COMPETITIVE FACTORS INFLUENCING WORLD TRADE IN INTEGRATED CIRCUITS

Report to the Subcommittee on International Trade of the Committee on Finance and the Subcommittee on International Finance of the Committee on Banking, Housing, and Urban Affairs of the United States Senate on Investigation No. 332-102 Under Section 332 of the Tariff Act of 1930, as Amended

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This report was prepared principally by

Nelson J. Hogge and Ross H. Reynolds, Jr. of the
Machinery and Equipment Division and
Cecilia L. Klein of the Office of Economic Research

H. M. Graves, Project Leader

Office of Industries
Norris A. Lynch, Director

Address all communications to
Office of the Secretary
United States International Trade Commission
Washington, D.C. 20436

NEWS
(202) 523-0161
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CONTACT: Nelson J. Hogge
(202) 523-0378

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USITC RELEASES REPORT ON COMPETITIVE FACTORS INFLUENCING WORLD TRADE IN INTEGRATED CIRCUITS

The U.S. International Trade Commission today released its public report on competitive factors influencing world trade in integrated circuits.

The study was requested by the Subcommittee on International Trade of the Committee on Finance and the Subcommittee on International Finance of the Committee on Banking, Housing, and Urban Affairs, United States Senate. It was forwarded, with confidential information included, to the Senate Committees on October 31, 1979.

The report focuses on factors affecting the present and future international competitive position of U.S. producers of integrated circuits. It contains certain production and trade data on integrated circuits for 1974-78. An analysis of foreign government involvement in the integrated circuit industry is provided, and a comparison is drawn between foreign government involvement and U.S. Government policies.

Copies of the Commission's report, Competitive Factors Influencing World Trade in Integrated Circuits (USITC Publication 1013), can be obtained by calling (202) 523-5178 or from the Office of the Secretary, 701 E Street NW., Washington, D.C. 20436.

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

Note.--The whole of the Commission's report to the Subcommittee on International Trade of the Committee on Finance and the Subcommittee on International Finance of the Committee on Banking, Housing and Urban Affairs may not be made public since it contains certain information that would result in the disclosure of the operations of individual concerns. This report is the same as the report to the Subcommittees except that the above mentioned information has been omitted. Such omissions are indicated by asterisks.

Summary

On October 25, 1978, the Subcommittee on International Trade, Senate Committee on Finance, and the Subcommittee on International Finance, Senate Committee on Banking, Housing, and Urban Affairs, requested the United States International Trade Commission to conduct a study pursuant to section 332 of the Tariff Act of 1930 on trends in international trade in integrated circuits (Senate request appended to report). On December 7, 1978, the Commission instituted an investigation focusing on (1) factors affecting the present and future international competitive position of United States producers, (2) an analysis of foreign government involvement in the industry in the form of incentives to foreign producers and disincentives to U.S. entry into foreign markets, and (3) a comparison of such involvement with U.S. Government policies affecting the integrated circuits industry.

The data and information gathered by the Commission through questionnaires and a public hearing provide insights into issues affecting trade in integrated circuits which may be of interest to both public and private groups.

Summary of international competitive position of the U.S. industry

Integrated circuits (IC's) are basic or "building block" electronic components of digital computers, calculators, industrial process-control equipment and a myriad of other products.

The integrated circuits industry is a relatively new, high-technology industry which has been developed essentially within the last twenty years. The industry has rapidly growing and changing markets and rapid technological developments. With world consumption of integrated circuits exceeding $5.5 billion in 1978 and growing at a rate of about 18 percent per year, the industry is highly competitive, and at present there are three major producing areas--The United States, Western Europe, and Japan. The industry is characterized by firms which are multinational in their operations. Such firms, whether based in the United States, Japan, or the European Community, have foreign producing facilities which are utilized to convert parts shipped from home-based facilities into completed integrated circuits.

The U.S. integrated circuits industry is currently the world's leader in integrated circuits technology and production. The industry is operating at capacity and is increasingly moving to higher density chips, an area of advanced technology which is expected to be the cornerstone of world demand in the foreseeable future. At a time when industry profits are relatively low, the need for new technology is requiring greater capital expenditures for research and development.

The U.S. integrated circuits industry for the foreseeable future is expected to continue (1) to grow in absolute terms, (2) to remain the principal world producer and leader in technological development, and (3) to maintain profitability. It is likely that U.S. producers will continue to allocate a sizeable share of their investment to other countries, such as Europe, in order to expand as rapidly as possible and to help maintain

relative market share. The U.S. competitive advantage is expected to continue to be derived principally from continuous development of and production of new and advanced products. In 1978, U.S. industry's world market share was * * * times larger in value than the Japanese industry's share, and * * * times larger in value than the West European industry's market share. World market share accounted for by the Japanese industry increased steadily from * * * percent in 1974 to * * * percent in 1978. Much of the increase in Japanese market share was gained at the expense of U.S. producers, whose share of the market declined from * * * percent to * * * percent during the period. European producers' share declined from * * * to * * * percent during the period. Thus, the U.S. industry is growing less rapidly than its principal competitor, Japan, and is expected to continue to lose world market share. (Immediately following this summary, see table highlighting shipments, market share, investment, and employment data for the United States and Japan.)

The projected drop in U.S. producers' market share can be attributed to a number of factors. First, the U.S. industry is losing market share due to limited production capabilities which are a result of underinvestment after the 1974-75 recession. Some firms do not appear to be able to fund capital investments at a rate required to keep pace with additional new world demand and technology needs, and will lose new markets to competitors able to expand at faster rates and meet new product demand. As capital requirements of the industry intensify, it is likely that the domestic industry will experience a modest restructuring with the exit of some marginal small-and middle-size firms. In addition, because of the increased capital requirements, the number of business entries will not be as great as in the past. The investment situation results in part from the relative levels of a number of factors in the business environments of the competing countries such as inflation and interest rates, savings levels, and government tax and trade policies. As an example, Japan's low interest rates, government funded research and development programs, and nontariff barriers, appear to enable the Japanese integrated circuits industry to invest and grow at a greater rate than the U.S. industry.

The U.S. industry is also losing world market share as Japan and the European countries, through technology transfer and research, expand their production bases and become more efficient as a result of production experience and economies of scale. Based on investigation findings, the Japanese industry appears to be able to produce a given level of output for a lower input of capital and labor than the U.S. industry. In 1978, the Japanese industry invested about * * * cents to produce one dollar in shipments and exports, compared with the U.S. industry's investment of about * * * cents. In the same year, the Japanese industry spent * * * cents on research for each dollar of shipments and exports, and the U.S. industry spent * * * cents. Foreign investment in the United States is likely to continue as foreign interests seek to supplement their own technology and improve their position in the large U.S. market for integrated circuits.

Trade patterns established by the United States worldwide integrated circuits industry are not expected to change dramatically in the foreseeable future. United States exports to unrelated parties are expected to remain the largest growing segment of the export market. On the other hand, the United States industry will continue to supply the major portion of worldwide demand for its integrated circuits through exports from foreign manufacturing facilities. These will be mostly exports to related parties which will process the integrated circuits further and/or incorporate them into end products.

The long-term health of the U.S. integrated circuit industry depends on continued strong research and development efforts, a strong economy, an accelerated rate of investment, and wide acceptance of and adherence to the concepts of free trade adopted at the Tokyo Round of trade negotiations under the GATT.

Factors influencing the U.S. integrated circuits industry's market share

The declining share of the world market held by U.S. producers of integrated circuits is a cause of major concern to the U.S. industry. Three major factors influencing the U.S. industry's competitive position have been examined during this investigation: (1) U.S. industry's ability to meet investment requirements, (2) foreign industries' competitive strategies, and (3) domestic and foreign government involvement in the market (discussed separately as last section of this summary). While all these factors play a role in determining the U.S. industry's market position, the industry considers investment the most important. The industry points out that it is its ability to meet investment requirements that will determine whether the U.S. industry can maintain its technological lead through advanced research and can expand production facilities to meet growing world demand.

U.S. industry's ability to meet investment requirements.--Investment is a critical dimension of the present and future market position of the U.S. industry. Sources of funds to finance future growth are limited to profits, equity, debt, depreciation, and government incentives. The U.S. industry in looking to the future and the vast markets expected to develop for integrated circuits is concerned that it may lack the ability to increase capacity sufficiently. The industry contends that, in the present investment climate in the United States, internal sources of funds and external capital markets cannot support the expansion necessary to maintain its market share in the increasing world market for integrated circuits.

To counter the fact that U.S. industry's ability to meet investment requirements is limited, as cited above, the U.S. industry has proposed revisions in existing regulations regarding taxes and conditions of trade. The industry believes that capital gains taxes should be postponed on the sale of securities, that the "useful-life" provision of the investment tax credit statute should be shortened or removed, and that various other tax proposals designed to increase the availability of research and development funds should be adopted.

Foreign industry strategies.--The U.S. industry feels that its major foreign industrial competitors are attacking the preeminent market position of the U.S. industry by: (1) increasing their purchase of U.S. technology; (2) acquiring controlling interest in U.S. firms, thereby gaining access to U.S. know-how and technology; and (3) increasing market share in the United States and other markets by using false claims of quality superiority and by pricing their products in the U.S. market below those in home markets.

U.S. industry representatives allege that competitors in Europe and Japan are attempting to close the technology gap through an increase in licensing arrangements with U.S.-based companies for the most sophisticated commercial technologies, and acquisition of controlling interests in U.S. firms and their technologies. A number of U.S. business observers indicate that the sale of U.S. technology to overseas buyers is increasing because of increasing foreign demand, barriers to U.S. exports, and profitable overseas direct investment. Information gathered from responses to the Commission's questionnaire and other sources regarding the closing of the technology gap is inconclusive.

U.S. industry representatives, in testimony before the Commission, indicated that they feel the devaluation of the U.S. dollar, depressed stock prices, and the advantages associated with close access to the U.S. market have encouraged foreign integrated circuits producers to invest in U.S. semiconductor firms. Thus, they contend, it was cheaper to buy technology and U.S. market share through the purchases of existing companies, than use in-house development or adaptation of the latest technologies.

A large increase in the value of foreign investment in the U.S. industry has taken place during the last decade. Foreign investment in the industry has been directed at firms which provide accessibility to U.S. high technology and easy entry to the large U.S. market. Foreign investment (both European and Japanese) in the United States is valued at $515 million and has principally come about through the purchase of U.S. producers' equity. Western Europe has been the principal source of foreign investment in the United States. Investment by Japan represents only about 3.1 percent of investment from foreign sources.

Quality of integrated circuits is an important factor in purchasing decisions for major end-users, and the Commission received testimony both from U.S. and foreign firms concerning differences in product quality and test procedures. Representatives of the U.S. integrated circuits industry testifying before the Commission were emphatic in their denials that U.S. circuits differed in quality or reliability from those of Japanese manufacture. They maintained that the manufacturing processes were essentially similar and that independent laboratory tests had shown no difference in reliability in use between the two. They also indicated that the "double" testing techniques of the Japanese were expensive and that they considered this "better deal" given to buyers of Japanese circuits a type of market penetration technique.

A spokesman for the Japanese industry in testimony before the Commission rejected the U.S. industry's explanation of the "quality" issue. He characterized the Japanese approach to quality as a preventive approach where in the initial designing process the configurations are designed so as to reduce the probability of any defects. This approach, he maintained, is different from increasing the quality control and detection capabilities after the device is produced, a process that does increase costs.

A significant and growing portion of the world market for integrated circuits is in large scale integration (LSI) memory circuits used in computers. The most advanced example of LSI circuitry commercially available at the present time is the 16K random access memory (RAM). U.S. industry representatives stated before the Commission that this portion of the U.S. market has been targeted by the Japanese industry for penetration. According to the U.S. industry, the 16K RAM market was chosen because a large share of the U.S. market in this device would provide the Japanese with valuable production experience that, in time, would lower their costs and help them compete more effectively in markets for even more densely constructed devices. Specifically, U.S. industry has indicated that while Japanese commercial development of the 16K RAM initially lagged behind U.S. development, low-pricing practices have allowed Japanese producers in a period of only 3 years to accumulate a U.S. market share of approximately 35 percent in this key product. The U.S. industry accusations regarding Japanese marketing and pricing practices for 16K RAM's, and the contention that Japan currently supplies more than one-third of U.S. consumption of these devices, are not verifiable from the data currently available to the Commission.

<u>Outlook for the Japanese and Western European integrated circuits industries</u>

<u>Japan</u>.--The integrated circuits industry in Japan is expected to grow in terms of output as well as technology. The industry is the focus of public and private attention aimed at developing a sophisticated and technologically advanced product able to penetrate growing end-user markets. Economic factors, such as a low inflation rate, low short-term interest rates, and the cooperation among key scientists in various Japanese companies should ensure continued progress in the competitive position of the Japanese integrated circuits industry in world markets.

For the foreseeable future, Japan is expected to supply the major part of its export markets through exports from the home islands. The majority of these shipments are likely to go to foreign related parties for further processing or integration into finished products. However, as the Japanese expand their off-shore processing facilities in size and number, it is likely that there will be an increase in exports to world markets from off-shore Japanese facilities. However, because of lead-time requirements to design and implement new facilities, no significant change in trade patterns is expected in the near future.

The Japanese integrated circuits industry can be expected to focus its research and development activities on the leading edge of integrated circuits development. For this reason, levels of investment should remain strong and continued growth of new facilities is expected. Based on current data, there is little reason to believe that the advantage enjoyed by the Japanese compared to the United States in labor productivity and output per unit of investment will change. This relationship should be watched closely since any radical change could indicate a potential shift in Japan's competitive position vis-a-vis the United States.

Western Europe.--Behind the tariff structure currently in effect, the integrated circuits industry in Western Europe is expected to grow significantly. However, Western Europe's position in international trade is not expected to change dramatically since it is expected that domestic suppliers will concentrate on fulfilling European demand. Industrial growth is expected to be aided further by the various incentives offered to domestic producers.

Within the European market, the United States position should remain strong. U.S. capital investment and technological advantage within the Western European markets should provide sufficient market position to ensure the viability of United States versus European manufacturers in Western Europe. Because of expected market demand and the tariff structure within Europe, the Japanese can be expected to focus attention on establishing manufacturing facilities within Western Europe. The Japanese market share within Europe is presently small, but assuming the location of European production facilities, can be expected to increase in the foreseeable future. This may lead to a modest change in market share relationships between supplying countries in Europe.

Government involvement in integrated circuits

Domestic and foreign government policies relating to tariff and nontariff barriers, industrial assistance and incentives, and monetary and fiscal matters influence in varying degrees world markets and trade in integrated circuits. Tariffs remain a barrier to the free flow of integrated circuits into world markets, particularly in the EC where the latest multilateral trade negotiations failed to achieve a reduction in duties. Also, the U.S. industry alleges that various nontariff trade barriers in Europe and Japan represent a significant problem to increased integrated circuits exports. U.S., Japanese, and Western European policies affecting integrated circuits are discussed below.

United States.--In the United States, Government expenditures aimed at assisting industry research and development in the integrated circuits industry are small. Unlike the 1960's period, when Government funding through military contracts provided a source of funding for research and development, the only current proposal involves a very high speed integration program. This effort, designed to increase the speed of the circuits and to harden them against nuclear radiation, has not yet been funded.

It can be expected that the integrated circuits industry, like any other domestic industry could be adversely affected by current inflation rates, high interest rates, and any consistent decline in demand as a result of a recession. These factors could limit the ability of the industry to either accumulate sufficient capital necessary for R. & D. to advance technology or to obtain necessary funding in the open market. This is particularly true of small-and middle-sized firms which are less able to fund required expenditures to move into higher technology items which will be the dominant force in world integrated circuits markets.

Japan.--The low inflation and short-term interest rates evident in Japan in recent years have provided a base for overall industrial expansion--including integrated circuits--at a more favorable rate than in the United States. The ability of various integrated circuits producers to work together to advance technology without fear of government action has further fostered the economic health and advancement of the integrated circuits industry. The Japanese government has suggested integrated circuits as a target industry for development which should lead to increasing the Japanese industry's competitive posture in world markets. The government has also funded research in high technology integrated circuits which could be significant in providing a quantum jump in closing the technology gap between Japanese and U.S. integrated circuits producers. According to published reports the Very Large Scale Integration program in Japan involves a total funding of $360 million over 4 years, $240 million of which consists of government loans.

The rates of duty on integrated circuits entering Japan, 12 percent ad valorem, and certain valuation practices were indicated as tariff barriers by U.S. producers responding to the Commission's questionnaire. Among the significant nontariff barriers mentioned were (1) the refusal of Nippon Telephone and Telegraph to allow incorporation of imported integrated circuits into its equipment, (2) barriers to the establishment of majority-owned joint ventures or subsidiaries, and (3) difficulties with standards and customs documentation. The industry hopes that nontariff trade barriers in Japan will be modified or eliminated as a result of the implementation of the recently concluded multilateral trade negotiations. In the event that legal and institutional changes are not made, U.S. industry exports will serve a diminishing share of the Japanese market.

Western Europe.--U.S. producers have expressed disappointment that the EC's common external tariff of 17 percent ad valorem on integrated circuits was not reduced in line with U.S. and Japanese concessions in the recently concluded multilateral trade negotiations. The U.S. industry also fears that trade barriers, particularly nontariff measures, and foreign government subsidies to local firms will erode its market position. The majority of U.S firms responding to the Commission questionnaire alleged that significant nontariff barriers to their exports exist in Europe. The most significant barriers to exports identified by U.S. producers of integrated circuits concerned government procurement--particularly refusal of European, state-owned telecommunications agencies to use foreign-made equipment or equipment containing significant quantities of imported components. Other tariff and nontariff measures mentioned as significant obstacles to exports of integrated circuits by U.S. firms included: difficulties with standards, border tax adjustments, and rules of origin.

There is little doubt that foreign producers wishing to tap the growing potential for integrated circuits in Western Europe are encouraged to locate in Europe by the existence of tariff and nontariff barriers. In addition, several European governments provide incentives to all industries aimed at establishing new facilities in the market. While not applying exclusively to integrated circuits, when viewed in combination with tariffs, the incentives offer an attraction for locating integrated circuits facilities in Europe. Indeed, many U.S. firms have already taken advantage of these incentives to locate production facilities overseas and are expected to increase their manufacturing capacity abroad within the existing market structure. In light of the anticipated market demand, Japanese and other foreign producers can be expected to take advantage of the incentives to locate additional facilities in Western Europe.

In addition, some European governments are providing funds for reconstruction and development aimed at strengthening the domestic producers' position in European markets. Because of the growing internal demand, it is not expected that any increased production of the European integrated circuits producers will soon lead to a significant increase in their exports. The Federal Republic of Germany is reported to have dedicated $300 million over 2 years for the development of very large scale integration devices and to upgrade technology. The Government of France is providing up to $300 million in grants and loans for the development of advanced integrated circuits. The United Kingdom has allocated approximately $300 million over 3 to 5 years to develop equipment and advanced components.

Integrated circuits: U.S. and Japanese shipments, market share, investment, and employment, 1974-78

Item	1974 United States	1974 Japan	1975 United States	1975 Japan	1976 United States	1976 Japan
Shipments, total----1,000 dollars--	2,162,710	***	1,832,606	***	2,523,851	***
Related--------do----	1,139,624	***	1,003,002	***	1,446,889	***
Unrelated--------do----	1,023,086	***	829,604	***	1,076,962	***
Market share--------percent--	***	***	***	***	***	***
Investment:						
Plants and equipment 1,000 dollars--	544,215	41,155	542,598	33,714	625,795	115,371
Research and development---do----	329,897	75,020	422,488	76,007	422,292	99,751
Employment:						
All persons --------	106,026	***	84,736	***	102,188	***
Production and related workers----	74,020	***	63,244	***	80,888	***

Item	1977 United States	1977 Japan	1978 United States	1978 Japan
Shipments, total----1,000 dollars--	2,838,526	***	3,672,609	***
Related--------do----	1,531,969	***	1,937,452	***
Unrelated--------do----	1,306,557	***	1,735,157	***
Market share--------percent--	***	***	***	***
Investment:				
Plants and equipment 1,000 dollars--	667,114	96,615	897,053	172,131
Research and development---do----	465,633	130,936	529,651	199,207
Employment:				
All persons--------	112,364	***	131,578	***
Production and related workers----	87,932	***	102,441	***

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Note.--Western European data are not available.

Introduction

On October 25, 1978, the Subcommittee on International Trade, Senate Committee on Finance, and the Subcommittee on International Finance, Senate Committee on Banking, Housing, and Urban Affairs requested the United States International Trade Commission to conduct a study pursuant to section 332 of the Tariff Act of 1930 on trends in international trade in integrated circuits. The Commission was requested to focus the study on factors affecting the present and future competitive position of U.S. producers and, in particular, to include data and analysis concerning foreign government involvement in the form of incentives and disincentives on U.S. entry into foreign markets, and to compare such involvement with U.S. Government involvement. The Commission was instructed to submit the report of the study not later than September 30, 1979; the date of submission was subsequently postponed to October 31, 1979. The Commission instituted investigation No. 332-102, Competitive Factors Influencing World Trade in Integrated Circuits, on December 7, 1978. Notice of the institution of the investigation was published in the Federal Register (43 F.R. 59447, Dec. 20, 1978).

In connection with the investigation, the Commission held a public hearing in San Francisco, Calif., on May 30 and 31, 1979. Notice of the public hearing was published in the Federal Register (44 F.R. 25523, May 1, 1979) and was posted at the Office of the Secretary to the Commission in Washington, D.C., and at the Commission's office in New York City.

In its investigation, the Commission obtained data on the U.S. industry through responses to questionnaires. It also solicited the cooperation of certain foreign producers to help establish a data base on worldwide production and trade in integrated circuits. To this end, questionnaires were submitted through the Department of State to the six largest producers in Western Europe and the 10 largest producers in Japan. The responses by the Japanese industry included some data on each of the 10 producers in Japan and some aggregations prepared by the Japanese Ministry of International Trade and Industry. Western European producers chose not to respond to the questionnaires, so the Commission turned to various public sources of information on Western European industries. As a result, the Commission was unable to collect specific product data for native European producers. However, this did not seriously jeopardize the evaluation of world trade in integrated circuits because European producers are not a major factor in world trade.

In August 1979, the Commission received a confidential submission from a U.S. producer alleging that 16K RAMs (16,000 bit random access memories) were being made in Japan and sold in the United States at prices much lower than they were being sold in the Japanese home market. The Commission received the submission too late to request substantiating information from other domestic and foreign producers for use in the investigation.

The Commission's report establishes a partial 5-year history of developments in the integrated circuit industry on various topics including research, investment, shipments, exports, and imports. It outlines conditions of competition faced by U.S. producers in certain foreign markets and the influence of

governments on the industry. The report identifies the principal economic factors which affect the growth of the U.S. industry. It also compares the U.S. industry with the Japanese industry in several important aspects of performance over the 5-year period.

Description and Uses

The integrated circuit is an outgrowth of the semiconductor industry which has been developed in the last 35 years. The semiconductor industry had its origin in the invention of the point contact transistor at Bell Laboratories in 1948. This seminal invention was followed within the next decade by a number of other significant inventions, the junction transistor, crystal growing and purification techniques, diffusion techniques, oxide masking and planar technology which are basic to integrated circuit fabrication, all of which inventions originated in the United States and most at Bell Laboratories.

The new semiconductor technology was rapidly disseminated to receptive entrepreneurs who formed new companies or expanded existing businesses over the next three decades to exploit this technology worldwide at a revolutionary pace. For example, integrated circuits were pioneered at Texas Instruments, one of the originally small businesses which early moved into this new technology, and Fairchild Semiconductor.

Semiconductor technology has spread far beyond its originally conceived application to telecommunications and its popularly perceived applications to computers, calculators, and watches and is having an accelerating impact in areas such as automotive, energy control, home entertainment, and consumer products.

The transistor has had its most significant impact not as a component replacing vacuum tubes in established products, but as a component of products which were uneconomical before the development of the transistor. Thus, the transistor has stimulated growth, including the invention and innovation on a considerable scale of products. 1/

This technology supports an extremely fast growing integrated circuit market currently estimated at approximately $6 billion and is linked with an electronics market of $180 billion a year. In this environment, basic and applied research have become ever more costly and significant benefits are derived from the availability of a large-scale organization to mobilize scientific talent and capital investment.

1/ Nelson, Richard R., The Rand Corporation, "The Link Between Science and Invention: The Case of the Transistor," The Rate and Direction of Inventive Activity - Economic and Social Factors, 1962, p. 553.

With the seventies, the advent of foreign producers of integrated circuits has changed traditional perspectives on the role of U.S. technological leadership. Today, the foreign producers are an increasingly significant factor in the marketplace. They are also a factor in new product design and development. The Japanese, for example, have established a program whereby several of the largest Japanese electronic firms will pool their research efforts in a common facility toward the goal of very large scale integration of circuits.

The initial fuel for the semiconductor revolution was, as previously indicated, United States technology and innovation. Although other countries have narrowed the gap, the United States innovative contribution continues to be preeminent in this high technology arena which ranks at the forefront in terms of research and development expenditures. (Bell Laboratories, the originator of this technology and now having a relatively small production interest, nevertheless remains a major contributor to the United States technology leadership.) Newly emerged domestic companies have played important roles in the evolution of integration from small scale to large scale, primarily working in the metal oxide silicon (MOS) technology originated at Bell Laboratories.

Description

Integrated circuits (IC's) are defined as encapsulated miniature electronic circuits produced within or on a semiconductor crystal, which is usually made of silicon. The circuits range from simple logic circuits and amplifiers to complex integrated circuits containing thousands of transistors and other components.

Integrated circuit chips (before mounting and encapsulation) range in size from about 1.3 to 5 millimeters square and consist of a combination of active electronic components such as transistors and diodes with passive components such as resistors and capacitors within and on a single semiconductor crystal. The construction of these elements within the semiconductor is achieved through the introduction of electrically active impurities into narrowly defined regions of the semiconductor.

Digital bipolar and digital MOS integrated circuits are used in products which utilize digital techniques such as calculators, computers, and digital test equipment. Linear integrated circuits are used in applications where the electronic signals are not reduced to the "on-off" digital code. Examples are analog devices, such as audio amplifiers and analog computers. Other, or hybrid integrated circuits, are a combination of integrated circuit types. Articles covered by this investigation are limited to integrated circuits only and do not include discrete devices such as transistors, diodes, solid-state displays, and similar devices.

Uses

Integrated circuits were developed in the early 1960's as an outgrowth of the technology that spawned semiconductor transistors and diodes. The early uses of integrated circuits were in operational amplifiers, logic circuits, and shift registers of small capacity employed as parts of process control devices, calculators, and computers. As technology improved, integrated circuits became increasingly complex, to include more functions. Today the calculating and memory functions of a pocket-type calculator are included in a single integrated circuit, a substitute for hundreds of discrete components. The principal use of integrated circuits is in computers. Other uses include home appliances such as clocks, radios, television receivers, dishwashers, sewing machines, security systems, and even personal computers. Integrated circuits are finding their way into automobiles, and this industry is expected to become a large user of these devices in a few years. The use of integrated circuits to replace tens of thousands of discrete components and interconnecting wires in computers and data processing machines has caused, and is still causing, a near revolution in the size, power, and variety of application of these machines. It is in the variety of integrated circuit applications that there is no forseeable limit. The microminiature computer appears to have no end of uses from teaching toys, to automobile pollution control, and to the control of unmanned space vehicles millions of miles from earth.

Tariff Treatment

Integrated circuits and parts are classified under item 687.60 of the Tariff Schedules of the United States (TSUS). Entries from most-favored nations (MFN) are now dutiable at a rate of 6 percent ad valorem, the rate which has been in effect since January 1, 1972. Details are given in the following table. As a result of the recent Multilateral Trade Negotiations, the U.S. rate is to be reduced to 4.2 percent ad valorem in 8 annual stages commencing on January 1, 1980. Imports of integrated circuits from designated Communist countries are dutiable at the rate of 35 percent ad valorem. Integrated circuits are not eligible articles under the Generalized System of Preferences (GSP).

Integrated circuits: U.S. rates of duty on MFN imports, 1967-72 and 1987

(In percent ad valorem)

TSUS item No.	Prior rate	Rate of duty effective January 1					
		1968	1969	1970	1971	1972	1987 1/
687.60 (pt.)	12.5	11	10	8.5	7	6	4.2

1/ Final rate negotiated in Tokyo Round of trade negotiations. This rate will result from a reduction from 6 percent ad valorem in 8 annual stages commencing on January 1, 1980.

Integrated circuits are also entered under TSUS items 806.30 and 807.00. Item 806.30 provides for imports of certain metal articles which were previously processed in the United States and then exported for further processing. Article 807.00 provides for imported articles assembled in whole or in part of U.S.-fabricated components. Imports qualifying under those provisions, which have never been the subject of trade-agreement concessions, are dutiable, in effect, only to the extent of the value added abroad.

Profiles of U.S. and Foreign Producers

U.S. and foreign integrated circuit industries are multinational. To measure trade flows, data on the worldwide industry were collected on the following basis: (1) Shipments are articles produced and sold in the same country; they exclude exports or imports on which no further operations or modifications were performed. U.S. domestic shipments are those produced and sold in the United States. U.S. foreign subsidiary shipments are those produced and sold within the respective foreign countries where U.S. plants are located. Shipments are a measure of market access in a country where an investment is made. (2) Shipments data on the Japanese multinational industry were collected on the same basis. (3) Exports are articles produced in one country and sold in another. (4) Imports are articles sold in the importing country and produced in another country.

U.S. producers

About 40 U.S. firms produce integrated circuits. * * * is the largest firm accounting for about * * * percent of the value of shipments and exports produced in U.S. domestic plants and U.S. plants located in foreign countries. The next three largest producers are * * *. These three producers account for about * * * percent of the value of total shipments and exports produced in all U.S.-owned plants. * * *. The concentration of the four largest producers was about the same in 1978 as in 1974.

In 1979, U.S. producers' plants were capacity limited with promised deliveries on certain product segments extending out 26 weeks. Plant-capacity limitations are expected to remain over the next few years.

Production

Production flow of integrated circuits and parts.--Most U.S. firms have established foreign subsidiaries or at least have foreign contracts for the assembly and testing of integrated circuits. Figure 1 shows the flow of wafers and chips exported from the United States as parts to other countries. U.S. firms generally register these exports with U.S. customs so that

duty-free treatment can be obtained under the provisions of TSUS items 806.30 and 807.00 when the finished integrated circuits are returned to the United States.

U.S. subsidiaries or contractors in the foreign countries assemble the chips into final packages. These assemblies are normally sealed offshore and tested or exported to the United States or a third country for final testing. The last material transformation is that of sealing the IC package. This transformation determines the country of origin for U.S. Customs purposes. The final test does not change the country of origin. For simplicity, this distinction is not shown in figure 1, and final seal and test are shown to be a single operation in a single location, which may not be the case.

After the IC has been tested, it is marked and packaged. It may then be sold locally, exported, or even assembled into some other product such as a calculator, radio, or computer. If assembled into another end product, then the integrated circuit loses its identity for customs purposes, and trade statistics on the IC are lost. To the extent that this happens, U.S. import statistics on IC's are understated. This does not mean, however, that the end product does not qualify for 807 treatment. On the contrary, the little chip which is the heart of the tested device may enter the U.S. duty free providing that it was properly registered upon export and even though the IC device has been assembled into an end product.

