Industry & Trade Summary

Metalworking Machine Tools and Accessories

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PREFACE

In 1991 the United States International Trade Commission initiated its current *Industry and Trade Summary* series of informational reports on the thousands of products imported into and exported from the United States. Each summary addresses a different commodity/industry area and contains information on product uses, U.S. and foreign producers, and customs treatment. Also included is an analysis of the basic factors affecting trends in consumption, production, and trade of the commodity, as well as those bearing on the competitiveness of U.S. industries in domestic and foreign markets.[1]

This report on metalworking machine tools and accessories covers the period 1988 through 1992 and represents one of approximately 250 to 300 individual reports to be produced in this series during the first half of the 1990s. Listed below are the individual summary reports published to date on the machinery and transportation sector.

USITC publication number	*Publication date*	*Title*
2430	November 1991	Aircraft, spacecraft, and related equipment
2505	April 1992.....	Construction and mining equipment
2546	August 1992	Agricultural and horticultural machinery
2570	November 1992	Electric household appliances
2633	June 1993	Textile machinery
2746	March 1994.....	Aircraft and Reaction Engines, Other Gas Turbines, and Parts
2751	March 1994.....	Certain Motor-Vehicle Parts and Accessories
2756	March 1994	Air-Conditioning Equipment and Parts
2765	April 1994.....	Metalworking Machine Tools and Accessories

[1] The information and analysis provided in this report are for the purpose of this report only. Nothing in this report should be construed to indicate how the Commission would find in an investigation conducted under statutory authority covering the same or similar subject matter.

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INTRODUCTION

This summary of industry and trade information covers metalworking machine tools and parts thereof, and certain machine tool accessories, such as work holders, tool holders, and dividing heads, (MMTA). The summary covers the period 1988 through 1992, but because of the U.S. industry's involvement with trade actions in the late 1980s, data from earlier years are used to provide the reader with a historical context. The report is organized into three major sections: U.S. and foreign industry profiles; tariffs and nontariff measures; and U.S. industry performance in domestic and foreign markets. Appendices provide explanations of tariff and trade agreement terms and further statistical information on the industry.

Metalworking machine tools (MMT) are stationary, power-driven machines designed to remove or work metal by processes other than flat rolling.[1] MMT range in size from small machines found in home workshops to large ones found in automobile stamping plants that can reach a height of 60 feet or more. Tool holders are clamps or other components that secure the cutting tools, whereas work holders and dividing heads hold or manipulate the parts being worked on. The major types of MMTA are shown in table 1.

MMT are generally categorized as either metal-cutting or metal-forming. For the purpose of this report, metal-cutting machine tools cover machine tools that shape or surface-work metal by removing metal in the form of chips, swarf (fine particles), dust, or similar forms, or by spark-erosion, ultrasonic, electrolytic, or other chipless methods. Metal-forming machine tools work metal by changing the shape or form of the metal through certain types of processes. These include forging, die-stamping, bending, straightening, shearing, punching, and drawing.

Metal-cutting machine tools are defined according to the type of cutting or removal technique employed, or the combination of techniques. Major types are lathes, machining centers, milling machines, drilling machines, boring machines, shapers, planers, finishing (mainly grinding) machines, and transfer machines or lines. Certain metal-cutting machine tools use processes other than mechanical energy. These machine tools are based upon laser, other light, or photon beam processes; or upon ultrasonic, electro-discharge, electro-chemical, electron beam, ion beam,[2] plasma arc, or water-jet processes. The most widely used types of these machine tools are electrical discharge machines (EDMs), lasers, plasma arc machines, and water-jet machines. EDM machines are used to cut extremely hard, high-strength, high-temperature resistant metals, such as tungsten and high refractory metals, found in many aerospace products. Lasers are used in the rapid cutting of patterns in sheet metal, spot and seam welding, and engraving. Plasma arc machines are used for cutting long, thick metal sheets or plates. Water-jet machine tools use high pressure water jets to cut metals and other materials.

Metal-forming machine tools are also classified according to the techniques by which they are used to form or shape metal. Important metal-forming machine tools include forging machines, presses, punching machines, shearing machines, and bending machines. Shearing machines are considered to be metal-forming machines because, in the shearing operation, metal is separated or parted rather than being removed in the form of chips.

Machine tool accessories include work holders, tool holders, and dividing heads. The category of work holders is comprised principally of jigs and fixtures, which hold or fix the position of the workpiece relative to the machine tool. Work holders and tool holders must provide for accurate, rigid, and quick clamping and changing of the workpiece or tool. The principal type of work holder and tool holder is the chuck, which exerts mechanical or hydraulic pressure through a set of jaws to hold the workpiece or tool.

Dividing heads are devices that allow for precise, equally spaced machining cuts on gears, sprockets, splines, serrations, and the like. Frequently, they are attached to the machine worktable that holds the workpiece and they rotate the workpiece relative to the cutting operation. Other machine tool accessories are devices designed to increase the precision of the machine tool.

MMT are assembled from a range of components, including tool beds; motors; electrical, hydraulic, and lubrication systems; and electronic or computer controls. Most metal-cutting machine tools also have one or more spindles for rotating the cutting tool. The most common types of MMT, such as machining centers, lathes, and milling machines, are produced on an assembly line, whereas highly engineered and complex machine tools, such as mechanical transfer presses and transfer lines, are custom-built.

MMT are controlled either manually or by numerical control (NC) devices.[3] Today, many machine tools are controlled by computer-numerical-control (CNC) controllers, programmable logic controllers (PLCs), or digital readout systems (DROs). CNC controllers resemble microcomputers and are frequently equipped with a keyboard and computer display. The controller is packaged with standard software to operate the machine, but can be programmed by the end-user. Builders, especially those producing metal-cutting machine tools, differentiate their products more on the controller hardware and software than on mechanical features

[1] Machine tools are generally designed to be mounted on the floor, on a bench, on a wall, or on another machine, and are usually provided with a base plate, stand, mounting frame, or the like. Although normally powered by electric motors, machine tools can also be worked by hand or pedal.

[2] Ion-beam milling machines are used in the production of semiconductors; however, trade in these machines is small relative to the category of metalworking machine tools.

[3] Numerical controls are machine tool control systems that operate a machine by means of numerically coded programs that are inserted or fed into the systems on tape, punched cards, dials, plugs, preset switches, or by playback of prerecorded operating systems.

Table 1
Metalworking machine tools and certain accessories: Major types,[1] by category

Metal-cutting machine tools:

- Transfer or station type machines
- Machining centers
- Lathes
- Milling machines
- Grinding machines, other than flat surface grinding machines
- Combination boring, milling, or drilling machines
- Gear cutting machines (including gear hobbers), and gear grinding or finishing machines
- Honing or lapping machines
- Flat-surface grinding machines
- Sawing or cutting-off machines
- Sharpening (tool or cutter grinding) machines
- Drilling or tapping machines
- Laser or photon beam process machines
- Broaching machines
- Electro-discharge machines
- Shaping or slotting machines
- Electro-chemical, electron-beam, and ion-beam or plasma arc process machines
- Water-jet machines

Metal-forming machine tools:

- Bending, folding, straightening, or flattening machines
- Mechanical presses, including transfer presses
- Metal container making machines
- Punching machines (including presses, and combination punching and shearing machines)
- Hydraulic presses
- Shearing machines (including presses)
- Thread rolling machines
- Machines for working wire
- Draw-benches for bars, tubes, profiles, wire, and the like

Accessories:

- Work holders:
  - Jigs
  - Fixtures
- Tool holders, including chucks and holders for dies
- Dividing heads and other special attachments

[1] Ranked by estimated value of U.S. producers' shipments in 1992.

Source: Compiled by the staff of the U.S. International Trade Commission.

which have become standardized. Such software features include routines for monitoring the status of the machine and tools during operation, for controlling the flow of tools to the workpiece, or for dynamically correcting machine performance during operation as heat distorts the dimensions of both workpiece and tool. CNC controllers are used extensively on metal-cutting machine tools and on certain metal-forming machine tools, such as punching and shearing machines, that have operations with multiple axes of motions.

PLCs are typically used to control large metal-forming machine tools that have sequential processes and few axes of motion. However, PLCs are becoming as sophisticated as CNC controllers. DROs are generally used on manually operated machine tools and home workshop machine tools. DROs display the digital coordinates of the workpiece relative to the machine tool, thereby allowing for greater precision in the machine.

MMTA are used by many manufacturing industries, especially the automotive, aerospace, home appliance, construction and agricultural machinery, and other heavy industries. Metal-cutting machine tools are also used extensively in the production of dies and molds for producing plastic products. They are also being applied in the cutting of hard materials other than metal, such as composites.

In terms of the value of 1992 U.S. producers' shipments of MMTA, metal-cutting machine tools accounted for 40 percent of the total; metal-forming machines tools accounted for 24 percent; and accessories, 36 percent. With respect to imports into the United States, the largest category was metal-cutting machine tools, which accounted for 69 percent of total U.S. imports of MMTA. Imports of metal-forming machine tools accounted for another 22 percent. The remaining 9 percent of imports of MMTA were accessories. The predominant types of accessories—work holders—are generally produced locally in close proximity to the end-user.

U.S. INDUSTRY PROFILE

Industry Structure

The production of MMTA is a highly capital-intensive process, which in turn relies upon other MMTA to cut, form, and hold machine tool components. The principal components, producer types, major products, and the principal consumers of the U.S. MMTA industry are shown in figure 1. Because of the high productivity and long service life of MMT, large numbers of MMT are not produced. This industry is small relative to other manufacturing sectors of the economy, in terms of the number and size of firms and the value of producers' shipments.

MMT covered in this summary account principally for all the production classified in the U.S. Bureau of the Census' Standard Industrial Classification (SIC) industry No. 3541, Machine Tools, Metal Cutting Types, and SIC 3542(pt.), Machine Tools, Metal Forming Types.[4] Machine tool accessories account for roughly 20 percent of the production classified in SIC 3545(pt.), Cutting Tools, Machine Tool Accessories, and Machinists' Precision Measuring Devices, and about 25 percent of SIC 3544(pt.), Special Dies and Tools, Die Sets, Jigs and Fixtures, and Industrial Molds.

Firms

In 1992, there were an estimated 1,000 U.S. firms producing MMTA. Data from the *1987 Census of Manufactures*, the most recent year for which such data are available, indicate that there were 381 firms in 417 establishments in the metal-cutting machine tool industry in 1987 and 196 firms in 207 establishments in the metal-forming machine tool industry.[5] About 400 firms were estimated to have produced machine tool accessories in 1987.[6] Since 1987, the number of firms producing MMTA has remained relatively constant, in part because foreign MMTA producers have increased capital investments in U.S. firms, or have established new production facilities in the United States.

According to the *1987 Census of Manufactures*, 93 percent of all metal-cutting machine tool production was concentrated in industry SIC 3541; and 87 percent of all metal-forming machine tool production was concentrated in industry SIC 3542. About 83 percent of production of SIC industry 3541 was of primary products (e.g., metal-cutting machine tools); about 91 percent of production of SIC industry 3542 was of primary products (e.g., metal-forming machine tools). Similar data for accessories are not available.

The U.S. MMTA industry is concentrated in Ohio, Michigan, Illinois, New York, Pennsylvania, and Wisconsin. Historically, production has been located near major markets, sources of raw materials, and skilled industrial labor pools. In recent years,

[4] For the purposes of this summary, production and trade data on metal-cutting machine tools and parts include: lasers for cutting and drilling classified in SIC 3699 (pt.), Electrical Machinery, Equipment, and Supplies, Not Elsewhere Classified (N.E.C.); and, ion milling machines (used in the manufacture of semiconductors), classified in SIC 3559 (pt.), Special Industry Machinery, N.E.C.

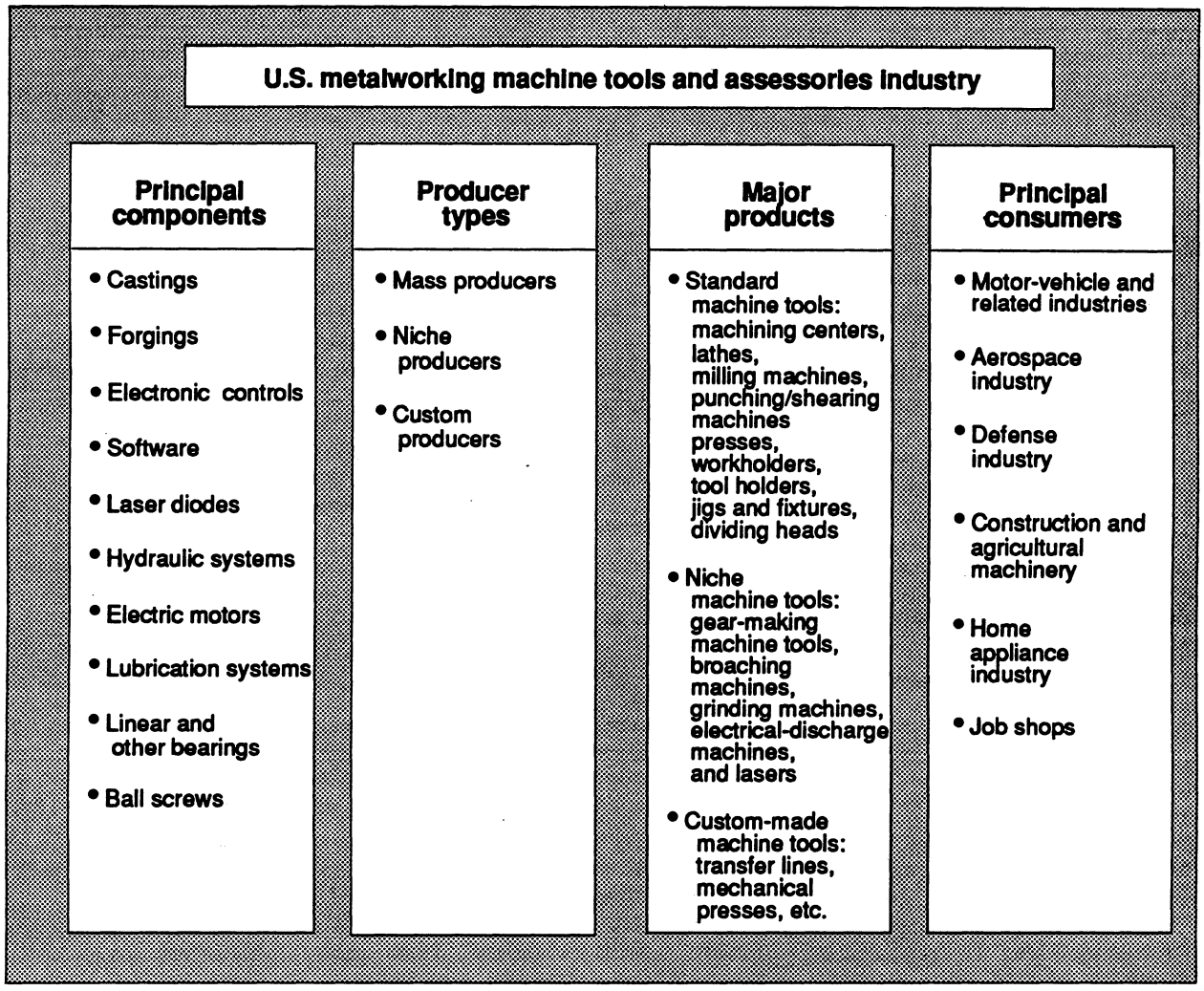
Production and trade data for metal-forming machine tools and parts include draw benches and wiredrawing machines, coil handling equipment (conversion and straightening), and certain other miscellaneous machine tools for working metal classified in SIC 3549(pt.), Metalworking Machinery, N.E.C. Since die-casting machines (classified in SIC 3542) are excluded from this summary, production data has been correspondingly adjusted.

