
Introduction

The semiconductor industry was born with the invention of the transistor at Bell Telephone laboratories in 1947. The transistor was first commercialized in the 1950’s by U.S. firms, and it soon became a major component of electronic products. In the 1960’s, the transistor was replaced by the integrated circuit. Like the transistor, the integrated circuit was first developed and commercialized by U.S. firms. Today, semiconductors are the main components of numerous electronic products including computers, photo copiers, and telecommunication equipment. In addition, they are increasingly finding their way into a host of other products from automobiles to machine tools.

Semiconductors can be divided into several broad product groups, the most important of which are memory devices, such as DRAM's (dynamic random access memory chips), and logic chips, such as the microprocessors and microcontrollers. The total world market for semiconductors stood at $35 billion in 1988, reached $91.5 billion in 1994, increased to $122 billion in 1998, and hit $204 billion in 2000.

U.S. enterprises dominated the world market from the 1950s until the early 1980s. At the height of U.S. success in the mid-1970s, U.S. firms held close to 70 percent of the world market. During the 1980s, however, the market share of U.S. firms plummeted, falling to 29 percent by 1990, while the share held by Japanese producers rose from 24 percent at the end of the 1970s to 49 percent by 1990. By the end of the 1980s, the United States was a net importer of semiconductors, while 5 of the 10 largest semiconductor producers were Japanese. More significantly still, by 1988 Japanese firms had captured more than 80 percent of the world market for the most widely used integrated circuit in digital equipment, the DRAM. Invented by Intel and once produced exclusively by U.S. firms, as of 1988 only two U.S. firms were in the DRAM market, Micron Technologies and Texas Instruments, and Texas Instruments was manufacturing most of its DRAM's in Japan.

The late 1980’s may have been something of a high-water mark in the global success of Japanese semiconductor firms. By the mid-1990s, the U.S. industry was again gaining global market share. By 1994, U.S. manufacturers had increased their share of the world semiconductor market to 42 percent, while the share taken by Japanese firms stood at 41 percent, down almost 10 percentage points from their high. Also, foreign firms held 22.4 percent of the Japanese semiconductor market in 1994, up from about 14 percent in 1990. As the 1990s progressed, Japan's share of the global market continued to decline. In this case we explore some reasons for the rise of Japan's semiconductor industry and for the subsequent decline in its growth in global market share.

Japan's Industrial Policy

Why were the Japanese so successful in the global semiconductor industry between the 1970s and late 1980s? One argument is that the industrial policy of the Japanese government was the driving force behind that success. During the 1960s and 1970s, the Japanese government, principally through the Ministry of International Trade
and Industry (MITI), sought to build a competitive semiconductor industry by limiting foreign competition in the domestic market and acquiring foreign technology and know-how. The foreign investment laws created after World War II (by the U.S. occupation government) required the Japanese government to approve all applications for foreign direct investment in Japan. MITI consistently rejected all applications by U.S. semiconductor firms to set up wholly owned subsidiaries in Japan, to set up joint ventures in which the U.S. partner would have a majority stake, or to acquire equity in Japanese semiconductor firms. At the same time, the government limited foreign import penetration of the Japanese market through a combination of high tariffs and restrictive quotas. Import penetration of the Japanese market was also limited by requirements that Japanese companies get permission from MITI before buying advanced integrated circuits from foreign companies. For example, until 1974, integrated circuits that contained more than 200 circuit elements could not be imported without special permission.

Since U.S. producers were denied direct access to the Japanese semiconductor market, they typically sought indirect access by licensing their product and process know-how to Japanese enterprises. This too was regulated by MITI. MITI's policy was to insist that if a foreign firm were going to license technology in Japan, that technology had to be licensed to all Japanese firms that requested access. In other words, U.S. firms were not able to discriminate between licensees. MITI also conditioned approval of certain deals on the willingness of the involved Japanese firms to diffuse their technological developments, through sublicensing agreements, to other Japanese firms. The net result of these policies was to encourage the rapid diffusion of advanced semiconductor product and process technology throughout the Japanese semiconductor industry.

U.S. firms went along with this policy because it was their only way to get access to the Japanese market. Initially, licensing was a very lucrative arrangement. By the end of the 1960s, Japanese semiconductor firms were reportedly paying at least 10 percent of their sales revenues as royalties to U.S. firms: 2 percent to General Electric, 4.5 percent to Fairchild, and 3.5 percent to Texas Instruments. The most notable long-run consequence, however, was a transfer of U.S. technological know-how to a number of emerging Japanese competitors. Shielded from foreign competition by import barriers and restrictions on foreign direct investment and armed with state-of-the-art technological know-how, the Japanese firms had only each other to compete with for a share of the rapidly growing Japanese semiconductor market. Stimulated by MITI's insistence that technology be shared among all Japanese semiconductor firms, this competition was intense and based primarily on cost (since everyone had the same technology). The firms that rose to the top in this tough environment, such as NEC, were more than capable of going head to head with U.S. semiconductor firms by the mid-1970s.