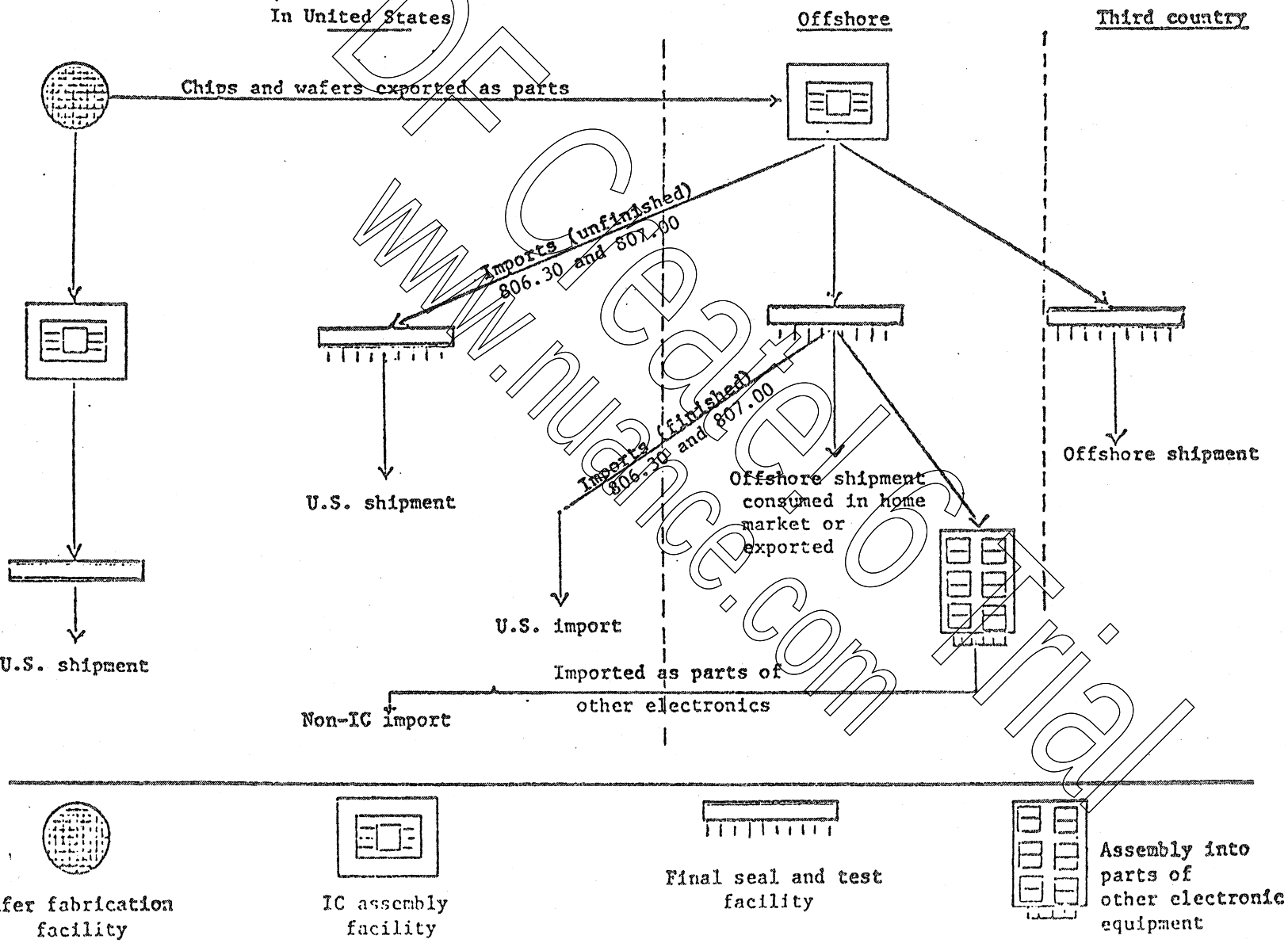
Production operations.--The three basic operations in the production of an integrated circuit are wafer fabrication, assembly, and testing. These operations need not be performed in the same plant or in the same country.

Wafer fabrication, the most technically difficult operation, is for the most part done in industrial countries. U.S. firms produced * * * percent of their wafers in the United States in 1978 (table A-1). The remaining * * * percent were produced by their subsidiaries located in industrial countries.

The assembly of individual integrated circuits into the packages is done largely in foreign countries. In 1978, U.S. firms did * * * percent of assembly in the United States and * * * percent in other industrial countries. The remaining * * * percent was done in developing countries. Much of the assembly is manual; automation of the assembly operation (except in a few firms) is lagging behind that available for wafer fabrication and testing. After assembly the integrated circuits are either tested offshore or returned to the United States for final test.

Testing is increasing in U.S. foreign subsidiary plants. In 1974, * * * percent of the finished-tested IC's were produced in the United States. By 1978, only * * * percent of these IC's were finished in the United States. This is significant considering that the volume produced increased from * * *

Figure 1.--Production and flow of wafers, assemblies, and finished-tested integrated circuits by U.S. producers.



billion to * * * billion units during that time. The test operation makes use of technologically advanced digital computer-controlled test equipment. Since the test function is automated, the output of a single testing machine can be quite high. The test programs are written in computer language and can be supplied from the United States by the original designer in the wafer fabrication plant.

Production by type of device.--The investigation identified four major categories of integrated circuits: linear; digital bipolar; digital MOS; and other. The last category includes combinations of functional types such as linear-digital (analog to digital converters, etc.), combinations of technological types such as bipolar and field effect, and all other integrated circuits not specifically classified in the first three categories. There are several ways of determining the overall production trends by type of device.

As shown in table A-2, production has been indicated by the number of wafer starts, the number of assemblies produced, and the number of finished integrated circuits produced domestically by U.S. firms, by type of IC. As noted in the previous sections, almost * * * percent of wafer fabrication by U.S. firms is done in the United States. Thus, the number of wafer starts by type of integrated circuit might seem to be a measure of the market for the different types.

Digital MOS wafer starts accounted for over half of all starts in 1978. Commencing in 1976, the relative share of all types measured has been nearly constant. During 1976-78 the total number of starts increased 1.6 times. Wafer starts are not, however, a true indication of production or markets. Many factors, such as the maturity of the production technology, the number of chips per wafer, the yield of good IC's per wafer, the complexity of the devices, etc., affect the final delivery of a finished IC.

Production by wafer size.--The number of integrated circuit chips that can be produced from a single wafer is directly related to the size of the wafer. Since the production process (wafer fabrication) is extremely lengthy and difficult, more chips produced on a wafer can reduce unit production costs. The industry trend to the use of larger wafers is shown in the following table.

Wafer starts of U.S. firms, in domestic and foreign plants, by size of wafer, 1974-78

(In percent)

Facilities	1974			1975			1976			1977			1978		
	2"	3"	4"	2"	3"	4"	2"	3"	4"	2"	3"	4"	2"	3"	4"
Domestic	63	37	-	31	69	-	20	80	-	11	86	3	9	80	11
Foreign	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***

Source: Compiled from data submitted in response to questionnaire of the U.S. International Trade Commission.

Capital equipment.--Capital equipment is used in 5 major areas in the manufacture of integrated circuits. The areas are:

Wafer manufacture
Mask fabrication
Wafer (IC) fabrication
Assembly
Test

Wafer manufacture.--This equipment is used to prepare the basic raw slice or wafer of substrate material. Such equipment consists of apparatus for growing the crystal ingot, slicing or sawing the ingot into thin wafers, and polishing the wafers. The equipment is essential to the production of integrated circuits but much of it is used outside the IC industry. Many IC manufacturers purchase the raw, unprocessed wafers from large chemical companies rather than producing them in-house.

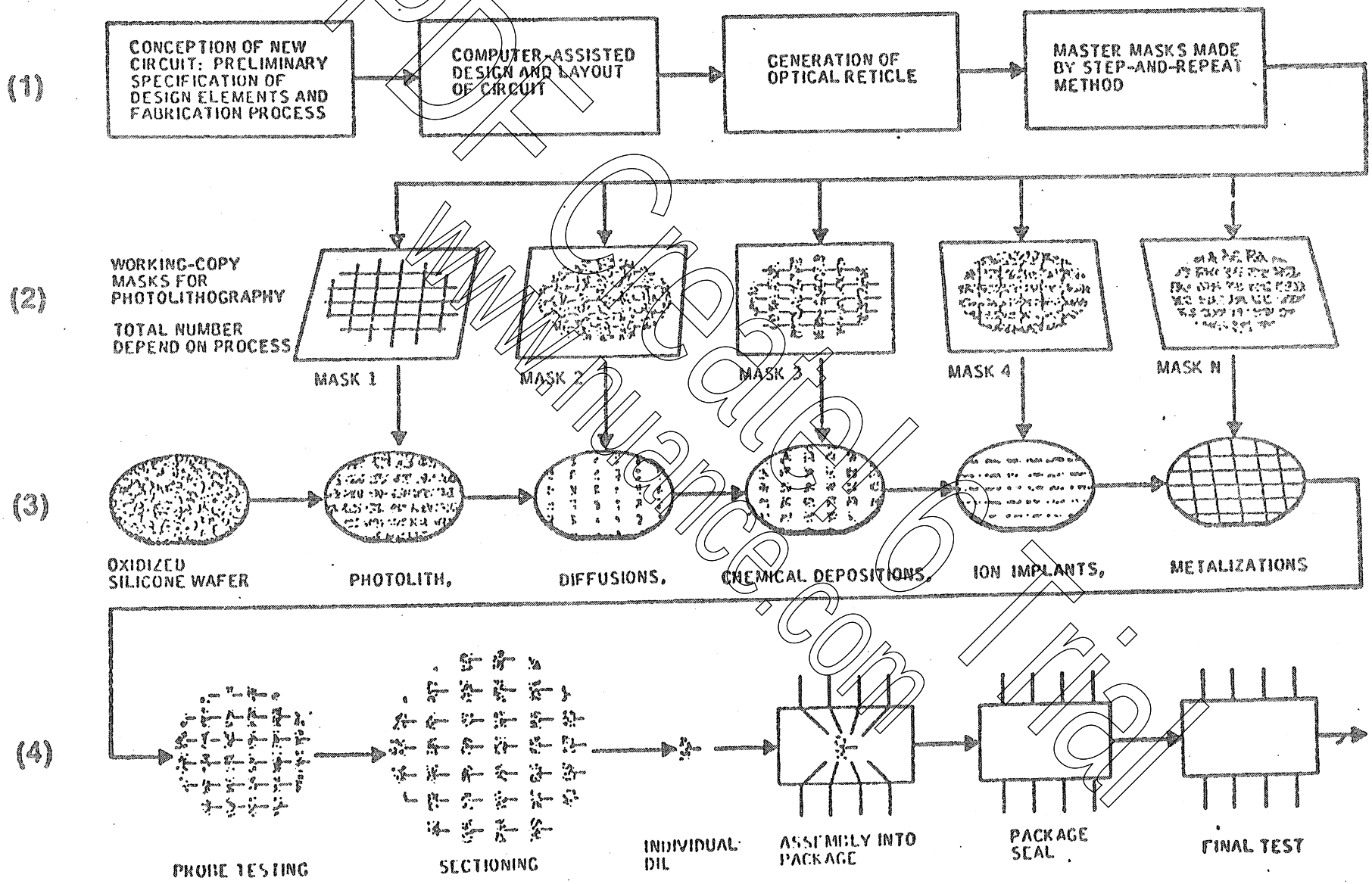
Mask fabrication.--Before the start of the manufacture of an integrated circuit, the IC device must be designed (figure 2, line (1)) and the process masks must be fabricated. The mask fabrication equipment is used to make the masks (negatives or positives) which are used to create the integrated patterns on the wafer. The various masks are shown in figure 2 line (2). Since the masks are the masters which will be used repeatedly to produce thousands of IC's, the accuracy of the image on these masks must be extremely precise. Errors on the masks are directly transferred to each IC.

Wafer (IC) fabrication.--Starting with the raw wafer (or slice) and a set of masks, the IC is produced by etching away, depositing on, and implanting in the surface of the wafer. Numerous IC's are formed on a single wafer. The production steps are shown in figure 2, lines (2) and (3). Wafer-fabrication machines are costly and must be capable of delivering extremely close tolerances. The overlay of the image from one mask must be perfectly aligned with, and of exactly the same dimensions as the image created by the preceding mask.

Assembly.--The wafer containing tens or hundreds of IC's is first scribed and then broken (sectioned) into individual chips (dice) as shown in figure 2, line (4). The individual chip is then mounted in its final container (package) which has both external and internal package wires. After assembly, the package is sealed. For most firms this is a labor intensive operation.

Test.--Testing of the integrated circuit is performed at two stages in the production process. Probe testing is done after the wafer is finished and before it is sectioned. Defective dice are marked and eliminated before assembly. Final testing is done after assembly to insure that the device functions within the electrical specifications and tolerances set by the manufacturer.

Figure 2.--Design and manufacturing steps in the production of integrated circuits.



(Courtesy of Honeywell, Inc.)

U.S. domestic shipments (excluding exports)

U.S. domestic shipments of integrated circuits increased generally from $1.2 billion in 1974 to about $2.1 billion in 1978 (table A-3). Shipments to unrelated parties, increasing from $698 million in 1974 to $1.3 billion in 1978 (table A-4), accounted for about 50 to 61 percent of U.S. domestic shipments during the period. Shipments to related parties were generally smaller increasing from $506 million in 1974 to $815 million in 1978 (table A-5). Digital MOS devices were the largest product segment shipped in 1978 and digital bipolar devices were the largest product segment shipped in 1974.

Shipments from U.S. foreign subsidiaries (excluding exports)

Shipments from foreign subsidiary plants owned by U.S. producers increased irregularly from * * * million in 1974 to $359 million in 1978 (table A-6). Shipments from plants located in West Germany to West German markets and from plants located in France to French markets accounted for about * * * of U.S. foreign subsidiary shipments. Developed countries account for about * * * percent of U.S. foreign subsidiary shipments with developing countries accounting for the remainder.

Shipments from U.S. foreign subsidiary plants to related parties fluctuated between * * * million and * * * million during 1974-78 (table A-7). Shipments to unrelated parties declined from * * * million to * * * million during the period (table A-8). The decline in shipments from U.S. foreign subsidiary plants to unrelated parties is occurring as U.S. investment in plants in those countries is rising. * * *.

Exports

U.S. exports.--U.S. exports of integrated circuits increased from $217 million in 1974 to $295 million in 1978 (table A-9); the increase equates to a rise of 35 percent in value. U.S. exports decreased sharply in 1975 and the 1974 level was not exceeded until 1978.

Despite a sharp decrease in 1975, U.S. exports to related parties increased from $120 million in 1974 to $134 million in 1978, an increase of 11.7 percent, relative to 1974 (table A-10). In addition, U.S. domestic exports to unrelated parties increased by 65 percent in value during the period rising from $97 million to $161 million (table A-11).

During 1974-78, over one-half of the value of U.S. exports of integrated circuits were shipped each year to Europe; these exports increased by 43 percent during the period (table A-12). West Germany, the United Kingdom, and France accounted for about 60 percent of the value of U.S. exports to Europe and 36 percent of total value of U.S. exports.

The value of U.S. exports to Japan more than doubled from * * * million in 1974 to * * * million in 1978 and accounted for the large bulk--(86 percent in 1978)--of the total exports to Asian countries.

U.S. export administration.--In the United States, a license is required on exports of advanced integrated circuits. The license is issued by the Office of Export Administration, U.S. Department of Commerce. To obtain the license, approval of the U.S. Department of Defense and the U.S. intelligence community is also required. A veto by either the Department of Commerce, the Department of Defense, or any member of the intelligence community would result in a denial of the export license.

The difficulty in obtaining an export license is directly related to the ultimate shipment destination of the device. Approval to export an advanced device to another Coordinating Committee (COCOM) country 1/ is usually routine. For exports to Soviet bloc countries, license approvals are based on three primary considerations: (1) end-use in the United States, (2) availability from Soviet bloc sources, and (3) potential strategic purposes.

The license procedure adopted by the United States and other COCOM countries has been said to be ineffective--advanced integrated circuits can be purchased in COCOM countries by Soviet bloc users and transported abroad in diplomatic pouches. Further, it is unlikely that Soviet bloc countries would design strategic weapons systems around components that can be secured only from COCOM sources. The program has been a small barrier to U.S. exports. However, the semiconductor industry does report delays in shipments and administrative costs incident to the program.

Exports of U.S. foreign subsidiaries.--Total exports of integrated circuits by U.S. foreign subsidiaries increased from $425 million in 1974 to $938 million in 1978 (table A-13). Except for the recession year, 1975, developing countries accounted for approximately * * * percent of the value. These percentages dropped significantly in 1975 when U.S. firms and their foreign subsidiaries reduced employment significantly. * * * was the leading exporter and accounted for * * * million in exports in 1978. France was the leading exporter among industrial nations accounting for * * * million in 1978.

1/ COCOM countries are members of the North Atlantic Treaty Organization (NATO) and Japan.

Exports of U.S. foreign subsidiaries to related parties followed the trend of total exports and comprised over 75 percent by value (table A-14). Like total exports, related party exports by developing countries were about 3 times the value of such exports from industrial countries. * * * was the largest source of related exports from developing countries whereas * * * was the leading source from developed countries.

Exports of U.S. foreign subsidiaries to unrelated parties during 1974-78 were dominated by the * * * which accounted for a minimum of * * * percent and a maximum of * * * percent of the value each year during the period (table A-15). Unrelated party exports by other developing countries and individual countries were small by comparison.

Over 90 percent of the value of exports from U.S. foreign subsidiaries originated in Asia and Europe. The percentage from Asia ranged from 61 to 76 during 1974-78 and from Europe 18 to 30. The developing countries accounted for most of the exports from Asia (tables A-16 to A-20), whereas the * * * accounted for most of the exports from Europe.

U.S. foreign subsidiaries in Asia, chiefly in the developing countries, shipped most of their exports to the United States during 1974-78. In 1978, 78 percent of the value of their exports was sent to North America, * * * percent to Europe, and * * * percent remained in Asia. Of those exports to countries in Asia, Japan accounted for about * * * and developing countries accounted for the remainder.

Exports of U.S. subsidiaries located in Europe were destined principally for countries in Europe. Nearly 80 percent of the value of these exports remained in Europe in 1978 whereas exports to North America accounted for * * * percent and to Asia * * * percent.

The largest export market for U.S. foreign subsidiaries was North America, chiefly the United States, which accounted for about 60 percent of the value of these exports during 1974-78. Europe accounted for about * * * percent of their market, and Asia about * * * percent.

U.S. domestic shipments and exports and shipments and exports from U.S. foreign subsidiaries

Data on the values of shipments and exports by U.S. firms from facilities in this country and abroad, with breakdowns for related and unrelated party transactions, are given in table A-21 and are depicted in figure 3. Shipments and exports combined decreased 16 percent between 1974 and 1975 from $2.2 billion to $1.8 billion, and then increased by 101 percent to $3.7 billion in 1978. Most of the decline in 1975 and the rise in 1976-78 were in unrelated party transactions. Of the total growth in related party transactions, the largest part was accounted for by U.S. foreign subsidiaries. From 1975 to 1978, their transactions grew to $1.3 billion, an increase of 135 percent.

As shown in the table below, integrated circuits are shipped and exported from U.S. domestic plants by a ratio of about 2 to 1 over U.S. plants located in foreign countries. This is in spite of the heavy increase in foreign subsidiary related party shipments and exports shown in figure 3.

Integrated circuits: Shipments and exports from domestic and foreign plants

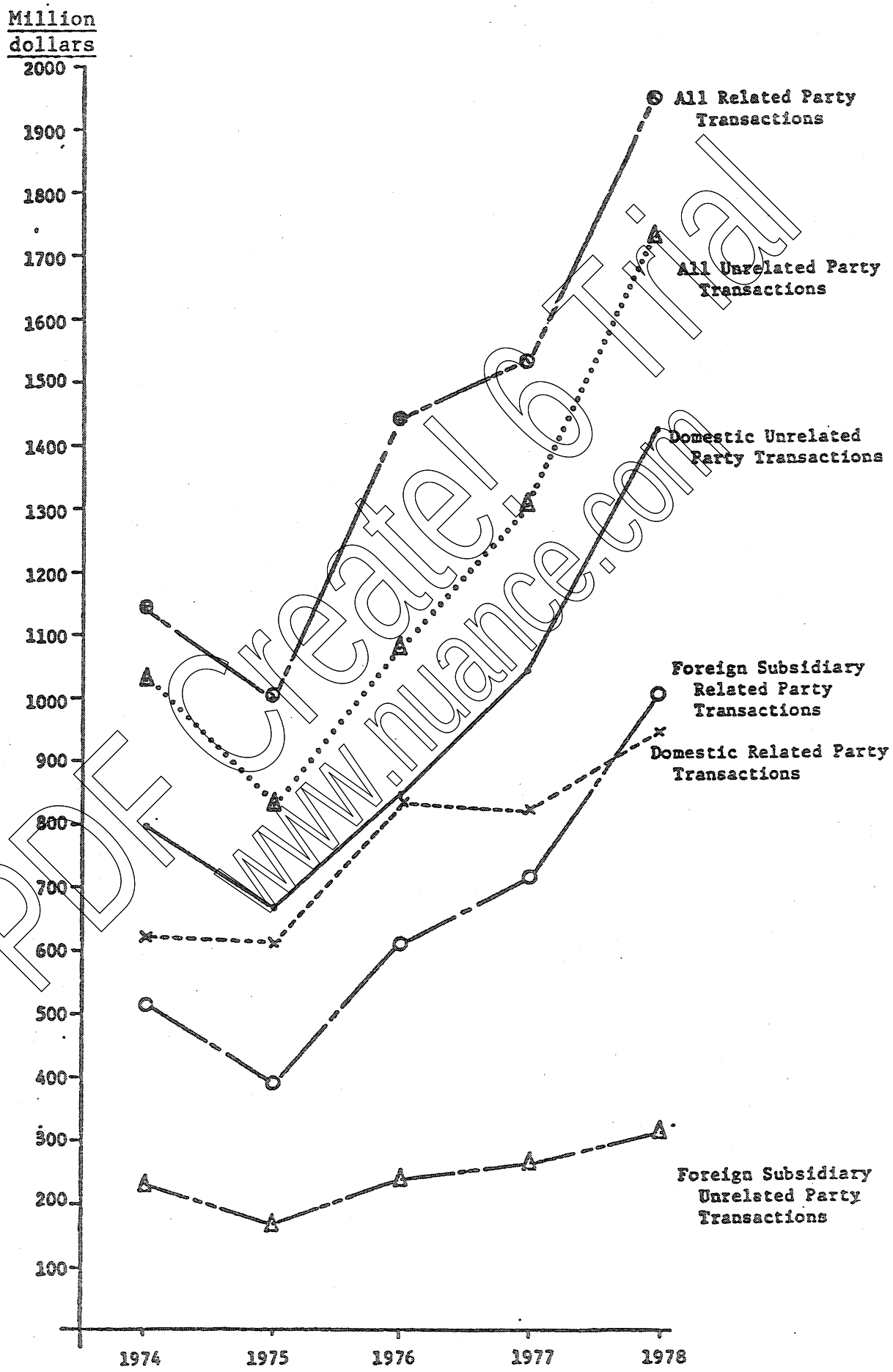
	1974	1975	1976	1977	1978
Total transactions--1,000 dollars--	2,162,710	1,832,606	2,523,851	2,838,526	3,672,609
Domestic facilities:					
Value----------do----	1,421,505	1,279,137	1,679,067	1,864,768	2,374,903
Percent of total----------	66	70	67	66	65
Foreign facilities:					
Value----------1,000 dollars--	741,205	553,469	844,784	973,758	1,297,706
Percent of total----------	34	30	33	34	35

Imports

U.S. imports.--According to data given in completed questionnaires, the value of U.S. imports of integrated circuits increased from $584 million in 1974 to $1.2 billion in 1978 (table A-22). Over 95 percent of the value of all imports were from foreign subsidiaries of U.S. firms, principally producers of integrated circuits (table A-23). Although small, imports from unrelated parties grew 233 percent during 1974-78 (table A-24).

Responses to the Commission's questionnaire show that integrated circuits imported under TSUS items 806.30 and 807.00 increased from $402 million in 1974 to $883 million in 1978 (table A-25), for a growth of 120 percent in value. Such imports fluctuated between 69 and 75 percent of the total. The dutiable-value share of these imports, that value added abroad, diminished from 57 percent in 1974 to 39 percent in 1978. This is due to the increasing value of those parts of the completed IC device produced in the United States. In general, each product segment followed similar trends, although for all other integrated circuits, the value of 806.30 and 807.00 imports fluctuated between 14 and 37 percent of total imports during 1974-78.

Figure 3.—Total shipments and exports by U.S. firms and their foreign subsidiaries, by type of transaction, 1974-78



Integrated circuits: Relative share of and value of 806.30 and 807.00 imports to total imports, by types, 1974-78

(In percent)

Type	1974	1975	1976	1977	1978
Linear	60	55	58	67	70
Digital bipolar	64	79	72	80	80
Digital MOS	86	85	85	80	78
All other	21	24	14	17	37
Average	69	75	72	74	75

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Note.--These percentages are based on total imports including those of U.S. producers, foreign producers, and other direct importers.

Imports by U.S. foreign subsidiaries.--Total imports of integrated circuits by U.S. foreign subsidiaries increased from $187 million in 1974 to $370 million in 1978 (table A-26), a growth of 98 percent. In 1978, subsidiaries in developing countries, led by * * * with an import value of * * *, accounted for approximately * * * of all imports by U.S. foreign manufacturing subsidiaries, compared with * * * in 1974. U.S. subsidiaries in the * * * were the principal importers in 1974-76 replaced by those in * * * in 1978.

Over 90 percent of the value of total imports of U.S. foreign manufacturing subsidiaries originated with related parties outside the United States, thus the trend of imports by related transactions follows closely the trend of total imports (table A-27). Imports of IC's by U.S. foreign manufacturing subsidiaries in the * * * account for the great bulk of unrelated-party imports (table A-28).

U.S. apparent consumption

The value of U.S. apparent consumption of integrated circuits, as reported in Commission's questionnaires, increased from $1.8 billion in 1974 to $3.3 billion in 1978 (table A-29). 1/ The ratio of imports to U.S. apparent consumption ranged from 33 to 36 percent. U.S. apparent consumption was also computed by subtracting the value of 806.30 and 807.00 imports entered duty-free from the total value of imports (table A-30). U.S. apparent consumption and the ratio of imports to apparent consumption are lower when the adjusted data are used, but the trends are about the same. The adjusted value of imports of U.S. goods returned duty free is largely value added by U.S. foreign subsidiaries.

1/ It is estimated that these data account for between 80 percent and 90 percent of total U.S. apparent consumption.

Trade balance

Trade data furnished by the industry, when adjusted for 806.30 and 807.00, indicate that the trade balance of integrated circuits grew from a deficit of $196 million in 1974 to a deficit of $349 million in 1978 (table A-31). Imports under TSUS items 806.30 and 807.00 from U.S. subsidiaries represent the vast majority of U.S. imports. The overall trade balance, unadjusted for 806.30/807.00 imports amounted to a deficit of $367 million in 1974 and a deficit of $884 million in 1978 (table A-32 and figure 4).

Employment

Overall foreign and domestic employment in plants owned by the U.S. industry producing integrated circuits and other products has increased over the period 1974-78 as shown in the following table. Total employment in reporting establishments grew 10.3 percent over the period 1974-78, while employment of persons solely engaged in IC production within the industry grew nearly 24 percent.

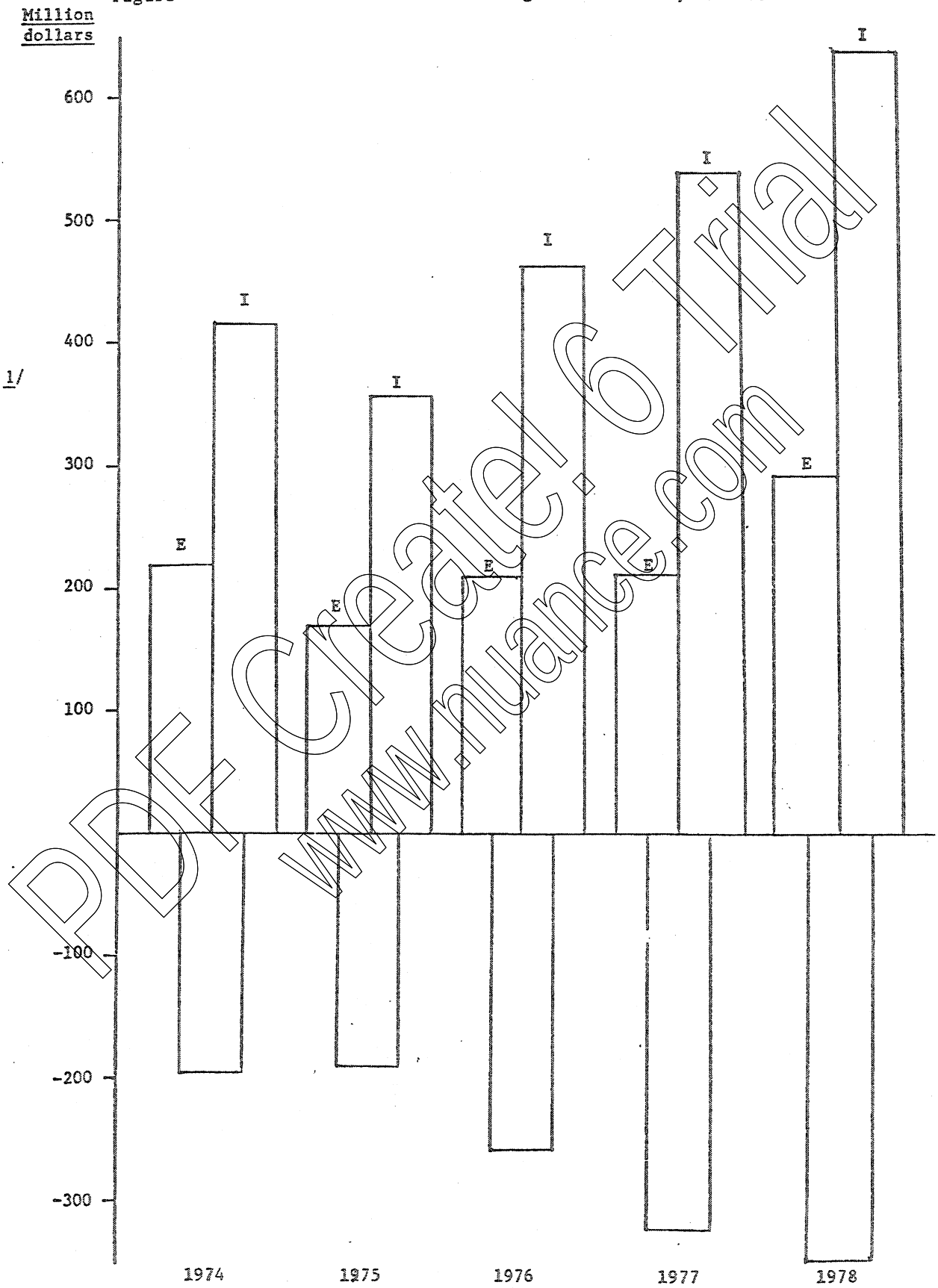
Total employment in the U.S. integrated circuit industry, 1974-78

Item	1974	1978	Difference (in percent)
U.S. domestic:			
All persons in reporting establishments	126,949	125,857	-.01
All persons on integrated circuits	62,322	66,426	6.6
U.S. foreign subsidiaries:			
All persons in reporting establishments	73,708	95,445	29.5
All persons on integrated circuits	43,704	65,152	49.1
Total:			
All persons in reporting establishments	200,657	221,302	10.3
All persons on integrated circuits	106,026	131,578	23.9

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Total domestic employment by U.S. firms producing integrated circuits and other products fell sharply during the economic downturn of 1974-75, from 126,949 to 103,463, then rose steadily in 1976 and 1977, reaching 125,857 in 1978. As shown in table A-33, the number of persons directly engaged in IC manufacture in U.S. domestic facilities followed a similar trend, showing a 7 percent increase over the period 1974-78. In contrast with domestic employment trends, the total number of workers in overseas establishments owned by U.S. firms producing integrated circuits and other products increased steadily from 73,708 in 1974 to 95,445 in 1978 (table A-34). Virtually all of the increase was in the number of workers producing integrated circuits.

Figure 4.--U.S. balance of trade in integrated circuits, 1974-78



1/ Total imports less the value of duty-free goods returned under TSUS items 806.30 and 807.00.

Most workers in U.S. foreign subsidiaries producing IC devices are located in Asia--Malaysia, Singapore, Korea and Taiwan. More than 83 percent were engaged in the assembly of circuits in 1978, usually from chips produced in the United States or Europe. Production workers engaged in wafer fabrication in Asia were only * * * percent of total production workers in these establishments in 1978. Nearly all the growth in employment in foreign subsidiaries of domestic IC firms in this period has been in Asia, mostly in Malaysia and * * *.