Welding machines, classified in the U.S. Bureau of the Census' Standard Industrial Classification (SIC) industry No. 3548, Electric and Gas Welding and Soldering Equipment, are excluded from the scope of this summary.

[5] U.S. Bureau of the Census, *1987 Census of Manufactures*: Metalworking Machinery and Equipment, Industry Series MC87-I-35-C, (Washington, DC: GPO, Mar. 1990), p. 35C-8.

[6] Estimated by the staff of the U.S. International Trade Commission.

Figure 1
U.S. metalworking machine tools and accessories: Principal components, producer types, major products, and principal consumers



Source: Compiled by the staff of the U.S. International Trade Commission.

states with the most rapidly growing employment in the machine tool industry include Illinois, North Carolina, South Carolina, and California. In 1991, employment and production in Connecticut decreased as a major machine tool firm left the business and another firm ceased production.

Employment

The U.S. MMTA industry employed an estimated 94,000 persons in 1992, having declined from 108,300 persons in 1988 and a peak of 110,600 persons in 1989. The decline in employment was principally the result of industry layoffs related to falling orders during the recession of 1990-91 and the slow economic recovery during 1991-92. Some layoffs were also due to productivity improvements made by certain U.S. companies through the acquisition of modern production equipment. Other layoffs resulted from the merger of some machine tool builders and the departure of other firms from the industry. Hirings were minimal, especially during the 1990-91 recession, because U.S. builders substituted increased overtime hours for new hirings. However, a number of foreign builders established U.S. manufacturing facilities during 1988-90, adding jobs back to the industry.

U.S. employment in the MMT industry rose from 66,100 persons in 1988 to 67,300 persons in 1989, before falling to 54,000 persons in 1992; declining by 18 percent during 1988-92 (table 2).[7] During the

[7] In contrast, data from the U.S. Bureau of the Census' Annual Survey of Manufactures indicate that total employment in SIC industries 3541 and 3542 declined from 45,500 persons in 1988 to 41,500 persons in 1991, the most recent year for which data are available. Employment in SIC industry 3541 fell from 29,900 persons in 1988 to 28,000 persons in 1991; and in SIC industry 3542, employment declined from 14,600 persons in 1988 to 13,500 persons in 1991.

Table 2
Metalworking machine tools and accessories: Number of employees, production workers, production-worker average hourly earnings, and production-worker average weekly overtime for applicable SIC industries, 1988-92

(In thousands, except as noted)

SIC/Item	1988	1989	1990	1991	1992
SIC 3541, Machine tools, metal-cutting types:					
All employees	48.0	48.9	45.8	41.5	37.7
Production workers	30.5	31.7	29.5	26.0	23.1
Production-worker average hourly earnings (dollars)	11.33	11.70	12.21	12.84	13.34
Production-worker average weekly overtime (hours)	4.6	5.3	4.0	3.9	4.0
SIC 3542, Machine tools, metal-forming types:					
All employees	18.1	18.4	18.2	17.2	16.3
Production workers	11.7	11.9	11.4	10.5	10.2
Production-worker average hourly earnings (dollars)	11.85	12.15	12.41	12.54	13.33
Production-worker average weekly overtime (hours)	6.3	6.0	4.8	3.4	5.4
Total employment for SICs 3541 and 3542:					
All employees	66.1	67.3	64.0	58.7	54.0
Production workers	42.2	43.6	40.9	36.5	33.3
SIC 3544, Special dies and tools, die sets, jigs and fixtures, and industrial molds:					
All employees	145.7	148.9	147.9	141.7	141.2
Production workers	111.6	115.0	114.5	108.3	107.4
Production-worker average hourly earnings (dollars)	12.22	12.62	12.92	13.15	13.48
Production-worker average weekly overtime (hours)	6.1	6.1	5.6	5.2	5.6
SIC 3545, Cutting tools, machine tool accessories, and machinists' precision measuring devices:					
All employees	56.4	58.4	56.3	52.6	51.1
Production workers	40.1	41.5	39.6	36.8	35.9
Production-worker average hourly earnings (dollars)	10.20	10.59	10.90	11.29	11.56
Production-worker average weekly overtime (hours)	4.5	4.6	3.6	3.0	3.9

Source: Estimated by the staff of the U.S. International Trade Commission based on data from the U.S. Bureau of Labor Statistics.

period, estimated employment in the machine tool accessories industry declined from an estimated 43,000 persons in 1988 to an estimated 40,000 persons in 1992.[8] These estimates are based upon the production of machine tool accessories classified in SIC industries 3544 and 3545. Overall employment trends in SIC industries 3544 and 3545 are shown in table 2; however, employment data for these two groupings include a significant number of persons producing cutting tools, industrial molds, and dies, which are not covered in this summary. Employment in SIC 3544 and 3545 declined by 3 percent and 9 percent, respectively, during 1988-92.

Average hourly earnings for production workers in SIC industries 3541 and 3542 rose from $11.00 to $12.00 in 1988 to over $13.00 in 1992. In comparison, similar earnings for SIC 3714, Motor Vehicle Parts and Accessories, were $14.24 in 1992; and in SIC 3661, Telephone and Telegraph Apparatus, earnings were $12.13.

The production of MMTA involves a substantial amount of both labor and automation. Labor is used in the production of most components and subsequent assembly. Labor productivity, as measured by output per hour in the U.S. MMTA industry, lagged behind that of overall U.S. manufacturing during 1988-92 (table 3). Labor productivity in all manufacturing industries rose by 8 percent during this period, whereas

[7]—*Continued*
Both the U.S. Bureau of Labor Statistics (BLS) and the Bureau of the Census data reportedly cover employees in manufacturing establishments in a particular SIC industry. However, BLS data report employment in auxiliary units, such as administrative offices, warehouses, and research and development laboratories of multi-establishment companies, whereas Census aggregates these data at the 2-digit SIC level. BLS partially relies upon States to assign establishments to SIC industries, and errors may thereby be introduced. Both BLS and Census data classify facilities that assemble machine tools from imported parts as wholesalers in SIC 5084, Industrial Machinery and Equipment.

[8] Estimates compiled by the staff of the U.S. International Trade Commission.

productivity in the metal-cutting machine tool industry rose by 6 percent, and productivity in the metal forming machine tool industry declined by 10 percent. The decline in productivity among metal-forming machine tool builders was principally due to strong price competition, a decline in sales during the 1990-91 recession, and to slow sales in the economic recovery of 1992.

During 1988-92, U.S. machine tool builders invested in new machinery, facilities, and manufacturing technology (including computers) to increase productivity and quality. Companies implemented formal quality improvement programs, statistical process control, factory scheduling programs such as Manufacturing Resource Planning (MRP II), metric engineering, manufacturing in cells, and continuous flow production. In the area of design, computer-aided-design/computer-aided-manufacturing (CAD/CAM) and finite element analysis, which have reduced the length of design, engineering, and production cycles, also became more widely used. The improvements in financial performance and productivity occurred despite many MMT builders remaining undercapitalized.

Most machine tool builders apply automation to the integration of groupings of machine tools, known as cells, and to the use of CAD/CAM in their engineering and scheduling departments. Automated production cells are more frequently used in the production of mass-produced, standardized (including NC) machine tools. Specialized and custom machine tool producers depend less on automated machining cells and assembly equipment because of limited production and the wide range of sizes and configurations of machine tools produced. Some large machine tool builders have also installed flexible manufacturing systems. Japanese machine tool subsidiaries that have established manufacturing operations in the United States generally have very modern facilities. One such firm employs computer-integrated-manufacturing, known as CIM, which is rarely used by U.S.-owned machine tool builders, but is employed extensively in other industries in processing and assembly operations.

Financial Performance

Some of the most important financial performance measures of the machine tool industry are profits, return on investment (ROI), and current ratios.[9] These indicators for the U.S. durable goods and machine tool industries are shown in table 4. ROI provides a benchmark of profitability relative to investment, while the current ratio is an indicator of a firm's ability to cover its current liabilities. The latter ratio is especially important because while a firm might be profitable and can generate a return on investment, it might not be able to meet its current obligations without borrowing.

[9] A firm's total current assets divided by its total current liabilities.

During 1983-85, data compiled by the Association for Manufacturing Technology (AMT)[10] indicated that U.S. machine tool builders had negative ratios for income after taxes to net sales and to average net worth. During the same period, the current ratio declined from 3.1 percent to 2.3 percent,[11] and continued to fall through 1989, before rising slightly, indicating that net revenues are being used to meet operating expenses or other needs, such as investment in plant and equipment and in research and development. Although the U.S. machine tool industry improved its financial performance during 1986-92, its level of performance was substantially below that of the durable goods industry through 1990. During the 1990-91 recession, the financial performance of MMT companies declined as a result of a decrease in demand by user industries.

An indicator of the industry's lackluster financial performance is its low level of capacity utilization. The following tabulation shows the fourth quarter rate of production capacity utilization (in percent) for 1989 and 1992:[12]

Industry	1989	1992
Metal-cutting machine tools (SIC 3541)	84	70
Metal-forming machine tools (SIC 3542)	72	75
Special dies, tools, jigs, and fixtures (SIC 3544)	84	81
Machine tool accessories (SIC 3545)	82	76

Mergers, acquisitions, and foreign investment

The leading U.S. machine tool builders, in terms of sales and employment, are subsidiaries of medium-size, publicly held companies, or are subsidiaries of foreign firms, although the second largest U.S. firm is privately held. The remainder of the industry is comprised of small, privately held firms, some of which are family-owned. In 1992, there were only 12 publicly held U.S. machine tool builders, including those with parent firms.[13] The leading U.S.

[10] In 1988, the name of the National Machine Tool Builders' Association (NMTBA) was changed to "NMTBA—The Association for Manufacturing Technology". Effective January 1, 1992, the association changed the name to "AMT—The Association for Manufacturing Technology."

[11] A current ratio of more than 2 is considered excellent by accounting standards.

[12] U.S. Bureau of the Census, *Current Industrial Reports*: Survey of Plant Capacity 1990, MQ-C1 (90)-1 (Washington, DC: GPO, Mar. 1991) and Survey of Plant capacity, 1992 MQ-C1(92)-1 (Washington, DC; GPO, Mar. 1994). Data for prior Census surveys used different definitions of capacity and may not be directly comparable.

[13] Large publicly held corporations with machine tool subsidiaries include Litton Industries, Inc., National ACME, Newcor, Inc., and the Goldman Financial Group. In 1992, publicly held companies that principally produced machine tools were Boston Digital, Inc., Cincinnati Milacron, Inc., Giddings & Lewis Co., The Gleason Corp., Hardinge Brothers, Inc., Hurco Companies,

Table 3
Productivity (output per hour) indexes for all manufacturing industries, metalworking machine tools, and machine tool accessories, 1988-92

(1988 = 100.0)

Sector/industry	1988	1989	1990	1991	1992
Manufacturing	100.0	100.4	103.0	105.0	108.1
Machine tools:					
Metal-cutting	100.0	94.2	100.2	102.1	105.9
Metal-forming	100.0	116.0	112.4	102.6	90.0
Machine tool accessories	100.0	99.3	104.7	107.4	(1)

[1] Not available.

Source: Compiled by the staff of the U.S. International Trade Commission from annual productivity indexes for selected industries published in the U.S. Bureau of Labor Statistics, *Monthly Labor Review.*

Table 4
Selected financial ratios for U.S. producers of durable goods and metal working machine tools, 1986-92

(In percent)

Indicator	1986	1987	1988	1989	1990	1991	1992
After-tax income to net sales:							
Durable goods	2.9	4.5	5.1	4.2	3.1	[1]0.6	-1.4
Machine tools	-0.5	1.0	1.5	1.8	1.7	1.7	0.5
After-tax income to average net worth:							
Durable goods	7.8	11.9	14.0	11.4	8.1	[1]1.4	-1.5
Machine tools	-0.5	2.2	3.7	5.1	4.6	3.8	1.6
Ratio of current assets to current liabilities:							
Durable goods	1.6	1.6	2.0	1.6	1.5	1.5	1.5
Machine tools	2.2	2.0	2.0	1.8	1.9	2.0	2.0

[1] Declines occurred in iron and steel, transportation, and glass industries.

Source: AMT—The Association for Manufacturing Technology, *Economic Handbook of the Machine Tool Industry,* various editions.

machine tool builders, both privately and publicly held and U.S.- and foreign-owned, are ranked by 1992 MMT sales in the following tabulation (in millions of dollars):[14]

Company	Estimated MMT sales 1992
Giddings & Lewis Co	571.7
Ingersoll Milling Machine Co	410.0
Cincinnati Milacron Inc	380.0
Litton Industries Inc	306.6
Mazak Corp.(Japan)	300.0
Okuma America.(Japan)	150.0
The Gleason Corp.	147.3

The leading companies that derive the majority of their sales from producing MMT accessories and their estimated 1992 sales are: Kennametal Inc., $618 million; Doall Co. $101 million; Carboloy Inc., $90 million; and The Jacobs Chuck Manufacturing Co., $60 million. A significant share of Kennametal's sales are from cutting tools used on MMT.

