System) in its grouping of companies by industry. NEEDS is a primary supplier of data on Japanese companies operated by Nikkei Shinbun-sha.
3. Canon was not considered an electronics company in 1985.
4. Denso makes automobile electronics and is closely associated with Toyota.

Someone asked to name a Japanese IT or computer company will most likely name one of the *sogo-denki.* This is reasonable: the IT operations of the largest of these firms are as large or larger than many independent IT companies. But "pure" IT companies of great size are not common. Fujitsu Ltd., the parent firm of one of the largest computer groups in the world, is perhaps the closest to an exception.

Japanese IT companies have had a long-standing tradition of doing all of the activities in the value chain (Table 5.2) in an integrated and continuous manner. This is because they believe in the synergetic effect of a seamless operation. That is, firms sought to produce all key parts and components either themselves or through subcontractors and affiliated companies with which they had long-term working relations. Each activity was meticulously coordinated with other activities through constant communication and feedback. The firms' view was that good communications and the steady flow of information throughout the different stages of operations were of crucial importance to efficient production. Japanese companies were generally believed to be particularly adept at this type of coordination, and this integrated approach was considered to be at the root of the efficiency and high production quality of Japanese manufacturers.

Modular Production

Within the manufacturing links of the value chain (Table 5.2), a production model has emerged called modular production. It treats the components of the finished product

Table 5.2. *The Value Chain*

Typically, a production process consists of the following activities, in sequence. Each can be said to form a link in a chain that adds value in some way.

1	R&D, design and development
2	Key parts and components
3	Manufacturing and assembly
4	Logistics (distribution)
5	Marketing
6	Customer service, after-sales service.

as modules. As long as a module meets price and specifications—including an agreed interface—an assembler does not care about the specifics of what goes on inside it.

Modularity gives authority to the company's first-line suppliers—that is, the companies providing the modules—to innovate in their areas of expertise. The assembler thereby gains access to specialized R&D capabilities beyond what it has in-house.

Modularity also allows adapting products to specific markets. Thus, Nokia Corp. uses a module containing software to adapt otherwise similar mobile phones to the requirements of each telephone company.

Agile, Focused Firms

Even as the world-famous integrated Japanese electronics firms faltered, there have been a number of companies below the top 10 that have done relatively well.

In particular, quite a few Japanese companies have succeeded in establishing dominant positions as suppliers of essential parts in global value chains. That is, they have focused on niches. Examples include Nihon Densan (small motors for hard-disk drives), Nitto Denko Corp. (fine chemicals, including IC sealing resins), Rohm Co. Ltd. (custom large-scale integrated (LSI) semiconductors), and Murata Manufacturing Co. Ltd. (world's largest maker of ceramic capacitors). Many of the successful niche players were newcomers, but others were established firms that adapted. Having a very dynamic and decisive chief executive was a key factor in success.

Canon Inc., Ricoh Co. Ltd., and Sharp Corp. are examples of mid-sized, somewhat diversified companies that have adapted. All were founded in the 1920s or 1930s. However, they have transformed their strategies to meet global competition. Canon, for example shifted its focus from cameras to printing equipment to digital cameras, and dropped personal computers (PCs) to avoid dilution of resources. Ricoh, once also primarily a camera company, competes with Canon but is more focused on the printing equipment market, which it entered in the 1950s. For two decades, Sharp nurtured liquid crystal display (LCD) technology, and is now the global leader in flat television sets. (Sharp is a case study in volume 2.)

The Role of Asian Producers

The strategy of contracting out the manufacturing link in the value chain makes a lot of sense. There are many Asian firms well-suited to the task.

Take semiconductors. The plants, called "foundries," are extremely expensive to build and operate. For example, an Intel plant announced in July 2005 will cost some $3 billion to construct in the United States. As a result, many firms have become "fabless." That is, they do not own fabrication facilities. Instead, they draw

blueprints and design sheets and hand them to "dedicated foundries," as contract maker of semiconductors are called. One of the largest companies in the business is Taiwan Semiconductor Manufacturing Co. (TSMC). TSMC, which pioneered the industry in 1987, had $7.7 in revenue in 2004, and planned $2.7 billion in capital expenditures in 2005, according to the company. United Microelectronics Corp. (UMC), also Taiwan-based, is another major foundry. However, the field is not exclusively Taiwanese: IBM provides foundry services from plants in the United States, as do Toshiba and Fujitsu in Japan, albeit much later.

Many electronics products are assembled in Asia. Subcontracting assembly is a long-standing practice: the largest firm in the field, Silicon Valley's Solectron Corp., was founded in 1977. Two of the next three major firms are based in North America: Sanmina-SCI Corp. and Celestica Inc., a 1996 spinoff from IBM based in Canada. The fourth, Flextronics Intl. Ltd., is based in Singapore, but is the successor of a U.S.-based company. All four operate plants in Asia. Thus, small U.S. companies can work with another U.S. company to access Asian manufacturing facilities.