Price trends and determinants

Price trends.--U.S. producers of integrated circuits were asked to report their net prices of IC devices sold in largest volume in several categories to domestic original equipment manufacturer (OEM) customers during 1977 and 1978. Their prices were reported on a quarterly basis, f.o.b. point of shipment. Weighted aggregate indexes of the reported prices are given below.

Integrated circuits.--Indexes of weighted average unit prices of selected types of integrated circuits produced by U.S. firms, by quarter, 1977 and 1978

(Jan.-Mar. 1977 = 100.0)

Period	Linear circuits	Digital bipolar circuits	Digital MOS circuits	
			4K RAM	Other MOS
1977:				
January-March	100.0	100.0	100.0	100.0
April-June	101.2	102.8	88.9	88.8
July-September	89.6	83.7	80.2	88.2
October-December	87.5	76.1	77.8	79.4
1978:				
January-March	78.7	67.7	62.5	68.9
April-June	74.2	59.2	57.1	61.8
July-September	88.8	49.7	53.9	45.8
October-December	72.1	53.1	39.9	41.5

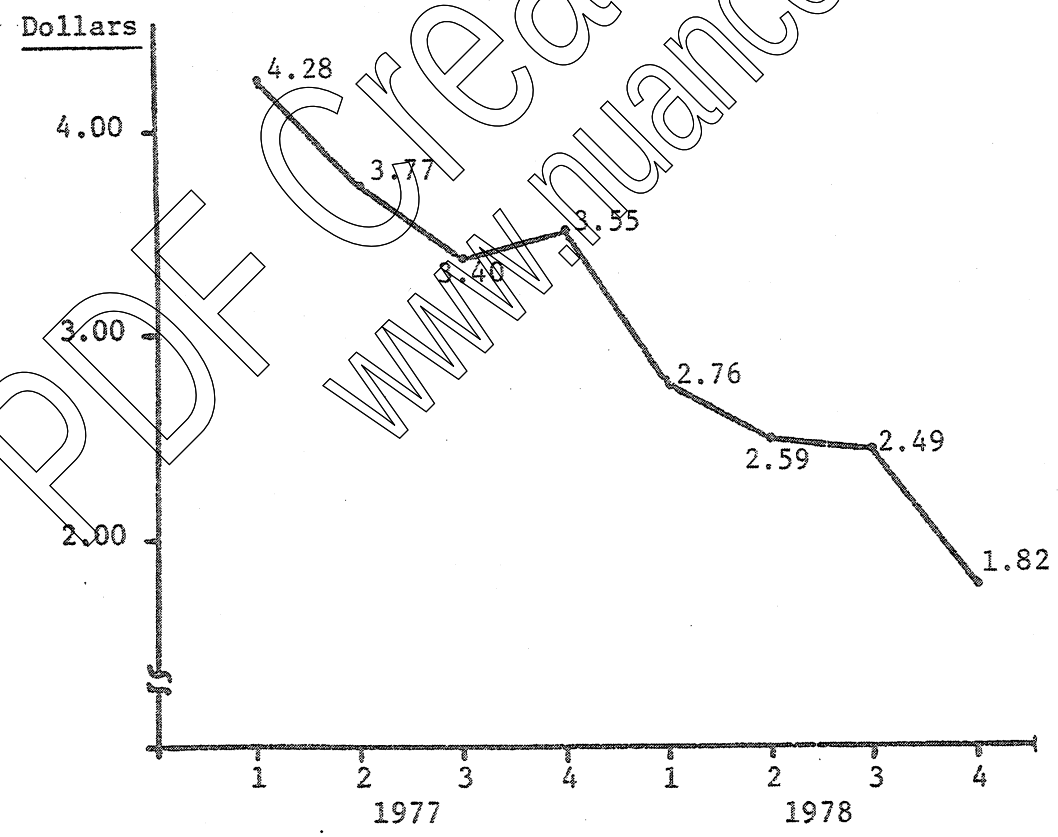
Source: Compiled from data submitted in responses to questionnaires of the U.S. International Trade Commission.

The index of such average prices for each type of circuit listed declined in 1977-78. Prices of linear devices declined by only 28 percent in those 2 years. The prices of digital bipolar circuits fell more sharply, by 47 percent, with most of the decline in 1977, then firming in 1978.

Prices of digital devices using MOS technology were reported for 4K RAMs and other MOS devices. This technology is being heavily emphasized at this time, with growth in U.S. producers' shipments higher for the MOS devices than those for any other type (table A-3). The fall in the average prices for those devices--about 60 percent--was sharper than that for linear and for digital bipolar circuits.

Figure 5 illustrates the trend in weighted average prices of 4K RAM's produced by four U.S. firms, by quarter, in 1977-78. These firms accounted for 88 percent of the reported 4K RAM sales to domestic OEM customers in the period. These devices, used mostly in computer memories, were introduced into the U.S. market in commercial quantities in late 1973 by Mostek and Texas Instruments. By the end of 1978, 13 other U.S. firms had initiated sales including 3 that began sales in 1978. Cumulative domestic sales of 4K RAM's to OEM's by reporting U.S. firms in this period were 43.4 million units, half of which took place in the last 3 quarters. Figure 5 illustrates the combined effects of increased competition and "learning curve" cost economies on unit prices of integrated circuits.

Figure 5.--Weighted average unit prices of 4K RAM's, by quarter, 1977 and 1978



Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Price determinants.--Prices for U.S.-produced integrated circuits generally fall over time and with accumulated output. U.S. firms producing these devices reported that they expect an average decline in cost of 20 to 30 percent with each doubling of the accumulated production base. 1/ These falling unit production costs and the intense competition which characterize the U.S. industry have produced sharply falling prices for most devices for a period of time after their introduction.

The cost economies which come with accumulated IC production are due to the production methods that characterize their manufacture. Hundreds of dice are laid out on a 3 inch or 4 inch wafer of silicon. 2/ But as the wafer progresses through the complex manufacturing process, dice that will not become functioning integrated circuit devices are tested out. The portion of the original number of dice that become saleable devices is called the yield ratio.

In the early stages of development and production, the yield of a particular device will be quite low, and the unit cost of production of saleable devices quite high. With time and production experience, however, yield per wafer rises, and unit costs fall. This fall in costs due to increased productivity over time is called the "learning curve" or the "experience curve." 3/

Chip density.--Since the introduction of integrated circuits in the mid-1960's, the number of electronic functions enclosed in one chip has nearly doubled every 2 years. These two factors, falling unit costs for individual chips and increasing chip density, have allowed the price per electronic function encompassed in an integrated circuit to fall from $50 per function in the mid-60's to less than one-twentieth of one cent per function for the 16K RAM. 4/

Innovation and its role.--Normally, the firm that initiates production of an innovative device expects to enjoy some brief period without direct competition. As other firms begin production, competitive forces drive price down towards falling costs. A narrowing advantage is sometimes held by the innovating firm. All other things being equal, as long as the cumulative output of the first firm exceeds that of its competitors, unit costs should be lower. To the extent that this is true, an innovator is in a position to reduce the market price and thus the level of profits of other producers.

1/ Official Report of the Proceedings before the United States International Trade Commission, Investigation No. 332-102 (hereafter Proceedings), p. 23.

2/ Integrated Circuit Engineering Corporation, Status '79: A Report on the Integrated Circuit Industry, (Scottsdale, Arizona, Pitcher Technical Publications, 1979), p. 7-6.

3/ Proceedings, pp. 22-23.

4/ Ibid., p. 17.

The profits earned during the earliest, uncontested marketing period and the price/cost edge described above enable the innovating firm to acquire and to dedicate more research and development funds to try to renew this advantage in the next generation of devices. 1/

Product maturity.--As cumulative output and production yields increase, average unit costs decrease at a slower rate. At the same time, competition is driving market prices lower and squeezing profit margins. As production continues, the device matures, as the technology that underlies it matures. Continued production of a mature device does not provide profit to fund the research and development necessary to renew the technology that permits the innovative advantage in costs and pricing. Indeed, the rapid advance of technology in the IC industry has frequently forced firms to abandon the production of devices only a few years old, in order to begin production of ones based on newer technology. 2/

Markets and marketing

Sales by type of market.--U.S. producers of integrated circuits were asked to report the destination of their domestic sales by type of market. Firms accounting for * * * percent 3/ of U.S. domestic shipments by U.S.-based firms reported the percentage distribution by product type of IC sales during 1974-78. These data are shown in aggregated form in table A-35.

Sales to distributors, who sell to a variety of equipment manufacturers, grew rapidly from about 14 percent of the total in 1974 to 25 percent in 1978. The market for integrated circuits for use in communications equipment also showed such steady development, increasing from 4.6 percent to 7.8 percent of domestic sales in the period. If the output of * * * were included in sales of * * *, the relative size of this market would undoubtedly increase.

The share of total sales accounted for by the consumer products market declined from nearly 17 percent in 1974 to less than 11 percent in 1978. Sales

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1/ Sciberras, Edmond, Multinational Electronic Companies and National Economic Policies, (Greenwich, Connecticut, Jai Press, 1977), pp. 24-25.

2/ Proceedings, p. 21; Tilton, John E., International Diffusion of Technology: The Case of Semiconductors, (Washington, D.C., The Brookings Institution, 1971), pp. 86-87.

3/ Six firms--* * *--did not supply the requested data on their shipments. * * * are computer manufacturers; * * * supplies its own * * * and * * *. * * * is a components producer not associated with any particular end product.

for government use also declined in relative importance, from a period high of 15 percent in 1975 to only 9 percent in 1978. Sales for industrial use accounted for 10.6 percent of total reported sales in 1978, while use of integrated circuits by the automobile industry accounted for only 1.1 percent of the total.

Computer market for integrated circuits.--Nearly all U.S. integrated circuit producers serve the computer market, at least to some extent. Some firms, * * * serve both captive and merchant markets; and others, * * *, serve only the merchant market. In Japan and Europe, nearly all integrated circuit producers are vertically integrated firms and many of them also produce computers.

At the present time, the U.S. computer industry is the largest single customer of the U.S. integrated circuit industry. In its questionnaire to producers, the U.S. International Trade Commission asked for the percentage of total domestically produced integrated circuit sales which were for use in computers. The U.S. firms which responded represented 81 percent of the value of shipments of all reported U.S.-produced integrated circuits in 1974 and 77 percent in 1978. The ratio of U.S. sales of integrated circuits for use in computers to total U.S. shipments of integrated circuits was * * * even though the total value of U.S. shipments of IC's increased by * * * percent during 1974-78.

Integrated circuits: Total U.S. domestic shipments and U.S. domestic sales to the computer industry, by types, 1974 and 1978

Type	1974			1978		
	Total	To computer industry	Ratio computer to total	Total	To computer industry	Ratio computer to total
	1,000 dollars	1,000 dollars	Percent	1,000 dollars	1,000 dollars	Percent
Linear	156,552	***	***	227,986	25,286	11
Digital bipolar	488,712	***	***	653,990	239,996	37
Digital MOS	379,866	***	***	886,198	454,036	51
All other	178,751	***	***	312,071	10,668	3
Total value, average price	1,203,881	***	***	2,080,245	729,986	35

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Factors affecting sales.--U.S. producers of integrated circuits ranked the marketing factors that were most important to success in selling to domestic and foreign customers. In the United States, price was considered the most important factor, followed by product quality and terms of delivery. Technical support was of least importance. U.S. producers felt that in the European market, quality and delivery, followed closely by technical support, were the most important marketing factors. The price of U.S.-made circuits in that market seemed to be the least important consideration. U.S. exporters to Japan identified quality as the overwhelming marketing factor in that country. Price and delivery were of secondary importance, and technical support was not seen as important by any major supplier to the Japanese market.

Because the quality of integrated circuits is an important factor in purchasing decisions for major end-users, the Commission's questionnaire surveyed U.S. and foreign firms concerning differences in product quality and test procedures. U.S. producers' responses were divided, with about half of the firms contending that Japanese IC devices are more thoroughly tested before sale, and therefore give the appearance of increased quality and reliability. A number of Japanese respondents contended, however, that Japanese IC devices were superior in design and craftsmanship to those of competitors. They attributed the superior design characteristics to extensive consultation with in-house users of the circuits. Better workmanship was the result of a more disciplined, dedicated work force and more fully automated assembly lines, they claimed.

Representatives of the U.S. integrated circuit industry testifying before the Commission were emphatic in their denials that U.S. circuits differed in quality or reliability from those of Japanese manufacture. Members of the Semiconductor Industry Association (SIA) testified that the manufacturing processes were essentially similar and that independent laboratory tests had shown no difference in reliability in use between the two. They maintained that the "double" testing techniques of the Japanese were expensive ("It is an economic issue, not a quality issue.") and that they considered this "better deal" given to buyers of Japanese circuits a type of market penetration technique. 1/

Distribution methods.--U.S. producers were asked to list the lines of distribution used in selling integrated circuits in U.S. and foreign markets. Of the domestic firms responding to the Commission's questionnaire, six stated that they were vertically integrated firms and that all or virtually all their IC output was supplied to in-house users for incorporation in other products. A number of the remaining companies also consume a portion of their own IC production, but the major portion of their output is sold to distributors or original equipment manufacturers unrelated to their companies.

1/ Proceedings, pp. 78-79, 196 ff; Third Composite Supplemental Submission to the United States International Trade Commission, Investigation No. 332-102, June 21, 1979.

Vertically-integrated firms.--More than one-half of total shipments of U.S. firms are to related parties, that is, to other branches of the same company. The * * * reporting firms whose captive shipments constitute all or virtually all of their output are * * *.

In these firms, marketing and distribution decisions are made with the end product that uses integrated circuits in mind. Market research costs are reduced, since the market is determined by the demand for the end-product. The development of new devices is less risky, since it is done with an exact product in mind. Coordination in custom-designing the device for its final use is easier within a company. Typical distribution problems concerning final price, delivery, and quality are minimized, and the end-product division has a controlled source of supply of integrated circuits.

In addition, captive establishments producing integrated circuits are not susceptible to open-market conditions such as those faced by independent producers. An assumed demand for their output, a share in end-product profit, and access to research and development funds generated by other divisions of the parent firm cushion captive IC producers from business cycle downturns or capital shortages that may damage the long-range planning of independent producers.

Insulation from business cycle swings, however, can be accompanied by isolation from market forces, and lessened competitive demands may slow reaction to new markets and limit the drive for technological growth. The semiconductor division of a firm more interested in its end-product output may be forced to produce uneconomic quantities of devices and thus forgo the cost economies of volume production. The IC producer divisions lose some independence and product development control to the internal demands of the parent firm and are likely to be bound by a much larger bureaucracy than independent producers. Moreover, the part of the firm's IC output sold outside the company may suffer in the open market if it is only a residual to the parent firm's needs. Other end-product IC users may not want to depend on a competitor for IC supplies.

Open-market distribution channels.--U.S. firms reporting substantial sales in the open market most often use independent distributors in selling in the United States. They stated that they also sold directly to OEM customers and through sales representatives. In foreign markets, sales to distributors and direct sales were more often used than a company sales office to supply customers. Four U.S. firms, * * *, reported sales in Japan through trading companies.

In general, the U.S. companies that responded to the Commission's questionnaire did not find their overseas distribution lines less efficient than their domestic practices. However, several reported that distribution in Japan was difficult owing to "layers" of buyers, each absorbing a level of profit, and thus eroding the price competitiveness of the imported device. All exporting firms also stated that a manufacturing presence in the overseas market was essential for sales and distribution on a large scale.

Research and development and technological advancement

The growth of the multibillion-dollar integrated circuit market is related to expenditures for research and development (R. & D.) and the advance of technology. U.S. firms spent over a half a billion dollars in 1978 for R. &. D. (table A-36). Total productive output fell in 1975 due to the recession, but R. &. D. expenditures in 1975 were up 28 percent over those in 1974. In 1976 there was a slight decline in overall expenditures, followed by a 10 percent increase to $466 million in 1977.

* * *. For all other companies reporting R. & D. expenditures, annual outlay doubled between 1974 and 1978 with no slackening in 1975 or 1976. The annual rate of increase in such expenditures for these companies from 1974 to 1978 was 19 percent a year. For all U.S. firms reporting, the compound growth in R. & D. expenditures was 12.6 percent a year during the same period.

Of the thousands of different individually designed integrated circuits, the random access memory (RAM) was selected by the Commission to illustrate technological advancement resulting from R. & D. In the higher storage capacities, the RAM is very difficult to produce. The 64K RAM is the forefront of applied technology.

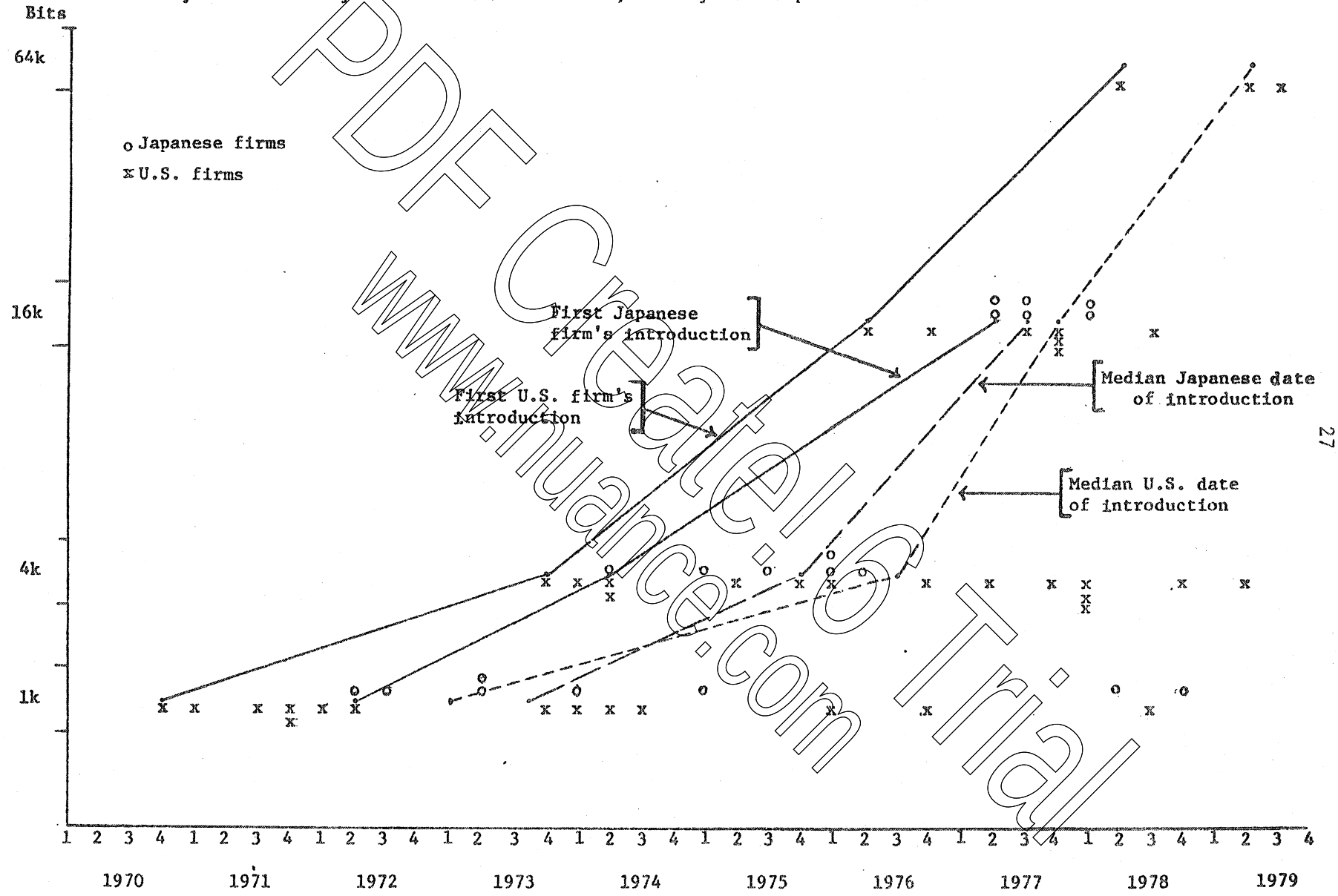
To show the advance in technology the introduction dates in production quantities of different size RAM's were plotted for each calendar quarter since 1970, as shown on figure 6. Since 1973, the most advanced companies have been able to quadruple memory capacity every 2 to 2-1/2 years. Along with U.S. firms, Japanese firms reported the introduction dates of the different capacity RAM's which are also shown on figure 6. The most advanced Japanese firms are from 1/2 to 1-1/2 years behind the most advanced U.S. firms. Two U.S. firms reported production of 64K RAMs and one U.S. firm provided an estimated introduction date (in production quantities) in the third quarter of 1979. Japanese respondents to the questionnaire gave no estimates for 64K RAM introduction in production quantities.

For the large majority of firms, funds for R. & D. are supplied from retained earnings. Only two companies reported any U.S. Government funding, and this in small amounts. A few firms reported R. & D. expenses as part of the cost of sales or out of current income.

Industry spokesmen have stated that more funds for research and development are needed if the industry is to maintain its technological preeminence. They suggest that the U.S. tax laws should be amended to allow an accelerated rate of depreciation on equipment used for research. Expenditures on research equipment are large and with the rapid rate of technological change in the industry, new, advanced equipment is continually needed.

The industry suggests that research and development funds should be provided in three different ways: (1) an investment tax credit for research; (2) a full tax credit up to 10 percent of a firm's research; expenditures for funds provided by the firm to an accredited university for research; and (3) an incentive to increase the level of research in the form of a 10-percent tax credit for research expenditures which exceeded the firm's average research expenditures for the previous 4 years.

Figure 6 .--Introduction 1/ of integrated circuit random access memory (RAM) technology by size of memory and date of introduction, January 1970-September 1979.



1/ In production quantities as reported in response to the U.S. International Trade Commission questionnaires.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Technology transfer

Technology flows between firms and countries through several channels. Some of these channels, as identified in the Commission questionnaire, are joint ventures, engineering personnel turnover, licenses, liaison offices, technical papers, and other transfer such as copying.

The extent to which licensing agreements increase technology flows can be examined by looking at royalty payments and receipts (table A-37). If the payments and receipts of U.S. firms to each other are removed, then the flow between the United States and other countries remains. This flow is summarized for all types of integrated circuits in the following table.

Total royalty payments and receipts to and from the United States, by U.S. firms

(In thousands of dollars)

Transaction	1974	1975	1976	1977	1978
Receipts	***	***	***	***	***
Payments	***	***	***	***	***
Net	***	***	***	***	***

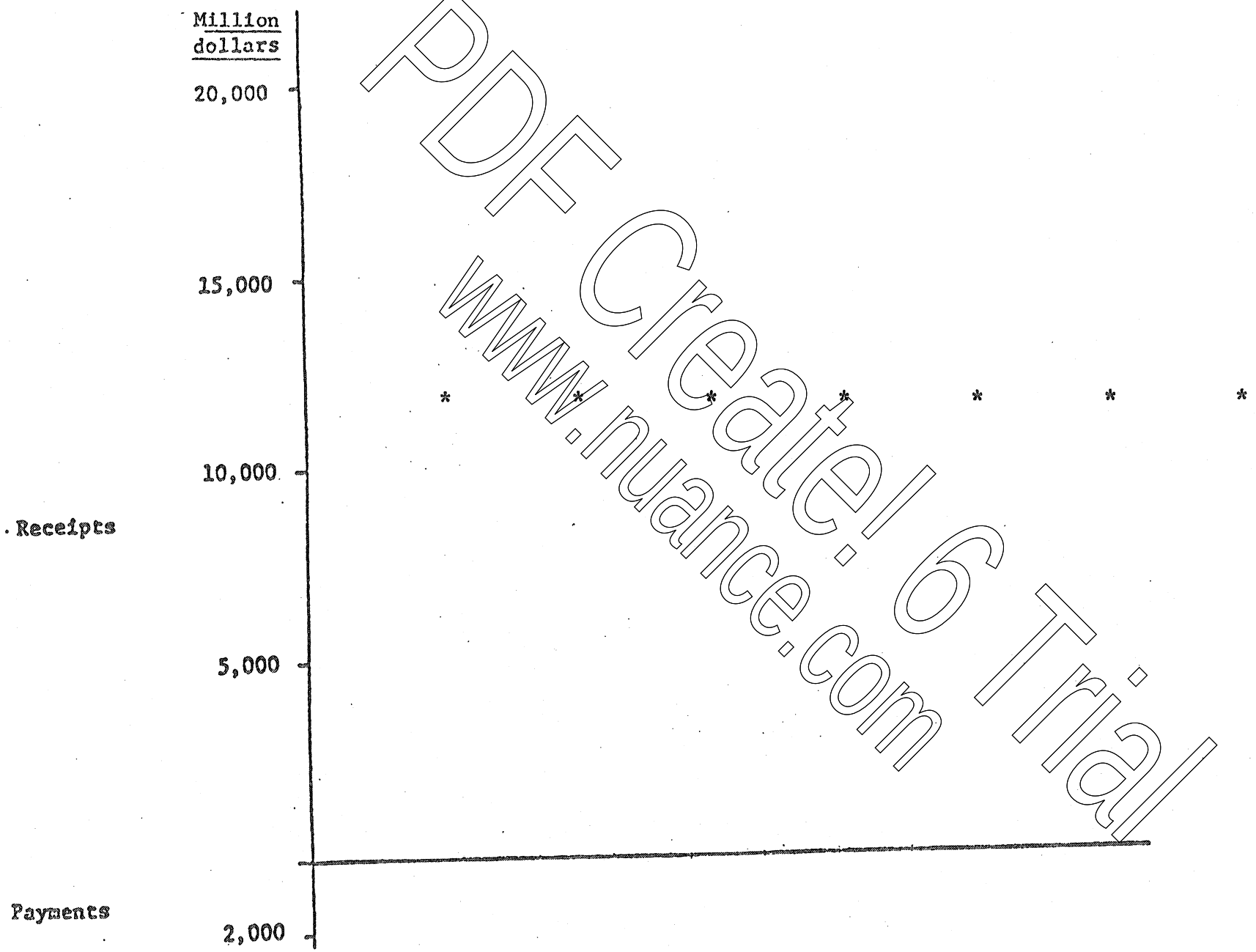
Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

In absolute terms the numbers appear small. However, cross-licensing agreements are frequently concluded without monetary remuneration. The flow to and from our major trading partners for 1978 is shown in figure 7.

Respondents to the questionnaire ranked the following technology transfer channels in order of importance: joint ventures, engineering personnel turnover, licenses, liaison offices, technical papers, and any other channels. Responses were to be given to both receipt and transfer out of technology, and to the source of the technology, i.e., in the United States or overseas. The following tabulation indicates the relative importance of the listed channels of technology transfer.

Transfer channel	Number of responses
Licensing	49
Technical papers	41
Liaison offices	21
Joint ventures	18
Engineering turnover	14
Other	4

Figure 7.--Royalty payments and receipts to and from U.S. firms, by countries, 1978



Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

The other types of technology transfer mechanisms reported are: purchase of a financially weak but technically strong firm, copying, product analysis, and consumer and vendor contacts. By using the ranking number for each of the responses as a weight, one may get a further breakdown of the importance of each channel.

For technology flow within the United States the weighted responses are:

Domestic	Transfer	Receive
Joint ventures	14	13
Engineering turnover	60	-
Licensing	61	9
Liaison offices	9	10
Technical papers	36	52

Engineering personnel turnover should probably be weighed carefully since no response gave any significance to receiving technology by hiring engineers and scientists. Licensing and technical papers were rated the most common means of communicating technical know-how.

With respect to the technology transfer to and from foreign sources, the weighted responses were as follows:

Foreign	Transfer	Receive
Joint ventures	16	9
Engineering turnover	-	-
Licensing	39	32
Liaison offices	16	16
Technical papers	35	45

The results posted above are essentially the same as those for U.S. internal flow of technology.

A final question was asked to elicit the importance of the technical education of foreign nationals in U.S. colleges and universities in the transfer of technology out of the United States. The responses pointed out that there are only a few universities capable of effectively teaching integrated circuit technology. Such education usually occurs in graduate level research programs. The most general response indicated that in-company training and experience were the basic source of expertise.

U.S. industry representatives allege that competitors in Europe and Japan are attempting to close the technology gap through, "an increase in licensing arrangements with U.S.-based companies for the most sophisticated commercial technologies, /and/ acquisition of controlling interests in U.S. firms and their technologies." 1/ A number of U.S. business observers indicate that the sale of U.S. technology to overseas buyers is increasing because of increasing foreign demand, barriers to U.S. exports, and profitable overseas direct investment. 2/

Information gathered from responses to the Commission's questionnaire and other sources regarding technology transfer is inconclusive. U.S. and Japanese firms producing integrated circuits were asked to list licensing agreements, cross-licenses, second-sourcing agreements, or joint technology development plans initiated within the last 5 years. Such licensing agreements reported by U.S. respondents totaled approximately 60 during the period 1974-78, 3/ increasing from 7 in 1974 to a high of 17 in 1977; there were 14 such licenses in 1978. The total includes 25 with Japanese-based and 30 with European-based firms. No trend in these agreements was noted since they are not exhaustive of solid-state technology transfer from U.S.-based firms to foreign firms. In addition, licensing and cross-licensing of patents in the IC industry do not always constitute real technology transfer, since the technology concerned may already be public.

U.S. investment

U.S. producers face the need to expand investment in plants and in equipment in order to serve an increasing demand for integrated circuits and to fund research needs for technology. Without the necessary U.S. investment, foreign producers are likely to increase capacity to supply the increasing demand, and U.S. producers are likely to lose worldwide market share.

The magnitude of the investment problem is demonstrated by the relationship between capital expenditures on plants and equipment and the value of industry shipments. In 1978, shipments from U.S. plants were $3.7 billion and investment in that year was $897 million, or about 25 percent of the value of shipments. Assuming an 18 percent annual growth 4/ in the value of shipments and a constant capital intensity ratio of 25 percent, the value of shipments of the producers reporting in the questionnaire will reach $22 billion in 1988, and the investment required to support those shipments is estimated at $5.5 billion. The assumption of the constant 25 percent ratio is conservative since producers are likely to become more capital intensive and their annual investment required in 1988 could reach $6.0 billion to $6.5 billion.

1/ Proceedings, p. 41.
2/ Wall Street Journal, Sept. 5, 1979, p. 11.
3/ Including two agreements concluded in January 1979.
4/ Annual growth in the value of U.S. shipments was 14 percent during 1974-78, but about 25 percent during 1976-78.

The availability of capital required to finance the investment and the willingness of the producers to commit investment funds even during a turndown in the business cycle are important considerations. The inability or unwillingness of manufacturers to invest sufficiently after the 1974-75 recession and an underestimation of market demand are, according to U.S. industry sources, the principal causes of the industry's current capacity problems. They argue that the present capacity limitation is a factor in providing foreign producers with the opportunity to broaden their customer base and to serve markets which U.S. producers are unable to serve.

The large investment needed to support future U.S. growth will have a different effect on large producers than on small producers. The large cost of necessary growth is more easily financed by large producers from internally generated funds. With their larger share of the market, large firms will have a higher equipment utilization rate, which will tend to make the large firms more investment efficient. Small- and medium-sized producers are likely to be more dependent on external sources of funds to finance growth and with a smaller market share and a lower equipment utilization rate, they tend to be less investment efficient. Thus, consolidations and mergers with end-product producers can be expected as investment demand grows and competition increases.

Factors affecting investment.--Sources of funds to finance future growth are limited to profits, equity, debt, depreciation and government incentives. Each of these sources is considered in detail below.

Profit.--Profit is the principal source of investment in the industry, and investment is made in anticipation of growth and future profit. Profit in the semiconductor industry, however, is lower than the average profit of all manufacturing industries. The investment of $3.3 billion in plants and equipment in 1974-78 has not resulted in higher profit to finance future investment. Instead, conditions of competition changed in the industry and benefits realized from increased automation and from the use of more efficient equipment were passed through to the end user in the form of lower prices (see following table).