During 1987-91, the structure of the industry changed dramatically as corporations divested their unprofitable machine tool subsidiaries. The lack of profitability was reportedly the result of the parent companies' failure to modernize their operations in the late 1970s and 1980s, a time when machine tool technology was rapidly changing.[15] Some of these machine tool subsidiaries were divested through leveraged buy-outs, but a few firms left the industry because they were unable to cover their debt obligations. Other machine tool firms dropped unprofitable product lines or acquired other firms to enhance or complement their business. For example, in October 1991, Giddings & Lewis, the fifth largest producer, acquired Cross & Trecker Corp., the largest U.S. producer in 1990, with sales of $431 million. The industry restructuring subsided in 1992, as there were no major mergers or acquisitions in that year. In mid-1993, Cincinnati Milacron, a leading U.S. MMT producer, purchased GTE Valenite Corp., a major U.S. producer of cutting tools used on MMT. Major mergers and acquisitions in the metalworking machine tool industry during 1987-93 are presented in table 5.

[13]—*Continued*
Inc., Met Coil Systems Corp., and Monarch Machine Tool Co. In mid-1991, Brown & Sharpe left the industry, and in October 1991, Cross & Trecker was acquired by Giddings & Lewis Co.

[14] *American Machinist,* "The Blue Bulletin," July 30, 1993; Gale Research, Inc., *Ward's Business Directory of U.S. Private and Public Companies 1993,* (Detroit: Gale Research Inc., 1993), p. 3226.

[15] Max Holland, *When the Machine Stopped: A Cautionary Tale from Industrial America,* (Boston: Harvard Business School Press, 1989).

Table 5
Metalworking machine tools: Major MMT industry mergers and acquisitions, 1987-93

Sector/company	Year	Activity
Metal-cutting machine tools:		
Makino Milling Machine Co. Ltd. (Japan)	1987	Acquired 49 percent of LeBlond Makino Machine Tool Co.
Ex-Cell-O management group	1987	Acquired Textron Inc.'s Ex-Cell-O Corp.'s European machine tool division in LBO
Herman Pfauter Gmbh & Co. (Germany)	1987	Acquired Barber-Colman Co.
Toyoda Machine Works Ltd.	1987	Acquired Grinders for Industry Inc.
AG Fur Industrielle Elektonie (AGIE) (Switzerland)	1988	Acquired Colt Industries Inc.'s Elox Division
Goldman Financial Corp. Inc.	1988	Acquired Jones & Lamson Machine Co. Inc.
Pratt & Whitney Co. Inc.	1988	Acquired Cross & Trecker Corp.'s Warner & Swasey grinding division
Goldman Financial Group	1989	Acquired Jones & Lamson's subsidiary Waterbury Ferrel
AMCA International Corp.	1989	Sold Giddings & Lewis Inc. to the public
DeVlieg-Bullard Inc.	1990	Acquired Litton Industries Inc.'s New Britain Machine Co.
Hurco Co.	1990	Acquired Eltee Pulistron Inc.
Nachi-Fujikoshi (Japan)	1991	Acquired National Broach & Machine Co.
Giddings & Lewis Inc.	1991	Acquired Cross & Trecker Corp.
Charterhouse Equity Partners and a Boston Digital Corp. management team	1993	Acquired Boston Digital Corp. in LBO
Dorries Scharmann USA Inc. (Germany)	1993	Acquired RD&D Corp.
Metal-forming machine tools:		
Kohlberg Kravis Roberts & Co.	1987	Acquired assets of Houdaille Industries (including Strippit Co.)
Met-Coil Systems Corp.	1988	Acquired Roper Whitney Corp.
Murata Machinery (Japan)	1989	Acquired Cross & Trecker Corp.'s Weideman Division forming Murata Weidemann Inc.
Murata Machinery (Japan)	1989	Acquired Cross & Trecker Corp.'s equity interest in Murata Warner Swasey, a joint venture between Cross & Trecker Corp. and Murata Machinery
Danley Machine	1991	Danley Machine forms joint venture with Komatsu (Japan)
Verson International Group (UK)	1991	Acquired Niagara Press
Verson International Group (UK)	1992	Acquired Hitachi Zozen Clearing Inc.

Source: Compiled by the staff of the U.S. International Trade Commission from various trade magazines.

There have been only a few U.S.-owned entrants in the MMTA industry since 1980. The last notable entrants to the industry were Fadal Engineering Co., Inc., which introduced its first machines in 1980, and Haas Automation, Inc., which introduced its first machines in 1989. Both companies produce vertical machining centers for the job shop market that are competitive with Japanese machine tools. In mid-1993, The American Way Company entered the industry with the production of small NC lathes, a very competitive market segment.

The greatest number of entrants into the U.S. MMTA industry have been foreign firms that have either acquired U.S. builders or established new production or assembly facilities in the United States. Japanese MMT builders have been the largest investors in the U.S. industry, followed by German MMT firms; their major investments in the United States are shown in table 6.

Japanese investment in the U.S. MMT industry is concentrated primarily in metal-cutting machines, such as machining centers, NC lathes, and milling machines. U.S. subsidiaries of Japanese MMT builders accounted for a significant portion of U.S. production of NC lathes and machining centers in 1992. Also, the leading U.S. producer of broaching machines and broaching tools, National Broach, was acquired in 1991 by a Japanese broaching tool competitor, Nachi-Fujikoshi. Other Japanese investments have been made in the production of punching and shearing machines, and stamping presses, both of which are types of metal-forming machine tools. Of the three largest U.S. press builders, one was a Japanese subsidiary that was sold in 1992 to a British press builder. Another U.S. press builder recently created a joint venture with the largest Japanese press builder.

Table 6
Metalworking machine tools: Major Japanese- and German-owned manufacturing establishments in the United States, 1992

Country of parent company/ company	Location	Products	Estimated Employment
Japan:			
American Precision Inc. (Mitsubishi Ltd.)	Hopinsville, KY	NC lathes, machining centers	250
Hitachi Seiki U.S.A. Inc.	Huntsville, AL	NC lathes	25
	Congers, NY	NC lathes, machining centers	60
LeBlond Makino Machine Tool Co.	Mason, OH	Machining centers, EDMs, lathes	270
Mazak Corp.	Florence, KY	NC lathes, machining centers	580
Miyano Machinery U.S.A. Inc.	Wood Dale, IL	NC lathes, machining centers, drills	55
Mori Seiki U.S.A. Inc.	Irving, TX	NC lathes, machining centers	25
National Broach and Machine Co.	Mt. Clemens, MI	Broaching machines	400
Okamoto Corp.	Buffalo Grove, IL	Surface grinders	50
Okuma Machine Tools Inc.	Charlotte, NC	NC lathes, machining centers grinders, and NC controls	290
Sugino USA, Corp.	Schaumberg, IL	Drilling and tapping machines	40
Toyoda Machinery U.S.A. Inc.	Arlington Heights, IL	NC lathes, machining centers, and grinding machine rebuilding	240
	Wixom, IL		
Germany:			
American Pfauter Ltd.	Elk Grove, IL	Gear hobbing and shaping machines	150
Hueller Hille Corp.[1]	Troy, MI	Transfer lines and machining centers	250
National Machinery GmbH	Tiffin, OH	Forging machines and presses	700
Peddinghaus Corp.	Bradley, IL	Fabricating systems and punching machines	140
Trumpf, Inc.	Farmington, CT	Punching and shearing machines, lasers	240

[1] In late 1993, the company changed its name to Thyssen Production Systems, Inc.

Source: Compiled by the staff of the U.S International Trade Commission from various sources.

German investment in the U.S. MMT industry covers a wide range of metalworking machine tools (table 6). MAHO, a major German MMT builder, produced machining centers in the United States during 1989-92; the firm shut down its U.S. production as it rationalized its global operations in 1992. The largest U.S. builder of metal-cutting lasers and a U.S. press builder are subsidiaries of German firms. The major U.S. producer of EDMs, Elox Corp., is Swiss-owned.

The foreign ownership of U.S. machine tool companies became a national policy issue in mid-1990, when Moore Special Tool Co., Inc. announced that it would sell a 40-percent interest in the company to Fanuc Machine Tool Controller Co. of Japan. Moore Special Tool Co., Inc. was the only U.S. producer of machine tools that satisfied the requirements of the U.S. Department of Defense and the U.S. Department of Energy for making atomic weaponry. However, the company had been unprofitable and reportedly needed a new infusion of capital. In December 1990, the U.S. Government's Committee on Foreign Investment in the United States (CFIUS) recommended to the President that the sale be approved, subject to certain conditions on the transfer of technology between Moore and Fanuc. In January 1991, the President announced his approval of the sale, but in February 1992, Fanuc rescinded its offer.[16]

[16] In January 1994, Moore Special Tool Co. was purchased by another U.S. specialty MMT builder, The Producto Machine Company.

Although U.S. machine tool builders have established marketing arrangements with foreign builders, such arrangements have been limited. A few U.S. builders prefer to purchase foreign-built machines and add on their own controllers and software. Most U.S. producers purchase castings, motors, gearboxes, bearings, computer controls, and linear motion components, including ball screws, from both domestic and foreign sources. However, several large builders have made substantial investments and produce their own ball screws. Some large and small U.S. builders also produce their own computer control units, including the software, rather than rely on other producers. For this reason, some machine tool builders perceive themselves more as being software producers, rather than as being machine tool builders.

Certain Japanese and German producers of machine tool components, such as computer controls, linear bearings and guides, and ball screws, have located production facilities in the United States. Other foreign component suppliers have subcontracted production to U.S. producers, or are contemplating future U.S. production.

Capital Expenditures

Capital expenditures for new and used plant and equipment by the U.S. MMT industry (including foreign-owned MMT producers) rose from $101 million in 1987 to $141 million in 1989, before declining to $107 million in 1991, the most recent year for which data are available (table 7). In 1985 and 1986, prior to the negotiation of voluntary restraint agreements with Japan and Taiwan covering their exports of certain machine tools to the United States, capital expenditures totaled $150 million and $111 million, respectively. The relatively high level of expenditures at that time was principally due to initial Japanese investment in production facilities in the United States. The trend continued in 1989 and 1990 as Japanese and other foreign machine tool builders established new U.S. facilities or expanded existing factories. The vast majority of capital expenditures has been for new production machinery, while purchases of used buildings and equipment have been minimal. In 1992, U.S.-owned producers of MMT made substantial investments in new plants, particularly firms such as Gleason Works, Fadal Engineering, and Haas Automation Inc.

During 1987-91, capital expenditures by the metal-cutting machine tool industry (SIC 3541) represented about 3 percent of annual product shipments and a little more than 2 percent of such shipments by the metal-forming machine tool industry (SIC 3542). This compares favorably with capital expenditures of about 3 percent of product shipments by all U.S. industrial machinery and equipment industries, SIC 35 (excluding SIC industry 357, Computer and Office Equipment).

MMT builders also require capital investment for technical centers and sales offices that are not related to their manufacturing plants. In order to remain competitive, large capital investments in advanced computer systems and research and development are required. Because of the expanding need for such investment, industry experts believe that many U.S.-owned machine tool builders are undercapitalized. For example, Pratt & Whitney Co., Inc., a producer of machining centers, grinding machines, and milling machines, went into bankruptcy in early 1991 due in large part to debt incurred during a leveraged buy-out in 1986, slow sales in the 1990-91 recession, and large requirements for working capital in order to keep pace with new technology.[17]

Distribution

Industry sources[18] estimate that approximately 60 percent of all new domestically produced machine tools (particularly the most commonly used machines such as lathes, machining centers, milling machines, and boring/drilling machines and their accessories), are sold through distributors. More expensive, niche, or special-purpose machine tools are sold directly to the customer because of their advanced degree of complexity, high level of engineering, and heightened customer support and service requirements. These

[17] "Pratt & Whitney In Bankruptcy After Sale of Units," *Metalworking Weekly Report*, Mar. 18, 1991, p. 43.

[18] Official of the American Machine Tool Distributors' Association, telephone interview by USITC staff, Oct. 23, 1992.

Table 7
Metalworking machine tools: Capital expenditures for new and used plant and machinery, by SIC industries 3541 and 3542, 1987-91

SIC industry/type	1987	1988	1989	1990	1991
			Million dollars		
SIC 3541, machine tools, metal-cutting types:					
Machinery and equipment	52.9	57.2	78.0	86.8	63.0
Buildings and structures	13.9	11.8	20.3	13.7	10.3
Total	66.8	69.0	98.3	100.5	73.3
SIC 3542, Machine tools, metal-forming types:					
Machinery and equipment	31.0	32.0	31.5	32.7	30.4
Buildings and structures	3.6	7.7	10.8	5.3	3.3
Total	34.6	39.7	42.3	38.0	33.7
Grand total	101.4	108.7	140.6	138.5	107.0

Source: U.S. Bureau of the Census, *Annual Survey of Manufactures*, 1988-91.

special-purpose tools include transfer lines, flexible manufacturing systems (FMSs), and ultra-precision machine tools. However, some distributors have also specialized in selling FMSs.

Distributors act as agents or representatives of manufacturers, but do not take title to the machine tools, nor maintain machine tool inventories. Distributors seek potential customers, assess their needs, perform application studies, and make equipment proposals. This process may take from 6 months to a year before an order is placed. In addition, distributors typically provide training, service, financing, and parts.

While there are no national distributors of machine tools, some distributors cover more states than others. Annual sales for the largest distributors range from approximately $125 million to $130 million, but sales for the average distributor range from $10 million to $15 million. Distributors typically represent the product lines of a number of manufacturers, both domestic and foreign, but are typically not involved in export sales.

U.S. sales of machine tools are typically based on fixed price contracts, the value of which depends upon the amount of engineering time expended, the cost of hardware and labor, and the desired level of profit. The fixed price of a contract is typically paid in full upon shipment. Frequently, however, the customer will test the machine tool at the producer's plant before acceptance is made. This is a common practice for large, highly engineered systems. Standard industry practice in the United States does not typically provide for progress payments which would help to balance the cash flow of the builder over the course of the contract. In contrast, European customers typically provide progress payments, as do Japanese customers, although less frequently. Progress payments in contracts with foreign customers have significantly benefited U.S. machine tool builders.

The availability of financing has become a significant sales incentive because of the high cost of machine tools, which generally range in price from $50,000 to $300,000 per unit. Financing is provided by manufacturers, distributors, financing firms,[19] or banks. Manufacturers and distributors who finance purchases generally do not require a detailed justification for the purchase, but do usually request a lien to be placed on the purchased equipment as collateral. In contrast, banks require a detailed justification and may require liens on additional equipment, or on the company itself as additional collateral.

Financing plans allow for a minimal down-payment and deferred payments for 2 to 3 months.[20] In some instances, deferred payments of up to 6 months have been offered as sales incentives.[21] Leasing, an alternative to financing, is becoming popular because it requires a lower initial payment. If the firm leases, the firm can also bypass most banks' typical equipment loan criteria that call for a specified return-on-investment within three years.[22]

According to the U.S. Bureau of Labor Statistics, prices for machine tools rose by approximately 4 percent per year on average during 1988-92 (table 8). Prices for products in SIC 3544 and SIC 3545 increased at a lower rate, by about 3 percent annually.