Trade Agreements

By the mid-1980's, the changing fortunes of the Japanese and U.S. semiconductor industries had given birth to a bitter trade dispute between the two countries. After incurring heavy losses, U.S. firms claimed they were facing unfair competition from Japan. They accused the Japanese of selling semiconductors, and especially DRAM's, in the United States for less than their fair market value while simultaneously shutting U.S. firms out of the important and lucrative Japanese semiconductor market. The dispute was settled by a 1986 trade agreement between
the United States and Japan. The agreement specified a fair market value for semiconductors. Japanese companies were not supposed to sell their semiconductors for less than this price outside of Japan. The agreement also sought to increase foreign access to Japan's domestic semiconductor market. In a non-binding side letter, the Japanese government agreed to help ensure that foreign manufacturers gained more than 20 percent of the Japanese market by the end of 1991, a significant increase from the 8.6 percent share held in 1986.

Although the agreement led to an increase in prices for semiconductors in the United States, foreign producers were still not able to capture a major share of Japan's semiconductor market. By early 1991 when the 1986 agreement was close to expiration, the American Semiconductor Industry Association claimed that foreigners held only a 12 percent share of the Japanese market (the Japanese claimed the foreign share was closer to 17 percent).

In June 1991, the United States and Japan signed a new five-year pact to replace the 1986 agreement. Unlike the previous agreement, this pact formally committed the Japanese to ensuring that foreign producers gained a 20 percent share of their semiconductor market by the end of 1992. In return, the United States agreed to abolish the fair market value system created under the 1986 pact.

This new agreement was greeted with a mixed reception on both sides. While most U.S. semiconductor manufacturers approved of the agreement, some analysts and politicians argued that the government should not have abolished the fair market value system. House Democratic Leader Richard Gephardt, for example, criticized the agreement for its lack of specific commitments by Japan to widen its chip market to foreign sellers. Similarly, Clyde Prestowitz, a former U.S. trade official who helped to craft the 1986 agreement, called the pact a step backward, primarily because it abolished the fair market value system. The Japanese, in contrast, expressed pleasure that the fair market value system had been removed, but many criticized the formal commitment to a 20 percent market share for foreign companies. For example, a senior official at Toshiba, one of Japan's largest semiconductor manufacturers, noted, "We believe that the agreement infringes the principles of free trade, which shouldn't be limited by an agreement of any kind." Similarly, a senior official from the NEC Corporation said, "As you know, the semiconductor was invented in the U.S. and the U.S. was number one in the world for a long time in semiconductors. The U.S. might be a little complacent about what it has achieved. There has been a lack of effort."

Despite such misgivings, the pact seemed to deliver what it promised. The foreign share of the Japanese semiconductor market reached 20 percent in the fourth quarter of 1992. Although it fell back somewhat in the first half of 1993, foreign producers again gained share in the fourth quarter, pushing their total share for the year to 19.4 percent, up from an average of 16.7 percent for all of 1992. The performance of foreigners was even better in 1994, when they captured over 22 percent of the Japanese market. In the fourth quarter of 1994, foreign producers gained a record 23.7 percent market share. However, some analysts wondered whether the pact had much to do with the foreign success. They pointed out that the value of the Japanese yen had strengthened by about 40 percent against the U.S. dollar since 1991. With the yen this high, the terms of trade in the Japanese semiconductor market had swung sharply toward foreign producers, who now had a distinct cost advantage over their
Japanese rivals.

Critics note that in the important DRAM market there has been only a limited U.S. resurgence (in contrast to the market for logic chips, where Intel, Motorola, and others continue to dominate). While both Micron Technology and Texas Instruments—the lone two U.S. DRAM manufacturers—did extremely well during 1994 and 1995, much of the DRAM market share gain in Japan has been made by South Korean firms, particularly Samsung. Samsung, which didn't even produce DRAM's in 1988, accounted for 12.7 percent of the world DRAM market in 1994, ahead of Japan's Hitachi Corp. and NEC, which accounted for 9.7 percent and 9.2 percent, respectively. The Japanese share of the world DRAM market was cut in half between 1988 and 1994 as customers switched to low-cost producers such as market leader Samsung and Micron Technology (which enjoyed a 4.5 percent market share in 1994). As of 1995, these trends showed no sign of slowing. One 1995 estimate suggested that South Korean firms were reinvesting 30 percent to 55 percent of their semiconductor revenues in new plants and equipment, the Americans were reinvesting 22 percent, while the Japanese were reinvesting only 15 percent. Also, a number of Taiwanese firms had announced aggressive plans to expand their presence in the DRAM business. In the face of this rapid investment in capacity by non-Japanese firms and the apparent reluctance of Japanese firms to invest, many thought it would be difficult for the Japanese producers to keep their 37 percent share of the global DRAM market.