Net earnings after taxes as a percent of sales, 1964-77

(In percent)

Year	Semiconductor manufacturing	All manufacturing industries
1964	5.2	5.2
1965	5.9	5.6
1966	5.3	5.6
1967	3.6	5.0
1968	3.4	5.1
1969	3.2	4.8
1970	1.1	4.0
1971	2.7	4.2
1972	5.0	4.3
1973	7.4	4.7
1974	6.1	5.5
1975	3.9	4.6
1976	5.4	5.4
1977	5.1	5.3
Average	4.5	5.0

Source: U.S. Department of Commerce, A Report on the U.S. Semiconductor Industry, September 1979, p. 57.

The reason that conditions of competition changed and profit was depressed can be traced to the volume-sensitive nature of the industry. As the leading producers place new and advanced equipment into operation, other producers must follow to maintain market share. Prices are bid down as other producers enter and subsequently begin production. Thus, an increase in investment and an increase in automation only assure an increase to a higher level of capital intensity and not an increase in profit. It is interesting to note that profit in the industry is higher when insufficient investment is made and capacity becomes limited. Owing to short supply, product prices are bid up. Under these conditions, however, foreign producers come in to serve the market.

The increasing capital intensiveness and stagnant profit in the industry make it difficult to finance investment growth internally. Further, according to questionnaire responses, as the technology moves toward very large scale circuit densities, production equipment to produce these increased densities is estimated to cost 8 times as much as production equipment to produce present large scale densities.

Equity.--Growth in the semiconductor industry financed from external funds comes principally from the issuance of capital stock. In 1977, equity accounted for 85 percent of external funds used by the industry, rising from 78 percent in 1974. In comparison, equity accounted for 72 percent of capital funds used by all manufacturing industries as shown in the table below.

Sources of capital funds for the semiconductor manufacturing industry and all manufacturing industries, 1969-77

Year	Equity		Long-term debt		Short-term debt	
	SC 1/	AM 2/	SC 1/	AM 2/	SC 1/	AM 2/
1969	70	72	29	22	1	6
1970	69	71	28	23	3	6
1971	70	71	28	24	2	5
1972	75	71	21	24	4	6
1973	80	71	18	23	2	6
1974	78	71	14	23	8	6
1975	83	72	13	24	9	4
1976	82	73	11	23	7	4
1977	85	72	10	24	5	4
Average	77	72	19	23	4	5

1/ SC is Semiconductor Industries.
2/ AM is all manufacturing industries.

Source: U.S. Department of Commerce, A Report on the U.S. Semiconductor Industry, September 1979, p. 56.

The industry's increased dependence on equity comes at a time when stock market prices are depressed and a price-to-earnings ratio range of 10 to 13 is commonplace even for large producers. During the 1960's, the market price of the stock of growth companies frequently traded 30-40 times earnings. Under present conditions in the equity market, producers are required to float an increased number of stock shares to raise the same amount of capital. The increased reliance on equity by the industry even during these depressed conditions indicates either a reluctance to rely on debt or a reluctance of financial institutions to make sufficient loans available.

Industry spokesmen argue that a significant problem facing a growing industry is raising sufficient equity capital. A partial solution, they say, would be to postpone capital gains taxes on the sale of securities. In this plan, the capital gains taxes could be postponed if proceeds of the sale were reinvested in either a new-issued stock or were invested in a long-term corporate instrument. The investor would be provided with a reinvestment schedule not to exceed 6 months from the date of sale.

Debt.--Debt is declining relatively as a source of external funds in the industry (previous table). In 1977, long- and short-term debt combined accounted for only 15 percent of external sources of capital funds. Industry reports state that, as a result of the 1974-75 recession, the industry is less willing to depend on debt financing. During the recession, a number of firms experienced difficulty in meeting principal and interest payments when distributors returned a large volume of integrated circuits which had been double-ordered.

Depreciation.--The semiconductor industry is characterized by continuous technical advances and rapid obsolescence of production equipment. The rate of obsolescence is higher than the average rate of obsolescence in all manufacturing industries. The higher rate of obsolescence provides a source of funds to the industry which is proportionally larger than that provided to all manufacturing industries. Funds generated in the industry through depreciation are estimated at $200-$300 million for 1978.

Industry official argue that the useful life provision of the investment tax credit law should be revised to reflect the real rate of obsolescence. The industry's position is that equipment used in this high technology industry has an average economic life of 3 years; thus, to remain competitive, new equipment should be brought into operation after such a period. In a submission to the Commission, the industry argues that the useful life provision should be reduced to 3 years and the entire 10 percent investment tax credit should be provided. An industry alternative calls for the removal of the useful life tax provision from the investment tax statute.

Foreign investment incentives.--According to industry sources, incentives provided by foreign governments offer an attractive means of financing industry growth. Funds provided through incentives by foreign governments reduce the industry's dependency on external capital markets. However, incentives are given a lower priority in U.S. investment strategy than other investment factors. Incentives determine in part where the investment is made not why the investment is made, according to industry spokesmen. The principal motives of U.S. investment abroad, they say, are market access to the EEC and low labor rates and a stable workforce in the Far East. The 17-percent rate of duty and local content requirement in the EEC, necessitate a local presence for effective competition in the European market.

Once a corporate decision is made to expand to a foreign location, various inducements are offered by countries seeking the investment to promote employment and exports. The final choice of location is largely determined by the incentive package offered by one country compared with the incentive package offered by another. The inducements usually take the form of cash grants, tax holidays, and various financial arrangements. The incentives, as reported in questionnaire responses, are detailed in appendix B.

Investment in plants and equipment.--U.S. semiconductor industry investment worldwide in plants and equipment exceeded $3.2 billion during 1974-78. Investment in production equipment accounted for the largest share of expenditures, being about 2.5 times larger than expenditures on plants and plant improvements. About 77 percent of expenditures were invested in the United States, followed by * * * percent in Western Europe and * * * percent in Asia. * * * were the countries with the largest U.S. investment. Investment by U.S. producers in the equity of foreign producers is minimal.

Investment in plants and plant improvements.--The semiconductor industry spent in excess of $943 million on plants and plant improvements worldwide during 1974-78 (table A-38). About $662 million was spent in the United States, followed * * * million in Western Europe and * * * million in Asia. The * * * million investment in Western Europe does not include the

value of investment incentives provided by respective governments. The largest increase in investment in plants and improvements occurred in 1978, when expenditures increased by 43 percent.

Investment in the United States in integrated circuit plants decreased from $135 million in 1974 to $103 million in 1975 and increased steadily each year to $173 million in 1978. The 25 percent decline in investment in the United States in 1975 reflects the impact of the recessionary period on the industry. Questionnaire responses show that the amount of investment made in the industry in 1974 was not exceeded until 1978.

The recession of 1974-75 affected U.S. investment in Asia much like U.S. investment in the United States. Investment in plants and improvements in Asia decreased irregularly from * * * million in 1974 to * * * million in 1977, and then increased to * * * million in 1978. Like the level of investment in the United States, the level of U.S. investment in Asia did not exceed the 1974 amount until 1978.

Investment in Europe by U.S. firms did not follow the same pattern as in the United States and Asia. The investment pattern in Europe is highly influenced by the investment strategies of a few large U.S. producers. The 1974-75 recession had a much smaller impact on U.S. investment in Europe. Investment in Europe increased from * * * million in 1974 to a peak of * * * million in 1976 reflecting major capital expansion by U.S. firms. In 1977, investment fell to a more traditional level of * * * million, then rose to * * * million in 1978.

* * *. Total U.S. investment in plants and plant improvement in 1974-78 is shown in the following tabulation:

Country	Investment (1,000 dollars)
United States	661,672
West Germany	***
France	***
Singapore	***
Japan	***
United Kingdom	***
Malaysia	***
Taiwan	***
All other	***
Total	943,202

Investment in production equipment.--U.S. investment in production equipment increased from $355 million in 1974 to $663 million in 1978 (table A-39). The investment totaled $2.3 billion during the period and was about 2.5 times as large as investment in plants and plant improvements. Equipment

purchased and placed in operation in the United States accounted for about 78 percent of investment, followed by Western Europe with * * * percent and Asia with * * * percent. Investment worldwide by U.S. firms in 1978 was greater than the total amount invested during 1975-77.

During 1974-78, there was no noticeable shift in U.S. investment in production equipment from the United States to Asia or Western Europe. In 1974, investment in the United States accounted for about 77.7 percent of total investment and in 1978, the United States accounted for about 76.3 percent of total investment. The following tabulation shows the percentage distribution of U.S. investment in production equipment, by areas, for 1974-78:

(In percent)

Area	1974	1975	1976	1977	1978	Average
Asia	***	***	***	***	***	***
Europe	***	***	***	***	***	***
United States	77.7	79.4	82.0	76.1	76.3	78.0
All other	***	***	***	***	***	***
Total	100	100	100	100	100	100

* * *. Total U.S. investment in production equipment, by principal countries, for the years 1974-78 is shown in the following tabulation.

Country	Investment (1,000 dollars)
United States	1,814,595
France	***
West Germany	***
Malaysia	***
United Kingdom	***
Singapore	***
Taiwan	***
Japan	***
All other	***
Total	2,325,573

Foreign investment in the U.S. semiconductor industry

A large increase in the value of foreign equity investment in the U.S. semiconductor industry has taken place during the last decade. Rising from $285,000 in 1969, the value of foreign ownership increased to $152.8 million in 1978 and is likely to increase substantially in 1979 (table A-40). Most of the equity ownership has resulted in majority (or controlling) interests.

Growth of foreign investment in the industry largely came about beginning in 1975. Prior to that time, foreign investment was valued at about $4.7 million with the principal investment being the purchase of 77 percent of the equity of Micropower in 1971 by Daima Seikosha (Seiko) of Japan for $3.4 million.

In 1975, the purchase of the Signetics Corp. for $43.9 million by the United States Philips Trust marked the first significant foreign entry into the U.S. industry. The United States Philips Trust is owned by shareholders of N.V. Philips, the Netherlands. At the end of 1975, foreign investment reached $51.3 million, or about 11 times as high as in 1974.

In 1976, additional foreign investment was rather limited. During that year, Supertex was purchased by Hong Kong interests and MOS Technology was purchased by Commodore International, Limited. Financial details on these investment purchases are not available.

In 1977, foreign investment in the industry increased by $92.1 million principally through the activities of West German investors. In that year, Siemens, Gmbh., of West Germany purchased 80 percent of the equity of Litronix and 20 percent of the equity of Advanced Micro Devices. Robert Bosch, Gmbh. of West Germany purchased 25 percent of the equity of American Microsystems and VDO purchased 25 percent of Solid State Scientific. The combined West German investment in the industry in 1977 was valued at $61.7 million; at the end of 1977, total foreign investment stood at $143.4 million.

Foreign investment increased by $8.9 million in 1978 with the purchase of Electronic Arrays, Inc., by Nippon Electric Co., Limited, of Japan. The purchase of Electronic Arrays represents the largest investment by Japanese interests in the U.S. industry. Total foreign investment increased to $152.3 million in 1978.

In May 1979, Schlumberger, Limited, tendered an offer of about $363 million for the equity of Fairchild Camera and Instrument. If approved by the Federal Trade Commission, this purchase will increase foreign investment in the U.S. semiconductor industry to $515.3 million.

Other than investment in U.S. producers' equity, the principal foreign investment in the U.S. semiconductor industry is the establishment of INMOS, Limited, Colorado Springs, Colo., funded by the National Enterprise Board (NEB) of the United Kingdom. With an initial funding of $50 million from NEB, INMOS is engaged in research and development of advanced, high-density memory circuits. INMOS is currently being considered by NEB for an additional $50 million grant. 1/ The key research engineers employed by INMOS were previously employed by Mostek, the leading U.S. producer of large scale memory circuits.

Western Europe has been the principal source of foreign investment. France is the largest investing country (assuming the Fairchild tender is approved), followed by West Germany and the Netherlands. France accounts for about 70.4 percent of the value of foreign investment, West Germany accounts

1/ Electronic News, July 23, 1979, p. 10.

for about 12.0 percent, and the Netherlands accounts for about 8.5 percent. Investment by Japan is valued at $16.1 million, or about 3.1 percent of investment from foreign sources, as shown in the table below.

Total foreign investment in the U.S. semiconductor industry, 1969 to present

Investor	Investment	Percent of total
	1,000 dollars	
United Kingdom	9,600	1.9
Bahamas	10,000	1.9
Canada	11,151	2.2
Japan	16,063	3.1
Netherlands	43,850	8.5
West Germany	61,653	12.0
France	363,000	70.4
Hong Kong	1/	-
Total	515,317	100.0

1/ Not available.

Source: Compiled from table A-40.

Foreign investment in the industry has been directed at high technology firms located in the area south of San Francisco. Investment provides accessibility to U.S. technology and easy entry to the large U.S. market. Sales of integrated circuits of U.S. firms controlled entirely or in part by foreign investors exceeded $853 million in 1978.

The growing level of foreign investment can be traced to two factors--poor financial performance by certain U.S. producers of integrated circuits and depressed conditions in the U.S. stock market. The profitability of Fairchild Camera is lower than the average profitability for the industry, and Litronix was operating under bankruptcy conditions in 1977 when purchased by Siemens. The equity of Advanced Micro Devices and American Microsystems was purchased by West German interests in 1977 at a premium significantly above the traded value. The current offer by Schlumberger for Fairchild Camera's stock was almost double the traded value a few months earlier. Fairchild previously had rejected a tender by Gould, Inc. (U.S. firm), which represented an offer of more than 50 percent above the market value. Increased foreign investment can be expected as the industry matures and competition becomes more intense.

SIA officials, in testimony before the Commission, indicated that they feel the devaluation of the U.S. dollar and the advantages associated with close access to the U.S. market have encouraged foreign IC producers to invest in U.S. semiconductor firms. They contend it was "cheaper to buy technology and U.S. market share through the purchases of existing companies, rather than through the in-house development or adaptation of the latest technologies." 1/

1/ Proceedings, p. 42.

A representative of the Electronics Industries Association of Japan (EIAJ), stated that a number of the recent direct foreign investments in the U.S. semiconductor industry were in companies whose financial situation was precarious; "that is, the sales of these firms were extremely weak or negative. The capitalization was not there and they were bailed out." 1/ He further suggested that the central problem was the availability of outside capital, and that, in search of funds for expansion and development of new products, U.S. firms producing integrated circuits were integrating vertically or encouraging direct investment. 2/ Partially supporting this point was the testimony of W. J. Sanders, chairman of the board of Advanced Micro Devices (AMD). Siemens holds a 20-percent interest in AMD, acquired at a time when the company needed a large infusion of capital, and other funds were unavailable. 3/

Foreign industries

Industries producing integrated circuits are located principally in industrial countries even though developing countries are vitally important in the production process. Among the foreign industrial countries, Japan appears to have established the most formidable integrated circuit industry.

The Commission attempted to establish the relative strengths of the foreign industries by sending questionnaires to major producers in foreign countries. Producers in European countries failed to respond. Only the Japanese cooperated by responding to the Commission's questionnaires.

Japanese industry.---The Commission submitted questionnaires to the 10 largest Japanese producers soliciting their cooperation in establishing a worldwide data base in production and trade in integrated circuits. The questionnaires submitted to Japanese producers were virtually identical to those submitted to U.S. producers.

The responses received from Japanese producers were aggregated in part by the Japanese Ministry of International Trade and Industry (MITI), unlike responses received from U.S. producers, which were mailed directly to the Commission and aggregated by the Commission staff.

When the consolidated Japanese responses were received, the covering letter to the Commission from MITI advised:

> MITI has gained an impression from the industry concerned that it would be reluctant for an individual firm unit to submit voluntarily its own answer to your questionnaire. Under these circumstances, MITI office has now ventured to act as go-between in an effort to help eliminate what individual manufacturers are worrying about by making a sum of their data. The reason why MITI has decided to sum up data of individual companies is based on the above policy to which you have already agreed.

1/ Proceedings, p. 268.
2/ Ibid., p. 269.

The Commission had previously agreed to accept the MITI aggregated response since the alternative would have been no response at all. MITI assured the Commission that the data were aggregated and the information was not altered in any respect.

Producers.--The semiconductor industry in Japan is heavily concentrated with five large, vertically integrated end-product producers (Nippon Electric, Hitachi, Toshiba, Matsushita, and Mitsubishi) accounting for about 66 percent of the total integrated circuit production of native firms. Further, the next five largest producers (Sharp, Sanyo, Sony, Fujitsu, and Oki), which are also vertically integrated end-product firms, account for about 16 percent of output. The largest Japanese producer, Nippon Electric, appears to possess both technical and market strengths to compete with the largest U.S. producers.

Japanese producers have established assembly plants in a number of developing countries including Ireland, Malaysia, and the Republic of Korea. Compared with the investment of U.S. producers, the investment by Japanese producers in these countries is small. Japanese producers tend to add more unit product value in Japan than U.S. producers add in the United States.

Unrelated parties provide the largest market in Japan for Japanese-produced integrated circuits. In 1978, shipments of integrated circuits to unrelated parties accounted for 62 percent of total Japanese shipments. Questionnaire responses show that shipments by Japanese producers to service internal demand of their end-product divisions (related parties) were consistently lower than shipments to unrelated parties during 1974-78.

Production.--Production data of the 10 largest Japanese producers showed a steady increase from 256 million units in 1974 to 964 million units in 1978 (table A-41). The largest increases came in 1976 and 1978, when production increased by 80 percent and 46 percent, respectively. A production decrease was not reported by the largest producers in 1975 even though official statistics show that output for the industry did decline in that year. The share of Japanese production accounted for by the 10 largest producers is shown in the table below.

Integrated circuits: Ratio of production quantity of 10 largest producers to production of Japanese industry, by types, 1974-78

(In percent)

Type	1974	1975	1976	1977	1978
Linear	89.4	113.1	94.7	86.9	87.7
Digital bipolar	65.5	76.6	75.0	60.1	59.0
Digital MOS	86.0	102.0	85.7	92.7	100.4
All other	26.8	46.9	38.7	32.8	44.2
Total	76.9	96.5	85.9	78.8	81.9

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission and from statistics of the Japanese Ministry of International Trade and Industry.

Production of Japanese foreign subsidiaries.--Production of integrated circuits in foreign locations by the largest Japanese producers increased from about * * * units in 1974 to about * * * units in 1978 (table A-42). The Republic of Korea was the largest source, accounting for about * * * units in 1978, or about * * * percent of total foreign production. Ireland and Malaysia accounted for the remainder. Unlike U.S. foreign production, the production of integrated circuits by Japanese producers in foreign countries is small, about * * * percent of total production.

Domestic shipments (excluding exports).--Domestic shipments in Japan increased from $264 million in 1974 to $931 million in 1978 (table A-43). These data reported in the questionnaire responses are slightly higher than those reported in official Japanese statistics. Shipments increased each year during the 5-year period including the recessionary period of 1974-75. The greatest period of growth occurred in 1978 when the value of shipments increased by 66 percent.

The largest Japanese producers reported that domestic shipments of integrated circuits to related parties increased from $110 million in 1974 to $354 million in 1978 (table A-44). The value of shipments to related parties accounted for about 42 percent of the value of total shipments in 1974, but declined irregularly to 38 percent in 1978.

The merchant market is the largest market in Japan, about 63 percent larger than the captive market. Shipments to the merchant market were valued at $577 million in 1978, compared with $155 million in 1974 (table A-45).

Domestic shipments by foreign subsidiaries (excluding exports).--Domestic integrated circuit shipments of foreign subsidiaries of Japanese producers were made by only two countries--the Republic of Korea and Ireland (table A-46). However, such shipments dramatically increased in value during 1974-78, and were predominantly from * * *. No domestic shipments * * * and in 1978 more than * * * percent of total shipments of foreign subsidiaries were from * * * as well as the great bulk of shipments to unrelated parties (tables A-47 and A-48). Total shipments by Japanese foreign subsidiaries increased from * * * in 1974 to * * * million in 1978.

Exports.--Total exports by Japanese producers of integrated circuits increased in each year during 1974-78, rising 54-fold from $3.6 million in 1974 to $204 million in 1978 (table A-49).

As shown in tables A-50 and A-51, Japanese producers' exports to related and unrelated parties generally followed the same trend as total exports during the 1974-78 period. Approximately * * * of the value of exports in 1978 was to related parties.

Data on Japanese exports by geographical areas and countries were not fully reported by responding Japanese producers. A few producers which account for a large share of the value of exports did not report country detail.

North America became the largest market for Japanese producers exports in 1977 when it accounted for * * * percent of the value of Japanese exports of IC's. Asia accounted for * * * percent in that year; it had previously been the major market. In 1978, North America received * * * percent of the value of Japanese exports, Asia, * * * percent, and Europe, * * * percent. Each of the three major markets is growing rapidly (table A-52).

Exports from * * * accounted for most of the exports of Japanese foreign manufacturing subsidiaries (table A-53). Fast-growing exports from * * * accounted for the remainder. Exports from Malaysia began in 1975 and those from * * * , in 1976. Yet in 1978 the * * * represented 42 percent of the value of exports, * * *, 35 percent, and * * *, 23 percent.

* * * * * * *

Imports.--Japanese producers imports of integrated circuits increased each year during 1974-78. The value increased from $33 million in 1974 to $90 million in 1978 (table A-55). Japanese producers are not major importers of integrated circuits, therefore these data are substantially lower than the value of Japanese imports as reported in official statistics (table A-56). Japanese producers' imports from related parties (table A-57) were only * * * as large as the value from unrelated parties (table A-58) but grew rapidly.

Consumption.--Japanese consumption was computed from official Japanese statistics owing to the low value of imports reported by Japanese producers. Japanese consumption more than doubled during the period 1974-78. The value increased from $408 million to $961 million (table A-59). The share of consumption supplied by imports decreased from 44 to 27 percent during the period. Although the value of imports fluctuated each year, the value of exports increased at a rapid pace and accounted substantially for the decreasing penetration ratio.

Trade Balance.--According to official Japanese statistics, the trade balance in integrated circuits has changed from $155 million negative in 1974 to $52 million negative in 1978 as shown in the table below. The negative trade balance is becoming smaller principally because of the rapid rate of growth of Japanese exports compared to the growth of Japanese imports. The appreciation of the Japanese yen against the U.S. dollar during 1976-78 does not appear to have affected the growth of exports.

Integrated circuits: Japanese trade balance, 1974-78

(In thousands of dollars)

Item	1974	1975	1976	1977	1978
Japan:					
Imports	178,553	134,351	199,026	186,866	255,092
Exports	23,330	45,295	56,583	97,794	203,003
Balance	-155,223	-89,056	-142,443	-89,072	-52,089

Source: Compiled from official statistics of the Japanese Ministry of International Trade and Industry and the Japanese Ministry of Finance.

Note.--Yen/dollar conversion: 1974-286, 1975-298, 1976-297, 1977-274, and 1978-212.

Employment.--Total Japanese domestic employment directly engaged in the manufacture of integrated circuits is a very small proportion of the total employment of Japanese IC producing firms, less than 7 percent in 1978. This is due to the size and diversity of the parent companies engaged in IC manufacture in Japan and to the vertically integrated structure of the Japanese electronics companies producing integrated circuits. As shown in table A-60, total domestic employment and employment in the semiconductor division of these firms fell between 1974 and 1978. The number of employees directly engaged in IC production grew, however, from 16,126 in 1974 to 20,416 in 1978.

Table A-61 shows employment in the foreign subsidiaries of Japanese IC-producing firms. Total employment in these establishments is small but has grown quite rapidly, from * * * in 1974 to nearly * * * in 1978. Most of these workers are engaged in the production of semiconductor devices other than integrated circuits.

Prices and pricing.--Eight Japanese IC-producing firms reported their net selling prices to domestic OEM customers, including those for largest selling devices in several categories during 1977 and 1978. These average unit selling prices were reported on a quarterly basis, f.o.b. point of shipment, in U.S. dollars. Unit values of intracompany shipments were not included. The following table presents weighted aggregate indexes of the reported prices of three types of integrated circuits, adjusted for yen/U.S. dollar exchange rate changes over the 2-year period.

Indexes of net domestic selling prices of selected types of integrated circuits produced by Japanese firms, by quarters, 1977 and 1978
(January-March 1977 = 100.0)

Period	Linear circuits	Digital bipolar circuits	Digital MOS circuits
1977:			
January-March	100.0	100.0	100.0
April-June	95.4	88.7	92.2
July-September	89.6	88.4	68.1
October-December	83.1	81.1	57.6
1978:			
January-March	88.4	88.2	54.0
April-June	81.6	85.2	51.5
July-September	70.9	76.3	44.6
October-December	70.8	77.0	43.8

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Note.--Yen/dollar conversion from International Financial Statistics, International Monetary Fund (series rf).

The reported dollar prices for Japanese produced IC devices were converted to their yen values in order to reflect the trend of these articles on their home market. When adjusted for exchange rate changes, reported average domestic prices for Japanese-produced IC devices fell sharply in all three categories during 1977-78. The most rapid decline occurred in the reported prices for MOS integrated circuits.

Markets and marketing

Sales by type of market.--Japanese firms producing integrated circuits were asked to report the destination of their domestic sales by type of market. Table A-62 shows the percentage distribution by product type of these IC shipments in Japan in 1974-78.

Consumer product manufacturers constituted the largest single domestic market for IC's in the period 1974-78, ranging between 35 and 39 percent of the total market. Distributors were the other major market, accounting for a range of 27 to 40 percent of sales over the period.

Computers are the third largest market. The Japanese industry's response to the Commission's questionnaire showed that domestic sales of integrated circuits to the computer industry was 14 percent of total domestic shipments in 1974, but decreased to 7 percent in 1978 even though in dollar value, these sales to the computer industry more than doubled between 1974 and 1978. The following table shows sales of Japanese produced integrated circuits to the Japanese computer industry, as compared with total Japanese production of integrated circuits, by types, for 1974 and 1978.

Integrated circuits: Total Japanese domestic shipments and Japanese domestic sales to the computer industry, by types, 1974 and 1978

Type	1974			1978		
	Total	To computer industry	Ratio computer to total	Total	To computer industry	Ratio computer to total
	1,000 dollars	1,000 dollars	Percent	1,000 dollars	1,000 dollars	Percent
Linear	***	***	***	***	***	***
Digital bipolar	***	***	***	***	***	***
Digital MOS	***	***	***	***	***	***
All other	***	***	***	***	***	***
Total	264,093	36,088	14	930,966	62,536	7

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Compared to the computer market in the United States, the market in Japan is small. This size difference accounts for the lower share of Japanese made IC's shipped to the computer market. In addition, Japanese producers supply a larger market for linear IC's than do U.S. producers thereby diminishing the share of total IC's shipped to the computer market.

Factors affecting sales.--Eight of the 10 responding Japanese IC producers gave full or partial answers when asked to rank the marketing factors that were most important to success in selling to domestic and foreign customers. The Japanese respondents reported that the quality of the product was the most important factor favoring their sales of integrated circuits in all markets. Price and efficiency of delivery followed quality in importance in the United States and Western European markets from the Japanese perspective, and technical support was the least important factor. In their own market, Japanese producers ranked prices as the least significant factor affecting sales, and delivery was generally felt to be of less importance than product quality and technical support.

Distribution methods.--The Japanese electronic firms manufacturing integrated circuits are vertically integrated enterprises that consume a substantial portion of their IC output internally. These firms reported that the stability of demand and the close technical cooperation afforded by producing for internal use were helpful in the production and sale of their products. Moreover, they contended that marketing information costs, selling expenses, and development risks were lower when production, marketing, and distribution decisions were made with specific end products in mind. For sales outside the company, however, they reported that this corporate structure presents some difficulties. Sensitivity to the market and flexibility in product development are lessened. Layers of internal bureaucracy, priority delivery to internal customers, and the production of specialized devices in uneconomic quantities can reduce the competitiveness of the devices in the open market.

All of the responding Japanese firms sell IC devices to other IC producers and users in Japan and export to other markets. Eight of the companies listed the methods of distribution they used in Japan and overseas. In Japan and Europe, direct sales and sales to distributors were the most commonly used methods. Exports through sales representatives were uncommon in these markets. In the United States, direct sales and sales through manufacturers' representatives were most frequent, followed by sales to distributors. In addition, three Japanese producers used trading companies when exporting to the U.S. market.

Research and development.--Questionnaire responses show that Japanese producers increased research and development expenditures from $75 million in 1974 to $199 million in 1978. The largest increase occurred in 1978, when expenditures rose by 52 percent. See table below.

Research and development

(1,000 dollars)

Country	1974	1975	1976	1977	1978
Japan	75,020	76,007	99,751	130,936	199,207

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

All research and development by Japanese producers were accomplished in Japan with funding coming from each firm's general funds. One producer indicated that all research and development funds came from retained earnings, and no firm reported that funding came from Government sources.

Investment in plants and equipment.--Japanese producers' investment in plants and equipment totaled $459 million during 1974-78. Japanese producers' investment was small, equivalent to about 14 percent of U.S. investment during the period. Production equipment accounted for about 81 percent of investment, and plants and plant improvements accounted for about 19 percent. About * * * percent of the expenditures were invested in Japan; the remaining * * * percent were invested in Malaysia, the Republic of Korea, Singapore, and Europe (not separately provided by country). Japanese investment followed the same investment trend as U.S. investment after the 1974-75 U.S. recession.

Investment in plants and plant improvements.--Japanese investment in plants and improvements decreased from $9 million in 1974 to $4 million in 1975 and then increased to $30 million in 1978 (table A-63). The largest increase in plant investment occurred in 1976 when expenditures increased by about $17 million. (* * *.) Total Japanese investment worldwide in plants and improvements during 1974-78 is shown in the following tabulation.

Area	Investment (1,000 dollars)
Japan	***
Europe 1/	***
Malaysia	***
Total	88,855

1/ European investment by countries was not separately provided.

Investment in production equipment.--Japanese investment in production equipment increased irregularly from $32 million in 1974 to $142 million in 1978 (table A-64). The largest increase took place in 1978, when expenditures almost doubled. (* * * .) Total worldwide Japanese investment in production equipment, for the period 1974-78, is shown in the following tabulation.

Area	Investment (1,000 dollars)
Japan	***
Malaysia	***
Republic of Korea	***
Europe 2/	***
Singapore	**
Total	370,131

2/ European investment by countries was not separately provided.

Foreign investment in Japan.--In the past, restrictions have been placed on foreign investment in the Japanese semiconductor industry. The only U.S. producer located in Japan is Texas Instruments, which was first established in 1968 as a joint venture with Sony. At the time the joint venture was formed, TI reached an understanding with the Japanese Government that 50 percent of the joint-venture capital would be owned by TI, that the scope of production would be decided in consultation with the Japanese Government and that TI patents would be disclosed. 3/ Sony divested itself of the arrangement in 1971, allowing TI to obtain 100-percent ownership.

Without TI's strong patent position in 1968, it is unlikely that it could have established a production presence in Japan. At that time, Japanese producers were using TI patents to produce integrated circuits and were incorporating these circuits in end products exported to the United States. TI threatened to obtain an injunction prohibiting importation of these end products in the United States. Since then, Japanese laws have been modified to permit foreign control of manufacturing or sales establishments.

3/ Japan Fact Book 1978, p. 63.

* * * * * * *

Western European industry.--Producers of integrated circuits in Western Europe fall principally into two groups--vertically integrated native electronic equipment producers whose presence in Europe predates the semiconductor era, and subsidiaries of multinational semiconductor firms which were purchased or established in Europe after World War II. The principal native European producers are N. V. Philips of the Netherlands, Siemens of West Germany, and Thomson-CSF (Sescosem, the Thomson semiconductor division) of France. The General Electric Co. Ltd. (not affiliated with the General Electric Co. of the United States) and Plessey Company Ltd. of the United Kingdom and SGS-ATES of Italy are also producers of note. All six of the producers were sent Commission questionnaires, and all declined to participate. Other principal foreign producers are subsidiaries of such U.S. firms as IBM, Texas Instruments, Motorola, and Fairchild Camera. U.S. subsidiaries command a strong presence in Western Europe both in market share and technical strength. About 56 percent of European consumption of semiconductors is provided by U.S. producers. 1/

Producers.--N. V. Philips Gloeilampenfabriken of the Netherlands is a large multinational firm with gross sales of more than $16 billion in 1978, of which more than $12 billion were in electronic products. Philips has facilities in more than 60 countries. The Philips semiconductor operations have production plants in the Netherlands, West Germany, the United Kingdom, and France. In addition, Philips owns 100 percent of the equity of Signetics Corp., a major U.S. producer of integrated circuits located in Sunnyvale, Calif., and operates offshore facilities producing semiconductors in at least four locations. The company manufactures a complete line of integrated circuit products.