Research and Development

Research and development (R&D) expenditures data for the U.S. metalworking machine tool industry are fragmentary. According to an AMT survey of U.S. firms affected by voluntary restraint agreements between the United States and Japan and Taiwan, R&D/engineering as a percent of sales during 1987-92 ranged from 5.2 percent to 11.9 percent.[23]

The typical machine tool R&D design project has a duration of 3 years, or more. However, this may be preceded by a research identification period of up to 2 years. Most companies fund R&D from retained earnings, but some manufacturers of specialized or niche machine tools have initiated product development programs as the result of U.S. Department of Defense contracts.

Some industry experts believe that U.S. machine tool builders lag behind foreign suppliers in technology in part because of the limited number of personnel available to conduct research and development.

[19] These include GE Capital Corp., The CIT Group, and Machine Tool Finance Group.

[20] Martin Eastman, "Backed for the Future," *Cutting Tool Engineering*, June 1992, pp. 105-108.

[21] Gary Slutsker, "Struggling Against the Tide," *Forbes*, Nov. 12, 1990, p. 318.

[22] Jean V. Owen, "Buying Machine Tools: A Strategy," *Manufacturing Engineering*, Dec. 1993, p. 29.

[23] AMT—The Association for Manufacturing Technology, "Position Paper on Trade Issues," Nov. 1993, p. 1.

Table 8
Metalworking machine tools and accessories: Producer price indexes for applicable SICs, 1988-92

(In percent, 1988=100.0)

SIC	1988	1989	1990	1991	1992
SIC 3541, Machine tools, metal-cutting type	100.0	105.3	110.7	114.9	118.1
SIC 3542, Machine tools, metal-forming type	100.0	104.2	112.2	115.8	117.6
SIC 3544, Special tools, dies, jigs, fixtures, and industrial molds	100.0	102.5	105.3	109.4	111.0
SIC 3545, Machine tool accessories	100.0	103.9	106.8	110.0	112.2

Source: Compiled by the staff of the U.S. International Trade Commission from U.S. Bureau of Labor Statistics data.

Engineers with qualified degrees generally make up only from 5 to 10 percent of a typical U.S. machine tool builder's workforce. Approximately 75 percent of such engineers would be involved in engineering, software development, electronics, and mechanical problems, with the remaining 25 percent involved in shop floor activities. Typically, three to five employees may be assigned to those machine tool development tasks that are outside of the firm's daily engineering tasks.[24] For example, Giddings & Lewis, the fifth-ranked U.S. machine tool builder in 1990, employed one percent (28 persons) of its workforce in R&D and another 13 percent (364 persons) in product development, custom engineering, and software development; or a total of 14 percent of company employment. Similarly, in 1990, Monarch Machine Tool Co. dedicated 16 percent (156 persons) of total company employment to R&D/engineering, including such functions as engineering on customer orders, improving product lines, and developing new products.

New products and innovations in machine tool technology are also driven by technological advances achieved by machine tool component suppliers, such as builders of computer controls, spindles, and cutting tools. The development of new metal alloys and new metal applications has also fostered machine tool innovation.

Other Factors

The performance of U.S. machine tool builders has been adversely affected by a number of factors. These include the high cost of capital in the United States during the 1980s relative to the cost of capital in other producing nations, and extended tax depreciation schedules for machine tools. In addition, extensive product liability laws have resulted in higher insurance costs.

According to a recent survey by the AMT, 18 percent of its members were not covered by product liability insurance.[25] AMT members indicated that their insurance carriers' premiums were either too expensive, or that they were denied insurance coverage. In 1992, the average product liability premium was $79,000, down from $101,700 in 1991, but still higher than the average premium of $59,100 in 1985. The average premium in the metal-forming machine tool industry was $103,500 in 1991, compared with $72,800 in the metal-cutting industry. Historically, premiums swing wildly from year to year, depending upon on the number of accident claims. In response to the product liability insurance problem, AMT has established a risk retention group to provide insurance. In 1991, 74 percent of the product liability claims were reported among metal-forming machine tool builders, with the remainder reported among metal-cutting machine tool builders.[26] Many of today's operational metal-forming machine tools are old and lack the safety features that are currently required.

U.S. Government Programs

Most of the U.S. Government assistance to the U.S. metalworking machine tool industry has occurred in military and civilian programs coordinated under the Machine Tool Domestic Action Plan. This Plan was designed to complement the Voluntary Restraint Agreements (VRAs), which limited imports of certain machine tools from Japan and Taiwan. The U.S. metalworking machine tool industry also participates in other U.S. Government programs, some of which are related specifically to national security issues, while others are available to most U.S. industries.

The Machine Tool Domestic Action Plan

In May 1986, the President directed the U.S. Departments of Commerce (DOC) and Defense (DOD), in cooperation with other federal agencies, to develop a Machine Tool Domestic Action Plan of programs to support the revitalization of the U.S. machine tool industry.[27] The objective of the Plan was to support the industry's own efforts to modernize.

The Machine Tool Domestic Action Plan covers DOD and other U.S. Government agency research funding, productivity and marketing programs, U.S. Government procurement of MMT, market expansion for advanced manufacturing technology, and improved U.S. export control licensing procedures. The Plan is summarized in table 9. The benefits of the Machine Tool Domestic Action Plan to the U.S. industry have been difficult to estimate because research projects initiated in 1988 and 1989 are still continuing, or have only recently been completed. The dispersion of this research and the subsequent development of commercial products will take additional time. It has also been difficult to determine the value of sales that may have resulted from the implementation of the Plan's programs, particularly from export promotion programs and the relaxation of export controls.

During the 1980s, U.S. machine tool builders generally participated in U.S. Department of Defense (DOD) R&D programs. The principal program was DOD's Manufacturing Technology Program (MANTECH),[28] but with the implementation of the Machine Tool Domestic Action Plan, DOD began to fund a greater amount of machine tool R&D.[29] DOD's MANTECH program has provided partial funding for the National Center for Manufacturing Sciences, Inc.(NCMS),[30] a research consortium, since its

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[24] Official of the National Science Foundation, interview by USITC staff, Apr. 1991.

[25] AMT—The Association for Manufacturing Technology, *Final Results - 17th Annual Product Liability Survey*, July 8, 1992.

[26] NMTBA—The Association for Manufacturing Technology, *Final Results - 16th Annual Product Liability Survey*, Mar. 13, 1991.

[27] See section on U.S.-Government trade-related investigations, p. 21.

[28] The U.S. Air Force serves as the lead agency within the MANTECH program supporting the Machine Tool Domestic Action Plan.

[29] See section on research and development, p. 11.

[30] Exempted from certain antitrust laws by authority of the National Cooperative Research Act of 1984 (15 U.S.C. 4301, et. seq.).

Table 9
U.S. Machine Tool Domestic Action Plan

Plan activity area	Programs
U.S. Department of Defense-sponsored research	Manufacturing Technology Program (MANTECH) funding for National Center for Manufacturing Sciences (NCMS) Other MANTECH programs Advanced Research Projects Agency (ARPA) programs University Research grants Index of DOD-sponsored research
Other Federal agency research funding	National Institute of Standards and Technology's Advanced Technology Program and Automation Program National Science Foundation grants U.S. Departments of Commerce and Energy's National Machine Tool Partnership technical service
Productivity and marketing programs	Expanded risk insurance coverage by the Export-Import Bank Export Trading Company (ETC) program U.S. Department of Labor training and evaluation programs Antitrust advice on joint R&D U.S.-Japan Machine Tool Cooperation Program (1990-1993)
Expanding the market for advanced manufacturing technology	U.S. Navy's Rapid Acquisition of Manufactured Parts Program Antitrust advice on joint manufacturing
Procurement related actions	Defense purchases of machine tools restricted to U.S.- or Canadian-origin[1] DOD procurement conferences
Improved export licensing procedures	Relaxed licenses for machine tool exports (1987-90) Decontrolling most machine tools (1990) Core List[2] changes limit export controls to most sophisticated machine tools and machine tool controllers (1991)

[1] 48 CFR 225.7004.

[2] The Core List is a list of dual-use items subject to export controls. 56 F.R. 30798.

Source: Compiled by the staff of the U.S. International Trade Commission from U.S. Department of Commerce data.

founding in 1987. Since 1988, NCMS has conducted only a few R&D projects on machine tool technologies. During 1988-90, 31 U.S. machine tool builders became members of NCMS; since 1991, 7 more have joined NCMS, but 15 builders have resigned their memberships.[31] The NCMS participates in MANTECH's Next Generation Workstation/ Machine Controller program begun in 1989. Other MANTECH initiatives include the Machine Tool Products and Processes program, the Machine Tool Sensor program, and the Precision Machining and Forming program. R&D expenditures on machine tools and related technologies under MANTECH totaled more than $33 million during 1988-91. In 1991, such expenditures were estimated to total $82 million for fiscal years 1991-95.[32] A small amount of R&D funding for machine tool technologies is channeled to universities by DOD's Advanced Research Projects Agency. In late 1993, one R&D contract for laser machine tools was funded under the Technology Reinvestment Project authorized in the

[31] Data compiled by the staff of the U.S. International Trade Commission from NCMS's membership as reported to the U.S. Department of Justice and published in the *Federal Register.*

[32] National Archives and Records Administration, Office of the Federal Register, "Statement of Press Secretary Fitzwater on Extension of the Voluntary Restraint Agreements With Japan and Taiwan, Dec. 27, 1991," *Weekly Compilation of Presidential Documents,* vol. 27, No. 52 (Washington, DC: GPO, Dec. 30, 1991), pp. 1895-1896.

Defense Conversion, Reinvestment, and Transition Act of 1992.[33]

During the 1980s, U.S. machine tool builders engaged in research to a limited extent with the U.S. Department of Commerce's National Institute of Standards and Technology (NIST). During 1980-91, 10 cooperative agreements between NIST's Manufacturing Engineering Laboratory and U.S. machine tool builders had been signed; three of those during 1988-91, and one of those with a builder that went out of business in 1991. A few machine tool technology contracts have been funded under the Advanced Technology Program[34] managed by NIST.

In October 1993, the U.S. Department of Commerce and the U.S. Department of Energy (DOE) launched the National Machine Tool Partnership, which provides technical assistance to U.S. machine tool builders and users. Related to this partnership is DOE's designation of five DOE laboratories as Machine Technology Centers to handle problems requiring capabilities that are not commercially available to solve problems with machine tool accuracy, temperature, environmental control systems, metrology, and machine tool controls. In late 1993, Cincinnati Milacron, Inc. signed a $7 million Cooperation Research and Development Agreement (CRADA)[35] with DOE to test the company's products in order to accelerate the company's machine tool development cycle.

The National Science Foundation provides grants to universities for machine tool research, but during FY 1987-90, such grants totaled only $3.5 million.[36] The principal universities involved in machine tool R&D are the University of Florida at Gainesville, the University of North Carolina at Charlotte, and the University of Michigan at Ann Arbor. The University of Wisconsin and Wayne State University also conduct some machine tool R&D. Outside of universities, the Institute of Advanced Manufacturing Sciences and Metcut Research Associates, Inc., both located in Cincinnati, OH, are the major commercial contractors for machine tool R&D.

Other Government Programs

Other U.S. Government programs involving the U.S. MMT industry include machine tool contingency plans for national emergencies, export promotion, and trade adjustment assistance. The U.S. Government maintains two programs to ensure a strong defense industrial base during national emergencies: the Defense Industrial Reserve and the Machine Tool Trigger Order Program. The Defense Industrial Reserve was authorized by the Defense Industrial Reserve Act of 1973 and specifically establishes the maintenance of a reserve of U.S. plants and equipment, including machine tools, owned by DOD for use in national security emergencies.[37] Also included in the reserve is a program known as "Tools for Schools", which provides machine tools to educational institutions.

The Machine Tool Trigger Order Program was authorized in August 1982 by the Defense Production Act under Title III. The purpose of the program is to reduce mobilization leadtimes for machine tools essential to defense production. This is to be accomplished through standby purchase agreements between machine tool builders and the U.S. Government. The Department of Commerce is responsible for identifying the contractors, with the overall responsibility for the program resting with the Federal Emergency Management Agency.

Machine tool builders participate in a number of other U.S. Government programs. In 1990, Hurco Companies Inc. of Indianapolis, IN, a builder of MMT controls and a seller of MMT, participates in the DOC's Japan Corporate Program. The program is designed to increase U.S. market access in Japan.[38] In September 1993, the industry's trade association, AMT, was awarded a grant of $425,000 under the DOC's Market Development Cooperator Program to establish full-service marketing assistance programs or liasion offices in China, Korea, and Mexico to facilitate exports to those markets.[39] Machine tool builders have also taken advantage of trade adjustment assistance programs administered by both the DOC and the U.S. Department of Labor (DOL). The DOC program assists companies and the DOL program assists workers who have lost their jobs because of increased import competition and are in need of financial assistance.

Consumer Characteristics and Factors Affecting Demand

The major customers of the U.S. metalworking machine tools and accessories industries are the transportation and nonelectrical machinery industries (figure 2). The automotive industry accounts for approximately 30 percent of the overall market; automotive parts and machinery for servicing the automotive industry, for 10 percent; the aerospace industry, for 10 percent; and the appliance industry, for 10 percent. Other significant markets include the construction and agricultural machinery industries. The energy and electrical power equipment industries are also expected to become important consumers in the mid-1990s. MMTA consumers are spread across the United States, but are concentrated in the Midwest. Other major consumers include U.S. manufacturing subsidiaries of Japanese companies; however, these tend to rely more on Japanese-brand machine tools.

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[33] National Archives and Records Administration, Office of the Federal Register, "Remarks on the Technology Reinvestment Project, October 22, 1993," *Weekly Compilation of Presidential Documents*, vol. 29, No. 42 (Washington, DC: GPO, Oct. 25, 1993), p. 2146. See 58 F.R. 15842-15843 and Public Law 102-484.

[34] 15 CFR 295.

[35] Under such agreements, private industry may conduct research with Federal laboratories. Authorized by the Federal Technology Transfer Act of 1986, Public Law 99-502.

