

Cato Institute Policy Analysis No. 99: The Semiconductor Industry and Foreign Competition

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Executive Summary

Perhaps the most disquieting aspect of the troubles presently faced by America's semiconductor industry is that high technology was the very area in which the United States was supposed to be superior. When the automobile and steel industries were in deep trouble in the late 1970s and early 1980s, pundits predicted that the future of American industry lay in "sunrise industries," high-technology fields where the cheap labor available to foreign competitors would be more than compensated for by our Yankee ingenuity.

Unfortunately, it seems we Yankees do not possess a monopoly on ingenuity, for the Japanese semiconductor industry has proven very competitive. In one particular area--the production and sale of general-purpose memory chips, so-called DRAMs (Dynamic Random Access Memory) and EPROMs (Erasable Programmable Read Only Memory)--the performance of American companies has been disastrous. In 1975, U.S. merchant producers (companies that make chips to sell to others rather than just for their own internal use) had 100 percent of the U.S. DRAM market. In 1986, they had 5 percent of that market.(1) When all chips sold by merchant producers are taken into account, the U.S. producers' market share declined from 60 percent in 1975 to less than 50 percent in 1985, while the Japanese share rose from 20 percent to 40 percent in the same period.(2)

Naturally, such a loss of industrial competitiveness and the accompanying losses in employment quickly turned the issue from a private one into a public one. In 1983, the Semiconductor Industry Association (SIA) published a report that accused the Japanese of a variety of unfair trade practices.(3) In 1986, the United States and Japan signed the Semiconductor Trade Agreement, under which the Japanese promised to take steps designed to alleviate the plight of American chipmakers. In February 1987, the Department of Defense's Science Board issued its "Report on Defense Semiconductor Dependency," which asserted military reasons for protecting and strengthening America's semiconductor industry; in April 1987, in response to Japanese violations of the 1986 Semiconductor Trade Agreement, the U.S. government imposed trade sanctions on Japanese imports; and, currently, the congressional trade bill would authorize \$500 million over the next five years to finance Sematech, a government-industry research consortium to develop new semiconductor manufacturing techniques, a proposal advanced by the SIA and then by the Defense Science Board.

This, of course, is not the first time foreign trade and protectionism have been discussed in the United States, and will certainly not be the last. In a democracy, it is inevitable that whenever one segment of society feels put upon by forces it believes are outside its control, it will petition the government for help; and there might well be some cases where a hands-off approach to international trade is not the best solution. However, before the United States embarks on a new round of trade protectionism, it should first investigate where the true interests of the nation as a whole--not just the semiconductor manufacturers--lie.

Us vs. Them

"We don't want [a U.S.-Japanese trade war] and the Japanese certainly don't want one," said the late Secretary of Commerce Malcolm Baldrige. "Japan sells about \$85 billion worth of goods to the United States in a year, while we sell about \$27 billion to the Japanese. Who has the most to lose?"(4) This presented, of course, a classic mercantilist question, and Baldrige clearly implied that the party with the most to lose was Japan--that the United States trade deficit with Japan indicated that Japan was somehow getting the better end of the deal.

Mercantilism, however, is not a highly regarded economic theory these days, and has not been for about 200 years. The classical mercantilists measured a nation's wealth by the amount of gold--these days, it would be by foreign reserves--that the nation possesses; when the United States buys \$100 million of goods from Japan, the United States "loses" \$100 million and Japan "gains" it--U.S. wealth is decreased and Japan's is increased.

Classical economists, starting with Adam Smith, successfully challenged mercantilist analysis by pointing out a simple fact: an informed voluntary trade is, by definition, to the advantage of both parties involved. This is a cliché, but a cliché is merely an often-repeated truth, and this truth is worth repeating. The United States doesn't really "lose" \$100 million by trading with Japan; it exchanges \$100 million for some amount of goods, an amount that is clearly worth more (to the American purchasers) than \$100 million. Similarly, Japan does not "gain" \$100 million from the trade-- it gains \$100 million minus the value of the goods to itself. Both parties gain, or else they would not trade. A cash trade "deficit" usually turns out to be a wealth surplus, since the dollars we give up are more than offset by the goods we get in return.

On the microeconomic level, when a Japanese chipmaker sells chips to an American chip user (typically a computer manufacturer), the American clearly gains by getting a better deal than he otherwise could; cessation of international trade would certainly hurt the American computer maker a great deal, since it would drive up its costs and thus its product prices, and drive down profits. One third of the total production cost of a microcomputer is in the chips.(5)

This is why it is useless to speak of which trading partner has the most to gain from trade and which has the most to lose. Japan's gains and the U.S. gains are hard to compare, since they are largely subjective, reflecting the value that each places on the goods that were sold; suffice it to say that both sides gain, and gain rather handsomely indeed.

In fact, it appears that in the short term, chip consumers may gain more than chip producers. Chip producers-- American as well as Japanese--have been having an unprofitable streak recently, suffering hefty losses while their customers have been raking in the benefits in low prices. Although this is unlikely to remain a long-term trend (economics teaches us that people rarely sell things at a loss for long), these days our cash trade "deficit" in the chip trade might actually mean a "surplus" in the total amount of wealth being exchanged. This is important because it is tempting--and, to some parties, profitable--to label the current trade situation as a case of "Us vs. Them," with "us" being the United States (the good guys) and "them" being Japan (the bad guys). The trouble with this idea, though, is that at least some of "us"--the chip consumers--benefit as much as "they" do from low Japanese chip prices. The real losers are American chipmakers, who are seeing themselves being undercut by Japanese competition. Japanese competition is not "bad for America"; it is bad for some Americans and good for others.

"Unfair" Competition

Naturally, U.S. chipmakers are not willing to simply complain that the Japanese outcompete them. The American public has little patience for companies that are failing just because they cannot do as good a job as the next guy. In fact, the Semiconductor Industry Association's 1983 report concentrated on several specific allegations of "unfair" competition:

* **Dumping.** The Japanese are said to sell their chips at below cost to the United States, thus forcing American chip manufacturers to take similar losses just to stay even.