Siemens is another large vertically integrated multinational firm, headquartered in West Germany, and had gross sales of more than $13 billion in 1978, of which 41 percent were in electronic products. Subsidiaries are located in Europe, North and South America, Africa, and Asia. With the acquisition of 20 percent of the equity of Advanced Micro Devices, a major U.S. producer, in October 1977, Siemens is in a position to become more competitive with the U.S. industry in integrated circuits.

Thomson-CSF, headquartered in Paris, had sales of $3 billion in 1978, all of which were of electronic products. Also a multinational, vertically integrated firm, it has industrial and commercial subsidiaries in Europe, North and South America, Africa, and Asia.

The General Electric Co. Ltd., with headquarters in London, another vertically integrated multinational firm, has subsidiaries in Europe, North America, Africa, and Asia. Gross sales in 1978 were nearly $6 billion, of which 60 percent were of electronic products.

1/ Semiconductor Industry Association, State of the Semiconductor Industry, June 13, 1979.

SGS-ATES is the surviving Italian firm of the original Societa Generale Semiconduttori. Since 1978, it has been an electronics subsidiary of the Government controlled by Instituto per la Reconstruzione Industriale, and is virtually the only Italian company with a complete line of semiconductor products. Total sales of SGS-ATES in 1976 were $65 million, of which 88 percent were in components.

A key factor in the strong presence of U.S. firms in Europe has been their access to advanced technology developed and produced in the United States prior to introduction in Europe. Faced with smaller, fragmented markets, native European producers have funded less research and development and have delayed production of advanced technology until U.S. firms have achieved economies of scale and unit prices have fallen. It has been estimated by Mackintosh Consultants, Inc., that U.S. firms in Western Europe have a 2- to 3-year technology lead over native European producers, a significant lead in the integrated circuit industry.

Production.--European production of integrated circuits increased in value from $343 million in 1974 to an estimated $642 million in 1978 (table A-65). The member countries of the European Economic Community accounted for over 90 percent of total European production value in 1978.

Of the EEC countries, West Germany was the largest producer in each year, with its value of production steadily increasing from $112 million in 1974 to $250 million in 1978. It accounted for 39 percent of the European total in 1978. The second largest European producer was the United Kingdom, with values of $100 million in 1974-76 and $147 million, or 23 percent of the European total, in 1978.

France and Italy tied for the next largest European producer in 1978 with French production increasing from $74 million in 1974 to $84 million in 1978, except for a decrease to $65 million in 1975. The production trend for Italy was the same as for France, with an increase from $29 million in 1974 to $84 million in 1978 and a decrease to $15 million in 1975. The only other EEC member with an increase in the value of production was the Netherlands with an increase from $7 million in 1974 to $23 million in 1978, or more than 200 percent. The only EEC member country to show a decrease in production was Belgium, whose value of production decreased from $8 million in 1978 to $3 million in 1976 and remained at that level through 1978.

Of the European countries outside the EEC, the only sizable producer was Switzerland, whose production increased from $4 million in 1974 to $40 million in 1978. A small amount of integrated circuits value was produced by Denmark, Ireland, and Luxembourg; however, available statistics do not segregate integrated circuits from discrete semiconductors or components for these countries. Other countries reporting small amounts of integrated circuits production during the 1974-78 period were Austria, Spain, and Sweden.

An analysis of European integrated circuit production as described earlier, coupled with knowledge of the latest geographical movements, acquisitions by multinational integrated circuit manufacturers, and governmental policies, would indicate certain future trends in the European industry. Production in West Germany, the United Kingdom, France, and the Netherlands is

expected to increase in the foreseeable future. However, producers in these countries are not expected to seriously threaten the current dominance in Europe of the U.S. integrated circuit industry. Apparently the largest market for integrated circuits production in Switzerland is the Swiss electronic watch industry, which accounts for the large increase in that country's production during the last 3 years. However, this rate of increase is not expected to continue since indications are that the worldwide watch industry is beginning to level off. Production of integrated circuits in the Netherlands is expected to increase because of the large resources of N. V. Philips which can be made available and because of this firm's acquisition of the Signetics Corp. Production trends in the other European countries discussed previously are not expected to significantly change the allocation of the European market share among the major producers in the near future.

Imports.--Except for a decrease in 1975 owing to the economic downturn, total imports of integrated circuits by the EEC countries increased in value each year from $309 million in 1974 to $597 million in 1977, or by 93 percent (table A-66). West German and United Kingdom imports rose by 87 and 105 percent, respectively, during 1974-77, and in 1977 amounted to $365 million, or 61 percent of all EC imports. The value of imports of the major importing EEC countries (West Germany, France, United Kingdom, the Netherlands, and Italy), as well as aggregated imports of the remaining EEC countries (Belgium, Denmark, Ireland, and Luxembourg), peaked in 1977. Only French and Italian imports declined in 1977 from their 1976 peak.

The United States is the largest single source of EEC imports (excluding intra-EEC imports), accounting for more than 27 percent of the value in the period 1974-77 (table A-67). Intra-EEC trade supplied an additional 40 percent, and Singapore was the third largest source. EEC imports from Asia have grown more rapidly than those from North America; imports from Malaysia, Singapore, and Taiwan accounted for more than 10 percent of the total in 1977. Japan is not a major source of European imports, although the value of these articles from Japan increased rapidly from $1.1 million in 1974 to nearly $6 million in 1977. The fastest growing major source of imported integrated circuits for the EEC members, however, is other Community members. The growth of intra-EEC imports has averaged nearly 38 percent a year.

Exports.--Table A-68 shows integrated circuit exports by the major EEC member countries. Exports grew steadily from $137 million in 1974 to $276 million in 1976, then fell to $273 million in 1977. West Germany is the largest exporter, with its value of exports rising from $58 million in 1974 to $103 million in 1977, or by 78 percent. West Germany accounted for 38 percent of all EEC exports in 1977. The EEC is a net importer of integrated circuits, with imports ranging from 1.8 to 2.2 times exports during the 1974-77 period. A growing portion of this trade is within the EEC. The trade deficit with suppliers outside the Community fell between 1976 and 1977.

As shown in table A-69, Europe is the major market for EEC-produced integrated circuits, with an export value of $196 million, or 75 percent of total exports in 1977. Exports to European nonmarket economy countries increased from $1.8 million in 1974 to $4.6 million in 1977, but was less than 2 percent of total exports in the latter year. EEC exports to Asia totaled $22 million

in 1977, with Singapore the largest single Asian market, accounting for 44 percent of the total. Exports to Japan were 21 percent of the total Asian value in that year, but less than 2 percent of total European exports. The United States is not a large market for European integrated circuits, accounting for less than 4 percent of total EEC exports in 1976 and 1977.

Consumption.--The value of apparent consumption of integrated circuits by EEC members increased each year from $497 million in 1974 to an estimated $1.0 billion in 1978 (table A-70). The largest yearly increase was in 1978, when apparent consumption rose by an estimated 68 percent from consumption in 1977.

The ratio of imports to apparent consumption, except for a peak of 60 percent in 1976, remained fairly constant at about 45 percent for the 1974-77 period. Although import statistics for 1978 are not available, it is believed that imports sharply increased in that year, supporting the fear expressed by some Europeans that EEC production will not be able to keep up with demand and end-product producers will become more dependent on imported integrated circuits particularly the data processing industry. The ratio of exports to production increased from 18 percent in 1974 to 32 percent in 1976, but fell to 23 percent in 1977.

Trade balance.--During 1974-77, all EEC member countries for which trade data were available showed a trade deficit in integrated circuits in each year (table A-71). Belgium, Denmark, Ireland, and Luxembourg were treated as one group, which also showed a trade deficit in each year.

The total EEC unfavorable trade balance in integrated circuits increased from $171 million in 1974 to $323 million in 1977; however, in 1975, it decreased to $117 million. In 1977, West Germany had the largest trade deficit ($130 million), followed by the United Kingdom with $62 million, the Netherlands with $55 million, France with $50 million, and Italy with $11 million. Several EEC member countries are making serious efforts involving industry and Government combinations in attempts to reduce these trade deficits.

International Trade Flows

The U.S. industry and its foreign subsidiaries played a dominant role in exports by the world integrated circuit industry during 1974-78. The combined exports of integrated circuits by the U.S.-owned industry, the Japanese-owned industry and by the EEC industry 1/ grew in value throughout 1974-78 except for an 11-percent decrease in 1975. By 1978, world integrated circuit exports totalled about $1.6 billion, compared with $705 million in 1974.

In each year the exports of U.S. plants and U.S. foreign subsidiaries together made up the largest share of world exports, but the U.S. share dropped steadily from 91 percent in 1974 to 79 percent in 1978.

1/ Specific data on exports by EEC foreign subsidiaries are not available, but the information available clearly indicates that exports by such subsidiaries are comparatively small.

Almost all of the loss in share of exports by the U.S.-owned industry was accounted for by an increased share of exports by the Japanese industry. In 1978, Japanese producers' exports were valued at * * * million, * * * times the * * * million in 1974. If intra-EEC trade is excluded, EEC industry exports amounted to about $108 million in 1977 which was 83 percent above the $59 million in 1974. However, the Western European industry share of combined world exports dropped from a peak of 12.5 percent in 1974 to 7.0 percent in 1977.

The role in exports played by foreign subsidiaries was greater for the U.S. industry than for the Japanese industry. U.S. foreign subsidiaries' share of U.S. industry exports increased from * * * percent in 1974 to * * * percent in 1978, whereas the Japanese foreign subsidiaries' share decreased from * * * percent in 1976 and to * * * percent of total exports in 1978. The small world share accounted for by Japanese producers' foreign subsidiaries reflects a large increase (172 percent) in exports from the Japanese industry's home base.

The European market remains the principal market for exports from the United States. Of industry exports of integrated circuits from the United States during 1974-78, most were directed to European markets in West Germany, the United Kingdom, and France. Most of the remaining exports from the United States in that period went to Japan, increasing from about 15 percent in 1974 to 20 percent in 1978.

For U.S. industry foreign subsidiaries, the Republic of Korea, Malaysia (the fastest growing) and Singapore have been the important markets. In 1978, exports to these countries accounted for about * * * percent of the total.

Exports of integrated circuits from Japan were limited in 1974-76. In 1977-78, exports were larger and were shipped to countries in Asia and in North America. In 1978, each of these two markets received more than * * * of total exports from Japan. Exports by Japanese-owned foreign subsidiaries were comparatively small throughout 1974-78. In 1978, they equalled only * * * percent of the exports from Japan. About * * * of the exports from these subsidiaries in 1978 went to * * * and the * * *.

As indicated, the industrial countries of Europe, together, are the most important market for exports from the United States whereas developing nations in Asia are the most important markets for U.S. foreign subsidiaries exports. For exports from Japan and its foreign subsidiaries, the growing markets in the developing countries in Asia are the most important.

U.S. imports about doubled from $584 million in 1974 to $1.2 billion in 1978 and the major sources throughout the period were the U.S. producers' foreign subsidiaries. In 1978, imports from U.S. subsidiaries accounted for over 90 percent of total U.S. imports of integrated circuits. These imports came principally from subsidiaries located in the Republic of Korea, Malaysia, and Singapore. A large share of the value of U.S. imports enters duty-free under the provisions of TSUS items 806.30 and 807.00. The share entered on a duty-free basis rose from about 43 percent in 1974 to about 61 percent in 1978.

Imports by U.S. producers' foreign subsidiaries about doubled in the period, increasing from $187 million in 1974 to $370 million in 1978. Throughout the period, the larger share of total imports by this group consisted of imports by subsidiaries located in industrial countries, principally * * *; however, total imports by subsidiaries located in the developing nations grew more rapidly (especially in the case of * * *, the largest importer throughout). U.S. subsidiaries in developing countries expanded their share of such imports from * * * percent in 1974 to * * * percent in 1978.

Factors Adversely Affecting the U.S. Industry

Trade barriers

In the Commission's questionnaire, U.S. and Japanese firms were asked to list the tariffs encountered recently in their 10 largest export markets, to describe any nontariff barriers to exports to those countries, and to document those nontariff barriers. The nontariff barriers were to cover exports by the respective nation's industry and by its foreign subsidiaries.

Tariffs.--Table A-72 shows the tariffs on integrated circuits applying in countries that together received over 90 percent of the value of U.S. exports of these items in 1978. In most of these countries, such imports are classified under item 8521 of the Brussels Tariff Nomenclature.

Tariff rates facing U.S. exports of integrated circuits in most major foreign markets exceed the U.S. duty of 6 percent ad valorem. The EEC levies a common external tariff of 17 percent ad valorem. U.S. producers feel that this duty rate is a barrier to their exports, and have expressed disappointment that no reduction in the rate was negotiated during the Tokyo Round. Two Japanese firms responding to the Commission's questionnaire specifically identified the EEC tariff as a significant barrier to trade.

With the exception of Hong Kong and Singapore, all major Asian countries receiving U.S. exports of integrated circuits maintain tariff barriers higher than the U.S. rate of duty. Japan applies a 12 percent ad valorem rate. Several other Asian countries apply tariff rates of between 20 and 30 percent ad valorem to imports of integrated circuits. Several producers have noted, however, that Korea and Taiwan exempt or rebate duties on items used in the manufacture of products for export. Malaysia and the Philippines provide free trade zones where imports also receive duty-free treatment, and may be used in export assemblies.

U.S. and Japanese producers' responses indicate that high tariffs are most burdensome in markets where the local IC industry has reached an essentially equal level of technology. In such markets, a substantial tariff duty either reduces the price competitiveness of imported circuits or forces the exporter to absorb the added cost. The Japanese and the EEC rates of duty

can be effective barriers for this reason. In situations where no equivalent local product exists, high technology products are not usually excluded in high tariffs. U.S. exporters of integrated circuits report tht the technological edge enjoyed by the U.S. industry is an essential factor in successful selling overseas. 1/

Several U.S. producers exporting to Europe complained of the trade barrier created by "rules of origin". Due to trade agreements in effect between the EEC and the seven members of the EFTA, non-agricultural trade between the members of these organizations has been duty free since mid-1977. EFTA countries retain their differing external tariffs for third countries, however, and only goods originating within the free-trade area enjoy the duty concession. In order to prevent non-member exporters from shipping to a member country with a low external tariff, then re-exporting to other, higher-tariff, member countries on a duty-free basis, detailed "rules of origin" have been worked out. 2/ These rules limit the amount of imported materials an item may contain and still receive duty-free treatment when it is exported within the free trade area. 3/

In the case of integrated circuits, U.S. producers have alleged that the rules of origin, limiting the value of imported components in the finished product to less than 5 percent, seriously impair the competitiveness of their products by limiting the market or by increasing the costs of a manufacturer in the EEC/EFTA free trade area that purchases imported integrated circuits.

Another barrier alleged by the U.S. industry concerns the Japanese customs valuation practices. In Japan, if customs officials feel that the invoice value of imported goods does not reflect normal value in trade, they raise this value for tariff duty purposes. This practice is called "customs uplift". The U.S. industry claims that in Japan, the added costs are arbitrarily calculated and inadequately explained, and that the process is time consuming and expensive. 4/

Nontariff barriers (NTB's).--U.S. firms producing integrated circuits were asked in the Commission's questionaire to document nontariff barriers encountered in their major overseas markets. These firms alleged that significant nontariff barriers to their exports exist in Europe, Latin America, and particularly in Japan. Almost no evidence supporting these allegations was offered in the questionnaire responses, despite the specific Commission request to cite laws and to document the existence of trade barriers. This lack of documentation is partially due to the extra-legal nature of many of the barriers. Therefore, much of the information contained in the following section was gathered from previously published sources. The thrust of the respondents' claims are noted and supporting material from secondary sources, where available, has been added.

1/ Proceedings, p. 73; Second Supplemental Submission, pt. 1, p. 2.
2/ U.S. Department of Commerce, Overseas Business Reports, OBR 78-03, Business Guide to the European Common Market, p. 5.
3/ U.S. Department of Commerce, Overseas Business Reports, OBR 78-04, EEC and EFTA Rules of Origin Governing Preferential Trade, pp. 2-6.
4/ U.S. Department of Commerce, Office of International Trade Policy, Inventory of Nontariff Barriers (hereafter Inventory of NTB's). These materials were gathered during the trade negotiations of the Tokyo Round, 1975-78.

Japanese firms producing integrated circuits also responded to the Commission's questions concerning nontariff barriers. Their responses lacked supporting evidence, but are included in order to show a foreign perspective on the problems of nontariff barriers.

Restrictions in government procurement.--U.S. and Japanese producers of integrated circuits reported some difficulties with foreign government procurement practices. The majority of the responses, however, especially by U.S. firms, focused on the refusal of foreign state-owned telecommunications agencies to use foreign-made equipment or equipment containing significant quantities of imported components. This is an important barrier because the use of integrated circuits in telecommunications equipment is large and growing rapidly. Of the total telephone systems outside the United States, state-owned operations account for over 80 percent, 1/ a substantial market.

The barrier to sales of U.S.-produced integrated circuits posed by the foreign public post, telephone and telegraph authorities (PTT) is two-fold. Approval procedures for equipment purchases by these agencies, mainly in developed countries, are designed to limit the use of imported equipment. In addition, standards and specifications are geared to the locally-produced equipment, are often arbitrary, and vary from country to country. Approved technical specifications and standards are often undefined or unavailable. These difficulties reinforce prevailing policies, in Japan and the EEC for example, that require local sourcing unless the needed equipment is unavailable locally. U.S. exporters have reported that sales of telephone and switching equipment to Europe are limited to second sourcing. Access to the Japanese market for such equipment is even more restricted. 2/ In addition, most PTT authorities insist that the components of the locally-produced equipment must also be locally sourced. None of the European PTT authorities is subject to the Government Procurement code negotiated during the Tokyo Round, and the opening of the Japanese telecommunications market is still under negotiation. 3/

Europe.--European Community policy dictates that sizeable public contracts be awarded on a competitive basis without regard to nationality of supplier, that only a limited number of contracts should be offered on a selective basis, and that criteria used in selection must be publicized. The PTT authorities are not currently covered by these provisions, however, and computers are excluded until 1981. 4/

1/ U.S. International Trade Commission, A Baseline Study of the Telephone Terminal and Switching Equipment Industry, February 1979, p. 32, (hereafter A Baseline Study).

2/ Ibid, p. 32.

3/ Joint Statement by the Governments of Japan and the United States, June 2, 1979.

4/ U.S. Department of Commerce, Overseas Business Report, OBR 78-03, A Business Guide to the European Common Market, pp. 7-8.

Several U.S. producers complained of discriminatory purchasing practices employed by European government or PTT authorities. For example, government procurement in France is restricted to a "preferential list of suppliers" that gives highest priority to locally-owned companies, followed by foreign subsidiaries located in France and producing in France or the EEC. These priorities are informal. The Italian Government and its agencies also do not ordinarily purchase an import unless domestic supplies cannot meet the needs. 1/ The Italian telecommunications services are controlled by the same government-owned holding company that has majority interest in SGS-ATES, the only major native IC producer in Italy. Local suppliers of equipment to the PTT authority are required to use SGS-ATES integrated circuits, and suppliers of military contracts are encouraged to do the same when possible. These restrictions in Italy also are informal. A large Japanese producer also noted that the French and Italian governments show a "strong preference" for locally produced products.

In the United Kingdom, government standards for electronic components, including integrated circuits, are contained in standard BS9000, General Requirements for Electronic Components of Assessed Quality. Applied principally in procurement for defense, the standard has been interpreted as requiring the presence of an official inspector in a plant in the United Kingdom. A major U.S. producer complained that, in order to avoid the standard on government contracts, it was necessary to put OEM's using imported components through "heavy bureaucratic" procedures, which was inferred to mean some loss in U.S. competitiveness.

One Japanese producer of integrated circuits noted that, in general, "it is difficult to sell to foreign governments." Another reported that the "Buy American Act" and similar European government policies will undoubtedly affect the market available for future Japanese exports.

Japan.--Government procurement in Japan is, for the most part, closed to imported goods. The system is highly decentralized, depends heavily on selective tenders and negotiated contracts rather than on public bids, and favors domestic suppliers of proven reliability who generally maintain close contact with the individual procurement offices. Although official government regulation barring the use of imported goods no longer applies, official administrative guidance and custom administration are believed to restrict purchases of foreign products. 2/

Nearly every U.S. producer that reported barriers to foreign government purchases of U.S. integrated circuits listed as a significant barrier the refusal of the Japanese PTT authority, Nippon Telephone and Telegraph (NTT), to purchase foreign-made telecommunications equipment or equipment using foreign components. NTT is not literally an agency of the Japanese government, but a "public service corporation," wholly-owned by the government and is

1/ U.S. Department of Commerce, Overseas Business Report, OBR 78-26, Marketing in Italy, p. 11.

2/ U.S. Department of Commerce, Overseas Business Report, OBR 78-16, Marketing in Japan, pp. 12-13; Inventory of NTB's.

subject to executive and legislative review of its operations. Officially, NTT sets its own procurement policies.

Discussions between the U.S. Department of State and NTT officials in mid-1978 indicated, that while NTT's stated procurement policy is based on open tender, in practice NTT negotiates most contracts on a noncompetitive basis. In some cases a selective tender arrangement is followed in which procurement officers qualify firms for bidding from a list of registered companies. Through private contracts and selective tender, NTT restricts its purchases to designated suppliers * * *. 1/

In June of this year, the United States and Japan issued a joint statement endorsing the concept of "reciprocity of access," under which U.S. firms producing telecommunications equipment would be granted access to NTT's market in proportion to Japanese gains in access to the U.S. telecommunications market. Implementation of the agreement is to be delayed, however, for up to 18 months, while specific areas to be opened to imports are negotiated. 2/

Private industry purchases.--Reluctance or refusal by foreign private industries to purchase imported integrated circuits was reported by ten U.S. exporting firms. In some cases, this was perceived to be due to the difficulties created by other trade barriers, such as foreign exchange controls, import licensing and standards barriers. Korea, France and the United Kingdom are major markets where such reluctance or refusal was experienced. In Italy, it was reported that government guidance to the private telecommunications industry required that preference be given to SGS-ATES for IC purchases.

It was in Japan, however, that such restrictions were deemed to be most serious. 3/ In questionnaire responses, four major U.S. producers said Japanese private companies using and distributing integrated circuits will generally purchase imported components only when they are unavailable from a Japanese firm. Sworn public testimony and confidential submissions support the assertion that "in Japan, basically, we have been denied access to the market." It was alleged that such barriers although not, as a rule, based on law, were pervasive, and that, "in spite of years of aggressive attempts" to sell there, local suppliers were normally preferred. 4/

1/ A Baseline Study, p. 33.
2/ Joint Statement by the Governments of Japan and the United States, June 2, 1979.
3/ Proceeding, p. 73.
4/ Ibid., p. 73; Second Composite Supplemental Submission to the United States International Trade Commission, Investigation No. 332-102 (hereafter Second Supplemental Submission), June 15, 1979, parts 1 and 2.

Some reported experience implied Japanese government involvement. It was reported that sales have been cancelled after application to MITI for an import license, and that this was due to telephone calls received by prospective purchasers asking why they were importing when essentially comparable domestic products were available. 1/

More generally, U.S. producers insisted that a "buy-national" psychology pervaded much of Japanese industry. To thwart transactions, the U.S. producers say, prospective Japanese buyers have insisted on compliance to arbitrary standards, have requested sensitive proprietary information on such topics as production yields and internal company organization, and have closely inspected samples, and asked detailed questions about the production process, but without completing the sale. U.S. exporters also complained that "buy-national" policies forced them to rely on distributors who were "weak" and not really interested in selling the product. 2/

These marketing difficulties are summed up in the statement of an executive of a major integrated circuit producing firm: "They don't want to buy our products; they are looking for excuses not to buy them and for information to help the domestic (Japanese) industry." 3/

Obstacles to the establishment of foreign subsidiaries.--U.S. and Japanese producers of integrated circuits were asked if their manufacturing and sales subsidiaries located overseas aided their exports, and to identify any foreign government policies that tended to prohibit or impede establishment of foreign subsidiaries, joint ventures or other affiliations.

All respondents engaged in exporting reported that manufacturing or sales subsidiaries in foreign markets were essential to support a sustained export effort. Technical service to customers and help with customs procedures were listed as reasons that some formal presence in the country was necessary. Most respondents felt that a manufacturing facility in a foreign overseas market would be even more helpful, in part because buyers have more confidence in service, product reliability and delivery when dealing with a local concern. It was reported that residency in the foreign market also helps to overcome economic nationalism.

The chief reason given for locating manufacturing facilities in certain foreign countries is to assure significant access to some foreign markets. U.S. producers in particular supported this claim. Seven firms maintained that to sell in Europe or Japan a manufacturing presence was necessary to overcome such barriers as tariffs, buy-national policies and attitudes of public and private enterprises, or any competitive edge based on local low factor costs. Access to important foreign PTT markets also requires local production facilities.

1/ Second Supplemental Submission, parts 1 and 2.
2/ Second Supplemental Submission, part 1, pp. 3-4.
3/ Ibid., p. 4.

Thirteen U.S. firms and one Japanese firm reported foreign government policies that prohibited or impeded direct investment in subsidiary firms, joint ventures, or other business concerns. U.S. firms most frequently cited difficulties in establishing marketing or manufacturing subsidiaries in Japan. In his testimony for the Semiconductor Industry of America, Mr. Robert Noyce, Vice Chairman of the Board of Intel Corporation, stated that

> the Japanese, with rare exceptions, have effectively prohibited both the construction of foreign-owned plants in Japan and foreign investment in existing Japanese semiconductor companies. They have even prevented the formation of sales subsidiaries in Japan. 1/

He further testified that the manufacturing presence of Texas Instruments in Japan was due solely to their ability to withhold key IC production patents from the Japanese unless access was granted. Without these patent rights, exports of Japanese products using integrated circuits could have been challenged. 2/

Although foreign ownership of companies and the foreign sales operations are now legal in Japan, establishment of such facilities are still difficult. U.S. producers feel that this difficulty will continue to limit exports to that enormous market. 3/ This barrier is considered unfair by U.S. businessmen who feel that acquisition of U.S. firms by foreign interests is generally not as restricted. In addition, a Japanese IC firm stated that the Republic of Korea restricts the establishment of trading firms by foreigners. U.S. producers also reported that Mexico does not permit majority foreign ownership, and that France and Italy require government approval of foreign acquisitions of local firms.

Standards.--Although primarily intended to protect consumers by establishing minimum criteria for quality, reliability and safety, technical product standards can easily become trade barriers if not drawn up or administered in an open and objective fashion. Four U.S. producers of integrated circuits found that, in some markets, standards were difficult to identify or to comply with. Japanese respondents did not report any such problems.

U.S. producers stated that standards constituted a barrier to export to Japan. In testimony before the Commission, Robert N. Noyce, Vice Chairman of the Board of Intel Corp. stated that "businessman after businessman from the United States has been rebuffed by the Japanese on the rationale of noncom-

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1/ Proceedings, p. 74.
2/ Ibid., pp. 76-77.
3/ Second Supplemental Submission, part 2, p. 6.

pliance with standards." He maintained that U.S. firms bidding on contracts were not given access to the specifications or standards associated with the components to be supplied, or were disqualified from the competition based on secret supplements to published standards. 1/ A major U.S.-based multinational corporation reported that "unwritten standards" made compliance with Japanese government or NTT requirements all but impossible.

Foreign producers, it is reported, are not allowed to participate in the formulation of industry standards in Japan, and are not notified in a timely or convenient manner of the nature of changes in mandatory standards, a vivid contrast to the characteristics of U.S. standards formulation. 2/ A large U.S. electronics firm maintained that standards for end-use equipment tended to exclude foreign products and that this exclusion extended back into the standard-development stage when interested foreign firms were not participating. In addition, provision for overseas testing of components destined for Japan is lacking and application of standards to imports is uneven. 3/ One major U.S. exporter of integrated circuits alleged that standards applications vary for imports, pointing to "discriminatory interpretation" of the standards at point of entry. NTT standards for electronic equipment and components are often design, rather than performance-based, placing outside suppliers not well acquainted with the design specifications at a disadvantage. Moreover, equipment development for NTT takes place in the laboratories of local suppliers, making some of the designs proprietary information and closing the contracts to all other suppliers.

U.S. producers also stated that the electronics standards certification process in the United Kingdom constituted a barrier to sales. Standard BS 9000, General Requirements for Electronic Components of Assumed Quality, is proclaimed by the British Standards Institution. It is currently specified in many defense and government telecommunications contracts, and the use of certified components is also growing in private applications. In order to comply, most of the manufacture of the integrated circuit must be accomplished in the United Kingdom where the official inspectors are located. This effectively bars an imported circuit from certification. Enforcement of the standard has been irregular, and particularly lax when the imported types of circuits are unavailable locally. Currently, BS 9000 standards and those of the EEC's Electrical Standards Committee (CENELEC) are being harmonized.

1/ Proceedings, p. 78.

2/ American Chamber of Commerce in Japan, White Paper on United States-Japan Trade, May 1979, p. 16.

3/ Ibid., pp. 16-17.

Closed-end markets and distributor practices.--In testimony before the Commission, a representative of the Electronic Industries Association of Japan stated that market access in semiconductors is not as easy in Japan as in the United States due to the historical development of that industry in Japan. The Japanese semiconductor industry developed from end-use product manufacturers who perceived a need for semiconductors and filled it by creating their own production capability. In other words, "what the U.S. producers exporting to Japan face is essentially a captive market situation." 1/

This point of view is not fully supported by the data gathered by the Commission staff. U.S. producers accounting for approximately 85 percent of domestic IC output reported that * * * percent of their domestic shipments were to related entities, i.e., to captive end markets. The 10 Japanese IC producers who responded to the Commission's questionnaire account for more than 80 percent of the IC output of native Japanese firms. These firms reported that only * * * percent of their domestic shipments were to their own captive end-users. On this basis, the U.S. market for integrated circuits is more dominated by captive producers than is the Japanese market.

The U.S. industry has repeatedly complained in this investigation that Japanese firms will purchase imported integrated circuits that are based on technology unavailable locally, but that sales drop when production of these items begins in Japan. 2/ The level of captive production by Japanese IC producers would reinforce this consumption pattern, but could not alone account for the marketing difficulties reported by U.S. exporters. The preference of Japanese firms for Japanese products seems more significant.

U.S. producers of integrated circuits who have exported to Japan also complain that access to good distributors is denied. One U.S. firm engaged in exporting integrated circuits to Japan reported that the trading companies gave better representation to the Japanese buyers than to the U.S. exporting firms. A second company reported that "we have no access to the finest most competitive distributors, but are forced to use inferior distributors, . . . often almost bankrupt and (who) can barely hold their own financially." 3/

Japanese electronics industry spokesmen deny that their market is closed to U.S. exporters. They feel that, in addition to the "captive market" problem, U.S. exporters lack an understanding of the Japanese market and have failed to try hard enough to make sales. 4/ In testimony before the Commission, SIA spokesmen blamed trade barriers for their lack of success in the Japanese market. They claimed thay many years of intense effort and much investment have been devoted trying to develop this market in at least one case, the sales staff was native Japanese, and not hampered by cultural problems. 5/

1/ Proceedings, p. 219.
2/ Ibid., p. 73; Second Supplemental Submission, part 1, p. 2.
3/ Second Supplemental Submission, part 1, p. 4, and part 2, p. 5.
4/ Electronic News, June 11, 1979; Proceedings, pp. 295 and 260.
5/ Proceedings, pp. 76 and 159.

The native European IC industry is also characterized by vertically integrated electronics firms that consume a substantial portion of their own IC production. The U.S. position in this market is quite strong, however, due to the presence of U.S. manufacturing facilities and the commanding technological lead embodied in those facilities.