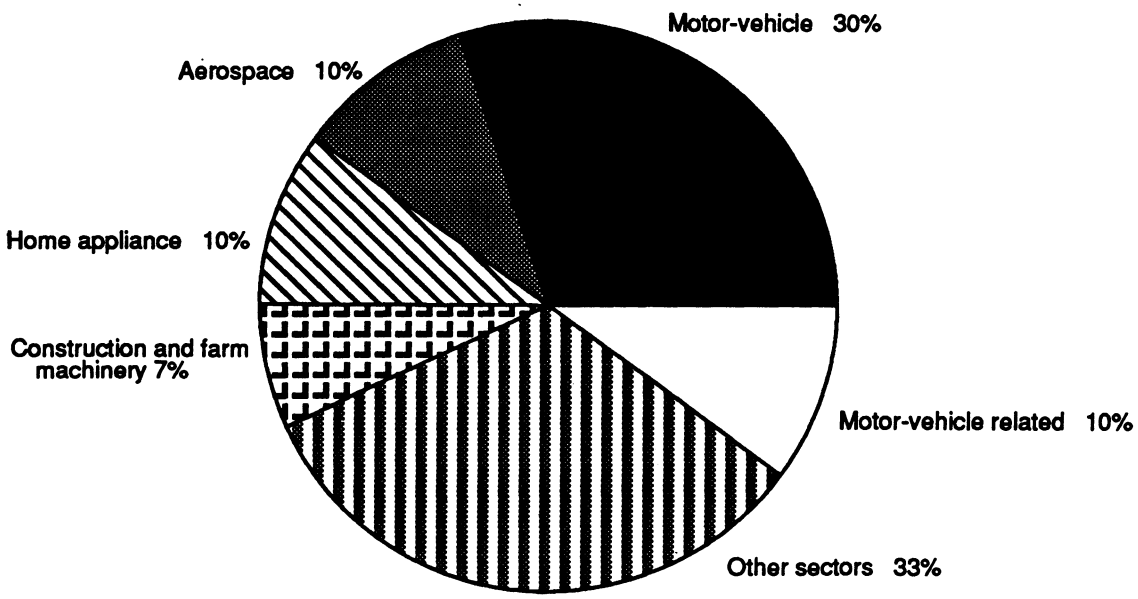
[36] National Science Foundation, Directorate of Engineering, Division of Design and Manufacturing. More recent data are not readily available.

[37] 50 U.S.C. § 2535 Supplement IV 1992. See Public Law 93-155.

[38] 55 F.R. 50340.

[39] 58 F.R. 49472 and Jerry Morse, "Commerce's Market Development Coopertor Program Reflects New Partnership Between Private Sector and Federal Government," *Business America*, Oct. 4, 1993, pp. 18-20.

Figure 2
Metalworking machine tools: U.S. market, by sector



Source: Estimated by the staff of the U.S. International Trade Commission.

The major factors influencing purchases of machine tools and accessories are service, quality (including reliability and level of technology), price, and training. In the mid-1980s, price was the foremost factor in importance affecting purchase decisions. In recent years, however, service has become the most important factor because manufacturers cannot afford to have critical machinery fail and disrupt production.[40]

The principal factors influencing the demand for new machine tools continue to be reduced production time, higher quality, and greater manufacturing flexibility. Manufacturers demand machines that can reduce the length of set-up time and production cycle time. Quality has increased as computerized controls have ensured repeatability (that parts can be repeatedly produced to the same precision) and accuracy by relying less on human input. With respect to manufacturing flexibility, the increased use of computer controls means that machine tools, either stand-alone or in manufacturing systems, can be adjusted to just-in-time manufacturing, or to production runs of varying lengths. The effects associated with these factors on certain components of machine tools are shown in table 10.

U.S. consumers of machine tools have been characterized as being unsophisticated with regard to their use of machine tools.[41] Reportedly, users generally do not operate machine tools at their full capabilities, which can result in higher costs and lower productivity. There has also been some reluctance on the part of industry to purchase machines incorporating advanced machine tool technology. In foreign markets, purchasers focus on the level of technology, whereas in the U.S. market, purchasers frequently consider price as the most important factor.[42] The relative lack of investment in machinery utilizing the most advanced technology can be demonstrated in statistics related to machine tool age. During 1983-89, the percentage of MMT in use shifted sharply away from older age categories, reflecting the purchase of more modern equipment (table 11). However, the shift to newer machine tools (less than 9 years old) amounted to only approximately 5 percent of the total population.

Another measure of the slow adoption of MMT incorporating advanced technology is the small base of numerically-controlled (NC) machine tools throughout industry. In 1989, NC machine tools accounted for just 13 percent of the metal-cutting machine tools in place in U.S. industry and 4 percent of metal-forming machine tools. However, for metal-cutting machine tools less than 9 years old, 21 percent were NC machines, and for metal-forming machine tools, 9 percent were NC machines. The low level of NC metal-forming machine tools in use by U.S. industry is in large part due to the lag in the application of NC technology to such machines. In many instances, NC technology cannot be adopted to metal-forming machine tools.

During the past decade, the U.S. market for MMT, as measured in number of units, has contracted because machine tool consumer industries have curtailed or downsized their U.S. manufacturing operations, or

[40] Various industry sources, USITC staff interviews, 1992 and 1993.

[41] "Ferrostaal Heats Up the 'Universal' Market," *Tooling & Production,* Apr. 1991, p. 10.

[42] Ibid.

Table 10
Trends in components and systems due to end-user demands for speed, quality, and flexibility

Component/System	*Year 1988*	*1993/94*	*Near future*
Speed			
Spindle R.P.M.s	6,000	8,000	30,000-40,000
Number of spindles on machining center or lathe	1 spindle	1-2 spindles spindles	2 or more
Cutting tools	Titanium nitrade coatings	Cubic boron nitride , (CBN) diamond coatings	Perishable tooling
Automatic Tool Change (ATC) times/ tool capacity (number of tools)	45 seconds/ 25 tools	15 seconds/ 50 tools	10-12 seconds
Quality			
Precision and repeatability: General machining	0.005 inch	0.0005 inch	0.0001 inch
Grinding	0.005 inch	0.0001 inch	0.00002 inch
Computer-numerical-control (CNC)	16-bit bus RISC chip w/ 64-bit bus	32-bit bus	
Software programming	Standard (AI) and diagnostics	Artificial intelligence scale	AI on a broader
Flexibility			
Metal-forming die change times	4 hours	5-15 minutes	
Work holders	Dedicated modular	Universal or jigs	Programmable

Source: Compiled by the staff of the U.S. International Trade Commission with assistance from the AMT—The Association for Manufacturing Technology.

Table 11
Metalworking machine tools: U.S. population of machines in 1983 and 1989, by age categories

	Age in years					
	In 1983			In 1989		
Machine type	0 to 4	5 to 9	10 or more	0 to 4	5 to 9	10 or more
	Percent					
Metal-cutting machines	14.2	20.2	65.6	15.6	24.0	60.4
Metal-forming machines	9.4	17.7	72.9	11.3	20.7	68.0
Metalworking machine tools	13.1	19.6	67.3	14.7	23.4	61.9

Source: The 13th and 14th inventories of metalworking equipment conducted by *American Machinist*, published in "Measuring the Effect of NC," *American Machinist*, Nov. 1983, p. 124, and "Big Gains for Smaller Plants," *American Machinist*, Nov. 1989, pp. 92-93.

shifted their production operations offshore. The substitution of non-metallic materials for metals and electronics for mechanical devices has also reduced the need for metalworking operations, and hence for MMT. At the same time, the increased productivity of MMT has also reduced the need for more machines. Machine tools are now capable of performing a greater range of tasks with more throughput. Data on the erosion of the U.S. customer base for machine tools are not available, but numerous U.S. machine tool producers have reported that some customers have moved U.S. production involving machine tools offshore and that other customers have simply gone out of business.

Plastics continue to replace metals in many applications, thus eliminating the need for machine tools in the production process. Composite materials likewise are replacing aluminum in many aerospace applications, thereby reducing the need for machine tools. In other industries, production of parts using near-net-shape forming has eliminated the need for extensive machining operations and produced less scrap. Near-net-shape forming uses powdered-metal (PM) under extreme pressure to form parts and components almost to the exact shape required. PM parts can also be made of lightweight materials. Most U.S. and European automobile manufacturers use PM parts in engines, such as PM-forged steel connecting rods and bearing caps, and in other applications such as water pumps, cranking motors, and ring gears.

As the capabilities of certain machine tools expand, they become substitutes for other types of machine tools. For example, machine tools that use lasers for cutting metal are replacing punching and shearing machines in some applications. Because of increases in the precision and accuracy of milling machines, these machines can now be used in surface finishing applications that once required grinding and other finishing machine tools.

FOREIGN INDUSTRY PROFILE

During 1988-92, the major foreign producers of MMTA were Japan, Germany, the Commonwealth of Independent States (formerly most of the Soviet Union), Italy, and Switzerland. Metalworking machine tool production by the world's leading producers is shown in table 12. As a region, the European Union (EU), formerly known as the European Community, ranks as the world's largest producer. Production peaked in 1990 in many of the leading producer countries, among them the United States, Italy, and Switzerland. But in Japan and Germany, production peaked the following year in 1991, before beginning to decline as recessions in those countries followed the 1990-91 recession in the United States. In nominal dollar terms, the United States ranked as either the fourth or fifth largest producer during 1988-92. Chinese machine tool production showed the greatest growth during 1988-92. Production growth shown in table 12 may have been affected by translation of foreign currencies into U.S. dollars.

The major producers, with the exception of the former Soviet Union, are significantly involved in

Table 12
Metalworking machine tools:[1] Production in selected countries, the EU, and the world, 1988-92

Value (million dollars)

Source	1988	1989	1990	1991	1992[2]
Japan	8,722.5	10,058.9	10,945.3	11,638.7	8,671.3
Germany	(3)	(3)	(3)	8,841.9	7,852.0
West Germany	6,572.1	6,867.6	8,734.3	(3)	(3)
East Germany	1,457.0	1,445.0	1,085.0	(3)	(3)
United States	2,519.0	3,514.2	3,471.8	3,266.0	3,187.0
Italy	2,639.1	3,004.9	3,705.9	3,470.1	3,056.4
Soviet Union	4,263.1	5,000.0	4,000.0	(3)	(3)
Russia	(3)	(3)	(3)	3,200.0	1,050.0
Ukraine	(3)	(3)	(3)	1,280.0	740.0
China	750.6	1,151.9	821.7	1,445.5	1,738.6
Switzerland	1,865.0	2,247.7	2,930.5	2,011.9	1,695.0
United Kingdom	1,501.4	1,483.7	1,679.4	1,293.6	1,049.3
Taiwan	782.5	1,013.0	943.7	992.2	983.7
France	876.2	966.1	1,311.5	1,021.4	926.2
Spain	702.2	806.7	1,014.8	750.6	630.5
Korea	632.4	744.2	785.1	798.4	600.0
All other	4,651.5	4,170.0	3,852.6	2,936.8	2,430.3
Total	37,934.6	42,473.9	45,281.6	42,947.1	34,610.3
EU[4]	12,662.0	13,507.2	16,984.0	15,869.6	13,904.3

[1] Data are for metalworking machine tools only and exclude parts.
[2] Data are estimated for 1992 by *American Machinist*, and revisions are expected to be published in early 1994.
[3] Country did not exist in that year.
[4] Includes Germany or former West Germany, France, the United Kingdom, Italy, Spain, Portugal, Denmark, the Netherlands, and Belgium.

Source: Compiled by the staff of the U.S. International Trade Commission from various February and March editions of *American Machinist*.

export markets. Japanese exports, as a share of production, declined from 37 percent in 1988 (47 percent in 1987) to 34 percent in 1991, before rising to an estimated 41 percent in 1992. The decline in 1991 was largely attributable to the establishing of foreign production plants by Japanese builders.[43] The increase in 1992 reflected Japanese machine tool builders seeking export markets because of the depressed conditions in the Japanese domestic market. In contrast, U.S. exports, as a share of production, rose from 31 percent in 1988 (23 percent in 1987) to 32 percent in 1992. The increase was due to a greater export orientation on the part of U.S. builders, improvements in product quality, and favorable exchange rates relative to the currencies of U.S. competitors. During 1988-92, Germany exported from 57 to 62 percent of its production of these products and Switzerland exported from 86 to 88 percent.

The leading global producers of machine tools in terms of MMT sales in 1992 were primarily Japanese firms, followed by German and U.S. firms. Table 13 ranks the top global firms by MMT sales for Japan, Germany, and the United States. The data show that the leading U.S. companies overall have a lower volume of sales per firm. In addition, four of the top five U.S. companies are fairly specialized: Giddings & Lewis specializes in large transfer lines and automated machining systems; Ingersoll Milling Machine produces large-size specialized milling machines; Litton Industries produces grinding and machining systems for the motor-vehicle industries; and Gleason Works produces gear-making machine tools. Although not included in table 13, the largest Swiss machine tool company was George Fischer, with sales of $333 million in 1992, and the largest Italian company was Comau SpA, with sales of $280 million. The major global markets for MMT, for the most part, are also the major producing countries of MMT. Estimated apparent consumption of MMT for 1991 and 1992, from *American Machinist*,[44] are shown in the following tabulation (in millions of dollars):

Market	Apparent consumption 1991	1992
Japan	8,327.3	5,678.2
Germany	6,046.6	5,033.7
United States	4,340.1	3,877.5
Italy	2,718.0	2,384.7
China	1,819.8	2,313.6

The major markets for the United States, Japan, the EU, Switzerland, and Taiwan in 1992 are shown in figure 3. In 1992, the U.S. machine tool industry had significant markets in Mexico, Canada, the EU, and Asia (China, Japan, Korea, and Taiwan). Similarly, Japan had significant markets in the EU, Asia, and the United States. Japan exported 28 percent of its total MMTA exports to the U.S. market and Taiwan exported 17 percent. In contrast, the U.S. market

[43] Export percentages are based on data from Joseph Jablonowski, "World Machine-Tool Output Gains 15%," *American Machinist*, Feb. 1989, p. 61, and Anderson Ashburn, "1992 Machine Tool Output: World Total Drops By $8 Billion," *American Machinist*, Mar. 1993, p. 33.

[44] Anderson Ashburn, "1992 Machine Tool Output: World Total Drops By $8 Billion," *American Machinist*, Mar. 1993, p. 33.