* **Government Targeting.** The Japanese have the benefit of government subsidies (from the infamous Ministry of International Trade and Industry, or MITI) which American chipmakers do not receive, so the game is not being

played on a "level playing field."

* Import Restraints. While the Japanese merrily export chips (and other things) to the open U.S. market, they stubbornly refuse to let American exporters return the favor.

The great thing about being in favor of fairness is that it is, by definition, so hard to oppose. When a presidential candidate campaigns on a platform of fair trade, how could anybody disagree with him? What would be the alternative, "unfair trade"?

Still, before launching a crusade for fair international trade, we must ask ourselves a few key questions:

* Are the trade policies in question really unfair?

* Do these trade policies contribute substantially to the American producers' woes?

* Even if these trade policies are unfair, could we not profit from them?

* If we find that we do want to do something about Japanese trade policies (whether or not they are fair), will our planned actions actually bring about the desired results?

The answers to these questions are by no means obvious.

Dumping

The dumping issue has surfaced with a vengeance in the U.S.-Japanese "voluntary" Semiconductor Trade Agreement of August 1986. Prior to the agreement, U.S. authorities had declared the Japanese guilty of selling chips below cost, with the intent of driving American competitors out of the market and then recouping their losses using their "unfairly won" market share. In response, Japan agreed to a "worldwide minimum price for Japanese chips determined by the U.S. government." (6) Note the adjective "worldwide"--Japanese exports to other countries, such as Europe, South Korea, etc. would be controlled by this agreement just as surely as exports to the United States.

Now, let us defer for a moment the allegation that dumping is "unfair"--we will get to it shortly. Is Japan's sale of chips below cost to American firms actually harmful to American interests? The mercantilist would, of course, say yes. Mercantilists consider any successful competition by a foreign producer to be harmful. If the foreign producer happens to be unrestrained by considerations of cost, that just makes it all the more likely that the producer can compete successfully.

The trouble with the mercantilist view is that it considers only the interests of the American chip producer. The American chip consumer, on the other hand, is more than glad to buy chips for less than they cost to make. Just as any low-priced competition is bad for the producer (whether it is "fair" or "unfair"), so it is good for the consumer. An American computer manufacturer does not really care how much it costs the Japanese to produce a silicon wafer; he has his own competitors to worry about, and he will profit from any price decrease in his product's components, whatever its origin.

From a macroeconomic point of view, the situation looks even better. Suppose that the Japanese are selling the United States \$100 million of chips that cost them \$125 million to make. Presumably, to the American chip consumers, the chips are worth \$150 million (or some amount greater than \$100 million, or else they would not be buying them). In terms of net change in wealth--factoring in both cash and product value--Americans gained \$50 million and the Japanese actually lost \$25 million. Both American gains and Japanese losses are greater than what they would be if no dumping took place. Admittedly, this is a crude model, but seemingly the only reasonable one--how can the Japanese (or anyone, for that matter) at all profit from selling a product below cost?

But, the anti-dumping argument goes, the consumer benefits from foreign dumping are only short-term, to be followed by long-term disadvantages caused by dumping's destruction of the domestic competition. Dumping, it is said, is actually "predatory pricing," in which dumpers sell products at artificially low prices, drive the competition out of

business, and then take advantage of their monopoly position to recoup their losses by charging exorbitant rates. Certainly, if this were true, we might well be justified in forgoing the short-term advantages of dumping in order to avoid the long-term harm from the imminent monopoly.

But this just is not true. Predatory pricing is a theoretical bugaboo with no real possibility of practical manifestation. It requires more than just an establishment of a monopoly (which is itself a hard proposition, considering the losses a firm has to incur to get it)--it requires retention of the monopoly even after prices are raised.

Once the Japanese manufacturers, at great cost to their pocketbooks, destroy the American chipmakers and start charging monopolistic prices, what is to prevent a would-be competitor from undercutting them? Certainly there are entry costs, but they may be more easily borne by the would-be competitor than the dumping costs incurred by the would-be monopolist. Furthermore, there are plenty of "captive producers" in the domestic market who produce chips but simply do not choose to sell them to others;(7) if someone tries to charge monopoly prices, the captive producers can easily jump into the fray with little start-up costs. (Western Electric, for example, tried to use its "captive" chipmaking ability to sell to the commercial market in 1983--an arguably bad time to do this.(8))

But, finally, let us even assume that not a single chipmaker or would-be chipmaker remains on American shores. It is a capital error to assume that the Japanese are somehow the monolithic Japan, Inc., able to monopolize anything in every way. Even the Defense Science Board report, while maintaining that Japanese chipmakers often cooperate in R&D, acknowledges that "in the application of resulting technology to products [chips], the [Japanese] companies compete fiercely."(9) To really profit from predatory pricing, the fiercely competing Japanese companies would have to organize a cartel to keep prices artificially high. But the only people guilty of even contemplating any sort of semiconductor industry cartel these days are the American chipmakers and the American government.

If the Japanese are not dumping for predatory pricing's sake, why are they dumping at all? There must be some reason for anything as silly as selling something below cost.

There is indeed a reason, and it is hardly as sinister as the protectionists would have us believe. According to one observer, "Japanese companies were accused of selling below what the anti-dumping laws call 'fair market value,'" which is based on "average rather than marginal costs."(10) Say that company A spends \$100 million to build a plant and another \$100 million on R&D for the basic chip design. It then produces 50 million chips a year, each costing \$1 to make (raw materials, labor, etc.). What is the cost to be used for fair market value calculations? If the initial investments are depreciated over 5 years, it would cost \$90 million $((100+100)/5+50)$ per year to produce 50 million chips, an average cost of \$1.80 each.

Unfortunately, though company A may have definitively calculated the "fair market value" of a chip at \$1.80, it may have a hard time getting the market to agree. Prices are, of course, determined not just by the supply curve but also by the demand curve; if the customers are not willing to pay more than \$1.25 for each chip, the company will be hard put to make them pay more (unless, of course, it can get the government to enforce a Semiconductor Trade Agreement).