Import licensing.--Import licensing involves the submission of a special application or documents to one or more government bodies as a precondition for the right to import goods. If licenses are not automatically granted, the costs, delays, and uncertainties associated with compliance can detract from the competitiveness of imported goods relative to domestic products. In addition, licensing is frequently used to administer quantitative restrictions on imports. In recent years, the use of non-automatic import licenses to control trade has declined; it is currently used principally in developing countries. 1/

More than half of the U.S. exporting producers of integrated circuits, that responded to the Commission's questionnaire reported facing import licensing requirements in their export markets. Three-quarters of these indicated that the licenses constituted a significant barrier to their exports in certain countries. Although three major Japanese IC producers identified countries where licenses are required for imports, only one, the largest, maintained that these requirements were a significant trade barrier.

U.S. and Japanese producers of integrated circuits identified Brazil, the Republic of Korea, Taiwan, Mexico, France, and Italy as countries requiring import licenses for importation of their products. One major Japanese firm stated that the delays associated with receiving import licenses in Italy, France, and Brazil prevented rapid service to customers who required it, and thus constituted a "barrier to sale". Several U.S. firms also noted that licenses were a barrier to their exports due to delays associated with the procedure.

Brazil was singled out by U.S. repondents to the questionnaire as a country where import licensing constitutes a serious barrier to trade. For most imports Brazil requires a permit. Regulations require that a very complex follow-up procedure be carried out before the permit is validated, all time-consuming and costly. One Japanese firm alleged that Brazil prohibits the importation of circuits for use in computers and another firm maintained that local governments in Brazil impose a quota on the permissible value of IC imports per company. No U.S. firms reported similar restrictions.

Mexico is liberalizing its import licensing system, but as of mid-1978 half of the items in Mexico's schedule of import trade still required licenses for importation. Mexican firms may not place orders abroad, nor attempt to receive shipped goods until import licenses have been acquired from the Secretariate of Commerce. License applications are evaluated by industry

1/ U.S. International Trade Commission, Interim Staff Analysis of Nontariff Agreements, Vol. 5, Import Licensing Agreement, February 1979, p. i.

specialists to determine whether items are "essential" before a license is issued. 1/

Five U.S. and Japanese firms claimed that France and Italy require licenses for imports of integrated circuits. Two Japanese firms alleged that these countries also apply "strict" quotas to IC imports, but some U.S. firms felt that the licenses were not a serious barrier to their exports. One firm, an industry leader, complained of delays, not cancellations, and another major producer opined that, in general, licenses did not constitute a barrier in major markets.

Financial controls and prior deposit requirements.--Foreign exchange controls and other regulations on the method or timing of payment for imports make trade more difficult by increasing the administrative and financial cost of selling overseas. Required prior deposits of up to several times the value of the import shipment are, in effect, a tax on the transaction, tying up working capital without payment of interest and exposing the deposit to adverse exchange-rate changes during the months that the deposit is held.

Four U.S. firms and one Japanese firm said they had encountered these practices in their export markets. Such practices are found to be most common in developing countries, mainly for monetary reasons. Table A-72 lists major foreign markets for U.S. exports of integrated circuits that maintain restrictions on trade payments and import deposit requirements.

Customs procedures and documentation.--Complex, arbitrary, or dilatory customs procedures can constitute an effective trade barrier by adding to the administrative costs of exporting. In their responses to the Commission's questionnaire, U.S. producers exporting integrated circuits identified several foreign customs practices that either impeded the sale of their products or significantly increased their costs.

Customs procedures.--Customs procedures were seen as significant trade barriers by U.S. producers of integrated circuits only in the case of Japan. Most practices described below are based on the Japanese Customs Tariff Law, and its provisions are closely followed. U.S. exporters complain that extensive paperwork and expensive delays associated with these procedures limit their competitiveness in the Japanese market and act as a deterrent to imports. 2/

An official of one firm stated that inspection of routine imports of integrated circuits by Japanese customs officials is so thorough that the boxes are "virtually ransacked," and each circuit package individually handled. These problems are the result of the provision of the Japanese tariff law requiring an item count if, as with integrated circuits, the duty

1/ U.S. Department of Commerce, Overseas Business Reports, Marketing in Brazil, OBR 79-16, pp. 13-14.

2/ Inventory of NTB's.

is levied on a per item basis. 1/ In addition, advertising materials in a box are not allowed entry if not specifically included in the contents list. The official contrasts this treatment with the random inspection practices of U.S. customs agents, and feels that the exclusion of the advertising brochures is simple harrassment. 2/ Strict adherence is the norm, and "once the import declaration (including a description and item count) has been accepted by customs, it cannot be altered without special approval of customs". 3/

An executive of another U.S. firm exporting integrated circuits to Japan stated that on imported components sent out of Japan for testing, repair, or replacement, recovery of duty is very difficult. 4/ Complaints received by the U.S. Department of Commerce from other exporters to Japan are that official procedures to justify the export and to identify the item add greatly to the time necessary to make repairs. Sales samples enter duty-free, but if they have commercial value, the samples must be photographed and bond must be posted. If these samples are not exported within a year, the duty-free status lapses. 5/

Finally, it was reported to the Commerce Department that customs clearance charges in excess of import duties, commodity taxes and documentation fees are often imposed arbitrarily. Customs procedures allegedly vary by location, and unexpected delays in clearing customs can result in substantial storage charges. Because of such complicated and time-consuming procedures, many importers feel they must employ professional customs specialists to expedite the process, further increasing import costs. 6/

Documentation.--The documentation required of importers in order to take possession of merchandise at point of entry varies from country to country. The developed Western countries generally have few requirements, while Japan and most developing countries require more complex documentation. Although documentation is not generally processed in a discriminatory manner, certain requirements and the overall complexity and slowness of the procedures in some countries can cause delay and expense that detract from the competitiveness of the imported goods.

Japanese customs officials may demand any documentation necessary to determine valuation for duty assessment, and no deviation from the import declaration information is permitted without special customs approval. 7/

1/ Inventory of NTB's.
2/ Second Supplemental Submission, part 1, p. 3.
3/ U.S. Department of Commerce, Overseas Business Reports, Marketing in Japan, 78-16, p. 20.
4/ Second Supplemental Submission, part 2, p. 7.
5/ Inventory of NTB's; U.S. Department of Commerce, Overseas Business Reports, Marketing in Japan, OBR 18-16, p. 22.
6/ Inventory of NTB's.
7/ U.S. Department of Commerce, Overseas Business Reports, Marketing in Japan, OBR 78-16, p. 20.

Commercial invoices covering most imports by Mexico must be certified at a Mexican consulate, and personally signed by the seller. Invoices that arrive improperly executed can cause the shipment to be subject to heavy fines. 1/ Inaccuracies in the import documentation in Brazil can also bring stiff fines, and pro forma invoices or price lists must be specially filed with the Foreign Trade Department of the Bank of Brazil (CACEX). 2/

Non-tariff charges.--At the foreign point of entry, U.S. exports, including integrated circuits, are subject to a variety of taxes, fees and surcharges in addition to tariff duties. Although not normally levied in a discriminatory manner, the charges can add more to the cost of imported goods than do tariff duties, and are considered to be a substantial nontariff barrier by some U.S. exporters. 3/

Consumption taxes.--Many U.S. trading partners rely on taxes on consumption, such as value-added taxes, commodity taxes, and single-stage sales taxes to provide a significant portion of government revenue. Under GATT rules, such "indirect" taxes may be applied to imports and waived or rebated on exports; that is, they are eligible for border tax adjustments. The U.S. government uses direct taxes, such as taxes on income, profits, and payrolls, as the major source of its revenue, and these taxes are not subject to border tax adjustments under the GATT. For this reason, U.S. exporters complain that their products often bear the cost of a significant portion of both U.S. and foreign taxes when sold in foreign markets, but that many imports into the United States are free of these charges. 4/ In addition, the foreign practice of applying these taxes to the landed, duty-paid value of the imports magnifies the cost of import duties. Table A-72 lists the major foreign markets for U.S. exports of integrated circuits that apply consumption taxes.

The value added tax (VAT), used by most European countries, is a flat rate tax applied to domestic goods at each stage of transfer in the production process. It is applied to imported goods and rebated or waived on exports. In the case of intermediate goods used in the manufacture of other products, the tax payments are credited to the tax liability on the next transfer until the product is sold to the final customer. Credit allowed for prior taxes leaves as the tax base the value added in the production process. 5/ Thus the VAT liability incurred by imported integrated circuits at point of entry should

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1/ U.S. Department of Commerce, Overseas Business Reports, Marketing in Mexico, OBR 78-42, pp. 21-22.

2/ U.S. Department of Commerce, Overseas Business Reports, Marketing in Brazil, OBR 79-16, pp. 13-14.

3/ U.S. Tariff Commission, Trade Barriers Report, April 1974, Part II, Chapter VII, p. 36.

4/ Ibid., p. 39.

5/ Ibid., pp. 36-37.

be credited against the final tax liability of the finished products incorporating them, and should not, by itself, constitute a barrier to U.S. exports. Rather it is the differing systems of taxation, preventing border tax adjustments in "direct" taxation countries and allowing them in "indirect" systems, that produces the perceived inequity. 1/ U.S. producers of integrated circuits responding to the Commissions questionnaire reported that value added taxes did not significantly affect their competitive positions in the countries that levied the taxes. Three major U.S.-based firms noted, however, that the rebating of such taxes on exports did aid IC producers in these countries in overseas markets, thus damaging U.S. exports in third country markets.

Other taxes and surcharges.--As indicated in table A-72, a number of countries levy surcharges and other taxes on imports in addition to import duties. In general, these taxes and fees are for balance of payments or general revenue purposes, or are intended to pay for certain customs services. Harbor fees, which are quite common, are not in this report, since international trade in integrated circuits is conducted almost exclusively by air transportation. There were no reported complaints concerning these taxes and fees, since in most cases, they amount to less than 5 percent of import value. 2/

Results of the multilateral trade negotiations.--The Trade Agreements Act of 1979 implements the results of the Tokyo Round of trade negotiations. Under its provisions the current U.S. duty rate of 6 percent ad valorem applied to integrated circuits will be reduced in eight annual stages to 4.2 percent on January 1, 1987. Japan has also agreed to a staged reduction of its duty on these products, from the current level of 12 percent to 4.2 percent ad valorem. The EEC refused to negotiate any reduction in the 17-percent ad valorem rate of duty now in effect

Other provisions of the act address U.S. compliance with codes intended to provide international discipline for most NTB's cited by U.S. industries as inhibiting trade. The most significant accomplishments of the MTN with respect to trade in integrated circuits are the codes covering customs valuation, government procurement, product standards, imports licensing, and export subsidies. The EEC, Japan, and some developing countries are also signatories to these codes. If the major foreign markets for U.S. integrated circuits apply the provisions of these codes, several major nontariff barriers to U.S. exports will be lowered.

Specifically, observance of uniform, simplified rules of customs valuation in foreign markets should reduce the incidence of abritrary or unexpected "uplift" of the invoice of U.S. exports. The imports licensing code mandates simplified procedures, prohibits discrimination in the granting of licenses, and requires publication of regulations governing their distribution. This should reduce the expensive delays associated with acquiring import licenses. The product standards agreements should make standards among countries more uniform.

1/ Grossman, Gene M., "Alernative Border Tax Policies," Journal of World Trade Law, Vol. 12, No. 8, 1978, pp. 452-454.

2/ U.S. Department of Commerce, Overseas Business Reports, Marketing in . . . series, 1978-1979.

The agreement on government procurement requires open bidding from both domestic and foreign suppliers, the application of international technical specifications, and publication of criteria of selection. Because much depends on how these codes are enforced, the impact on U.S. exports is uncertain. The EEC did not agree to open procurement for its public telecommunication industry to imports or to local equipment containing imported components. Japan has agreed to open its public telecommunications purchases to imports, but the extent has yet to be decided. It is expected that this agreement will play a significant role in reducing restriction on sales of computers and component parts to foreign government and public entities.

In cases of price discrimination due to dumping or the trade effects of subsidization, compensatory duties may be applied under sections 731 or 701, respectively, of the Trade Agreements Act of 1979, in accordance with the Subsidies/Countervailing Duty Measures Agreement of the MTN. These provisions are substantially the same as those under the previous trade legislation, except for the addition of proof of material injury required in countervailing duty cases.

On balance, the MTN agreements on nontariff barriers are expected to have a small but positive impact on the competitiveness of U.S. exports of integrated circuits if the provisions are observed and enforced in major foreign markets. The staged reduction of the duty rate applied to integrated circuits imports by Japan probably will have a very gradual impact, due to the long period over which the reduction will be accomplished.

Market Share, Research and Development, and Investment

Market share.--The importance of market share is related to the significant savings in production costs to be realized from the experience factor: with each doubling of the volume of production for a given product, U.S. producers allege, cost tends to decrease by about 20 to 30 percent. A loss of market share results in a longer-time frame doubling of the production base, a slower rate of decrease in unit costs and a loss in relative competitiveness.

In recent years, the Japanese integrated circuit industry experienced the fastest rate of growth in the world industry. In dollar terms, the Japanese industry's shipments and exports in 1978 were * * * times the level in 1974; in comparison, the U.S. industry's shipments and exports were * * * times as large. The different rates of growth are reflected in changes in market share. World market share, expressed in dollar terms, accounted for by the Japanese industry increased from * * * percent in 1974 to * * * percent in 1978. Virtually all of the increase in Japanese market share was at the expense of U.S. producers share which declined from * * * percent to * * *

percent during the period. The small Western European producers' share changed little during the period. The tabulation below shows the respective annual market shares of U.S.-, Japanese-, and Western European-owned integrated circuit industries, 1974-78, in percent.

Year	U.S.-based	Japanese-based	European-based
1974----------	***	***	***
1975----------	***	***	***
1976----------	***	***	***
1977----------	***	***	***
1978----------	***	***	***

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

The loss of market share by the U.S. industry and the gain by the Japanese industry were accounted for in part by the U.S. industry's failure to expand capacity based on conservative estimates of demand which were largely influenced by the 1974-75 depression. The growth of the Japanese industry is explained in part by the relatively smaller production base in 1974 and the increase in the value of the yen during the period.

Another factor behind the growth of Japanese market share is the purchase of integrated circuits by U.S. producers from Japanese producers. * * *. This Japanese producer reported that U.S. producers purchased these devices because of either capacity limitations or an inability to make comparable parts. Available information suggests that a significant share of these devices consisted of large scale integration (LSI) circuits, possibly 16K RAMs.

A significant and growing portion of the world market for integrated circuits is in LSI memory circuits for use in computers. The most advanced example of LSI circuitry commercially available at the present time is the 16K RAM. SIA representatives stated before the Commission that this device is "the cornerstone of today's market for integrated circuits," 1/ and that this portion of the U.S. market has been targeted by the Japanese IC industry for penetration. According to the SIA, the 16K RAM market was chosen because a large share of the U.S. market in this device would provide the Japanese with valuable production experience that, in time, would lower their costs and help them compete more effectively in markets for even more densely constructed devices. "A producer's fate in the 16K RAM market will determine his likelihood of success in the next generation of integrated circuit development." 2/ These members of the domestic IC industry are concerned because--

1/ Proceedings, p. 46.
2/ Ibid., p. 47.

> /although/ Japanese commercial development of the 16K RAM initially lagged behind U.S. development, low-pricing practices have allowed Japanese producers in a period of only 3 years to accumulate a U.S. market share of approximately 35 percent in this key state of the art of semiconductor products. 1/

SIA representatives feel that the "intensified foreign competition" in the 16K RAM market will reduce the industry's profitability by causing prices to fall faster than normally, thus narrowing profit margins. In turn, the industry alleges it will have less time to realize a return on investment in research, product development, and capital equipment. This would come at a time when the industry is facing exponentially increased capital requirements in order to achieve the next generation of integrated circuits. Specifically, the SIA contends that Japanese producers offered 16K RAM's for $6 apiece in the United States in the fourth quarter of 1978, while prices in Japan were twice that or more; the U.S. producers' price at the time was $7 to $8.

In confidential submissions to the Commission, U.S. industry sources estimated that imports of 16K RAMs represented approximately one-third of that U.S. market in the first half of 1979. 2/ Subsequently, an additional confidential submission by the largest U.S. producer of 16K RAM's suggested that the Japanese share of the total U.S. market for these devices would rise to about 42 percent for 1979 as a whole. 3/ In the same submission, this U.S. producer documented U.S. and Japanese prices for 16K RAM's delivered in each others' markets. In the first quarter of 1979, the sale price for a device to a Japanese IC producer at that time was * * * per unit, compared with the same Japanese company's sale price in the United States of * * * per unit--about * * *, after allowing for export costs. These price differences are occuring even as Japan is reportedly experiencing shortages in RAM devices. 4/ The U.S. producer's conclusion is--

> that these Japanese companies are extending themselves to grab U.S. market share at lower prices while being unwilling or unable to supply home market demand at significantly higher prices. This has the effect of crippling the U.S. industry and jeopardizing its ability to form the necessary capital to compete in world markets. 5/

1/ Proceedings, p. 45.
2/ First Composite Supplemental Submission in the Matter of Integrated Circuits and Their Use in Computers (hereafter First Supplemental Submission), June 15, 1979.
3/ Confidential Submission by an SIA Member, Aug. 17, 1979.
4/ Electronic News, July 9, 1979, p. 39.
5/ Confidential Submission by an SIA Member, Aug. 17, 1979.

However, U.S. industry accusations regarding Japanese marketing and pricing practices for 16K RAM's, and the contention that Japan currently supplies more than one-third of U.S. consumption of these devices, are not independently verifiable with the data currently available to the Commission or under current market conditions. Comprehensive price data on 16K RAM's were not provided by U.S. and foreign producers in the Commission's questionnaire. Neither official U.S. trade statistics nor the trade data gathered in the questionnaire are sufficiently disaggregated to identify 16K RAM's from other MOS devices.

In addition, a further complication in determining the reasons for increased imports of 16K RAM's arises from the shortage conditions that have developed in the U.S. market for this LSI device. At least since May 1979, the U.S. demand for 16K RAM's has exceeded the available supply. SIA representatives testified before the Commission in May 1979 that the shortage was due to an overall "capacity short situation" in the U.S. market that has developed "because of lack of investment in the period 2 or 3 years ago." 1/ One top executive pointed out that increasing production capacity requires a lead time of several years. 2/ A major computer firm's spokesman stated recently that, barring a "serious recession, this shortage could continue for some time." 3/ By July 1979, orders were being taken and commitments made by major suppliers through the fourth quarter of 1980. 4/ Reports in early September indicated that the shortage was seriously affecting end-product users, and fourth quarter 1979 revenues for some firms would be affected. 5/

Finally, U.S. producers of 16K RAM's are exporting these devices to Japan and purchasing imported Japanese 16K RAM's in the United States. 6/ There was also testimony taken by the Commission indicating that a major U.S. producer may have chosen to shift production out of 16K RAM's owing to price suppression caused by Japanese imports. 7/ In later public statements, a spokesman for the firm stated such shifts were due to capacity limits that forced his company to concentrate on production of products for which there was no other source. 8/ In any case, such trade in 16K RAM's and production decisions would tend to increase the level of import penetration, independently of efforts by Japanese producers.

1/ Proceedings, pp. 113, 193.
2/ Ibid., p. 115.
3/ Electronic News, Sept. 3, 1979, p. 47.
4/ Ibid., July 16, 1979, p. 49.
5/ Ibid., Sept. 3, 1979, p. 1 ff.
6/ Proceedings, p. 193; Confidential Submission by an SIA member, August 17, 1979; Electronic News, July 11, 1979, p. 24.
7/ Proceedings, pp. 113-114.
8/ Electronics, July 5, 1979, p. 96.

Research and development.--During 1974-78, the U.S. integrated circuit industry invested about $2.2 billion in research and development, 3.8 times the $581 million invested by the Japanese industry. The data show a strong position in research and development for the U.S. industry and, with that position, continued leadership and large market share.

However, in each year during 1974-78, except 1975, the ratio of investment in research and development to shipments and exports was higher for the Japanese-owned industry than for the U.S.-owned industry. Based on data from questionnaire responses, the Japanese industry invested about * * * cents on research and development for each dollar of shipments and exports in 1978, whereas the U.S. industry invested about * * * cents. The respective annual ratios are given in the tabulation below.

Research and develoment as a percentage of shipments and exports, 1974-78

(In percent)

Area	1974	1975	1976	1977	1978
United States	***	***	***	***	***
Japan	***	***	***	***	***

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

The investments in research and development by the Japanese-owned industry understate total investments. A more accurate measure would come from the addition of sums allotted for research and development by the Japanese Government as well as the imputed expenditures contained in (a) technology purchased from the U.S.-owned industry in various forms, e.g., licenses, and (b) equity in U.S.-firms, both of which add to the indicated research intensiveness.

During 1974-78, the Japanese industry paid the U.S. industry * * * for licenses and technology compared with U.S. industry payments to the Japanese industry of less than * * *. The Japanese Government is also financing research on advanced memory circuits in its VLSI laboratories. The most frequently reported budget allottment to the VLSI laboratory is $240 million spread over 4 years. The combined impact of the purchased technology and the research in the VLSI laboratory had the effect in 1978 of increasing investment in research and development in the Japanese industry to about * * * cents for each dollar of shipments and exports.

A principal determinant of the level of research and development in a firm is likely market share. The sales of the firm determine its market share and research and development funds in a firm are usually budgeted as a percentage of sales. Thus, a loss in market share may result in reduced growth in research and development funding, producing a slower rate of new product discovery and development. A slower rate of new product discovery and development is likely to result in still further loss of market share. In the U.S. industry view, the concept of market share and how it is influenced by research and development funding underlies the strategy adopted by other countries that are providing large research budgets for advanced integrated circuit designs.

Investment.--During 1974-78, U.S. industry's investment in plants and equipment was * * * times larger than the Japanese industry's investment in plants and equipment. However, U.S. producers capacity at present is unable to meet demand. Based on the responses to the Commission questionnaires, the principal reasons for this condition were (1) the U.S. industry underestimated demand after the recent recession and (2) the U.S. industry is not as investment efficient (provided the data reported to the Commission are reasonably accurate) as the Japanese industry.

The industry's assessment of demand strengths in the industry is critical in determining growth and market share. The investment must be committed 2 to 3 years before the facilities become operational. During the 1974-75 recession, as reported, U.S. firms underestimated future levels of demand. Given the resulting U.S. industry's lack of capacity, foreign suppliers who had an apparent excess of capacity were able to increase their share of the U.S. market.

Based on the data submitted by U.S. and Japanese producers to the Commission, the Japanese industry is able to produce one dollar in shipments and exports for about * * * cents in investment, compared with about * * * cents for the U.S. industry. As a reciprocal of that measure, 1978 data show the Japanese industry produced * * * in shipments and exports for a one-dollar investment in plants and equipment compared with * * * for the U.S. industry. The tabulation below shows the changes in the relationship between investment and shipments and exports for the U.S. and Japanese industries during 1974-78.

Value of shipments and exports for one dollar investment in plants and equipment, U.S.- and Japanese-based industries, 1974-78

(In dollars)

Area	1974	1975	1976	1977	1978
United States	***	***	***	***	***
Japan	***	***	***	***	***

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Differences in accounting allocations may explain in part the differences shown. Investment in production plants and equipment in one industry could be recognized as investment in research equipment in another industry. An aggregation of investment in research and plants and equipment in both industries would likely be a more meaningful measure of the relative efficiencies. The tabulation below shows the amount of shipments and exports for each dollar of total investment in the U.S. and Japanese industries during 1974-78.

Value of shipments and exports for one dollar investment in research and plants and equipment, U.S.- and Japanese-based industries, 1974-78

(In dollars)

Area	1974	1975	1976	1977	1978
United States	***	***	***	***	***
Japan	***	***	***	***	***

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Allowing that differences remain after investment in research and plants and equipment is aggregated, the data appear to indicate that the Japanese industry has been able to achieve a higher unit of output than the U.S. industry for a given unit of investment input.

Productivity of labor

Shipments and exports per employee were also used to measure the relative efficiencies of the U.S. and Japanese industries. During 1974-75, the value of U.S. shipments and exports per employee was the larger, but in 1976-78 the Japanese values were larger and the disparity increased sharply, as shown below.

1974-78 shipments and exports per employee, U.S. and Japanese industries

(In dollars)

Area	1974	1975	1976	1977	1978
United States	***	***	***	***	***
Japan	***	***	***	***	***

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

However in this measure of efficiency, both the exchange rate and perhaps Japanese employment practices bias the data. The * * * of shipments and exports per employee in 1978 would have amounted to * * * using 1974 exchange rates. The basis for the employment data on the Japanese industry may differ from that for the U.S. industry. Japanese producers often use temporary employees or contract labor in their plants and these types of employees may not have been included in the Japanese employment data. Clarification of this problem was requested of the Economic Counselor of the Japanese Embassy but was not received. The data, however, indicate that the Japanese shipments and exports per employee are rising somewhat faster than U.S. shipments and exports per employee.

Role of governments in assisting research and development

In addition to tariffs and many of the NTB's that result from their policies and actions, governments have employed other means for aiding domestic industry. In testimony before the Commission and in responses to the questionnaires, U.S. industry representatives expressed great concern that the governments of Japan and several Western European countries are providing funds in the form of grants and loans to their major semiconductor firms for "advanced research in integrated circuit technology, mostly for very large scale integration." 1/ The industry points out that these efforts pose a threat to the superior technology position of the United States, and that foreign producers may be able to sell sophisticated circuits in world markets at comparatively low prices. As a result, U.S. prices for similar circuits could be depressed in the early phase of marketing when U.S. producers normally expect to recover much of their development costs. If these costs cannot be recovered, the industry alleges that its ability to mount future research programs will be severely affected. 2/

Government funding for these foreign research and development programs identified in published sources totals $1.6 billion over 3 to 5 years through 1981. 3/ The U.S. industry points out that foreign government funding is, for the most part, focused on research and development of VLSI for computer applications. U.S. industry research is less focused, and is spread over "a wide variety of products and technology, everything from automobile ignition systems, through the super computers, through telecommunications networks." 4/

United States.--A U.S. Government program designed to fund state-of-the-art integrated circuit research is being run by the U.S. Department of Defense. Referred to as the Very High Speed Integration (VHSI) program, it is budgeted for $201 million over 5 years ending in 1984. 5/ Although some

1/ Proceedings, pp. 42-43.
2/ Ibid., p. 83; and questionnaire response by U.S. producers.
3/ Proceedings, p. 83, table 4.
4/ Ibid., p. 137.
5/ Conversation with VHSI Program Manager, U.S. Department of Defense, Oct. 15, 1979.

spillover into commercial application can be expected, SIA members commenting on the VHSI program in the Commission's questionnaire did not believe that it would have extensive commercial use, that privately developed technology would develop more quickly, and that the VHSI program might even "divert needed manpower from the commercial effort." They contrasted this with the direct commercial applications in computers that would result from the foreign VLSI programs.

Europe.--Several European governments have initiated funding programs aimed at improving the technological capabilities of their native IC industries, particularly in the areas of computer applications and telecommunications. A reported $300 million will be dedicated by the West German Government over 2 years to develop VLSI circuits and to upgrade the production technology available to West German IC producers. 1/ It is intended to unite several parallel programs sponsored by the Government in recent years, including research in components, data processing, and communication technologies. The focal point, however, will be in components development, including VLSI. 2/

The French Government is providing up to $300 million in grants and loans for the development of advanced integrated circuits, and is encouraging licensing and second-sourcing agreements with U.S. firms. The French IC market is expected to triple by 1985, with most of the growth in MOS integrated circuits, an area currently dominated by imports. With expanded research in materials and advanced IC design, French IC producers hope to reduce their dependence on imported devices. Such research would be tightly coordinated with other Government programs to aid the development of the French computer industry. 3/

The United Kingdom has allocated roughly $300 million over 3 to 5 years to develop equipment and advanced components. 4/ Some of the funds are in the form of loans to specific companies. A major part of the funding has been invested in the creation of a new integrated circuit production firm, INMOS Ltd. (see page 38). Future investments will be of a joint-venture type, rather than full funding. 5/

The Commission of the European Communities has proposed a development program aimed at coordinating the efforts of the EEC members in research and development of advanced component and data processing technology. The proposal called for the creation of common European standards to help unify a badly fragmented European data systems market, the coordination of government procurement policies and the opening of bidding to all producers in order to encourage competition, Community financial aid in leasing and sales of computers, and Community coordination and funding of research and development

1/ Proceedings, p. 83, table 4; Electronic News, Apr. 30, 1979, p. 1.
2/ Electronic News, May 28, 1979.
3/ Proceedings, p. 83, table 4; Electronic News, April 30, 1979, p. 12ff.
4/ Proceedings, p. 83, table 4; Datamation, August 1978, p. 73.
5/ Electronic News, July 23, 1979, p. 10.

in selected areas in the computer and electronic components industries. The cost of the program at the Community's level was projected at roughly $100 million over the 5 years 1978-82, and individual country programs coordinated with the Community proposal were to have brought the total to $1 billion. 1/ No agreement has been reached on the proposal, however.

Japan.--The U.S. industry expresses concern over the Japanese VLSI program. 2/ According to published reports, the Japanese VLSI program involves total funding of $360 million over 4 years, $250 million of which consists of government loans. These loans will be repaid from profits realized through the application of the VLSI technology developed by the program. In addition, the Japanese Government, through MITI, has provided a combined technical laboratory where researchers from five primary Japanese IC firms work together to develop the new materials and production techniques that will underlie the advance to VLSI circuitry. Since the funding has direct commercial application, the U.S. industry feels that "this is simply a subsidy to the Japanese industry which permits the Japanese companies to sell their goods at lower prices. 3/

U.S. industry opinion reflected in responses to the Commission's questionnaire indicated that the Japanese VLSI program is seen as "a concerted effort by the Japanese Government to coordinate the development of a higher level of technology, including related equipment development, in an effort to achieve the same end-product dominance in the computer market that they enjoy in other electronic markets." It was feared that "the Japanese program is a very real threat to the technology position of the United States."

Representatives of the EIAJ testifying before the Commission defended the foreign government funding by pointing out that "the American industry was itself heavily subsidized and supported by the United States government during its own developing stages." 4/ It was suggested that any accusations of foreign subsidies be handled in the framework of the new subsidies code negotiated during the Tokyo Round. While affirming that the direct foreign government aid for VLSI development existed, these representatives maintained that indirect U.S. Government aid in the form of purchases from the U.S. industry had underwritten the development of the IC industry in its infancy, 5/ and had provided the industry with the volume sales necessary to achieve "experience curve" economies and, therefore, lower prices. 6/

1/ Commission of the European Communities, A 4-year Programme for the Development of Informatics in the Community, vol. 1, Oct. 29, 1976.
2/ Proceedings, pp. 45 and 158.
3/ Ibid., pp. 83 and 132.
4/ Ibid., p. 255.
5/ Ibid., pp. 272-275.
6/ Post-hearing Brief in Behalf of the Electronic Industries Association of Japan in the Matter of Integrated Circuits and Their Use in Computers, June 15, 1979, p. 18.