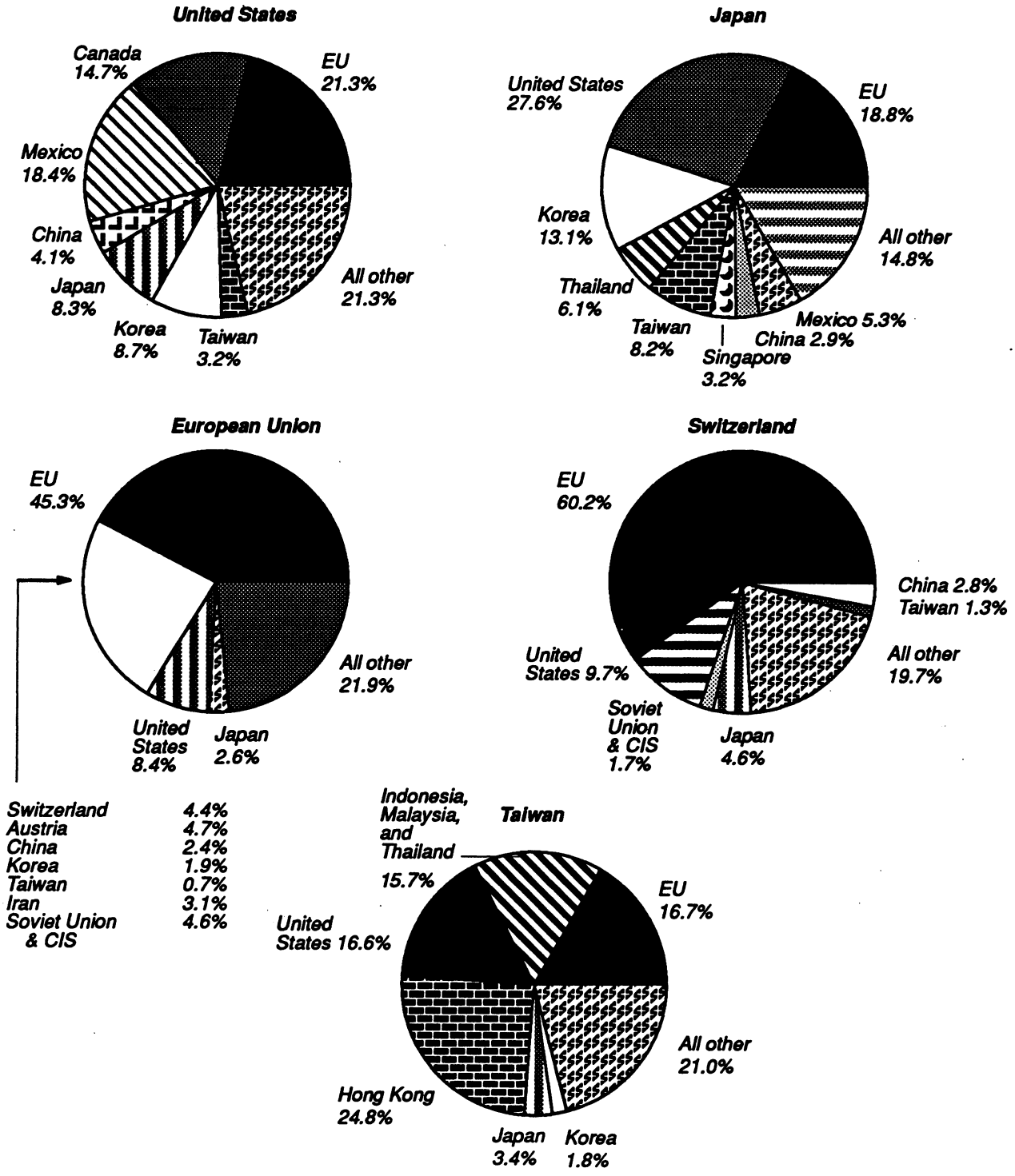
Table 13
Metalworking machine tools: Leading producers of MMT, ranked by MMT sales, for Japan, Germany, and the United States, 1992

Japan company	Sales	Germany company	Sales	United States company	Sales
	Million dollars		*Million dollars*		*Million dollars*
Amada Co. Ltd	1,090.1	Thyseen Maschinenbau GmbH	600.0	Giddings & Lewis Inc	571.7
Yamazaki Mazak Corp	734.5	Schuler Group	529.6	Ingersoll Milling Machine Co	410.0
Okuma Machinery Works	603.0	Trumpf Group	410.4	Cincinnati Milacron Inc	380.0
Komatsu Ltd	513.3	Mueller-Wiengarten AG	324.1	Litton Industries Inc	306.6
Toyoda Machine Works	473.1	Gildemeister Group[1]	304.8	Gleason Works	147.3
Mori Seiki Co. Ltd	458.7	Grob-Werke GmbH & Co. KG	268.9	Hurco Companies, Inc	87.8
Toshiba Machine Co. Ltd	435.2	MAHO Group[2]	267.9	Fadal Engineering Co., Inc	87.3
Fuji Machine Manufacturing Co. Ltd	423.7	Pittler Consolidated Group	262.5	Hardinge Brothers Inc	84.8
Nippei Toyama Corp	378.3	Boehringer	245.9	Monarch Machine Tool Co	77.9
Sodick Co. Ltd	311.7	Alfing Kessler Sondermaschinen	243.3	Allied Products Corp	73.0
Hitachi Seiki Co. Ltd	281.7	Traub Group[1]	214.5	Newcor Inc	62.6

[1] Gildemeister and Traub merged in 1993.
[2] MAHO and Deckel AG, which had 1992 sales of $197 million, merged in 1993.

Source: Compiled from *American Machinist*, "The Blue Bulletin," July 30, 1993.

Figure 3
Selected destinations for MMTA exports of major producing countries, 1991



Source: Compiled by the staff of the U.S. International Trade Commission from statistics from the U.S. Bureau of the Census, 1992; Japan Tariff Association, *Japan Exports and Imports; Commodity by Country,* Dec. 1992; Eurostat, *NIMEXE, 1992;* Direction Generale des Douanes, *Statistique du Commerce Exterieur de La Suisse: Statistique Annuelle, 1992;* Statistical Department, Directorate General of Customs, Ministry of Finance, The Republic of China, *Monthly Statistics of Imports, The Republic of China,* Taiwan District, Dec. 1992.

accounted for only approximately 8 and 10 percent, respectively, of exports from the EU and Switzerland. EU and Swiss builders both depend more on European markets and exported little to Asia.

A 1989 Massachusetts Institute of Technology (MIT) study of the U.S. MMT industry cites three factors that led to a decline in the industry's competitiveness from the 1960s to the late 1980s.[45] First, the study indicated that the industry was fragmented into small family-operated businesses, and even as production became more concentrated in the 1970s, the increase in the number of larger firms came about primarily through acquisitions. The study also indicated that parent firms frequently operated their MMT subsidiaries as separate businesses, rarely merging their operations to effect economies of scale. Second, the study reported that these small firms, with their lack of resources for reinvestment and R&D, were overly dependent upon outside R&D contracts and relied on less sophisticated equipment for sales, rather than maintaining strong development programs. Third, the MMT industry is subject to wide swings during the business cycle.

The MMT industry is a capital-goods industry and is subject to larger fluctuations in the business cycle. In an upturn in the business cycle, sales of MMT lag behind the expansion of end-user industries, but lead the decline when demand in user industries fall and MMT orders are cancelled. According to the 1989 MIT study, cyclicality of MMT orders exposes firms to cash-flow problems, and creates difficulties in recruiting and retaining skilled employees and adjusting to large swings in order backlogs.[46] Cash-flow uncertainty reduces a firm's ability to develop a longer time horizon to reinvest in the business and to prepare to compete in the next upturn in the business cycle. During the peaks in the cycles, user industries usually turn to imports when domestically produced MMT are not available. Japanese MMT producers were able to exploit these gaps between U.S. industry orders and U.S. MMT production bottlenecks through rapid deliveries from inventory (at low prices).[47] Japanese producers also improved product quality, were more responsive to consumer demands, provided timely deliveries, and frequently offered attractive financing.[48]

Another possible reason for foreign success in the U.S. MMT market was acquiescence by some U.S. MMT builders.[49] Cincinnati Milacron, for example, concentrated on its high-end MMT, while largely abdicating the standard MMT market for middle and low-end of the market. In 1990, Cincinnati Milacron began the "Wolfpack" program to efficiently develop MMT and has since produced several new models. The company also announced its goal of returning to the middle and low end of the market. Since 1990, U.S. competitiveness in the MMT market increased, in part, due to Cincinnati Milacron's new corporate strategy, Giddings & Lewis's acquisition and revitalization of Cross & Trecker Corp. in 1991, and because of increased competitiveness on the part of many other U.S. MMT builders, such as Fadal Engineering, Haas Automation, and Hardinge Brothers, Inc.

According to the MIT study, Japanese and German producers became more competitive during the 1960s-1980s because of the following six factors: 1) greater rationalization of production; 2) greater export orientation; 3) a long-term perspective; 4) continuous and focused innovation; 5) a higher level of domestic user sophistication; and 6) greater competitive differentiation (focusing on industry strengths).[50]

Industry rationalization in Japan was promoted in the 1970s by the Government's Ministry of International Trade and Industry (MITI), and in Germany by Government research institutes and universities specializing in machine tool research. Rationalization in the U.S. industry has come about primarily as firms left the industry, gone out of business, or sold unprofitable product lines.

Japanese and German producers have also been supported by Government institutes specializing in machine tool and manufacturing research. Much of the Japanese government support has been conducted at MITI's mechanical engineering and metrology laboratories. Germany has about 20 university institutes that focus on machine tool R&D. The institute at Aachen is considered by many industry experts as being the best machine tool research facility in the world.

In addition, Japanese, German, and Swiss MMT industries are supported by strong component industries that produce computer controllers, castings, ball screws, bearings, and motors. Taiwan, known as a source of inexpensive MMT castings, is now purchasing castings from China to reduce costs, but still relies on Japanese sources for ball screws, bearings, and controllers. Strong cutting tool industries in these countries have also contributed to MMT applications that have led to MMT product enhancements. Many U.S. MMT use foreign components because of their quality or price. With the operation of the VRAs, U.S. component industries have became more competitive as Japanese producers that established U.S. production sought U.S. suppliers. A few U.S.-owned firms have successfully sought to use only U.S.-made components in their machines.[51]

In late 1993, CECIMO,[52] the European trade association for MMT, publicly began to press for the

[45] Artemis March, "The U.S. Machine Tool Industry and Its Foreign Competitors," in The MIT Commission on Industrial Productivity, *Working Papers of the MIT Commission on Industrial Productivity* vol. 2 (Cambridge, MA: MIT Press, 1989), pp. 9-10.

[46] Ibid., p. 10.

[47] Ibid.

[48] Ibid., p. 12. See also Ravi Sarathy, "The Interplay of Industrial Policy and International Strategy: Japan's Machine Tool Industry," *California Management Review*, vol. 31, No. 3 (Spring 1989), pp. 132-160.

[49] Ralph E. Winter, "Milacron Wolfpack Goes in for the Kill," *The Wall Street Journal*, Aug. 14, 1990, p. All.

[50] Artemis March, pp. 51-53.

[51] For example, Fadal Engineering maintains a policy of using only U.S.-made components.

[52] The European Committee for Co-Operation of the Machine Tool Industries, represents the metalworking machine tool industries of Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

adoption of European-wide industrial policies that would offset manufacturing technology threats from the United States and Japan.[53] CECIMO recognized that the United States had recovered its competitive position in manufacturing technology.[54] CECIMO sees European MMT and other manufacturing firms as paying higher costs in terms of employee benefits and social system taxes than U.S. or Japanese competitors.[55] CECIMO's additional concerns with respect to the European MMT industry are that their capital costs are high and MMT amortization is lengthy; that research programs are inaccessible by small firms and biased toward basic research; and that worker training programs are weak.[56]

U.S. TRADE MEASURES

Tariff Measures

Metalworking machine tools are classified in headings 8456 to 8463 of the Harmonized Tariff Schedule (HTS) of the United States, and parts are classified in subheadings 8466.93 through 8466.94. Accessories are classified under subheadings 8466.10 through 8466.30.[57] Table 14 shows the pre-Uruguay Round column 1-general rate of duty, preferential rates of duty, and U.S. exports and imports for 1992 for each 8-digit Harmonized Tariff Schedule (HTS) subheading covering MMTA.[58] In 1992, the trade-weighted-average rate of duty for the products covered herein, including U.S. imports entering free of duty under preferential tariff programs, was 4.0 percent ad valorem. The 1993 most-favored-nation (MFN) rates of duty for all but a few MMT and parts range from 4.2 percent ad valorem to 4.4 percent ad valorem. A duty rate of 5.8 percent ad valorem is applicable to imports of gear-cutting machine tools, parts, and work holders thereof. However, unfinished cast-iron parts for machine tools are free of duty. Duties on accessories range from 3.7 ad valorem to 9.5 percent ad valorem.

The North American Free Trade Agreement (NAFTA), as implemented by the North American Free Trade Agreement Implementation Act (Public Law 103-182, approved Dec. 8, 1993), provided for the elimination of U.S. duties effective January 1, 1994 on MMTA imported from Mexico. Also effective January 1, 1994, Mexico eliminated many duties immediately and is obligated to phase out its remaining duties on imports of such goods from the United States over a 5-year period.

The recently completed (December 1993) GATT Uruguay Round of trade negotiations may result in further reductions in U.S. and foreign duties on the articles covered by this summary. The Uruguay Round schedule of U.S. concessions was not available when this summary was prepared.

In terms of tariff classification, machine tools that enter the United States without electronic or hydraulic systems are classified as parts of machine tools. Since 1987, there have been a number of U.S. Customs Service classification decisions affecting these products, particularly defining products covered by the VRAs and defining the classification of parts and machines.

U.S. machine tool builders have not utilized foreign-trade zones in the past. However, in 1990, Hurco Companies, Inc., a builder of MMT computer controls and seller of MMT, applied for foreign-trade subzone status for its manufacturing facility in Indianapolis, IN. If subzone status were granted, Hurco would be exempt from paying duty on materials or components used to produce machine tools for export. In addition, with respect to domestic sales, the company would be assessed duty rates that apply to the finished products rather than to their imported components. About half of the materials used by Hurco are imported.[59] The U.S. Department of Commerce has not made a final decision to approve this application.

Nontariff Measures

During 1988-92, U.S. imports of MMT and parts were affected principally by voluntary restraint agreements with Japan and Taiwan. Imports of machine tool accessories were not affected. There were no other significant nontariff measures affecting U.S. imports of MMTA.

U.S. Government Trade-Related Investigations

During 1988-92, the U.S. Government conducted two investigations under the antidumping law and three investigations under section 337 of the Tariff Act of 1930; and trade sanctions were imposed on two foreign firms by U.S. legislation. In addition, voluntary restraint agreements (VRAs) resulting from an investigation in 1983 with respect to Japan and Taiwan were in effect during 1987-91 and were extended during 1992-93. Table 15 shows U.S. Government trade-related investigations since 1982, one year prior to the investigation that resulted in the VRAs.