What is more, there is nothing unfair or unreasonable about selling each chip for \$1.25. The firm still makes a profit of \$.25 on each chip sold, because it only costs \$1 to produce that chip. It may take more time to recoup the original investment this way, but as long as the price is higher than the marginal cost, it is a sound business decision to keep selling. (Prices below average cost might call into question the soundness of the original decision to get into the business in the first place, but it is too late to do anything about that once the fixed costs have been paid.)

Other perfectly good reasons can be supplied for selling chips at below what one might think to be the "cost." Boombust conditions, endemic in the industry, drive prices down below average cost;(11) chip obsolescence, which happens every few years, does the same. Another reason for below-cost sales is to liquidate large surpluses--products that are already on the shelf and that must be gotten rid of at any price, even below marginal cost.(12)

The bottom line is that "dumping" is just a pejorative name for a variety of perfectly sound, fair business practices that are beneficial to American consumers.

Japanese Governmental Subsidies

A more serious fairness issue that has been raised by critics is that the Japanese chip producers supposedly enjoy governmental subsidies that U.S. chipmakers do not have. Therefore, U.S. chipmakers cannot possibly compete without matching subsidies of their own, whether they be direct payments or some sort of artificial price supports.

One would not want to argue that the Japanese subsidies were a good thing. In fact, one of the troubles with subsidies is that they tend to reproduce at an amazing rate, with each nation creating subsidies to offset other nations' subsidies and each industry demanding subsidies of its own whenever it is seen that the government is willing to subsidize some other industry.

However, the questions we must ask are (1) What exactly has the scope of Japanese subsidies been? and (2) Are Japanese governmental subsidies really bad for America?

In the recent debate over protectionism and industrial policy, the name of Japan's Ministry of International Trade and Industry (MITI) has acquired an almost mythical status. Both industrial policy advocates and protectionists have sought to explain much of Japan's economic success as a result of MITI's intervention--the former to justify a comparable American industrial policy and the latter to justify American retaliation in the name of "fairness."

The facts, however, do not justify this point of view. According to David Henderson, former senior staff economist with the president's Council of Economic Advisers, "The idea that central planning is responsible for Japan's success is a myth. MITI has made no contribution to many of Japan's biggest industrial successes."(13)

In fact, in the late 1970s, only 28 percent of Japanese R&D expenditures (including defense) was paid for by the Japanese government; at the same time, 48 percent of U.S. R&D was government-funded.(14) In the computer industry, Japan spent \$127 million in the 1976-82 period while the United States spent \$279 million in the shorter 1978-82 period. The Japan Development Bank's low-interest loans to the electronic machinery industry in 1982 were equivalent to less than 0.5 percent of the total plant investment by the industry.(15) The Semiconductor Industry Association's report indicates that in 1978 (the last year for which it provides figures), MITI's semiconductor industry subsidies were \$45.7 million--but equipping a single production facility can cost up to \$75 million.(16)

Note that the Defense Science Board's report recommends that the Department of Defense (DOD) spend \$400 million per year to stimulate the U.S. semiconductor industry.(17) According to one study, "When American negotiators complain of the Japanese joint research ventures in electronics, the Japanese quickly point to the Defense Department's VHSIC (Very High Speed Integrated Circuit) program. Even the production equipment developed for this program will not be permitted to be sold abroad. . . . We claim that the purpose of such defense programs is not commercial development. Whatever their purposes, our trade partners retort, these policies have commercial consequences and must be considered when negotiating."(18) The very existence of the vast U.S. defense establishment (much bigger than Japan's) guarantees that much high-technology research would be subsidized by the DOD. Our slate is hardly clean in the area of government subsidies, especially when one considers how small MITI's and the Japan Development Bank's aid to Japan's semiconductor industry has really been.

In fact, whatever subsidies the Japanese government has provided in the past have had hardly the effect that the protectionists and the subsidy enthusiasts claim. It is certainly not clear that the subsidies actually helped Japan's economy; in fact, the evidence points to the contrary.

If the Japanese government chooses to give, say, \$100 million to the Japanese semiconductor industry, there is no doubt that the industry will be helped. By using that \$100 million to pay for what would otherwise be \$300 million of semiconductors, the industry can now profitably sell them for, say, \$250 million (while at the same time, even equally productive American competitors would have to charge \$350 million to make the same profit).

We may concede that American chipmakers will not like this state of affairs (just as they would not like it if the Japanese managed to sell chips for \$250 million without any government help). However, the buyers naturally have an entirely different opinion. The \$100 million Japanese government subsidy actually goes directly into the American chip buyers' pockets. Without the subsidy, the American buyers would have had to pay \$350 million. With the subsidy, they only have to pay \$250 million. The Japanese manufacturers still make the same \$50 million profit, with the Japanese

taxpayer footing the bill--and there are more American companies buying computer chips than making them.

On a macroeconomic level, the picture with subsidies is the same as with dumping. Americans acquired \$350 million of wealth for \$250 million cash; the Japanese acquired \$250 million cash but had to give up goods that cost them \$300 million to produce. It appears that the United States is the real beneficiary here, not Japan; in fact, if these are the real terms of our trade, then the answer to Secretary Baldrige's question--"who has the most to lose" from a cutoff of trade?--is emphatically the United States.

Government subsidies are not a good idea, either for the Japanese or the Americans. Though they do indeed help those being subsidized (which includes both Japanese producers and American consumers), they are economically foolish for the subsidizing government and are cruelly unfair to those trying to compete on their own.

However, in our quest for "fairness" we should neither overestimate the level of Japan's subsidies (which is relatively small) nor ignore the money that the U.S. government is pouring into the American semiconductor industry through lucrative defense contracts (many of which cannot even be bid on by foreigners). Neither should we ignore practical political considerations. What subsidies the Japanese government does provide are--like all subsidies--politically entrenched and thus very difficult to remove. Imagine for a moment that a foreign competitor demanded that the U.S. government stop subsidizing its farmers. The U.S. government, American consumers, and foreign competitors would all benefit from abolition of subsidies, but the chances of this are slim. In fact, if we impose our own subsidies to "counteract" Japanese subsidies, we will surely have as hard a time removing them as we would convincing the Japanese to remove theirs.