APPENDIX A

STATISTICAL TABLES

Table A-1.--Integrated circuits: Domestic and foreign production by U.S. firms of wafer starts, assemblies, and finished integrated circuits, by major countries, 1974-78

(In thousands of units)

Item	1974	1975	1976	1977	1978
Wafer starts:					
Industrial nations:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Japan	***	***	***	***	***
All other	***	***	***	***	***
Subtotal	***	***	***	***	***
United States	***	***	***	***	***
Developing nations	***	***	***	***	***
Total	***	***	***	***	***
Assemblies:					
Industrial nations:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Japan	***	***	***	***	***
All other	***	***	***	***	***
Subtotal	***	***	***	***	***
United States	***	***	***	***	***
Developing nations:					
Taiwan	***	***	***	***	***
Hong Kong	***	***	***	***	***
Republic of Korea	***	***	***	***	***
Malaysia	***	***	***	***	***
Philippines	***	***	***	***	***
Singapore	***	***	***	***	***
All other	***	***	***	***	***
Subtotal	***	***	***	***	***
Total	***	***	***	***	***
Finished integrated circuits:					
Industrial nations:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Japan	***	***	***	***	***
All other	***	***	***	***	***
Subtotal	***	***	***	***	***
United States	***	***	***	***	***
Developing nations:					
Taiwan	***	***	***	***	***
Hong Kong	***	***	***	***	***
Republic of Korea	***	***	***	***	***
Malaysia	***	***	***	***	***
Philippines	***	***	***	***	***
Singapore	***	***	***	***	***
All other	***	***	***	***	***
Subtotal	***	***	***	***	***
Total	1,735,470	1,249,329	2,193,548	2,742,771	3,567,513

Table A-2.--Integrated circuits: U.S. production of wafer starts, assemblies, and finished integrated circuits, by types, 1974-78

(In thousands of units)

Production of--	1974	1975	1976	1977	1978
Wafer starts:					
Linear	***	***	***	***	***
Digital bipolar	***	***	***	***	***
Digital MOS	***	***	***	***	***
Other	***	***	***	***	***
Total	11,671	7,664	10,590	13,493	17,014
Assemblies:					
Linear	***	***	***	***	***
Digital bipolar	***	***	***	***	***
Digital MOS	***	***	***	***	***
Other	***	***	***	***	***
Total	249,632	175,793	244,668	313,552	371,695
Finished integrated circuits:					
Linear	***	***	***	***	***
Digital bipolar	***	***	***	***	***
Digital MOS	***	***	***	***	***
Other	***	***	***	***	***
Total	648,498	441,025	610,695	772,763	943,710

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-3.--Integrated circuits: Total U.S. domestic shipments (excluding exports), by types, 1974-78

(In thousands of dollars)

Type	1974	1975	1976	1977	1978
Linear	***	***	***	***	***
Digital bipolar	***	***	***	***	***
Digital MOS	***	***	***	***	***
All other	***	***	***	***	***
Total	1,203,881	1,109,120	1,468,236	1,648,074	2,080,245

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-4.--Integrated circuits: U.S. domestic shipments (excluding exports), to unrelated parties, by types, 1974-78

(In thousands of dollars)

Type	1974	1975	1976	1977	1978
Linear	***	***	***	***	***
Digital bipolar	***	***	***	***	***
Digital MOS	***	***	***	***	***
All other	***	***	***	***	***
Total	698,113	580,373	727,754	916,607	1,265,389

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-5.--Integrated circuits: U.S. domestic shipments (excluding exports), to related parties, by types, 1974-78

(In thousands of dollars)

Type	1974	1975	1976	1977	1978
Linear	***	***	***	***	***
Digital bipolar	***	***	***	***	***
Digital MOS	***	***	***	***	***
All other	***	***	***	***	***
Total	505,768	528,747	740,482	731,467	814,856

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-6.--Integrated circuits: Total shipments of the foreign subsidiaries of U.S. firms in their home markets, by locales, 1974-78

(In thousands of dollars)

Locale	1974	1975	1976	1977	1978
Industrial:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Japan	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Developing:					
Taiwan	***	***	***	***	***
Hong Kong	***	***	***	***	***
Republic of Korea	***	***	***	***	***
Singapore	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Grand total	316,080	221,213	304,774	272,174	359,332

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-7.--Integrated circuits: Shipments of the foreign subsidiaries of U.S. firms to related parties in their home markets, by locales, 1974-78

(In thousands of dollars)

Locale	1974	1975	1976	1977	1978
Industrial:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Japan	***	***	***	***	***
Total	***	***	***	***	***
Developing:					
Singapore	***	***	***	***	***
Taiwan	***	***	***	***	***
Hong Kong	***	***	***	***	***
Total	***	***	***	***	***
Grand total	***	***	***	***	***

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-8.--Integrated circuits: Shipments of the foreign subsidiaries of U.S. firms to unrelated parties in their home markets, by locales, 1974-78

(In thousands of dollars)

Locale	1974	1975	1976	1977	1978
Industrial:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Developing:					
Taiwan	***	***	***	***	***
Hong Kong	***	***	***	***	***
Republic of Korea	***	***	***	***	***
Singapore	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Grand total	***	***	***	***	***

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-9.--Integrated circuits: Total U.S. exports, by types, 1974-78

(In thousands of dollars)

Type	1974	1975	1976	1977	1978
Linear	***	***	***	***	***
Digital bipolar	***	***	***	***	***
Digital MOS	***	***	***	***	***
All other	***	***	***	***	***
Total	217,624	170,017	210,831	216,694	294,658

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Note.--Totals on Tables A-9 and A-12 are different due to reporting of U.S. producers.

Table A-10.--Integrated circuits: U.S. exports to related parties, by types, 1974-78

(In thousands of dollars)

Type	1974	1975	1976	1977	1978
Linear	***	***	***	***	***
Digital bipolar	***	***	***	***	***
Digital MOS	***	***	***	***	***
All other	***	***	***	***	***
Total	120,009	83,792	95,245	89,980	134,084

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-11.--Integrated circuits: U.S. exports to unrelated parties, by types, 1974-78

(In thousands of dollars)

Type	1974	1975	1976	1977	1978
Linear	***	***	***	***	***
Digital bipolar	***	***	***	***	***
Digital MOS	***	***	***	***	***
All other	***	***	***	***	***
Total	97,615	86,225	115,586	126,714	160,574

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-12.--Integrated circuits: U.S. exports by geographical areas and by countries, 1974-78

(In thousands of dollars)

Geographical area and country	1974	1975	1976	1977	1978
Asia:					
Japan	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Europe:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Netherlands	***	***	***	***	***
All other	***	***	***	***	***
Total	129,427	95,485	120,124	147,366	184,091
North America:					
Canada	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
All other	***	***	***	***	***
Grand total	198,128	169,463	213,143	218,983	300,329

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Note.--Totals on Tables A-9 and A-12 are different due to reporting of U.S. producers.

Table A-13.--Integrated circuits: Total exports of U.S. foreign manufacturing subsidiaries, by locales, 1974-78

(In thousands of dollars)

Locale	1974	1975	1976	1977	1978
Industrial:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Netherlands	***	***	***	***	***
Japan	***	***	***	***	***
Italy	***	***	***	***	***
Scandinavia	***	***	***	***	***
All other	***	***	***	***	***
Total	112,535	121,123	138,097	141,777	214,679
Developing:					
Taiwan	***	***	***	***	***
Hong Kong	***	***	***	***	***
Republic of Korea	***	***	***	***	***
Malaysia	***	***	***	***	***
Philippines	***	***	***	***	***
Singapore	***	***	***	***	***
Portugal	***	***	***	***	***
El Salvador	***	***	***	***	***
All other	***	***	***	***	***
Total	312,590	211,133	401,913	559,807	723,695
Grand total	425,125	332,256	540,010	701,584	938,374

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-14.--Integrated circuits: Exports of U.S. foreign manufacturing subsidiaries to related parties, by locales, 1974-78

(In thousands of dollars)

Locale	1974	1975	1976	1977	1978
Industrial:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Netherlands	***	***	***	***	***
Japan	***	***	***	***	***
Italy	***	***	***	***	***
Scandinavia	***	***	***	***	***
Total	***	***	***	***	***
Developing:					
Taiwan	***	***	***	***	***
Hong Kong	***	***	***	***	***
Republic of Korea	***	***	***	***	***
Malaysia	***	***	***	***	***
Philippines	***	***	***	***	***
Singapore	***	***	***	***	***
Portugal	***	***	***	***	***
El Salvador	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Grand total	330,353	238,307	424,584	534,476	745,457

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-15.--Integrated circuits: Exports of U.S. foreign manufacturing subsidiaries to unrelated parties, by locales, 1974-78

(In thousands of dollars)

Locale	1974	1975	1976	1977	1978
Industrial:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Netherlands	***	***	***	***	***
Japan	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Developing:					
Taiwan	***	***	***	***	***
Hong Kong	***	***	***	***	***
Republic of Korea	***	***	***	***	***
Malaysia	***	***	***	***	***
Philippines	***	***	***	***	***
Singapore	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Grand total	94,772	73,949	115,426	167,108	192,917

Table A-16.--Integrated circuits: Exports by U.S. foreign subsidiaries, by exporting areas and by markets, 1974

(In thousands of dollars)

Exporting area	Asian markets			European markets	
	Japan	All other	Total	United Kingdom	France
Asia:					
Japan	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Europe:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Netherlands	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
North America:					
Canada	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
All other	***	***	***	***	***
Grand total	22,320	3,193	25,513	26,362	19,998

Exporting area	European markets--Continued				North American
	West Germany	Nether-lands	All other	Total	Canada
Asia:					
Japan	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Europe:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Netherlands	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
North America:					
Canada	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
All other	***	***	***	***	***
Grand total	27,564	***	***	132,073	***

Exporting area	North American markets--Cont.				
	United States	All other	Total	All other	Grand total
Asia:					
Japan	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Europe:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Netherlands	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
North America:					
Canada	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
All other	***	-	6,145	-	9,393
Grand total	297,826	***	305,329	1,896	464,811

Source: Compiled from data submitted in response to questionnaires of the U.S.

Table A-17.--Integrated circuits: Exports by U.S. foreign subsidiaries, by exporting areas and by markets, 1975

(In thousands of dollars)

Exporting area	Asian markets			European markets	
	Japan	All other	Total	United Kingdom	France
Asia:					
Japan	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Europe:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Netherlands	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
North America:					
Canada	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
All other	***	***	***	***	***
Grand total	22,235	4,356	26,591	16,427	18,369

Exporting area	European markets--Continued				North American
	West Germany	Nether-lands	All other	Total	Canada
Asia:					
Japan	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Europe:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Netherlands	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
North America:					
Canada	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
All other	***	***	***	***	***
Grand total	20,773	1,856	59,293	116,718	***

Exporting area	North American markets--Cont.			All other	Grand total
	United States	All other	Total		
Asia:					
Japan	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Europe:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Netherlands	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
North America:					
Canada	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
All other	***	***	***	***	***
Grand total	208,435	***	215,949	2,112	361,370

Table A-18.--Integrated circuits: Exports by U.S. foreign subsidiaries, by exporting areas and by markets, 1976

(In thousands of dollars)

Exporting area	Asian markets			European markets	
	Japan	All other	Total	United Kingdom	France
Asia:					
Japan	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Europe:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Netherlands	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
North America:					
Canada	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
All other	***	***	***	***	***
Grand total	38,817	7,379	46,196	26,011	67,799

Exporting area	European markets--Continued				North American
	West Germany	Nether-lands	All other	Total	Canada
Asia:					
Japan	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Europe:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Netherlands	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
North America:					
Canada	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
All other	***	***	***	***	***
Grand total	71,232	2,139	99,823	267,004	***

Exporting area	North American markets--Cont.			All other	Grand total
	United States	All other	Total		
Asia:					
Japan	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Europe:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Netherlands	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
North America:					
Canada	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
All other	***	***	***	***	***
Grand total	393,339	***	400,426	7,071	720,697

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-19.--Integrated circuits: Exports by U.S. foreign subsidiaries, by exporting areas and by markets, 1977

(In thousands of dollars)

Exporting area	Asian markets			European markets	
	Japan	All other	Total	United Kingdom	France
Asia:					
Japan	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Europe:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Netherlands	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
North America:					
Canada	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
All other	***	***	***	***	***
Grand total	48,817	10,465	59,282	38,479	49,971

Exporting area	European markets--Continued				North American
	West Germany	Nether-lands	All other	Total	Canada
Asia:					
Japan	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Europe:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Netherlands	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
North America:					
Canada	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
All other	***	***	***	***	***
Grand total	83,807	2,610	78,950	253,817	***

Exporting area	North American markets--Cont.				
	United States	All other	Total	All other	Grand total
Asia:					
Japan	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Europe:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Netherlands	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
North America:					
Canada	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
All other	***	***	***	***	***
Grand total	542,875	***	551,684	9,400	874,183

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-20.--Integrated circuits: Exports by U.S. foreign subsidiaries, by exporting areas and by markets, 1978

(In thousands of dollars)

Exporting area	Asian markets			European markets	
	Japan	All other	Total	United Kingdom	France
Asia:					
Japan	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Europe:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Netherlands	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
North America:					
Canada	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
All other	***	***	***	***	***
Grand total	52,211	15,838	68,049	44,008	54,278

Exporting area	European markets--Continued				North American
	West Germany	Nether-lands	All other	Total	Canada
Asia:					
Japan	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Europe:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Netherlands	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
North America:					
Canada	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
All other	***	***	***	***	***
Grand total	80,046	5,229	125,125	314,686	***

Exporting area	North American markets--Cont.			All other	Grand total
	United States	All other	Total		
Asia:					
Japan	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Europe:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Netherlands	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
North America:					
Canada	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
All other	***	***	***	***	***
Grand total	733,583	***	738,481	9,227	1,130,443

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-21.-Integrated circuits: Shipments and exports by U.S. firms and their foreign subsidiaries, by types of transactions, 1974-78

(In thousands of dollars)

Type of transaction	1974	1975	1976	1977	1978
U.S. facilities:					
Domestic related-party shipments	505,768	528,747	740,482	731,467	814,856
Domestic related-party exports	120,009	83,792	95,245	89,980	134,084
Subtotal	625,777	612,539	835,727	821,447	948,940
Domestic unrelated-party shipments	698,113	580,373	727,754	916,607	1,265,389
Domestic unrelated-party exports	97,615	86,225	115,586	126,714	160,574
Subtotal	795,728	666,598	843,340	1,043,321	1,425,963
Foreign facilities:					
Foreign subsidiary related-party shipments	183,494	132,156	186,578	176,046	243,055
Foreign subsidiary related-party exports	330,353	258,307	424,584	534,476	745,457
Subtotal	513,847	390,463	611,162	710,522	988,512
Foreign subsidiary unrelated-party shipments	132,586	89,057	118,196	96,128	116,277
Foreign subsidiary unrelated-party exports	94,772	73,949	115,426	167,108	192,917
Subtotal	227,358	163,006	233,622	263,236	309,194
Total related-party transactions	1,139,624	1,003,002	1,446,889	1,531,969	1,937,452
Total unrelated-party transactions	1,023,086	829,604	1,076,962	1,306,557	1,735,157
Grand total	2,162,710	1,832,606	2,523,851	2,838,526	3,672,609

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-22.--Integrated circuits: Total U.S. imports, by types, 1974-78

(In thousands of dollars)

Type	1974	1975	1976	1977	1978
Linear	***	***	***	***	***
Digital bipolar	***	***	***	***	***
Digital MOS	***	***	***	***	***
All other	***	***	***	***	***
Total	584,233	539,068	661,062	858,438	1,178,322

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-23.--Integrated circuits: U.S. imports from related parties, by types, 1974-78

(In thousands of dollars)

Type	1974	1975	1976	1977	1978
Linear	***	***	***	***	***
Digital bipolar	***	***	***	***	***
Digital MOS	***	***	***	***	***
All other	***	***	***	***	***
Total	575,278	530,893	637,633	837,651	1,148,420

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-24.--Integrated circuits: U.S. imports from unrelated parties, by types, 1974-78

(In thousands of dollars)

Type	1974	1975	1976	1977	1978
Linear	***	***	***	***	***
Digital bipolar	***	***	***	***	***
Digital MOS	***	***	***	***	***
All other	***	***	***	***	***
Total	8,955	8,175	23,429	20,787	29,902

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-25.--Integrated circuits: U.S. imports entered under the provisions of TSUS items 806.30 and 807.00, by types, 1974-78

(In thousands of dollars)

Type	1974	1975	1976	1977	1978
Linear:					
Total	***	***	***	***	***
Duty-free	***	***	***	***	***
Digital bipolar:					
Total	***	***	***	***	***
Duty-free	***	***	***	***	***
Digital MOS:					
Total	186,604	204,918	241,765	296,657	447,799
Duty-free	95,598	108,315	124,046	164,274	283,345
All other:					
Total	***	***	***	***	***
Duty-free	***	***	***	***	***
Grand total:					
Total	401,905	401,890	474,975	635,718	882,684
Duty-free	171,108	179,358	194,723	321,651	534,570

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-26.--Integrated circuits: Total imports of U.S. foreign manufacturing subsidiaries, by locales, 1974-78

(In thousands of dollars)

Locale	1974	1975	1976	1977	1978
Industrial:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Netherlands	***	***	***	***	***
Japan	***	***	***	***	***
Italy	***	***	***	***	***
Canada	***	***	***	***	***
All other	***	***	***	***	***
Total	160,587	130,518	159,283	167,397	245,508
Developing:					
Hong Kong	***	***	***	***	***
Republic of Korea	***	***	***	***	***
Malaysia	***	***	***	***	***
Singapore	***	***	***	***	***
Argentina	***	***	***	***	***
Brazil	***	***	***	***	***
Total	26,171	37,175	55,456	69,919	124,462
Grand total	186,758	167,693	214,739	237,316	369,970

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-27.--Integrated circuits: Imports of U.S. foreign manufacturing subsidiaries from related parties, by locales, 1974-78

(In thousands of dollars)

Locale	1974	1975	1976	1977	1978
Industrial:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Netherlands	***	***	***	***	***
Japan	***	***	***	***	***
Italy	***	***	***	***	***
Canada	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Developing:					
Hong Kong	***	***	***	***	***
Republic of Korea	***	***	***	***	***
Malaysia	***	***	***	***	***
Singapore	***	***	***	***	***
Argentina	***	***	***	***	***
Brazil	***	***	***	***	***
Total	***	***	***	***	***
Grand total	174,508	156,983	205,139	226,592	358,861

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-28.--Integrated circuits: Imports of U.S. foreign manufacturing subsidiaries from unrelated parties, by locales, 1974-78

(In thousands of dollars)

Locale	1974	1975	1976	1977	1978
Industrial:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
Japan	***	***	***	***	***
Italy	***	***	***	***	***
Total	***	***	***	***	***
Developing:					
Hong Kong	***	***	***	***	***
Brazil	***	***	***	***	***
Total	***	***	***	***	***
Grand total	12,250	10,710	9,600	10,212	11,109

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-29.--Integrated circuits: U.S. shipments (excluding exports), imports, and apparent consumption, by types, 1974-78

Type and year	Shipments	Imports	Apparent consumption	Ratio of consumption by types to total consumption	Ratio of imports to apparent consumption
	1,000 dollars	1,000 dollars	1,000 dollars	Percent	Percent
Linear:					
1974	***	***	***	***	***
1975	***	***	***	***	***
1976	***	***	***	***	***
1977	***	***	***	***	***
1978	***	***	***	***	***
Digital bipolar:					
1974	***	***	***	***	***
1975	***	***	***	***	***
1976	***	***	***	***	***
1977	***	***	***	***	***
1978	***	***	***	***	***
Digital MOS:					
1974	***	***	***	***	***
1975	***	***	***	***	***
1976	***	***	***	***	***
1977	***	***	***	***	***
1978	***	***	***	***	***
All other:					
1974	***	***	***	***	***
1975	***	***	***	***	***
1976	***	***	***	***	***
1977	***	***	***	***	***
1978	***	***	***	***	***
Total, all types:					
1974	1,203,881	584,233	1,788,114	100	33
1975	1,109,120	539,068	1,648,188	100	33
1976	1,468,236	661,062	2,129,298	100	31
1977	1,648,074	858,438	2,506,512	100	34
1978	2,080,245	1,178,322	3,258,567	100	36

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-30.--Integrated circuits: U.S. shipments, dutiable imports, and adjusted apparent consumption, by types, 1974-78 1/

Type and year	Shipments	Dutiable imports	Adjusted apparent consumption	Ratio of dutiable imports to adjusted apparent consumption
	1,000 dollars	1,000 dollars	1,000 dollars	Percent
Linear:				
1974	***	***	***	***
1975	***	***	***	***
1976	***	***	***	***
1977	***	***	***	***
1978	***	***	***	***
Digital bipolar:				
1974	***	***	***	***
1975	***	***	***	***
1976	***	***	***	***
1977	***	***	***	***
1978	***	***	***	***
Digital MOS:				
1974	***	***	***	***
1975	***	***	***	***
1976	***	***	***	***
1977	***	***	***	***
1978	***	***	***	***
All other:				
1974	***	***	***	***
1975	***	***	***	***
1976	***	***	***	***
1977	***	***	***	***
1978	***	***	***	***
Total, all types:				
1974	1,203,881	413,125	1,617,006	26
1975	1,109,120	359,710	1,468,830	24
1976	1,468,236	466,339	1,934,575	24
1977	1,648,074	536,787	2,184,861	25
1978	2,080,245	643,752	2,723,997	24

1/ Imports and consumption have been adjusted by excluding the value of duty-free material returned under the provisions of TSUS items 806.70 and 807.00.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-31.--Integrated circuits: U.S. adjusted balance of trade by types, 1974-78

(In thousands of dollars)

Type and year	Adjusted imports 1/	Exports	Balance of trade
Linear:			
1974	***	***	***
1975	***	***	***
1976	***	***	***
1977	***	***	***
1978	***	***	***
Digital bipolar:			
1974	***	***	***
1975	***	***	***
1976	***	***	***
1977	***	***	***
1978	***	***	***
Digital MOS:			
1974	***	***	***
1975	***	***	***
1976	***	***	***
1977	***	***	***
1978	***	***	***
All other:			
1974	***	***	***
1975	***	***	***
1976	***	***	***
1977	***	***	***
1978	***	***	***
Total, all types:			
1974	413,125	217,624	-195,501
1975	359,710	170,017	-189,693
1976	466,339	210,831	-255,508
1977	536,787	216,694	-320,093
1978	643,752	294,658	-349,094

1/ Total imports less the duty-free U.S. value returned under TSUS items 806.30 and 807.00.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-32.--Integrated circuits: U.S. trade balance, by types, 1974-78

(In thousands of dollars)

Item	1974	1975	1976	1977	1978
Linear:					
Imports	***	***	***	***	***
Exports	***	***	***	***	***
Balance	***	***	***	***	***
Digital bipolar:					
Imports	***	***	***	***	***
Exports	***	***	***	***	***
Balance	***	***	***	***	***
Digital MOS:					
Imports	***	***	***	***	***
Exports	***	***	***	***	***
Balance	***	***	***	***	***
All other:					
Imports	***	***	***	***	***
Exports	***	***	***	***	***
Balance	***	***	***	***	***
Total:					
Imports	584,233	539,068	661,062	858,438	1,178,322
Exports	217,624	170,017	210,831	216,649	294,658
Balance	-366,609	-369,051	-450,231	-641,744	-883,664

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-33.--Average number of employees, total and production and related workers in domestic establishments of U.S. firms engaged in producing integrated circuits, by types and by stages of manufacture, 1974-78

Item	1974	1975	1976	1977	1978
All persons employed in reporting establishments	126,949	103,463	107,852	114,004	125,857
All persons employed in producing semiconductors	85,813	68,031	71,673	79,428	89,365
All persons employed in producing integrated circuits	62,322	47,197	48,551	56,058	66,426
Production and related workers, total	33,053	28,494	31,033	35,497	41,764
Linear devices, total	***	***	***	***	***
Wafer fabrication	***	***	***	***	***
Assemblies	***	***	***	***	***
Finished devices	***	***	***	***	***
Digital bipolar devices, total	***	***	***	***	***
Wafer fabrication	***	***	***	***	***
Assemblies	***	***	***	***	***
Finished devices	***	***	***	***	***
Digital MOS devices, total	***	***	***	***	***
Wafer fabrication	***	***	***	***	***
Assemblies	***	***	***	***	***
Finished devices	***	***	***	***	***
Other (including hybrid) devices, total	***	***	***	***	***
Wafer fabrication	***	***	***	***	***
Assemblies	***	***	***	***	***
Finished devices	***	***	***	***	***

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission, adjusted for incomplete submission.

Table A-34.--Average number of employees in foreign subsidiary establishments of U.S. firms, total and production and related workers engaged in producing integrated circuits, by region and by stages of manufacture, 1974-78

Item	1974	1975	1976	1977	1978
All persons employed in reporting establishments	73,708	63,321	85,310	86,896	95,445
All persons employed in producing semiconductors	69,799	58,652	78,290	81,133	89,278
All persons employed in producing integrated circuits	43,704	37,539	53,637	56,306	65,152
Production and related workers, total	40,967	34,750	49,855	52,435	60,677
Asia, total	***	***	***	***	***
Wafer fabrication	***	***	***	***	***
Assemblies	***	***	***	***	***
Finished devices	***	***	***	***	***
Europe, total	***	***	***	***	***
Wafer fabrication	***	***	***	***	***
Assemblies	***	***	***	***	***
Finished devices	***	***	***	***	***
Western Hemisphere, total	***	***	***	***	***
Assemblies	***	***	***	***	***
Finished devices	***	***	***	***	***

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission, adjusted for incomplete submission.

Table A-35.--Integrated circuits: Percentage distribution of domestic sales of U.S. producers, by types of markets, 1974-78

(In percent)

Type of market	1974	1975	1976	1977	1978
Computer	40.3	35.3	33.4	35.1	35.5
Consumer product	16.6	16.3	10.1	9.6	10.5
Industrial	9.1	11.1	11.4	9.7	10.6
Communications	4.6	5.7	6.1	7.7	7.8
Automotive	1.0	0.7	0.6	0.8	1.1
Government	13.7	15.0	11.7	12.3	9.0
Distributor	13.9	14.4	21.9	20.0	25.0
All other	.8	1.5	4.8	4.8	.5
Total	100.0	100.0	100.0	100.0	100.0

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-36.--Integrated circuits: Worldwide expenditures for research and development by U.S. firms and their foreign subsidiaries, 1974-78

(In thousands of dollars)

Area and country	1974	1975	1976	1977	1978
Asia:					
Japan	***	***	***	***	***
Subtotal	***	***	***	***	***
Europe:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
All other	***	***	***	***	***
Subtotal	***	***	***	***	***
North America:					
United States	***	***	***	***	***
All other	***	***	***	***	***
Subtotal	***	***	***	***	***
All other	***	***	***	***	***
Total	329,897	422,488	422,292	465,633	529,651
***	***	***	***	***	***

Source: Compiled from data submitted in response to questionnaires of the

Table A-37.--Integrated circuits: Receipts and royalty payments, by U.S. firms, by types of device and by countries, 1974-78

(In thousands of dollars)

Type and country	1974		1975		1976		1977		1978	
	Receipts	Payments	Receipts	Payments	Receipts	Payments	Receipts	Payments	Receipts	Payments
Linear:										
France	***	***	***	***	***	***	***	***	***	***
West Germany	***	***	***	***	***	***	***	***	***	***
Japan	***	***	***	***	***	***	***	***	***	***
United States	***	***	***	***	***	***	***	***	***	***
All other	***	***	***	***	***	***	***	***	***	***
Total	***	***	***	***	***	***	***	***	***	***
Digital bipolar:										
France	***	***	***	***	***	***	***	***	***	***
West Germany	***	***	***	***	***	***	***	***	***	***
Japan	***	***	***	***	***	***	***	***	***	***
United States	***	***	***	***	***	***	***	***	***	***
All other	***	***	***	***	***	***	***	***	***	***
Total	***	***	***	***	***	***	***	***	***	***
Digital MOS:										
France	***	***	***	***	***	***	***	***	***	***
West Germany	***	***	***	***	***	***	***	***	***	***
Japan	***	***	***	***	***	***	***	***	***	***
United States	***	***	***	***	***	***	***	***	***	***
All other	***	***	***	***	***	***	***	***	***	***
Total	***	***	***	***	***	***	***	***	***	***
All other:										
United Kingdom	***	***	***	***	***	***	***	***	***	***
France	***	***	***	***	***	***	***	***	***	***
West Germany	***	***	***	***	***	***	***	***	***	***
Netherlands	***	***	***	***	***	***	***	***	***	***
Japan	***	***	***	***	***	***	***	***	***	***
United States	***	***	***	***	***	***	***	***	***	***
All other	***	***	***	***	***	***	***	***	***	***
Total	***	***	***	***	***	***	***	***	***	***
Total:										
United Kingdom	***	***	***	***	***	***	***	***	***	***
France	***	***	***	***	***	***	***	***	***	***
West Germany	***	***	***	***	***	***	***	***	***	***
Netherlands	***	***	***	***	***	***	***	***	***	***
Japan	***	***	***	***	***	***	***	***	***	***
United States	***	***	***	***	***	***	***	***	***	***
All other	***	***	***	***	***	***	***	***	***	***
Total	***	***	***	***	***	***	***	***	***	***
Total, less United States	***	***	***	***	***	***	***	***	***	***

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-38.--Integrated circuits: U.S. investment in plants and plant improvements (excluding production equipment), by locales, 1974-78

(In thousands of dollars)

Locale	1974	1975	1976	1977	1978
Europe:					
West Germany	***	***	***	***	***
France	***	***	***	***	***
United Kingdom	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Asia:					
Japan	***	***	***	***	***
Singapore	***	***	***	***	***
Malaysia	***	***	***	***	***
Taiwan	***	***	***	***	***
Philippines	***	***	***	***	***
Hong Kong	***	***	***	***	***
Republic of Korea	***	***	***	***	***
Thailand	***	***	***	***	***
Indonesia	***	***	***	***	***
Total	***	***	***	***	***
North America:					
United States	135,217	102,567	123,916	127,189	172,783
Mexico	***	***	***	***	***
Canada	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
All other	***	***	***	***	***
Grand total	188,844	168,770	195,062	164,031	234,495

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-39.--Integrated circuits: U.S. investments in production equipment, by locales, 1974-78

(In thousands of dollars)

Locale	1974	1975	1976	1977	1978
Europe:					
France	***	***	***	***	***
West Germany	***	***	***	***	***
United Kingdom	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
Asia:					
Malaysia	***	***	***	***	***
Singapore	***	***	***	***	***
Taiwan	***	***	***	***	***
Japan	***	***	***	***	***
Republic of Korea	***	***	***	***	***
Philippines	***	***	***	***	***
Indonesia	***	***	***	***	***
Hong Kong	***	***	***	***	***
Thailand	***	***	***	***	***
Total	***	***	***	***	***
North America:					
United States	276,135	296,938	353,067	383,036	505,419
Mexico	***	***	***	***	***
Canada	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***
All other	***	***	***	***	***
Grand total	355,371	373,828	430,733	503,083	662,558

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

A-40.--Integrated circuits: Foreign investment in the U.S. semiconductor industry, special years 1969 to 1979

U.S. producer	Foreign company	Foreign country	equity ownership	Investment
Monolithic Memories	Northern Telecom Limited	Canada	12.4	$285,000
Micropower	Daima Seikosha (Seiko)	Japan	77.0	3,385,000
EXAR	Toyo Electronics	do	53.0	1,073,000
Maruman	Mansei Kogyo Kabushiki Kaishi	do	60.0	2,700,000
Signetics	N. V. Philips	Netherlands	100.0	43,850,000
Supertex	Hong Kong Interests	Hong Kong	1/	1/
MOS Technology	Commodore International Limited	Bahamas	100.0	1/
Frontier	do	do	100.0	10,000,000
Intersil	Northern Telecom Limited	Canada	24.0	10,865,629
Interdesign	Ferranti Limited	United Kingdom	100.0	3,500,000
American Microsystems	Robert Bosch, Gmbh.	West Germany	25.0	14,230,000
Litronix	Siemens, Gmbh.	do	80.0	16,200,000
Advanced Micro Devices	do	do	20.0	26,723,087
Solid State Scientific	VDO	do	25.0	4,500,000
Siliconix	Lucas	United Kingdom	24.0	6,100,000
Electronic Arrays	Nippon Electric Co.	Japan	100.0	8,905,000
Fairchild Camera and Instrument 2/	Schlumberger, Limited	France	100.0	363,000,000

Not available.
Reported in Electronics News, May 1979.

Source: Hearing Before the Committee on Commerce, Science, and Transportation, United States Senate . . . On Environmental Policy and Innovation in the Semiconductor and Computer Industries . . . (95th Cong. 2d sess.). Serial No. 95-138, 1978, pp. 96-97.

Table A-41.--Integrated circuits: Japanese domestic production of finished integrated circuits,1/ by types, 1974-78

(In thousands of units)

Type	1974	1975	1976	1977	1978
Linear	***	***	***	***	***
Digital bipolar	***	***	***	***	***
Digital MOS	***	***	***	***	***
All other	***	***	***	***	***
Total	255,845	318,058	572,407	658,972	963,546

1/ Data requested for wafer starts and assemblies, but not supplied by Japanese producers.

Source: Compiled from data submitted in response to questionnaires of the U.S. Internatiional Trade Commission.