In March 1983, the National Machine Tool Builders' Association filed a petition with the Secretary of Commerce under section 232 of the Trade Expansion Act of 1962 requesting quotas on certain U.S. imports of metalworking machine tools, based on the view that such imports threaten to impair U.S. national security.[60] The Secretary made an affirmative finding. After considering mobilization, defense, and economic planning factors, the President announced on May 20, 1986, that VRAs would be sought with Japan, Taiwan, West Germany, and Switzerland.[61] The President also announced the implementation of the Machine Tool Domestic Action Plan to support the revitalization of the U.S. metalworking machine tool industry.

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[53] "Europeans Fear U.S., Japanese Competition," *American Machinist*, Dec. 1993, p. 22.

[54] Ibid.

[55] Ibid.

[56] Ibid.

[57] Computer controls for machine tools are classified under HTS subheading 8537.10.00.30 and tools used in machine tools for cutting, pressing, stamping, or punching metal are classified in heading 8207.

[58] Appendix A includes an explanation of tariff and trade agreement terms.

[59] 56 F.R. 65040.

[60] 48 F.R. 15174.

[61] National Archives and Records Administration, Office of the Federal Register, "Machine Tool Imports, Statement by the President. May 20, 1986," *Weekly Compilation of Presidential Documents*, vol. 22, No. 21 (Washington, DC: GPO, May 26, 1986), pp. 661-662.

Table 14
Metalworking machine tools and accessories: Harmonized Tariff Schedule subheading; description; U.S. col. 1 rate of duty as of Jan. 1, 1993; U.S. exports, 1992; and U.S. imports, 1992

HTS subheading	Description	Col. 1 rate of duty As of Jan. 1, 1993		U.S. exports, 1992	U.S. imports, 1992
		General	Special[1]		
				— *Million dollars* —	
8456.10.10	Machine tools operated by laser or other light or photon beam processes, for working metal	4.4%	Free (A, CA, E, IL, J)	20	53
8456.20.10	Machine tools operated by ultrasonic processes, for working metal	4.4%	Free (A, CA, E, IL, J)	(2)	(2)
8456.30.10	Machine tools operated by electro-discharge processes, for working metal	4.4%	Free (A, CA, E, IL, J)	17	93
8456.90.10	Machine tools operated by electro-chemical, electron-beam, ionic-beam, or plasma-arc processes, for working metal	4.4%	Free (A, CA, E, IL, J)	12	7
8457.10.00	Machining centers for working metal	4.2%	Free (A, CA, E, IL, J)	61	352
8457.20.00	Unit construction machines (single station), for working metal	4.2%	Free (A, CA, E, IL, J)	12	3
8457.30.00	Multistation transfer machines for working metal	4.2%	Free (A, CA, E, IL, J)	104	55
8458.11.00	Horizontal lathes for removing metal, numerically controlled	4.4%	Free (A, CA, E, IL, J)	36	273
8458.19.00	Horizontal lathes for removing metal, other than numerically controlled	4.4%	Free (A, CA, E, IL, J)	13	54
8458.91.10	Vertical turret lathes for removing metal, numerically controlled	4.2%	Free (A, CA, E, IL, J)	4	19
8458.91.50	Lathes for removing metal, nesi, numerically controlled	4.4%	Free (A, CA, E, IL, J)	3	7
8458.99.10	Vertical turret lathes for removing metal, other than numerically controlled	4.2%	Free (A, CA, E, IL, J)	1	1
8458.99.50	Lathes for removing metal, nesi, other than numerically controlled, nesi	4.4%	Free (A, CA, E, IL, J)	10	19
8459.10.00	Way-type unit head machines for drilling, boring, milling, threading, or tapping by removing metal, other than lathes of heading 8458	4.2%	Free (A, CA, E, IL, J)	2	1
8459.21.00	Drilling machines, for removing metal, numerically controlled, nesi	4.2%	Free (A, CA, E, IL, J)	11	15
8459.29.00	Drilling machines, for removing metal, other than numerically controlled, nesi	4.2%	Free (A, CA, E, IL, J)	9	42
8459.31.00	Boring-milling machines, for removing metal, numerically controlled, nesi	4.2%	Free (A, CA, E, IL, J)	4	20
8459.39.00	Boring-milling machines, for removing metal, other than numerically controlled, nesi	4.2%	Free (A, CA, E, IL, J)	3	8
8459.40.00	Boring machines, for removing metal, nesi	4.2%	Free (A, CA, E, IL, J)	9	11
8459.51.00	Milling machines, for removing metal, knee type, numerically controlled, nesi	4.2%	Free (A, CA, E, IL, J)	4	5
8459.59.00	Milling machines, for removing metal, knee type, other than numerically controlled, nesi	4.2%	Free (A, CA, E, IL, J)	14	22
8459.61.00	Milling machines, for removing metal, other than knee type, numerically controlled, nesi	4.2%	Free (A, CA, E, IL, J)	26	36
8459.69.00	Milling machines, for removing metal, other than knee type, other than numerically controlled, nesi	4.2%	Free (A, CA, E, IL, J)	18	10
8459.70.00	Threading or tapping machines, for removing metal, nesi	4.4%	Free (A, CA, E, IL, J)	10	16
8460.11.00	Flat-surface grinding machines, for metals, sintered metal carbides or cermets, in which positioning in any one axis can be set up to an accuracy of at least 0.01 mm, numerically controlled	4.4%	Free (A, CA, E, IL, J)	7	8

See footnotes at end of table.

Table 14—*Continued*
Metalworking machine tools and accessories: Harmonized Tariff Schedule subheading; description; U.S. col. 1 rate of duty as of Jan. 1, 1993; U.S. exports, 1992; and U.S. imports, 1992

HTS subheading	Description	Col. 1 rate of duty As of Jan. 1, 1993		U.S. exports, 1992	U.S. imports, 1992
		General	Special[1]		
				— *Million dollars* —	
8460.19.00	Flat-surface grinding machines, for metals, sintered metal carbides or cermets, in which positioning in any one axis can be set up to an accuracy of at least 0.01 mm, nes	4.4%	Free (A, CA, E, IL, J)	10	31
8460.21.00	Grinding machines nesi, for metals, sintered metal carbides or cermets, in which positioning in any one axis can be set up to an accuracy of at least 0.01 mm, numerically controlled	4.4%	Free (A, CA, E, IL, J)	47	69
8460.29.00	Grinding machines nesi, for metals, sintered metal carbides or cermets, in which positioning in any one axis can be set up to an accuracy of at least 0.01 mm, nesi	4.4%	Free (A, CA, E, IL, J)	28	48
8460.31.00	Sharpening (tool or cutter grinding) machines, for metals, sintered metal carbides or cermets, numerically controlled	4.4%	Free (A, CA, E, IL, J)	3	7
8460.39.00	Sharpening (tool or cutter grinding) machines, other than numerically controlled	4.4%	Free (A, CA, E, IL, J)	6	17
8460.40.00	Honing or lapping machines, for metals, sintered metal carbides or cermets	4.4%	Free (A, CA, E, IL, J)	16	11
8460.90.00	Machine tools for deburring, grinding, polishing or otherwise finishing metal, sintered metal carbides or cermets, nesi	4.4%	Free (A, CA, E, IL, J)	28	49
8461.10.00	Planing machines, for metals, sintered metal carbides, or cermets	4.4%	Free (A, CA, E, IL, J)	7	(2)
8461.20.00	Shaping or slotting machines, for metals, sintered metal carbides, or cermets	4.4%	Free (A, CA, E, IL, J)	3	7
8461.30.00	Broaching machines, for metals, sintered metal carbides, or cermets	4.4%	Free (A, CA, E, IL, J)	11	8
8461.40.10	Gear cutting machines, for metals, sintered metal carbides, or cermets	5.8%	Free (A, CA, E, IL, J)	45	17
8461.40.50	Gear grinding or finishing machines, for metals, sintered metal carbides or cermets	4.4%	Free (A, CA, E, IL, J)	8	23
8461.50.00	Sawing or cutting-off machines, for metals, sintered metal carbides, or cermets	4.4%	Free (A, CA, E, IL, J)	25	49
8461.90.00	Machine tools for working by removing metal, sintered metal carbides or cermets, nesi	4.4%	Free (A, CA, E, IL, J)	28	12
8462.10.00	Forging or die-stamping machines (including presses) and hammers for working metal or metal carbides	4.4%	Free (A, CA, E, IL, J)	63	81
8462.21.00	Bending, folding, straightening or flattening machines (including presses), numerically controlled, for working metal or metal carbides	4.4%	Free (A, CA, E, IL, J)	52	48
8462.29.00	Bending, folding, straightening or flattening machines (including presses), other than numerically controlled, for working metal or metal carbides	4.4%	Free (A, CA, E, IL, J)	72	57
8462.31.00	Shearing machines (including presses) excluding combined punching and shearing machines, numerically controlled, for working metal or metal carbides	4.4%	Free (A, CA, E, IL, J)	8	5
8462.39.00	Shearing machines (including presses) excluding combined punching and shearing machines, other than numerically controlled, for working metal or metal carbides	4.4%	Free (A, CA, E, IL, J)	14	18

See footnotes at end of table.

Table 14—*Continued*
Metalworking machine tools and accessories: Harmonized Tariff Schedule subheading; description; U.S. col. 1 rate of duty as of Jan. 1, 1993; U.S. exports, 1992; and U.S. imports, 1992

HTS subheading	Description	Col. 1 rate of duty As of Jan. 1, 1993		U.S. exports, 1992	U.S. imports, 1992
		General	Special[1]	— *Million dollars* —	
8462.41.00	Punching or notching machines (including presses), including combined punching and shearing machines, numerically controlled, for working metal or metal carbides	4.4%	Free (A, CA, E, IL, J)	31	32
8462.49.00	Punching or notching machines (including presses), including combined punching and shearing machines, other than numerically controlled, for working metal or metal carbides	4.4%	Free (A, CA, E, IL, J)	24	18
8462.91.00	Hydraulic presses, nesi	4.4%	Free (A, CA, E, IL, J)	25	33
8462.99.00	Machine tools (including nonhydraulic presses) for working metal or metal carbides, nes	4.4%	Free (A, CA, E, IL, J)	83	77
8463.10.00	Draw-benches for bars, tubes, profiles, wire, or the like, for working, metal, sintered metal carbides or cermets	4.4%	Free (A, CA, E, IL, J)	6	12
8463.20.00	Thread rolling machines for working metal, sintered metal carbides, or cermets	4.4%	Free (A, CA, E, IL, J)	3	3
8463.30.00	Machines for working wire of metal, sintered metal carbides, or cermets, nesi	4.4%	Free (A, CA, E, IL, J)	19	29
8463.90.00	Machine tools for working metal, sintered metal carbides, or cermets, without removing material, nesi	4.4%	Free (A, CA, E, IL, J)	125	25
8466.10.00	Tool holders and self-opening dieheads for use solely or principally with machines of headings 8456 to 8465	4.9%	Free (A, CA, E, IL, J)	66	98
8466.20.10	Work holders for use solely or principally for machine tools for cutting gears	5.8%	Free (A, CA, E, IL, J)	24	2
8466.20.90	Work holders for use solely or principally for machine tools other than those used in cutting gears	4.7%	Free (A, CA, E, IL, J)	72	106
8466.30.10	Dividing heads for use solely or principally for machine tools of headings 8456 to 8465	4.7%	Free (A, CA, E, IL, J)	1	1
8466.30.30	Special attachments (which are machines) for use solely or principally for machines of headings 8456 to 8465 excluding dividing heads	3.7%	Free (A, CA, E, IL, J)	12	7
8466.30.50	Special attachments for use solely or principally for machine tools of headings 8456 to 8465, nesi	9.5%	Free (A, CA, E, IL, J)	41	5
8466.93.10	Cast iron parts not advanced beyond cleaning and machined only for removal of fins, gates, spurs and risers or to permit location in finishing machines for machines of heading 8456 to 8461	Free		[3]4	5
8466.93.50	Parts and accessories of metalworking machine tools for cutting gears	5.8%	Free (A, CA, E, IL, J)	[3]24	4
8466.93.70	Parts and accessories for machines of headings 8456 to 8461, nesi	4.7%	Free (A, CA, E, IL, J)	[3]333	251
8466.94.10	Cast-iron parts not advanced beyond cleaning and machined only for removal of fins, gates, spurs and risers or to permit location in finishing machines, for machines of heading 8462 or 8463	Free		[3]3	[2]
8466.94.50	Parts and accessories for machines of heading 8462 or 8463, nesi	4.7%	Free (A, CA, E, IL, J)	[3]252	114

[1] Programs under which special tariff treatment may be provided, and the corresponding symbols for such programs as they are indicated in the "Special" subcolumn, are as follows: Generalized System of Preferences (A); Automotive Products Trade Act (B); Agreement on Trade in Civil Aircraft (C); United States-Canada Free-Trade Agreement (CA); Caribbean Basin Economic Recovery Act (E); United States-Israel Free Trade Area (IL); and Andean Free Trade Preference Act (J).
[2] Less than $500,000.
[3] Estimated by the staff of the U.S. International Trade Commission.

Source: U.S. exports and imports compiled from data of the U.S. Department of Commerce.