Japanese Import Restraints

One other thing that the Japanese have been accused of doing is shutting their markets to American exporters. To the extent that the Japanese do this--and they do--their protectionism is every bit as counterproductive as that which is now being proposed for the United States. However, the key questions are, first, whether there really are import restraints in the semiconductor industry, and, second, how large a role they play in the troubles of U.S. chipmakers.

The Semiconductor Industry Association's 1983 report discusses alleged Japanese import restraints as well as Japanese government subsidies. One of its recommendations, in fact, is that

the U.S. government should insist that U.S. semiconductor firms receive commercial opportunities in Japan that are fully equivalent to those enjoyed by Japanese firms . . . U.S. firms must receive real, not "cosmetic" market access, reflected in significantly greater participation by U.S. firms in the Japanese market. This will require an affirmative action program to normalize competition in Japan. The Japanese government should establish programs to see that this result is achieved. (Emphasis added)(19)

However, while the report produces evidence that U.S. semiconductor firms do not have a large market share in Japan, it offers no evidence that this is caused by Japanese government restrictions on imports. Consider the report's limp analysis:

[T]his low share [12 percent of the market], coupled with Japan's history of import restrictions, suggests that barriers to sales of foreign semiconductors remain.(20)

Neither the SIA report nor any subsequent publications have documented substantive import barriers, i.e. real, government-enforced barriers, rather than individual preferences (however irrational) on the part of Japanese consumers. Furthermore, the measures proposed by the report are futile almost to the point of being dangerous. The "affirmative action program" recommended by the report--and then echoed in the 1986 Semiconductor Trade Agreement, which "called for . . . U.S. chip makers to get more than their current 10 percent share in the Japanese market"(21)--is not something that is easily forced on a sovereign ally. How exactly do we force Japanese chip purchasers--not "Japan," but private citizens, free to buy what they please--to buy American chips simply in order to boost American companies' market share? This "affirmative action" is one of the most irrational economic policy proposals imaginable. It requires massive government interference in corporate purchasing decisions and guarantees sales to firms that have been unable to earn them; all in all, a very poor incentive system.

In fact, there are a lot of good reasons why in a market free from government import restraints American producers might fail to make headway. First, even discounting transportation costs, salesmanship does not travel well. Obviously, a Japanese salesman will do better at selling to Japanese just because he knows the market better (incidentally, the years of American trade superiority have undoubtedly taught the Japanese salesman to know even the American market better than Americans know the Japanese). Second, many Japanese companies consume more of their own chips than do most American "merchant suppliers." (22) Finally, there is, no doubt, some simple chauvinism at work. But considering the recent campaign in the United States to "Buy American"--a campaign supported by state and federal legislation, not just private bias--can we really be outraged? And, even if we are, what can the Japanese government do about it?

What is more--and perhaps the most injurious thing to American pride--there does not even seem to be a very good reason for the Japanese government to restrict American DRAM and EPROM imports. The U.S. government certainly does not restrict American chip sales, and still the Japanese seem to be able to outcompete American firms in the United States itself. This being the case, it seems pretty obvious why U.S. chip manufacturers have only a 10 percent market share in Japan and why it is quite unlikely that they will ever get anything higher, at least until they can compete better in their home market. In other words, in those areas where American chipmakers hurt most--and where calls for trade reform are loudest--opening up the Japanese market (if it is indeed closed) will help least.

To summarize the issue of Japanese import restrictions: (1) where they exist, they are undoubtedly bad, and should be abolished forthwith; (2) they do not seem to exist in the semiconductor industry; and (3) even if they did, they would not be very relevant as long as American chipmakers cannot even compete in their home market.

Semiconductors and National Security

The preceding discussion has been strictly concerned with economic issues, concentrating on the pocketbooks of chip consumers and chip producers more than anything else. National security, however, is a horse of a different color. Few would argue that for the sake of lower chip costs we should endanger American security. If American defense requires American-built chips, there is no doubt that American industry should be protected at all costs.

In February 1987, the DOD's Defense Science Board released its ominously titled "Report of the Defense Science Board Task Force on Defense Semiconductor Dependency." Its conclusions were "that a direct threat to the technological superiority deemed essential to U.S. defense systems exists" and that "U.S. defense will soon depend on foreign sources for state-of-the-art technology in semiconductors," considered by the board to be "an unacceptable situation" (emphasis in original). (23)

To avoid this "unacceptable situation," the Board recommended a vast DOD- and industry-funded research program, focusing on the establishment of a Semiconductor Manufacturing Technology Institute (costing the taxpayers a projected \$1 billion over 5 years) plus various other spending in universities, the DOD, and industry (amounting to an extra \$160 to \$350 million per year). (24)

Conspicuous by its absence from the report was any recommendation of import restrictions, whether tariffs or anti-dumping agreements. Although governmental support of Japanese industry, "allegedly explicit and implicit trade barriers," and dumping were all mentioned as possible causes of Japanese leadership, they were largely discounted. According to the report, "changes in these policies by themselves will not solve the problems that beset the U.S. semiconductor industry." (25)

The report's refusal to recommend import restrictions, however, is the only reasonable thing about it. In its main thrust--that Japanese leadership in the DRAM and ROM sectors of the semiconductor industry somehow threatens American national security--the report is an utter failure. In fact, none of the 100-odd pages of evidence that it presents actually support this position.

The key point that the report seeks to make is not that the U.S. defense industry uses semiconductors extensively-- in this day and age of high technology, that much is beyond doubt--but that domestic production is somehow inherently superior to foreign production in meeting the needs of the defense industry. In other words, if we can build our

missiles and fighter planes equally well with Japanese chips as with American chips--a plausible assumption, since the laws of physics and electronics work equally well for Japanese and Americans--then there is no reason why we should prefer more expensive American goods to cheaper, more efficient foreign goods. In fact, the report admits as much:

Finding 2.6. Acquisition of specific devices or materials for foreign sources for defense applications is not a critical problem as long as the U.S. has the knowledge and resources to substitute domestic sources in a timely fashion should the supply of foreign products and technology be interrupted. However, this substitution is possible only if it can in fact be accomplished within the time available and does not impoverish U.S. capabilities in other important areas.(26)

Readers will search in vain for any evidence that substitution of domestic production for interrupted foreign production cannot be reasonably accomplished; the report certainly produces no such evidence. In fact, not only are chips a manufactured good (unlike oil and strategic metals), which can be produced by anybody who has the knowledge, but there is also plenty of American industrial capacity (and expertise) that can be easily converted to producing DRAMs and ROMs.