In the summer of 1996, representatives from Japan and the United States met again to renegotiate the 1991 semiconductor agreement, which was due to expire July 31, 1996. This time, the Japanese were determined to oppose any attempt by the U.S. side to continue to impose numerical targets or otherwise interfere in the market mechanism. In making their case, the Japanese pointed out that during the first six months of 1996, the foreign share of the Japanese semiconductor market had risen to over 30 percent and that two-thirds of that share had been taken by American firms. In

![World Market Share 1982-2000](Figure 1)

**Figure 1**
World Market Share, 1982-2000
the wider global market, Japanese producers were seeing their share being taken by aggressive competitors from South Korea and now Taiwan. In the DRAM sector in particular, the rise in the value of the Japanese yen had made it increasingly difficult for Japanese firms to compete against the South Koreans and Taiwanese.

Publicly, the Americans declared that they would push for another agreement, and they voiced concerns that without some kind of deal, the Japanese market would once more be closed to foreign competition. Privately, however, government officials admitted that Japan's semiconductor industry seemed to be on the wane, and that it would be difficult to renew the agreement, particularly given the rise of new competitors and the profit boom being enjoyed by some of America's own semiconductor companies.

After the customary hard bargaining, which went down to the wire as so many trade deals seem to, an agreement was reached that enabled the American side to save face while basically giving the Japanese what they wanted. Under the deal, U.S. and Japanese industry associations agreed to create an entity to collect data about the sector and deliver it to their governments, which would meet annually to discuss the industry. In the words of one observer, the deal represented "the tiniest of fig leaves ... The idea that there will be government meetings yearly to review semiconductor trade but with no power to do anything about it means that everyone has decided to smile and go home."

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**Aftermath**

The years after the 1996 agreement were not kind to the semiconductor industry. In 1997, a glut of new capacity in South Korea and Taiwan produced excess capacity in memory chips. Prices for DRAM's fell by as much as 70 percent, and most of the world's major producers of memory chips posted significant losses. Among those worst hit were the big five Japanese semiconductor companies: NEC, Toshiba, Hitachi, Fujitsu, and Mitsubishi Electric. Throughout 1997-98, the yen continued to gain strength against the currencies of South Korea and Taiwan (the former collapsed in value in late 1997), effectively pricing Japanese firms out of the DRAM market. By late 1998, Japan's share of the global market for DRAM's had shrunk to 30 percent, down from a peak of 80 percent 10 years earlier, and Japan's share was forecast to fall to 20 percent by 2000. News reports suggested that Hitachi, Fujitsu, and Mitsubishi Electric were contemplating leaving the DRAM market and focusing on niches within the market for logic chips. The big gainers in the DRAM market were Taiwanese firms. Japan's share of the total semiconductor market (memory plus logic chips) fell from 36 percent in 1996 to 26.4 percent in 1998, while American firms saw their share of the total increase from 46.2 percent to 53.4 percent over the same period due to strong sales of logic chips (see Figure 1).

The global semiconductor industry quickly recovered from the 1997-98 slowdown, and in 1999 and 2000 global sales surged, hitting a record $204 billion in 2000. However, this boom was short lived. A global economic slowdown in 2001 precipitated a collapse in prices for semiconductors, and global sales contracted by more than 14 percent to $175 billion. Japanese firms were again particularly hard
hit. NEC announced 4,000 job cuts and stated it would exit the DRAM business in 2003. Fujitsu reported losses of $1.6 billion in its semiconductor business. Meanwhile, foreigners continued to hold onto their about 30 percent of Japan's semiconductor market in the 1996-2000 period. In the North American market, the share of Japanese firms stood at 11.6 percent in 2000, down from 19 percent in 1996. American firms accounted for 70.2 percent of the market, up from 67.6 percent in 1996.

Case Discussion Questions

1. What factors account for the rise of Japan's semiconductor manufacturers during the 1970s and 1980s?
2. Does the rise of Japanese semiconductor companies during the 1970s and 1980s indicate that government industrial policy can play an important role in facilitating national competitiveness in industries targeted by that policy?
3. What explains the relative decline of Japanese semiconductor firms since 1988? Can it be attributed to the 1991 semiconductor pact or to other economic factors?
4. What are the implications of your answer to question 3 for national trade policy?

Sources