Table A-42.--Integrated circuits: Production of finished integrated circuits,1/ by Japanese foreign subsidiaries, 1974-78

(In thousands of units)

Source	1974	1975	1976	1977	1978
Republic of Korea	***	***	***	***	***
Ireland	***	***	***	***	***
Malaysia	***	***	***	***	***
Total	***	***	***	***	***

1/ Data requested for wafer starts and assemblies, but not supplied by Japanese producers.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-43.--Integrated circuits: Japanese domestic shipments (excluding exports), by types, 1974-78

(In thousands of dollars)

Type	1974	1975	1976	1977	1978
Linear	***	***	***	***	***
Digital bipolar	***	***	***	***	***
Digital MOS	***	***	***	***	***
All other	***	***	***	***	***
Total	264,093	318,107	488,593	560,457	930,966

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-44.--Integrated circuits: Japanese domestic shipments (excluding exports), to related parties, by types, 1974-78

(In thousands of dollars)

Type	1974	1975	1976	1977	1978
Linear	***	***	***	***	***
Digital bipolar	***	***	***	***	***
Digital MOS	***	***	***	***	***
All other	***	***	***	***	***
Total	109,535	119,118	191,684	227,843	354,167

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-45.--Integrated circuits: Japanese domestic shipments (excluding exports), to unrelated parties, by types, 1974-78

(In thousands of dollars)

Type	1974	1975	1976	1977	1978
Linear	***	***	***	***	***
Digital bipolar	***	***	***	***	***
Digital MOS	***	***	***	***	***
All other	***	***	***	***	***
Total	154,558	198,989	296,909	332,614	576,799

Source: Compiled from data submitted in response to questionnaire of the U.S. International Trade Commission.

Table A-46.--Integrated circuits: Shipments (excluding exports) from Japanese foreign subsidiaries, by countries, 1974-78

(In thousands of dollars)

Country	1974	1975	1976	1977	1978
Republic of Korea	***	***	***	***	***
Ireland	***	***	***	***	***
Total	***	***	***	***	***

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-47.--Integrated circuits: Shipments (excluding exports) from Japanese foreign subsidiaries, by countries, to related parties, 1974-78

(In thousands of dollars)

Country	1974	1975	1976	1977	1978
Republic of Korea	***	***	***	***	***

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-48.--Integrated circuits: Shipments (excluding exports) from Japanese foreign subsidiaries, by countries, to unrelated parties, 1974-78

(In thousands of dollars)

Country	1974	1975	1976	1977	1978
Republic of Korea	***	***	***	***	***
Ireland	***	***	***	***	***
Total	***	***	***	***	***

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-49.--Integrated circuits: Japanese exports, by types, 1974-78

(In thousands of dollars)

Type	1974	1975	1976	1977	1978
Linear	***	***	***	***	***
Digital bipolar	***	***	***	***	***
Digital MOS	***	***	***	***	***
All other	***	***	***	***	***
Total	3,642	13,074	27,091	82,581	204,225

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-50.--Integrated circuits: Japanese exports to related parties, by types, 1974-78

(In thousands of dollars)

Type	1974	1975	1976	1977	1978
Linear	***	***	***	***	***
Digital bipolar	***	***	***	***	***
Digital MOS	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-51.--Integrated circuits: Japanese exports to unrelated parties, by types, 1974-78

(In thousands of dollars)

Type	1974	1975	1976	1977	1978
Linear	***	***	***	***	***
Digital bipolar	***	***	***	***	***
Digital MOS	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Note.--One company did not report segment data for 1975 and 1976.

Table A-52.--Integrated circuits: Japanese exports, by markets, 1974-78

(In thousands of dollars)

Market	1974	1975	1976	1977	1978
Asia, other than Japan	***	***	***	***	***
Europe:					
United Kingdom	***	***	***	***	***
France	***	***	***	***	***
West Germany	***	***	***	***	***
Netherlands	***	***	***	***	***
Other	***	***	***	***	***
Subtotal 1/	***	***	***	***	***
North America:					
Canada	***	***	***	***	***
Other	***	***	***	***	***
Subtotal 1/	***	***	***	***	***
Other	***	***	***	***	***
Total	3,643	13,076	27,098	82,582	204,226

1/ Area totals for Europe and North America usually exceed sums of countries because 1 producer reported area totals only; 9 producers reported Asian and all other area data; and 8 producers reported European and North American data.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-53.--Integrated circuits: Exports 1/ of Japanese foreign manufacturing subsidiaries, by countries, 1974-78

(In thousands of dollars)

Country	1974	1975	1976	1977	1978
Republic of Korea	***	***	***	***	***
Malaysia	***	***	***	***	***
Ireland	***	***	***	***	***
Total	***	***	***	***	***

1/ All reported exports of integrated circuits by Japanese foreign manufacturing subsidiaries during 1974-78 were to related parties.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-54.--Integrated circuits: Exports 1/ by Japanese foreign manufacturing subsidiaries, by exporting areas and by markets, 1974-78

(In thousands of dollars)

Year and exporting area	Japan	West Germany	Total
1974:			
Asia, other than Japan, total	***	***	***
1975:			
Asia, other than Japan, total	***	***	***
1976:			
Asia, other than Japan	***	***	***
Europe, other than United Kingdom, France, West Germany, and Netherlands	***	***	***
North America, other than Canada	***	***	***
Total	***	***	***
1977:			
Asia, other than Japan	***	***	***
Europe, other than United Kingdom, France, West Germany, and Netherlands	***	***	***
Total	***	***	***
1978:			
Asia, other than Japan	***	***	***
Europe, other than United Kingdom, France, West Germany, and Netherlands	***	***	***
Total	***	***	***

1/ All reported exports of integrated circuits of Japanese foreign manufacturing subsidiaries during 1974-78 were to related parties.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-55.--Integrated circuits: Imports of Japanese producers, by types, 1974-78

(In thousands of dollars)

Type	1974	1975	1976	1977	1978
Linear	***	***	***	***	***
Digital bipolar	***	***	***	***	***
Digital MOS	***	***	***	***	***
All other	***	***	***	***	***
Subtotal	***	***	***	***	***
Unidentified 1/	***	***	***	***	***
Total	32,999	36,713	50,029	64,706	90,381

1/ Consists of aggregated values not segregated by types as reported by 2 firms.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-56.--Integrated circuits: Japanese imports for consumption, by geographical areas, 1974-78

(In thousands of dollars)

Area	1974	1975	1976	1977	1978
Asia:					
Republic of Korea	5,855	8,303	15,248	13,349	17,280
Taiwan	13,209	7,818	6,963	2,166	4,268
Malaysia	192	3,086	4,770	3,163	8,405
Singapore	5,466	3,002	3,958	374	608
Philippines	6	1,654	11,616	7,624	12,677
Hong Kong	2,252	684	2,495	721	528
All other	9	140	84	-	26
Total	26,980	24,686	45,135	27,396	43,792
Europe:					
West Germany	22,912	13,641	19,705	23,417	14,338
France	14,925	12,667	15,437	11,396	9,849
United Kingdom	227	228	715	1,042	2,659
Netherlands	5	22	218	1,562	708
All other	193	108	864	1,796	2,868
Total	38,262	26,666	36,939	39,213	30,422
North America:					
United States	108,018	80,020	116,707	120,189	180,735
All other	5,278	2,891	240	67	92
Total	113,296	82,911	116,947	120,256	180,827
All other	16	88	6	1	51
Grand total	178,553	134,351	199,026	186,866	255,092

Source: Compiled from official statistics of the Japanese Ministry of International Trade and Industry and the Japanese Ministry of Finance.

Note.--Yen/dollar conversion: 1974, 286/1; 1975, 298/1; 1976, 297/1; 1977,

Table A-57.--Integrated circuits: Japanese producers' imports from related parties, by types, 1974-78

(In thousands of dollars)

Type	1974	1975	1976	1977	1978
Linear	***	***	***	***	***
Digital bipolar	***	***	***	***	***
Digital MOS	***	***	***	***	***
All other	***	***	***	***	***
Total	***	***	***	***	***

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-58.--Integrated circuits: Japanese producers' imports from unrelated parties, by types, 1974-78

(In thousands of dollars)

Type	1974	1975	1976	1977	1978
Linear	***	***	***	***	***
Digital bipolar	***	***	***	***	***
Digital MOS	***	***	***	***	***
All other	***	***	***	***	***
Subtotal	***	***	***	***	***
Unidentified 1/	***	***	***	***	***
Total	31,466	33,212	40,682	41,159	70,100

1/ Consists of aggregated values not segregated by types as reported by 2 firms.

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-59.--Integrated circuits: Japanese producers' shipments, imports for consumption, exports, and apparent consumption, 1974-78

(In thousands of dollars)

Year	Producers' shipments	Imports	Exports	Apparent consumption	Ratio (percent) of imports to consumption
1974	252,531	178,553	23,330	407,764	43.8
1975	260,245	134,351	45,295	349,301	38.5
1976	434,956	199,026	56,583	577,399	34.5
1977	517,339	186,866	97,794	606,411	30.8
1978	908,646	255,092	203,003	960,735	26.6

Source: Compiled from official statistics of the Japanese Ministry of International Trade and Industry and Japanese Ministry of Finance.

Note.--Yen/dollar conversion: 1974, 286/1; 1975, 298/1; 1976, 297/1; 1977, 274/1, and 1978, 212/1.

Table A-60.--Average number of persons employed in Japanese domestic establishments, total and production and related workers engaged in producing integrated circuits, by stages of manufacture, 1974-78

Item	1974	1975	1976	1977	1978
All persons employed in reporting establishments	329,579	314,881	309,355	305,715	301,765
All persons employed in producing semiconductors	33,914	31,914	33,166	32,875	33,344
All persons employed in producing integrated circuits	16,126	16,631	17,781	18,413	20,416
Production and related workers, total	8,089	8,261	8,985	9,388	11,068
Wafer fabrication	***	***	***	***	***
Assemblies	***	***	***	***	***
Finished devices	***	***	***	***	***

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-61.--Average number of employees in Japanese foreign subsidiary establishments, total and production and related workers engaged in producing integrated circuits, by regions and by stages of manufacture, 1974-78

Item	1974	1975	1976	1977	1978
All persons employed in reporting establishments	***	***	***	***	***
All persons employed in producing semiconductors	***	***	***	***	***
All persons employed in producing integrated circuits	***	***	***	***	***
Production and related workers, total	***	***	***	***	***
Asia, total	***	***	***	***	***
Assemblies	***	***	***	***	***
Finished devices	***	***	***	***	***
Europe, total	***	***	***	***	***
Assemblies	***	***	***	***	***
Finished devices					

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission, adjusted for incomplete submission.

Table A-62.--Integrated circuits: Percentage distribution of domestic sales of Japanese producers, by types of markets, 1974-78

(In percent)

Type of market	1974	1975	1976	1977	1978
Computer	16.8	9.8	12.0	14.5	8.8
Consumer product	38.5	41.5	41.3	37.8	35.3
Industrial	4.8	5.0	9.8	5.8	4.5
Communications	4.3	10.3	4.3	3.8	5.5
Automotive	1.5	2.0	1.8	3.8	4.0
Government	0	0.5	0	0.3	0
Distributor	27.3	28.5	28.5	31.5	39.8
All other	6.8	2.4	2.3	2.5	2.1
Total	100.0	100.0	100.0	100.0	100.0

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Note.--Numbers may not add to 100.0 due to rounding.

Table A-63.--Integrated circuits: Japanese investment in plants and plant improvements (excluding production equipment), by areas and countries, 1974-78

(In thousands of dollars)

Area and country	1974	1975	1976	1977	1978
Asia:					
Japan	***	***	***	***	***
Malaysia	***	***	***	***	***
Europe	***	***	***	***	***
Total	9,081	3,848	21,256	24,553	30,117

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-64.--Integrated circuits: Japanese investment in production equipment, by areas and countries, 1974-78

(In thousands of dollars)

Area and country	1974	1975	1976	1977	1978
Asia:					
Japan	***	***	***	***	***
Republic of Korea	***	***	***	***	***
Malaysia	***	***	***	***	***
Singapore	***	***	***	***	***
Europe	***	***	***	***	***
Total	32,074	29,866	94,115	72,062	142,014

Source: Compiled from data submitted in response to questionnaires of the U.S. International Trade Commission.

Table A-65.--Integrated circuits: European production, by selected countries, 1974-78

(In millions of dollars)

Country	1974	1975	1976	1977	1978 1/
European Economic Community: 2/					
Belgium	8	6	3	3	3
France	74	65	78	78	84
Italy	29	15	49	55	84
Netherlands	7	16	14	20	23
United Kingdom	100	100	100	118	147
West Germany	112	115	134	191	250
Subtotal	330	317	378	465	591
Other European countries:					
Austria	4	4	-	-	-
Spain	2	2	4	4	4
Sweden	3	4	5	6	7
Switzerland	4	4	25	27	40
Subtotal	13	14	34	37	51
Total	343	331	412	502	642

1/ Estimated by the staff of the U.S. International Trade Commission.
2/ Does not contain data for Luxembourg, Ireland, or Denmark.

Source: Mackintosh Yearbook of West European Electronics Data, 1977-79.

Table A-66.--Integrated circuits: European Economic Community imports, by types and by member countries, 1974-77

(In thousands of U.S. dollars)

Type	West Germany	France	United Kingdom	Netherlands	Italy	Other 1/	Total
Total imports: 2/							
1974	123,954	48,804	3/ 64,757	26,843	32,708	11,980	3/ 309,046
1975	94,725	36,436	3/ 59,102	27,257	29,140	17,970	3/ 264,630
1976	203,986	85,757	3/ 126,114	43,728	37,832	28,320	3/ 525,737
1977	232,204	74,121	3/ 132,644	87,162	36,435	34,019	3/ 596,585
Linear: 4/							
1976	95,373	28,033	5/ 15,310	24,043	16,346	14,337	5/ 193,442
1977	107,568	26,457	16,104	28,382	19,367	13,853	211,732
Digital: 4/							
1976	101,747	36,447	5/ 42,047	9,503	9,439	8,003	5/ 207,186
1977	111,620	28,830	44,228	42,876	8,957	9,204	245,714
Monolithic: 6/							
1974	120,801	37,879	4/	19,682	13,652	9,972	7/ 201,986
1975	83,421	27,981	4/	19,976	14,643	14,424	7/ 160,445
1976	197,120	64,480	5/ 57,357	33,546	25,786	22,340	5/ 400,628
1977	219,189	55,287	60,332	71,258	28,324	23,057	457,447
Hybrid:							
1974	3,153	10,925	4/	7,161	19,056	2,008	7/ 42,303
1975	13,095	9,795	4/	8,436	16,795	4,109	7/ 52,230
1976	6,866	21,278	5/ 20,342	10,183	12,046	5,980	5/ 76,695
1977	13,016	18,834	21,400	15,904	8,111	10,962	88,227

1/ Belgium, Denmark, Ireland, and Luxembourg.
2/ Consists of monolithic and hybrid integrated circuits.
3/ Aggregated data for the United Kingdom include microstructures not classifiable as integrated circuits.
4/ Data for 1974 and 1975 are not available.
5/ Estimated by the staff of the U.S. International Trade Commission.
6/ Consists of linear and digital integrated circuits.
7/ Does not include data from the United Kingdom.

Source: Eurostat Analytical Tables of Foreign Trade, NIMEXE, 1974-77, except as noted.

Table A-67.--Integrated circuits: European Economic Community, imports by sources, 1974-77

(In thousands of dollars)

Source	1974 1/	1975 1/	1976 1/	1977
Europe:				
Intra-EEC	82,989	80,833	145,584	217,202
EFTA	15,002	13,596	22,142	22,828
Other	283	-	440	471
Total	98,274	94,429	168,166	240,501
Asia:				
Japan	1,142	1,416	5,441	5,971
Republic of Korea	2,549	4,788	21,231	6,140
Taiwan	8,957	3,369	10,153	11,737
Malaysia	8,908	4,710	9,437	12,082
Singapore	18,823	14,418	39,593	32,719
Philippines	1,414	1,832	6,529	7,362
Hong Kong	182	469	2,621	3,899
Other	-	-	-	128
Total	41,975	31,002	95,004	80,038
North America:				
United States	136,919	111,876	217,695	149,423
Other	3,662	5,765	5,683	3,569
Total	140,581	117,641	223,378	152,992
Other and unidentified	28,204	22,569	39,189	72,143
Grand total	309,034	265,641	525,737	554,674

1/ Data for the United Kingdom include trade in microstructures not classifiable as integrated circuits.

Source: Eurostat Analytical Tables of Foreign Trade NIMEXE, 1974-77.

Table A-68.--Integrated circuits: European Economic Community exports, by types and by member countries, 1974-77

(In thousands of U.S. dollars)

Type	West Germany	France	United Kingdom	Netherlands	Italy	Other 1/	Total
Total exports: 2/							
1974	57,849	16,058	3/ 30,266	15,334	15,353	2,534	3/ 137,394
1975	63,796	16,582	3/ 30,058	20,824	14,471	2,320	3/ 148,052
1976	113,818	27,139	3/ 59,067	38,545	29,848	7,247	3/ 275,665
1977	102,584	24,180	3/ 70,615	32,003	25,914	17,872	3/ 273,167
Linear: 4/							
1976	54,679	14,408	5/ 6,296	31,589	15,414	804	5/ 123,190
1977	52,076	12,935	7,527	26,297	21,560	644	121,038
Digital: 4/							
1976	43,458	8,588	5/ 42,676	3,043	4,667	1,779	5/ 104,211
1977	48,300	5,642	51,023	1,504	381	2,190	109,039
Monolithic: 6/							
1974	57,085	14,362	4/	15,073	10,380	1,040	7/ 97,940
1975	56,808	14,975	4/	19,365	10,540	755	7/ 102,443
1976	98,136	22,996	3/ 48,972	34,632	20,080	2,310	3/ 227,401
1977	100,375	18,577	58,550	27,801	21,941	2,834	230,077
Hybrid:							
1974	764	1,696	4/	261	4,974	1,494	7/ 9,189
1975	6,987	1,607	4/	1,459	3,931	1,565	7/ 15,551
1976	15,681	4,143	490	3,913	9,768	4,664	3/ 38,660
1977	2,209	5,603	588	4,202	3,973	15,038	31,612

1/ Belgium, Denmark, Ireland, and Luxembourg.
2/ Consists of monolithic and hybrid integrated circuits.
3/ Aggregated data for the United Kingdom include microstructures not classifiable as integrated circuits.
4/ Data for 1974 and 1975 are not available.
5/ Estimated by the staff of the U.S. International Trade Commission; totals may differ due to rounding.
6/ Consists of linear and digital integrated circuits.
7/ Does not include data from the United Kingdom.

Source: Eurostat Analytical Tables of Foreign Trade NIMEXE, 1974-77.

Table A-69.--Integrated circuits: European Economic Community exports, by markets, 1974-77

(In thousands of dollars)

Market	1974 1/	1975 1/	1976 1/	1977
Europe:				
Intra-EC	78,769	75,294	154,192	154,156
EFTA	20,590	18,427	35,895	30,428
Nonmarket economy countries	1,845	2,332	3,015	4,578
Other	5,362	3,675	11,001	9,394
Total	106,566	99,728	204,203	195 556
Asia:				
Japan	490	919	2,418	4,666
Singapore	5,357	4,936	14,128	9,742
Australia/New Zealand	204	2,636	742	1,434
Other	2,878	3,261	10,456	6,128
Total	8,929	11,752	27,744	21,969
North America:				
United States	5,273	21,476	9,346	10,114
Other	465	248	598	782
Total	5,738	21,724	9,944	10,890
Other and unidentified	16,161	14,848	33,774	30,268
Total	137,394	148,052	275,665	261,690

1/ Data for the United Kingdom include trade in microstructures not classifiable as integrated circuits.

Source: Eurostat Analytical Tables of Foreign Trade NIMEXE, 1974-77.

Table A-70.--Integrated circuits: European Economic Community production, imports, exports, and apparent consumption, 1974-78 1/

Year	Production 2/	Imports	Exports	Apparent consumption	Ratio of exports to production	Ratio of imports to apparent consumption
	Million dollars				Percent	
1974	330.0	226.1	58.6	497.4	17.8	45.4
1975	313.0	183.8	72.8	424.1	23.2	43.3
1976	378.0	380.2	121.5	636.7	32.1	59.7
1977	465.0	328.5	107.5	685.9	23.1	47.9
1978	3/ 591.0	4/	4/	3/ 1,005.0	4/	4/

1/ Excludes intra-Community trade.
2/ Does not include data for Luxembourg, Ireland, or Denmark.
3/ Estimated.
4/ Not available.

Source: Mackintosh Yearbook of West European Electronics Data and Eurostat Analytical Tables of Foreign Trade.

Table A-71.--Integrated circuits: European Economic Community trade balance, by areas, 1974-77

(Value in thousands of dollars)

Item	1974	1975	1976	1977
West Germany:				
Imports	123,954	94,725	203,986	232,204
Exports	57,849	63,796	113,818	102,584
Balance	-66,105	-30,929	-90,168	-129,620
France:				
Imports	48,404	36,436	85,757	74,121
Exports	16,058	16,582	27,139	24,180
Balance	-32,346	-19,854	-58,618	-49,941
United Kingdom: 1/				
Imports	64,757	59,102	126,114	132,644
Exports	30,266	30,058	59,067	70,615
Balance	-34,491	-29,044	-67,047	-62,029
Netherlands:				
Imports	26,844	27,257	43,728	87,162
Exports	15,334	20,824	38,545	32,003
Balance	-11,510	-6,433	-5,183	-55,159
Italy:				
Imports	32,708	29,140	37,832	36,435
Exports	15,353	14,471	29,848	25,914
Balance	-17,355	-14,669	-7,984	-10,521
All other: 2/				
Imports	11,980	17,970	28,320	34,019
Exports	2,534	2,320	7,247	17,872
Balance	-9,446	-15,650	-21,073	-16,147
Total:				
Imports	308,647	264,630	525,737	596,585
Exports	137,394	148,051	275,664	273,168
Balance	-171,253	-116,579	-250,073	-323,417

1/ Includes microstructures not classifiable as integrated circuits.
2/ Belgium, Denmark, Ireland, and Luxembourg.

Source: Eurostat Analytical Tables of Foreign Trade NIMEXE, 1974-77.

Table A-72--Integrated circuits: Tariff and nontariff barriers applied to U.S. exports of integrated cirucits, by markets, 1978 and 1979

Market	Tariff rate	Nontariff charges		Restrictions on payments	Advance import deposits required
		Consumption taxes	Other charges		
	Percent ad valorem	Percent ad valorem			
Asia:					
Hong Kong	-	-	No	No	No
Japan	1/ 12	5-30	No	No	No
Korea	2/ 30	13	Yes	Yes	Yes
Malaysia	25	-	Yes	No	No
Philippines	30	7-70	Yes	Yes	Yes
Singapore	-	-	Yes	No	No
Taiwan	20	20-120	Yes	Yes	Yes
Europe:					
EEC:					
Belgium	17	10	No	No	No
Denmark	17	15	No	No	No
France	17	17.6	No	No	No
West Germany	17	3/	No	No	No
Ireland	17	10	No	No	No
Italy	17	14	No	Yes	No
Luxemburg	17	16	No	No	No
Netherlands	17	18	No	No	No
United Kingdom	17	15	No	No	No
EFTA:					
Austria	-	18	No	No	No
Finland	-	16.28	No	No	No
Norway	4/	20	No	No	No
Sweden	5	20.65	No	No	No
Switzerland	4/	5/ 8.4	Yes	No	No
Spain	6/ 1	3/	No	No	No
All other:					
Argentina	-	13	Yes	No	No
Australia	35	15	No	No	No
Brazil	55	7/	Yes	Yes	Yes
Canada	-	12	Yes	No	No
Mexico	15	-	Yes	No	No

1/ Effective rate; statutory rate is 15 percent.
2/ Temporary rate; statutory rate is 40 percent.
3/ Not available.
4/ Specific rate of duty, nominal amount.
5/ Wholesale rate level applied to imports. Retail rate is 5.6 percent.
6/ Monolithic integrated circuits; rate for hybrid circuits is 26 percent.
7/ The Industrialized Products Tax varies from none to 75 percent, by product; the Merchandize Circulation Tax is applied to all interstate (12 percent) and intrastate (14.5 or 15.5 percent, by region) commerce, on the value added.

Sources: International Customs Tariff Bureau, The International Customs Journal. U.S. Department of Commerce, Overseas Business Reports, Marketing in . . . Series. International Monetary Fund, Exchange Restrictions, 20th Annual Report.

APPENDIX B

FOREIGN INVESTMENT INCENTIVES PROVIDED BY GOVERNMENTS

Ireland

Cash Grants--30-40 percent of land, building and equipment

Financing Possibilities

1. Equipment Lease - Bank will finance 35 percent of equipment value, after receiving cash grant as down payment. Lease payments made over a 5 year period, at 0 percent interest, with title transferred to firm at end of period. (Bank uses depreciation advantage not needed by company because of tax holiday for company.)

2. Building - Government will arrange for deferral of payment on building and improvements to a 5 year term, payable two times a year.

3. Preferential Stock Issue - Can issue non-voting preferential shares to bank for a fixed dividend rate lower than commercial loan rate, with company buying back shares in 2 to 7 years. Used because of corporate income tax holiday, and tax-free dividends (e.g., to bank) on export industries.

4. EIB Loans - 40 percent of assets, 7-12 year term, 2-3 year moratorium on payments; negotiable.

Taxes

1. Income Tax - 10 year holiday. Current rates are 40 to 50 percent. Grants not considered income. Losses carry forward.

2. Property Taxes - 0.3 percent of real property value.

3. Depreciation - 100 percent of equipment allowed in first year, including grants.

- 50 percent of building allowed in first year, 4 percent per year thereafter; grant portion is not depreciable.

4. Value Added Tax - Standard EEC procedures.

Training Grants

1. L1,000 ($2,000.00) per employee headcount at end of 5 years. Paid as spent, even if all spent in first 2 years.

2. Use of regional training centers, no charge (instructors, equipment). They will develop training programs with American companies assistance.

United Kingdom

Cash Grants--22 percent for building and equipment (not land), as an option to 22 percent cash grant, can get 1,500 pounds/headcount instead.

Financing Possibilities

1. Equipment Hire Purchase - A lease option program, with 20 percent down payment, lease expense and full depreciation advantages. Terms negotiable.

2. Government "Soft Loan" - Low interest loan for maximum of 30 percent of total project cost, including working capital, over a 3 year period.

3. Interest Relief Grant - Cash grant of 3 points on loan, over a 5 year period. Can be combined with "soft" loan for a total period of 8 years. Negotiable.

4. Building Lease - A 5 year lease free period offered on building (for a standard building); producers finance modifications. Or, government can finance new building and producer leases with some relief on lease expenses (negotiable). Or, 99 year lease with token annual payments, after an initial lump sum payment (financed over 15 years).

5. Preferential Shares - Can issue non-voting preferential shares to government, with deferred divident payments up to 3 years; can buy back shares later (negotiable).

6. EIB Loans - 40 percent of assets, 7-12 year term, 2-3 year moratorium on payments (negotiable).

7. ECSC Loans - 30 percent of assets, 15 year term, 3-5 year moratorium on payments (negotiable).

Taxes

1. Income Tax - Current rates 52 percent. Regional grants not taxable as income. Interest relief grant and relocation grants normally taxable. Losses carry forward.

2. Property Tax - Approximately 40 pence per square foot.

3. Depreciation - 100 percent of equipment allowed in first year including grants.

- 54 percent of building allowed in first year, 4 percent per year thereafter; grant portion also depreciable.

4. Value Added Tax - Standard EEC procedures.

Training Grants

1. Apply training costs of initial crew to start-up capitalization, then use loan schemes for financing.

2. Use of training services skill centers, no charge for instructors and available equipment.

Other

Can participate in Department of Industry Microelectronics Program with grants of 25 percent. Negotiable.

Can go up to 50 percent, with possibilities of paying back from future earnings.

France

Cash Grants

25 percent cash grant to maximum of 25,000 French francs per employee in first 3 years.

20 percent cash grant to maximum of 20,000 French francs per employee in next 3 years.

Applicable to land, building, and equipment.

Financing Possibilities

1. Export Industry Financing - Low interest loan up to 70 percent of assets purchased.
   - 1/2 of loan financed for 10 years, with deferred payments in first 5 years; interest at 2 points below prime rate.
   - 1/2 of loan financed for 5 years at 1 point below prime rate.
2. Standard Bank Financing
3. EIB Loans - 40 percent assets, 7-12 year term, 2-3 year moratorium on payments. Negotiable.

Taxes

1. Income Tax
   - 50 percent rate. Half of corporate taxes are reimbursible to shareholder upon payment of dividends. (Net multinational company tax 25 percent.) Grants considered taxable income. Losses carry forward.

2. Local Taxes
   - Normally equal to sum of the following times local "rates."
     - 8 percent of land and building.
     - 16 percent of equipment less 25,000 French francs.
     - 20 percent of payroll.
   - Various local rates are: 14.38-21.807 percent.

   Collections are for support of three levels of government: regional, departmental, and municipality.

   A 5 year tax holiday may be granted by each of these governmental bodies.

3. Depreciation
   - No accelerated depreciation allowed on equipment may depreciate 25 percent of building in first year.

4. Value Added Tax
   - Standard EEC.

Training

1. 30,000 French francs maximum for each employee under 27 years old. This is based on 25 French francs per hour up to 1,200 hours (8 mos.) maximum. Applicable to any type of training program.

Singapore	- reduced taxes on exports.
Taiwan	- reduced taxes on exports.
Thailand	- 10 year tax holiday.

APPENDIX C

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APPENDIX D

LETTER OF CONGRESSIONAL REQUEST

ADLAI E. STEVENSON
ILLINOIS

COMMITTEE ON BANKING, HOUSING AND URBAN AFFAIRS
SUBCOMMITTEE ON INTERNATIONAL FINANCE (CHAIRMAN)
COMMITTEE ON COMMERCE, SCIENCE AND TRANSPORTATION
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY AND SPACE (CHAIRMAN)
SELECT COMMITTEE ON ETHICS (CHAIRMAN)
SELECT COMMITTEE ON INTELLIGENCE
SUBCOMMITTEE ON THE COLLECTION, PRODUCTION AND QUALITY OF INTELLIGENCE (CHAIRMAN)
DEMOCRATIC POLICY COMMITTEE

United States Senate

WASHINGTON, D.C. 20510

October 25, 1978

The Honorable Joseph O. Parker, Chairman
Offices of the Commissioners
International Trade Commission
701 E Street, NW
Washington, D. C. 20436

Dear Mr. Chairman:

We hereby request the International Trade Commission to conduct a study pursuant to section 332 of the Tariff Act of 1930 of trends in international trade in computers and integrated circuits. The study should focus on factors affecting the present and future international competitive position of United States producers. In particular the study should include data and analysis concerning foreign government involvement in the industry in the form of incentives to foreign producers and disincentives to U. S. entry into foreign markets, and compare such involvement with United States Government policies affecting the computer and integrated circuit industry. We expect the Commission to make appropriate use of the expertise and resources of other Federal agencies, including the Department of Commerce, in conducting the study.

Our staff will be available to consult with Commission experts on the details of the study. In order to be of greatest use the study should begin not later than January 1, 1979, with a final report to be submitted to the Congress not later than September 30, 1979.

Sincerely,

Abraham Ribicoff,
Chairman, Subcommittee
on International Trade,
Committee on Finance

Adlai E. Stevenson,
Chairman, Subcommittee
on International Finance,
Committee on Banking, Housing
and Urban Affairs

Library Cataloging Data

U.S. International Trade Commission.
Competitive factors influencing world trade in integrated circuits. Report to the Subcommittee on International Trade of the Committee on Finance and the Subcommittee on International Finance of the Committee on Banking, Housing, and Urban Affairs of the United States Senate on investigation no. 332-102 under section 332 of the Tariff act of 1930, as amended. Washington, 1979.

140 p. illus. 28 cm. (USITC Publication 1013)

1. Competition. 2. Commerce. 3. Electronics. 4. Electronic industries.
I. Title. II. Title: Integrated Circuits.

UNITED STATES
INTERNATIONAL TRADE COMMISSION
WASHINGTON, D.C. 20436

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