Remember, the leadership that the Japanese have is mostly in production of mass-market general-purpose memory chips. For economic purposes, we may draw distinctions between the "merchant" production that the Japanese have a lead in and the "captive" production by domestic companies such as AT&T and IBM for internal use; however, the fundamentals of chip production and design are the same in both cases. In time of war, AT&T and IBM can certainly be convinced to sell their chips to others; it is just that in time of peace, they choose not to for economic reasons.

Not finding any direct evidence that interruption of foreign supplies will not be easily remediable when it occurs, the report had to grasp for more tenuous straws such as "technological leadership." The issue of leadership centers on the premise that if we "lose" DRAM and ROM manufacturing to the Japanese, we will lose not only that particular segment, but also many (if not all) other portions of the electronics industry. Figure 1, taken from the Defense Science Board's Report, makes this point and relates it to national security.

Figure 1 Summary of the Basic Findings of the Defense Science Board Task Force

U.S. military forces depend heavily on technological superiority to win.

Electronics is the technology that can be leveraged most highly.

Semiconductors are the key to leadership in electronics.

Competitive high-volume production is the key to leadership in semiconductors.

High-volume production is supported by the commercial market.

Leadership in commercial volume production is being lost.

Semiconductor technology leadership will soon reside abroad.

This argument, like all good fallacious arguments, is 90 percent correct. It is true that U.S. military forces depend on technological superiority; it is true that competitive high-volume production is the key to leadership in merchant DRAM and ROM production; it is true that merchant DRAM and ROM production leadership is already residing abroad. What are questionable are two key points: (1) that merchant DRAM and ROM leadership is equivalent to semiconductor technology leadership, and (2) that "semiconductors are the key to leadership in electronics."

On the surface this seems like a pretty good record (only two errors out of seven assertions and six implications). Unfortunately, these are fatal errors, and betray either a misunderstanding of (or a desire to mislead about) the way computers and the computer industry work.

A computer system consists of two distinct parts: the software, the programs that tell the machine what to do; and the hardware, the pieces of electronic equipment that actually execute the instructions provided by the software. It is easy to overemphasize the importance of hardware, because it is "real"--it can be seen, touched, weighed, and measured--whereas software is merely a set of electronic encodings, bits that are turned on or off. However, software costs have risen from 20 percent of the total cost of a computer system in the mid-1960s to 80 percent of the total system cost by the mid-1980s. When a cruise missile looks down on a piece of terrain and decides whether or not it should drop a bomb on it, only a small fraction of the work is done by the hardware (the cameras, the chips, the detonation devices, etc). The majority of the image recognition and analysis is done by the software.

Hardware itself can be divided into two components: semi- conductors and everything else. "Everything else" includes disks, disk drives, tape drives, terminals, and printers. While semiconductors can legitimately be called the "smarts" of hardware, they are by no means the only component. A personal computer certainly would not do much if it were made of semiconductors alone.

Finally, semiconductors themselves fall into two categories: memory chips and logic chips. Memory chips, such as the DRAMs and ROMs, are the subject of today's protectionism debates. They allow the computer to store and access data. Of all the functions of the computer, they implement two: "remember a piece of information" and "recall a piece of information." Logic chips implement all the other functions of the computer. The Motorola 68000, the 8080, 6502, Z80, etc. (just to name a few of the more widely known ones) are all logic chips and can truly be considered the smarts of the computer, or at least of the hardware side.

The key factor in logic chips is not cost but design; both the speed of operation and the ease of programming of the computer are largely determined by the quality of the logic chip design. To its credit, the Defense Science Board's report admits that the United States still has a lead in "design-intensive custom logic and microprocessors,"(27) though it claims that the U.S. lead is being reduced by Japanese advances. No evidence for this decline is presented beyond Table 1 of the report, which merely states that the United States has a lead that is perceived to be declining.(28) Furthermore, the major recommendations of the report emphasize subsidies of memory chip manufacturing, not logic chip design.

There is no doubt that all of the above-mentioned components--software, non-semiconductor hardware, logic chips, and memory chips--are necessary for any computer system; no computer system will run without all four ingredients. However, the "leadership" argument states that memory chips are not just necessary but are vital to continuing superiority in all (or most) of the other fields.

This is simply wrong. The place of memory chips in the computer industry is well defined--they store and retrieve data. The Japanese may make them cheaper; the trend in today's technology is to make them more compact; with luck, they can even be made faster (a substantial consideration for today's computers). They will not, however, be made smarter; it takes logic chip advances and, especially, software advances, to add new smarts to computer systems. When the Defense Science Board's report says that "electronics is the technology that can be leveraged most highly,"(29) the technological advances that provide the leverage will come mostly from logic chips and software.

Memory chip production has become a manufacturing issue, not a design issue. As one observer points out, "A company's competitive position in the production of memory chips depends primarily on its manufacturing capabilities, whereas its competitive position in logic chips depends more on its design and engineering skills."(30) Perhaps in automobile and steel production--mature industries where the basic design has been long settled--manufacturing capability is indeed the key to leadership. In the computer industry, however, it is design advances in fields such as artificial intelligence, software engineering (to maximize software quality and minimize maintenance costs), and execution speed (partially a memory speed issue but mostly a logic chip and especially software issue) that are important.

What we have here is a crude sort of "Not Invented Here" syndrome, an attitude that "we can only make a good computer if we make every single one of its components." The Defense Science Board's chapter on "Effects on Downstream Industries" (where "downstream industries are those which use the products of the semiconductor industry," presumably including computer makers and defense contractors) puts it bluntly:

A strong domestic semiconductor industry is a prerequisite to a strong position in these downstream industries since the ability to perform competitive services and sell competitive products depends upon access to the most advanced semiconductor devices.(31)

As any good entrepreneur will tell you, any company that tries to do everything itself will lose to one that buys its expertise from those most competent to provide it. IBM bought the operating system for its wildly successful IBM PC from Microsoft, Inc.; Apple bought the logic chips for its MacIntosh from Motorola. Neither sacrificed "technological leadership"; in fact, they enhanced their leadership by focusing on those areas that they are best at. Economists know this as Ricardo's "comparative advantage"; businessmen know it as just plain good business.