Taiwan is the center of assembly activity. In 2002, the island's factories, coupled with subsidiaries on mainland China, produced 75% of the world's PC motherboards, and 60% of notebook PCs and LCD monitors. During the 1990s, PC-related industries in Taiwan grew 21% annually, going from $7 billion in 1990 to $47 billion in 2000. The bulk of this production went to the United States: $28 billion in 2000. Since 2000, Taiwanese companies have been moving assembly plants to mainland China. As a result, by 2003 some 90% of their PCs were assembled in China (Japan External Trade Organization estimate).

Open Innovation

IT companies in the United States have benefited from close relationships with universities. The role of the Massachusetts Institute of Technology (MIT) in populating Route 128 with high-tech firms and of Stanford University in turning the Santa Clara valley into Silicon Valley are well known. This was a movement of both people and ideas in both directions. Such close working relationships did not happen in Japan. This is not to say that in Japan university researchers and industry people did not interact. On the contrary, there were many contacts. However, due to government regulations imposed on the universities, they remained informal and of a personal nature.

Until the 1980s, faculty at most universities, even in the United States, did not commonly interact with the business community in ways that would encourage the transfer of ideas in either direction. There were attitudes on both sides hindering such cooperation.

Similarly, successful large firms, with their elite groups of engineers and scientists, historically were, like university faculties, somewhat dismissive of work done elsewhere. This was reflected in a not-invented-here (NIH) mentality that disregarded technologies developed outside the company. This was especially true in Japan, where rivalries with other *sogo-denki* and IT companies gave openness an aura of disloyalty to the firm.

The new paradigm is called "open innovation." This refers in part to the availability and use of external resources—especially technology provided from outside the firm. The key point here is that most successful firms in the global IT sector, including even the larger ones, have moved away from an NIH attitude and instead seek technology where and how they can find it.

Obtaining Technology

In an era in which technology need not be indigenous to the firm, how does a company acquire it?

Merger and acquisition is one way. Cisco Systems Inc., the world's top router manufacturer, acquired 70 high-tech ventures during the five years to 2000. Even well-established IBM was buying software companies and integrating them into a core business as it shifted from being a maker of big boxes to a service provider.

Joint R&D is another way. Some technologies are extremely expensive to develop. Several firms, even ultimate competitors, joining to fund the early, precommercialization stages of R&D can benefit everyone. This was the idea behind Japan's government-led collaborations. The privately organized ventures in the United States suffered some of the same problems of trust as the Japanese. But, in the United States, participants were self-selected and thus presumably not as reluctant as the Japanese firms had been. Moreover, joint R&D was often done as part of a joint venture that would market the product. This further reduced parent company concerns.

In short, there has been a market for technology in the United States that has contributed directly to the speed, breadth, and depth of creativity. The absence of such a market in Japan is arguably a shortcoming of the Japanese innovation system, and has resulted in overall inefficiency.

Merely increasing R&D spending without addressing this question will not improve the situation. Adopting the forms also is not enough if the underlying substance of a creative and risk-taking culture is lacking.

Strengthening the relationship between university and industry is a central concern for Japan. In this regard, an encouraging trend is now in sight. In 2002 Ministry of Economy, Trade, and Industries (METI) set a target of 1,000 university-spawned venture businesses by March 2005. Practically nonexistent in the 1990s, their number reached 900 in August 2004 and 1,112 as of March 2005. This is discussed further in Chapter 7.

Exits and Entries as a Source of Dynamism

Exits and entries are a key source of economic dynamism. In the United States, they occur when new technologies emerge. For example, when computers shifted from an emphasis on mainframes to minicomputers, names once high on the Fortune 500 list were replaced by new firms. Those firms have also been displaced as the IT revolution of the second half of the 1990s was driven by yet another wave of companies. A decade later, once again many of those technological pioneers have been pushed aside.

The key point here is that, in the United States, the emergence of new technologies has also meant the appearance of new business models and new management to capitalize on the new technology. This has not been the case in Japan. Thus, only 4 names on the list of 10 largest U.S. computer hardware firms by revenue in 1985 are on the 2004 list: IBM, Hewlett-Packard, NCR Corp., and Apple Computer Inc. (Hewlett-Packard absorbed the remains of Digital Equipment when H-P bought Compaq in 2002.) In contrast, there was only one change among Japan's top 10 electronics companies between the two years, although the relative rankings changed somewhat (see Table 5.1).

This ongoing large-scale replacement of old firms with new ones has made it possible for the United States to come back to the fore in the technology race. Why is this rapid turnover of players so important?