Other findings of the report are as suspect as the "interrupted foreign supply" issue and the "technology leadership" issue. A very interesting one is Finding 2.7:

Even more critical is the possible movement of electronic device and system capabilities to overseas locations from which the Soviet Union can readily access the technology. In that case, the U.S. could lose the considerable margin of advantage it holds over the U.S.S.R. in this critical area of technology--and upon which it relies to offset quantitative military disadvantages.(32)

In other words, it is not enough that the United States produce all of its own semiconductors--Japan must not be allowed to produce any. Production and design capabilities do not "move"; they replicate. Even if the United States regains a competitive advantage over Japan, Japan will still have its own, constantly improving, semiconductor industry, every bit as accessible (or inaccessible) to the Soviet Union as it is now. The only possible solution to the concern of Finding 2.7 is a preemptive strike against all foreign producers of semiconductors. Only by making sure that nobody except the United States can make semiconductors can we prevent the Soviets from stealing the technology.

Where the findings of the report vary from the implausible and unproven (that interruption of foreign semiconductor supplies will damage the United States in case of war or mobilization) to the implausible and vague (that some sort of "leadership" is being lost in the entire computer industry because of uncompetitiveness in memory chips) to the irremediable and downright silly (that any foreign production is a risk to the United States because the Soviets might steal it), the report's recommendations are almost innocuous:

1. "Support the establishment of a Semiconductor Manufacturing Technology Institute which would develop, demonstrate, and advance the technology base."(33) Projected cost: \$250 million from industry, plus \$200 million per year over five years from the DOD. "The principal and most crucial recommendation of the Task Force is that an Institute be established by a consortium of U.S. firms . . . to jointly advance the state-of-the-art in generic semiconductor manufacturing technology. An appropriate objective would be the development of the manufacturing technology needed for the 64 megabit DRAM." [Emphasis in original.](34)
2. "Establish at Eight Universities Centers of Excellence for Semiconductor Science and Engineering."(35) Projected cost: \$50 million per year from the DOD.
3. "Increase DOD spending for research and development in semiconductor materials, devices, and manufacturing infrastructure."(36) Projected cost: \$60 million in the first year, rising to \$250 million in the fourth and final year (paid by the DOD).
4. "Provide a source of discretionary funds to the DOD's semiconductor suppliers to underpin a healthy industrial research and development program."(37) Projected cost: \$50 million per year (paid by the DOD).
5. "Establish under the DOD a Government/ Industry/University forum for semiconductors."(38) Projected cost: \$200,000 per year (paid by the DOD).

After all the problems elucidated by the report, the recommendations seem almost a relief: only \$2 billion of taxpayer money over five years--small change to the DOD, smaller yet to the federal government.

Ignore for a moment that the ostensible reason for this funding--the bugaboo of "dependency on foreign supplies"--

appears to be fictional. It is admitted that one of the reasons that Japan is doing better than the United States in memory chip manufacture is more R&D expenditure (according to the report, 13 percent sales vs. 10 percent in 1970-85).(39) So, the report suggests, pump in some R&D money. Even if the subsidy is not vital for national security, it might help a slumping industry, and besides, it won't really hurt anything.

But \$2 billion invested in such research is \$2 billion not invested in something else--perhaps something more profitable for investors and for the nation. As one analysis states the problem, "The government directly funds some 775 research laboratories across the country, employing some 80,000 people (about one-sixth of the nation's scientists and engineers) and gobbling up about half of the annual \$123 billion that goes to pure and applied research nationwide. . . . But the work they do . . . does almost nothing for the country's broader economic competitiveness. Since the 1950s, only 5% of the government's 28,000 patented inventions have been licensed for commercial use."(40)

There are several good reasons for this condition. For one, government-funded bodies, lacking a profit incentive, are plagued with vast economic inefficiencies (witness the Pentagon's penchant for \$600 toilet seats) and thus provide far less bang for the investment buck. The government, by monopolizing half the national research budget and one-sixth of the nation's scientists, is consigning both of these valuable resources to a much less economically productive life than they would otherwise lead.

Second, the investment decisions themselves, being made for fundamentally noneconomic reasons, often ignore economic realities and subsidize the impractical or unprofitable. The Defense Science Board's report says that "The principal policy difference [between Japanese and American subsidies] is . . . that Japan has elected to focus its subsidies on emerging, leading edge industries, whereas the U.S. has to a considerable degree elected to subsidize sunset industries."(41) This praise of MITI's business acumen is largely unwarranted. As Katsuro Sakoh writes, "It seems clear that most of the funds disbursed by [Japanese] policy-implementation financing institutions are allocated by political or social considerations, rather than for consciously planned targeting of specific manufacturing industries."(42) In Japan, agriculture, coal mining, and shipbuilding have received vast government aid; automobiles and consumer electronics have gotten virtually none. Agriculture is now a massive budget drain, domestic coal production has decreased from 54 million metric tons in 1962 to 19 million metric tons in 1978, and shipbuilding is operating at 35 percent of capacity; automobiles and consumer electronics are, of course, Japan's great success stories.(43) Even in Japan, the government-invested dollar (which goes where privately invested dollars fear to tread) provides an inadequate rate of return.

Finally, note that nobody is better than the government at throwing good money after bad. What will happen when the \$2 billion runs out five years from now? Will American semiconductor companies be willing to dig into their own pockets to continue this high level of R&D investment? Or will they run to the DOD asking for another two or three billion dollars?

All in all, it seems that the \$2 billion that the DOD proposes to invest would be much better kept in the hands of the private sector, which is known for making generally sounder economic decisions than the government. By taking \$2 billion out of the private sector's hands, the DOD may actually hurt American technological leadership by depriving other industries of funds that would have otherwise been invested in them. Five years from now, those industries will in turn be hurting, and the Defense Science Board will perhaps recommend governmental subsidies for them too because for some mysterious reason these industries were not sufficiently funded in the past.

Americans can sleep securely tonight, knowing that our alleged "dependency" on Japanese semiconductors is unlikely to lose us World War III. Semiconductor manufacturers, however, cannot sleep securely, because they are in a bad spot profit-wise. Their predicament is quite likely caused by the low levels of R&D expenditure by American industry, and should perhaps be remedied by higher levels of R&D expenditure by American industry. Why the DOD should get involved in this is not clear; what is clear is that DOD involvement will not help the American economy as a whole.

The Economic Costs of Protection

An important question alluded to in the discussion above was this: even if we decide that something ought to be done about various Japanese trade practices (fair or unfair), what alternatives do we have? Can we make sure that our actions do not cause more harm than good?

One of the points that the above arguments tried to establish is that dumping and Japanese government subsidies actually have highly desirable effects for American chip consumers and, perhaps, for American as a whole. On the other hand, there is no doubt that the effects on American producers are quite damaging and can lead to a variety of costs. One could readily claim that, although cheap chips are good for the United States, their advantages are more than offset by the dislocation and suffering caused by declines in native chipmaking industry. Certainly protection of American workers should also be given some weight.

Alas, protecting the American worker is easier said than done. According to a report on trade protection in the United States published by the Institute for International Economics (IIE), the costs of saving American jobs by protectionism are literally staggering. Some 640,000 jobs were preserved in the U.S. textile industry by protectionist action in the years 1957-86.(44) Each job saved was estimated to cost the U.S. consumer from \$22,000 to \$42,000.(45) The recent spate of protection of the auto industry saved an estimated 55,000 jobs between 1981 and 1985, at a cost of \$105,000 per job (46); in carbon steel production, protectionism saved about 7,000 to 9,000 jobs between 1969 and 1986, at a cost of \$240,000 to \$750,000 per job saved.(47) In fact, the lowest cost per job saved among the 31 cases studied by the IIE was in the fisheries industry, where 27,000 jobs were saved at a cost of \$21,000 each.

These numbers may at first seem so high as to be implausible, but upon reflection they are actually quite logical. Restrictions on cheap imports coupled with the removal of competitive pressures on domestic producers will certainly raise prices dramatically. In fact, price increases are exactly what any producer wants, even if he pretends that he just wants to save workers' jobs. The only thing that is surprising is just how much of a price increase is seen for so little job savings.

Self-defeating side effects are also not uncommon. According to the IIE study:

An important factor in the difficulties of the textile industry during the 1950s was the protection benefiting United States cotton growers. This permitted foreign cotton textile manufacturers to obtain their raw material at much lower prices than their United States competitors.(48)

Is it so unlikely that, if American computermakers are not allowed to buy cheap foreign chips, they will soon be seeking protection because foreign computermakers can successfully undercut them?

The 1986 U.S.-Japanese Semiconductor Trade Agreement

The 1986 Semiconductor Trade Agreement between Japan and the United States was actually implemented with price increases very much in mind. A worldwide minimum price for Japanese chips was established, allegedly to counteract Japanese "dumping" effects. According to the Wall Street Journal, "Assigned prices for 256-kilobit D-rams, for example, ranged from about \$3 to \$7.50, compared with a \$2.25 average price before the agreement."(49) 256-kilobit EPROMs that sold for \$2.53 in Japan cost \$3.95 in the United States. Before the agreement took effect, it was estimated that it would cost American consumers an estimated \$568 million a year.(50)

By early 1987, it was fairly clear that the Japanese were not meeting the terms of the agreement. The agreement called for:

1. The Japanese government to prevent Japanese firms from selling chips either to U.S. companies or to anybody else (besides the Japanese themselves) at less than "fair market value"; and,
2. The Japanese government to promote U.S. chip sales to Japan and ensure that U.S. firms' share of the market rose significantly above the 10 percent level; if needed, the Japanese government would force Japanese companies to curtail their own production.

In April 1987, with neither goal being met, the United States slapped a 100 percent punitive tariff on \$300 million of Japanese consumer imports such as televisions, computers, and power tools.(51)

Now, it is never a good thing when trade agreements--or any other kind of international agreement--are violated, even

when they were bad agreements to start with. Unfortunately, reality makes fools of us all, and this agreement was made seemingly in ignorance of certain economic and political realities. As Fortune magazine put it, "the agreement has produced every perverse effect a free-trader could imagine."(52)

Like any trade restriction, the semiconductor accord begat a flourishing "gray market." "Chip brokers" smuggled chips out of Japan to other Asian countries, plugged them into dummy circuit boards (chips wired into circuit boards are not covered by the agreement), and sold them to U.S. companies at 20 to 40 percent below the prices set by the agreement. "Suitcase brigades" would fly with suitcases full of chips to the United States, Hong Kong, South Korea, Taiwan, or Singapore, relying on the easy portability of the chips (tens of thousands, worth hundreds of thousands of dollars, could fit into a bag) and lax customs checking (customs agents being loath to check every business traveler's suitcase). "'We aren't doing it deliberately', contends Tomihiro Matsumura, a senior vice president of NEC who heads the corporation's semiconductor group. It happens anyway, he says, because assigned prices in the U.S. 'go against the fundamental principles of business.' 'No matter what you do,' he explains, 'what is cheap is going to flow to where it's expensive.'"(53)

The gray market, which would have arisen anyway because of the American shortage of cheap chips, was exacerbated by the corresponding Japanese glut. As U.S. demand for the now-overpriced Japanese chips fell drastically, the Japanese began to face a vast oversupply. "'Prices just cratered', says Wilfred Corrigan, the president of LSI Logic Corp., a Milpitas, California concern that makes chips in the United States and Japan. 'They had to do something with all those chips they could not sell over here.'"(54)

Needless to say, with the glut caused by the first goal (stopping "dumping"), the second goal (increasing American market share in Japan) became virtually impossible to meet. If Americans had a hard time competing with preaccord prices in Japan, they would have a much harder time competing with the lower postaccord prices. On the other hand, Japan's legitimate export business was further hurt by the extended waiting period that MITI imposed for export licenses in order to stop the gray marketeers.