The IT revolution in the United States has been driven by the advent of what are called "disruptive innovations." These are innovations that make the technology of the installed base obsolete. Established companies, historically, have seen little benefit from such innovations. Consequently, it is generally new companies that first pursue them. If the innovation does indeed prove useful and successful, the new companies can supplant firms still wedded to the old ways. Even established firms can adapt, however, as IBM has shown.

For Japan, the incumbents, in general, have been more interested in maintaining existing businesses, so long as they are generating revenue, than in trying something new and untested. As a result, the Japanese IT industry moved too slowly to take on the new challenges. There is no doubt that the large Japanese firms were in a more disadvantageous situation than the U.S. newcomers, which did not have to worry about existing business. But it can be argued that the Japanese firms spent too much time and energy discussing whether or not they should move into the new businesses and, more importantly, how they should transform their organization to do this.

The example of routers, which are used to direct the flow of data on the Internet, is illuminating. The business is dominated by two companies—Cisco Systems, with a 60% global market share, and Juniper Networks, with a 30% share. Despite the sophistication of their switching technology, Japanese firms are not a major factor in routers even in their domestic market. Japanese switch makers such as Fujitsu, NEC, and Hitachi could have produced routers, but none dared to do so for fear of destroying their existing business with NTT.

Hard Lessons

Japanese IT companies have learned some lessons that are clearly discerned from their behavior. The more important ones are discussed here. These are narrowing focus, increasing protection of their intellectual property, and utilizing more external resources.

Narrowing Focus

In the face of fierce global competition, Japanese companies have realized they must discontinue the "do as others do" strategy. This means a narrower focus on areas where the company has some competitive advantage.

Thus, in semiconductors, there has been a shift from memory dynamic random access memory (DRAM) to more sophisticated chips. Elpeda, a joint venture of Hitachi and NEC formed in December 1999, is now the only Japanese company producing DRAM. In LSI, too, there are drives for strategic alliances among Japanese firms and with foreign companies. Renesas Technology, one of the largest semiconductor companies in the world, is a joint venture of Hitachi and Mitsubishi Electric formed in April 2003.

Protecting Intellectual Property

Japanese companies have become determined to protect their intellectual property. Japanese firms now feel that their failure to protect their production technology for

DRAM was a major factor in Korean and Taiwanese firms capturing the market. While previously Japanese firms were more likely to be defendants in intellectual property cases brought by U.S. and European companies, now Japanese are initiating litigation. Companies are strengthening their legal staff to deal with the increasing number of cases.

A number of companies have moved some operations back to Japan. They have weighed the advantage of using cheap labor against the risk of leakage of technologies from their plants. Perhaps remembering how much Japanese learned touring U.S. and European factories in the past, Japanese firms are closing their factories and research facilities to visitors. Some experts describe these movements as "black-boxing," which is now regarded as a very effective approach to protecting technologies and know-how.

Behind these new attitudes is a Japanese government policy of vigorously defending Japanese IPRs. In particular, the 2003 revision of the Custom Tariff law made it easier to take prompt action to stop imports of products deemed to violate Japanese IPRs. There is a determination to fight breaches of Japanese patents and other IPRs. This is particularly seen in digital consumer electronics, especially flat-panel displays, DVDs, and digital cameras. All of these were originally commercialized by Japanese firms, but Korean and Taiwanese companies have caught up quickly.

Utilizing More External Resources

Use of external resources to remain competitive is more widespread. For standardized parts, there is more willingness to buy from Taiwan and other Asian countries rather than producing in-house. Contracting out to foundries and assemblers is far more widespread than before. At the same time, Toshiba and Fujitsu each entered the foundry business in 2004, producing the most advanced LSIs designed by U.S. firms. In this way, cross-border value chains are being established with Japanese companies as important links.

The use of external technology resources can make it possible for companies to shorten the time to market, as well as to diffuse the risk associated with R&D. This kind of activity, namely, finding promising technologies out of the myriad of newly developed ones, requires the insight to discern the commercial potential of untested technologies, as well as the ability to translate them into a business model for exploitation. Such a talent (*mekiki* in Japanese, meaning "a person with insightful eyes") appears to have been very rare in Japan, making it difficult to nurture venture businesses.

Conclusion

What made the 1990s different from the 1970s and 1980s is the large number of disruptive innovations, particularly in the IT sector. Unlike in the United States, there were few market entrants in Japan to inject dynamism into the economy. New technology was not effectively exploited by established firms, which maintained old management practices and outmoded business models.

What has become clear as a result of the difficult experience of the 1990s is that it is incumbent on a national economy to nurture an entrepreneurial spirit and foster new business models if it is to benefit from new innovations. This is what happened in the United States and what did not happen in Japan.

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