Squeezed by these restrictions, Japanese companies pushed even harder in markets not covered by agreements, and also moved to buy American companies. This did not sit well with American protectionists, either; for instance, Fujitsu's planned acquisition of Fairchild Semiconductor Corp. was vetoed by the Reagan Administration in March of 1987 for fear of "giving away precious technology" to foreigners.(55)

In light of all this, it is not surprising that the Japanese--who only reluctantly accepted the agreement in the first place--should be equally reluctant to fully enforce it. Naturally, while Americans see the Japanese as the trade villains, the Japanese do not agree. Japan is beginning to have unemployment woes of its own, with some experts predicting 6 percent unemployment rates in a country used to rates of less than 3 percent.(56) Now their export industries--financed to a large extent by high Japanese saving rates, representing the sacrifices of the Japanese consumer--are, in Japanese minds, being made to pay for their own efficiency.

The complaints that the United States makes about Japan can easily be reversed in the minds of the Japanese. The Americans say that the Japanese spend "too little" and save "too much"--but some of former prime minister Nakasone's Japanese critics argue that it is rather the Americans who save too little and spend too much.(57) Americans complain about Japanese willingness to take short-term losses in order to obtain higher market share (which is exactly what the allegations of "dumping" mean), but the Japanese can easily put the blame on the American companies so obsessed with the bottom line that they avoid necessary short-term sacrifices.

Perhaps the worst aspect of the 1986 agreement is that it essentially requires the Japanese government to exercise dictatorial powers over its own citizens, a people as enamored of liberty as Americans are. As one observer has explained the demands placed on the Japanese government by the agreement,

To increase the U.S. share of the Japanese memory chip market, the Japanese must somehow compel private Japanese companies to purchase American products. . . . If it is to prevent dumping in either the United States or other markets by Japanese companies, the Japanese government must closely monitor exports by its computer firms and enforce strict price controls.(58)

Note that if the agreement called merely for elimination of overt import tariffs, the Japanese government could do that by a simple unilateral action; if the agreement attempted to prevent dumping to the United States alone, the American government could simply intervene at the border. Instead, the agreement calls for far broader restrictions, which require the Japanese government to take steps to coerce Japanese companies to do what the Americans want. Recall the vast opposition that America's own "affirmative action" policies and price controls have met with; imagine what the Japanese must feel when a foreign government tries to require such intrusive controls of citizens' daily business lives.

The U.S. government essentially strong-armed the Japanese into setting up a cartel, a cartel which was against the interest of American consumers, which was not practically enforceable by the Japanese government, and which, curiously enough, would have been criminal under U.S. antitrust law if two American producers had tried it. It is a well-known economic fact that people always break cartel agreements (witness OPEC) because cheating is so tempting, being to the benefit of both the cheating producer and the consumer. It should hardly be surprising, then, that such a misguided trade agreement would inevitably fail; the laws of economics and politics are not easily overturned with a stroke of a pen. Rather than using the agreement's failure as an excuse to exacerbate trade tensions, perhaps we should instead learn from it the mischief that protectionism can cause.

Conclusions

Several conclusions may be drawn from the evidence assessed here:

1. Japanese "dumping"--a reasonable and proper business practice labeled "unfair" by rather specious reasoning--is actually a boon to American consumers of chips. American chip consumers, like all consumers, love cheap products and use them to become more competitive themselves. American chip producers object to "dumping" for an obvious reason: nobody likes competition, especially efficient competition.
2. Japanese government subsidies, while hardly something to be approved of, have in effect been subsidies to American consumers just as much as to Japanese producers. Subsidies always distort the international trade picture, but these subsidies have not been remarkably large (nor is the American slate clean here, considering the volume of U.S. high- tech subsidized by the Defense Department).
3. Import restrictions against the American chips in question are largely mythical, hypothesized solely on America's low share of the Japanese market (a rather arrogant argument, implying that the Japanese can outcompete Americans only if they have import restrictions working in their favor). Import restrictions in other areas are present and should be removed; however, this is only likely to help those American industries that have proven able to compete well at home.
4. Japanese superiority in DRAM and EPROM production hardly threatens U.S. national security, either directly (by threat of cut-off of strategically vital supplies) or indirectly (as a loss of some sort of "industrial leadership"). In fact, the best way to preserve American leadership in high technology as a whole is to ensure maximum supplies of the best and cheapest goods available, regardless of where they come from.
5. Even if we wanted to protect our market against the Japanese, it would cost us truly vast amounts of money. Historically, trade restraints in various industries have cost tens of thousands of dollars per job saved; these costs, incidentally, may be a measure of just how much benefit American consumers derive from the absence of these restraints.
6. It is hardly a surprise that the Japanese violated the Semiconductor Trade Agreement. Part of the agreement established a goal--increased American market presence--that was made virtually impossible to achieve by the other part, which drove down Japanese domestic chip prices. Both aspects (anti-"dumping" and increased American market presence) called for the Japanese government to impose controls on private Japanese citizens that few Americans would tolerate from their own government.
7. Finally, before we panic about our "loss of technological leadership," we must not automatically assume that what is good for the chipmakers is good for the United States. By modern standards, DRAMs and EPROMs are remarkably low-tech; in fact, it is their consumers--who would be most hurt by increased protectionism-- that are on the true

forefront of technological development.

As usual, good solutions are hard to come by. In the years after World War II, when all our would-be competitors were lying in ruins, the United States enjoyed an unprecedented period of superiority in a vast number of industries. Much as we would like to retain this superiority, it is easier said than done. Protecting American industries hurts America as well as foreign competitors; better solutions need to be found. Perhaps they lie in lower interest rates or higher savings rates; perhaps we have something to learn from the Japanese zaibatsus, which (in a manner quite offensive to American antitrust laws) unite many diverse companies in diverse industries into a stronger, more competitive whole.

What seems clear is that a new round of protectionism and trade warfare will help no one, neither our competitors nor ourselves. (1)

FOOTNOTES

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(8) *Business Week*, May 23, 1986, p. 90.

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- (24) *Ibid.*, pp. 11-12.
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- (32) *Ibid.*, p. 3.
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- (35) *Ibid.*, p. 12.
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- (37) *Ibid.*
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