Table 15
U.S. Government investigations and actions related to trade in MMTA, 1982-93

Date	Type of investigation/ action	Responsible U.S. Government agency	Product	Petitioner	Respondent/ source country	Final outcome	
						Date	Action
1982	Factfinding under sec. 332 of the Tariff Act of 1930 (332-149)	U.S. International Trade Commission	Metalworking machine tools	U.S. International Trade Commission	Not applicable	1983	Report issued.[1]
1982	Sec. 103 of the Revenue Act of 1971	U.S. Trade Representative	Numerically-controlled (NC) machining centers and NC punching machines	Houdaille Industries Inc.	Government of Japan	1983	Petitioner denied relief.[2]
1982	Unfair practices in import trade (337-TA-133)	U.S. International Trade Commission	Vertical milling machines, parts, attachments, and accessories	Bridgeport Machines Div. of Textron Inc.	Mfrs. from Taiwan and Korea, and U.S. importers	1984	Terminated.[3]
1983	Sec. 232 of the Trade Expansion Act of 1962	U.S. Department of Commerce	Metalworking machine tools and parts	National Machine Tool Builders' Association (NMTBA)[4]	Japan, Taiwan, Germany, and Switzerland	1987	Five-year VRAs negotiated with Japan and Taiwan covering machining centers, lathes, milling machines, and punching and shearing machines.[5]
1988	Sec. 2443(a)(2) of the Omnibus Competitiveness Act of 1988 (Public Law 100-418)	U.S. Congress	U.S. imports of products or services of Toshiba Machine Co. and Kongsberg Trading Co.; U.S. Government procurement of products or services from Toshiba Corp. and Kongsberg Trading Co.	Not applicable	Toshiba Corp. (Japan), Toshiba Machine Co. (Japan), and Kongsberg Trading Co. (Norway)	1988	A three-year ban on U.S. imports from Toshiba Machine Co. and Kongsberg Trading Co. and a ban on U.S. Government contracting and procuring of products or services from Toshiba Corp. and Kongsberg Trading Co. The ban ended Dec. 31, 1991.[6]
1989	Unfair practices in import trade (337-TA-290)	U.S. International Trade Commission	Wire electrical discharge machines (EDMs)	Elox Corp. and A.G. fur Industrielle Electronik (AGIE) (Switzerland)	Sodick Inc., Sodick Co. Ltd., Bridgeport Machines Inc., KGK Corp., KGK International Corp., Yamazen Co. Ltd., and Yamazen U.S.A. Inc.	1990	USITC issued a limited exclusion order and a cease and desist order on the importation and sale of the subject wire-EDMs. USITC investigation terminated in 1991 because Elox stopped U.S. production of the subject EDMs.[7]
1989	Antidumping (731-TA-429)	U.S. International Trade Commission	Mechanical transfer presses	Verson Co.	Japan	1990	USITC voted affirmative, determining that the U.S. industry was materially injured.[8]

See footnotes at end of table.

Table 15—*Continued*
U.S. Government investigations and actions related to trade in MMTA, 1982-93

Date	Type of investigation/ action	Responsible U.S. Government agency	Product	Petitioner	Respondent/ source country	Final outcome	
						Date	Action
1991	Unfair practices in import trade (337-TA-333)	U.S. International Trade Commission	Certain woodworking accessories	Catlin Inc.	U.S. importers and manufacturers from Taiwan	1992	USITC issue a limited exclusion order against one respondent; other respondents consented.[9]
1992	Negotiation	U.S. Trade Representative	Computer-controlled machining centers, lathes, milling machines, and punching and shearing machines	Not applicable	Japan and Taiwan	1992	Extension of the VRAs with Japan and Taiwan covering Jan. 1, 1991 to Dec. 31, 1993. Scope of the VRAs limited to computer-controlled machine tools covered in original VRAs.
1992	Antidumping (731-TA-571)	U.S. International Trade Commission	Professional electric cutting and sanding/ grinding tools[10]	Black & Decker Co.	Japan	1993	USITC voted affirmative on most products, including metal sawing or cutting-off machines.[11]
1993	Unfair practices in import trade (337-TA-361)[12]	U.S. International Trade Commission	Portable on-car disc brake lathes and components thereof	Pro-Cut International Inc.	U.S. importer and a German manufacturer	Not applicable	Investigation still pending.

[1] U.S. International Trade Commission, *Competitive Assessment of the U.S. Metalworking Machine Tool Industry* (investigation No. 332-149), USITC publication 1428, Sept. 1983.
[2] 47 F.R. 20411.
[3] 49 F.R. 11897. See U.S. International Trade Commission, *Certain Vertical Milling Machines and Parts, Attachments, and Accessories Thereto* (investigation No. 337-TA-133), USITC publication 1512, Mar. 1984.
[4] Currently named "AMT—The Association for Manufacturing Technology".
[5] 48 F.R. 15174.
[6] In May 1986, Toshiba Machine Co., a subsidiary of Toshiba Corporation of Japan was found by Japanese authorities to have illegally shipped advanced milling machines to the Soviet Union that were used in the production of submarine propellers, a violation of multilateral export controls established by COCOM (Coordinating Committee on Multilateral Export Controls). The controls for the machines were supplied by Kongsberg Trading Co. of Norway. This section of the Omnibus Competitiveness Act of 1988 was implemented in Executive Order No. 12661. The Act provided sanctions that prohibited any department, agency, or instrumentality of the U.S. Government from contracting with, or procuring, products and services from both companies for a period of three years. U.S. imports of any products produced by Toshiba Machine Co. and Kongsberg Trading Co. were banned. However, the sanctions excluded articles essential to national security, contracts signed before June 30, 1987, the exercise of options on existing contracts, the continuance of maintenance and servicing contracts, and the acquisition of spare parts. Interim regulations on imports from Toshiba Corp. or Kongsberg were published in 54 F.R. 4780 and final rules, which became effective on Oct. 15, 1990, in 55 F.R. 37704.
[7] 56 F.R. 46328. AGIE previously had instituted civil legal actions in the United States over violations of the same patent by Colt Industries and Mitsubishi International Corporation. Both cases were settled prior to trial. AGIE also pursued a civil action in the U.S. District Court for the Northern District of Illinois against Sodick Co. Ltd. and KGK International Corp., both of Japan. AGIE instituted similar patent infringement litigation in Switzerland, France, the United Kingdom, and Italy.
[8] See notice of the Commission's determination, 55 F.R. 6324, and antidumping order, 55 F.R. 5642-5643. See also U.S. International Trade Commission, *Mechanical Transfer Presses from Japan* (investigation No. 731-TA-429 (final)), USITC publication 2257, Feb. 1990. The estimated weighted average dumping margins on these machines ranged from 7.49 percent ad valorem to 16.16 percent ad valorem.
[9] 58 F.R. 4718.
[10] Most products were woodworking machinery, but imports classified under HTS subheading 8461.50.00, metal sawing or cutting-off machines, were also covered.
[11] U.S. International Trade Commission, *Professional Electric Cutting and Sanding/Grinding Tools From Japan* (investigation No. 731-TA-571), USITC publication 2658, July 1993.
[12] 58 F.R. 63393.

On December 16, 1986, the President announced the conclusion of VRA agreements with Japan and Taiwan.[62,63] The U.S. Government informed West Germany[64] and Switzerland that their shipments to the United States should not exceed specified limits and would also be monitored. The U.S. Government also asked Brazil, Italy, Korea, Singapore, Spain, Sweden, and the United Kingdom to limit their machine tool exports to the United States to allow the domestic industry the opportunity to be the primary beneficiary of reduced imports from Japan and Taiwan.

The VRAs with Japan and Taiwan extended from January 1, 1987 through December 31, 1991. On December 27, 1991, the President directed the U.S. Trade Representative to negotiate a two-year extension of the VRAs with Japan and Taiwan.[65] On June 30, 1992, the United States signed a VRA with Japan and a voluntary restraint understanding (VRU) with Taiwan. Both the VRA and VRU covered calendar years 1992 and 1993, and were less restrictive in scope. At the end of 1993, the U.S. industry did not seek an extension of the VRAs. However, the industry did express its concern about possible dumping of MMT in the United States.[66]

The original VRAs (1987-91) with Japan and Taiwan covered machining centers, NC and non-NC lathes, and milling machines. The VRA with Japan also covered NC and non-NC punching and shearing machines. Definitions and criteria on how completed assemblies, knock-down kits for later assembly in the United States, and certain machine tool subassemblies were to be counted in the quotas were finally agreed to by all parties only in 1990.[67]

[62] National Archives and Records Administration, Office of the Federal Register, "United States Machine Tool Industry, Statement by the President. December 16, 1986," *Weekly Compilation of Presidential Documents,* vol. 22, No. 51 (Washington, DC: GPO, Dec. 22, 1986), pp. 1654-1655.

[63] Because the United States does not formally recognize Taiwan as a country, the VRA was signed between the American Institute in Taiwan (AIT), representing the United States, and the Coordination Council for North American Affairs (CCNAA), representing Taiwan.

[64] Germany, through the EC, refused to accept the VRAs because they did not comply with Article XI, Chapter IV of the General Agreement on Tariffs and Trade (GATT). GATT, *Trade Policy Review: The European Communities 1991,* Vol. I, (Geneva, Switzerland: GATT, 1991), p. 211.

[65] National Archives and Records Administration, Office of the Federal Register, "Statement of Press Secretary Fitzwater on Extension of the Voluntary Restraint Agreements With Japan and Taiwan, Dec. 27, 1991," *Weekly Compilation of Presidential Documents,* vol. 27, No. 52 (Washington, DC: GPO, Dec.30, 1991), pp. 1895-1896.

[66] AMT—The Association for Manufacturing Technology, *Position Paper on Trade Issues,* Nov. 1993, p. 3.

[67] In order to prevent circumvention of the VRAs, the DOC established criteria that defined what qualified as a "substantially complete" U.S.-made NC lathe and machining center. For example, if a machining center from Japan or Taiwan incorporated a certain amount of specified U.S. components, then the machine tool would be excluded from the VRA quotas. By mid-1991, eight Japanese machine tool builders and seven importers of

The 1992-93 VRA with Japan and VRU with Taiwan were limited to machining centers, CNC lathes, CNC punching and shearing machines, and CNC milling machines. The restrictions on non-computer-controlled lathes, punching and shearing machines, and milling machines expired on December 31, 1991. The U.S. Government requested Japan and Taiwan to continue the VRAs on all computer-controlled machine tools while negotiations were being conducted.

The VRAs with Japan and Taiwan (and subsequent VRU with Taiwan) required these countries to issue export licenses. The VRAs with Japan required export licenses only for NC lathes, machining centers, and NC punching and shearing machines. The Government of Japan provided administrative guidance on the remaining products. The VRA with Taiwan required export licenses for all the products covered. During 1987-88 (and for the last half of 1986—the transition period for the initial VRAs), the U.S. Government obtained agreements with the Governments of Japan and Taiwan regarding unlicensed exports, since there was no legal authority for the U.S. Customs Service to block entry of unlicensed VRA products.[68]

U.S. imports of VRA-covered products from Japan and Taiwan were limited to specified shares of apparent U.S. consumption for each of the specified product categories. Table 16 shows the annual market share limits for Japan and Taiwan during 1987-91 and for Japan during 1992-93. The share of apparent U.S. consumption that was supplied by Japan and Taiwan was translated into actual ceiling unit numbers. The VRU with Taiwan specified machine tool unit limits for six-month periods. The VRU allowed Taiwan to export 310 additional machine tools to the United States than were permitted under the VRA covering 1987-91.

During the operation of the VRAs, Japan did not always fill its quota and Taiwan usually filled or may have exceeded its quotas.[69] For example, in 1991, Japan filled only 79 percent of its quota levels and Taiwan filled 93 percent.[70] Since 1990, the United States and Taiwan have disagreed over whether Taiwan exceeded its quotas in 1989 and 1990.[71]

[67] *Continued*—Taiwan machine tools offered "substantially complete" U.S.-made NC lathes and machining centers.

[68] Legal authority to unilaterally enforce the export limits of the VRAs was provided in the Omnibus Trade and Competitiveness Act of 1988 (P.L. 100-418, Aug. 23, 1988).

[69] In July 1990, the GAO agreed with the DOC's conclusion that both Japan and Taiwan exceeded their quotas during 1986-88. See U.S. General Accounting Office, *Revitalizing the U.S. Machine Tool Industry,* GAO/NSIAD-90-182 (Washington, DC: GAO, July 1990), p. 1. Officials of the U.S. Department of Commerce, Office of Agreement Compliance, telephone interview by USITC staff, Jan. 14, 1994.

[70] Data are from U.S. Department of Commerce, Office of Agreements Compliance.

[71] For 1989 and 1990, the DOC counted some VRA machine tools from Israel as being from Taiwan. Machining centers were imported from Taiwan, modified, and then shipped to the United States as products of Israel. As a result, in May 1990, Israel invoked the dispute settlement procedures under the United States-Israel Free Trade Area Agreement and in July 1990 a dispute resolution panel was convened. As of January

Table 16
Voluntary Restraint Agreements: Annual market share limits for Japan and Taiwan, 1987-93

Products	VRAs 1987-91		*VRA and VRU 1992-93*			
			Japan		Taiwan	
	Japan	Taiwan	1992	1993	1992	1993
	Percent					
NC lathes	57.47	3.23	57.47	60.27	[1]	[1]
Non-NC lathes	4.81	24.70	[2]	[2]	[2]	[2]
Machining centers	51.54	4.66	51.54	54.03	[1]	[1]
Milling machines	3.15	19.29	7.17	7.47	[1]	[1]
NC punching and shearing machines	19.25	[3]	19.25	21.56	[2]	[2]
Non-NC punching and shearing machines	9.14	[2]	[2]	[2]	[2]	[2]

[1] VRU limit for Taiwan in 1992 expressed in machine units.
[2] Not covered in the 1992-93 VRA with Japan and VRU with Taiwan.
[3] Not covered in the 1987-91 VRA with Taiwan.

Source: Compiled by the staff of the U.S. International Trade Commission from data supplied by the U.S. Department of Commerce, Office of Agreements Compliance.

In March 1990, the United States-Japan Machine Tool Cooperation Plan was implemented by Japan's MITI and the U.S. Department of Commerce, to increase access to the Japanese market and Japanese transplants in the United States for U.S. machine tool builders.[72] The Plan expired along with the initial VRA at the end of 1991, but was continued along with the 2-year VRA extension until the end of 1993. The Plan included the dispatch of Japanese purchasing missions to the United States. According to the AMT, about $23.5 million in purchases were made under the Plan in 1992 and $13.5 million in the first half of 1993.[73]

During 1987-93, the VRAs reportedly had minimal effect on U.S. consumers while increasing investment and U.S. employment by both foreign- and U.S.-MMT builders, and developing U.S. sources of components.[74] According to industry sources and observers, during 1987-88, U.S. consumers of machine tools had to adjust to delays in delivery and to the lack of availability of certain types of machine tools. Subsequent investment by Japanese machine tool builders in U.S. production capacity eliminated many of the delivery and availability problems. Japanese builders with established U.S. production subsidiaries—Mazak Corp. and LeBlond Makino—have increased their production. Other Japanese machine tool builders have recently constructed new U.S. production facilities—i.e., Toyota Machine Works, Okuma Machinery, Miyano, Mori Seiki, and Hitachi Seiki. Japanese builders with production in the United States began purchasing some items, such as CNC controls, small components, and ball screws, from U.S. sources or from Japanese component suppliers that located production in United States.

[71] *Continued*—1994, the dispute was not resolved. See also U.S. International Trade Commission, *Operation of the Trade Agreements Program, 42nd Report, 1990*, USITC publication 2403, July 1991, p. 81.
[72] Hideo Shindo, Industrial Machinery Division, Machinery and Information Industries Bureau, Japan Ministry of International Trade and Industry, *Digest of Japanese Industry & Technology*, Oct. 31, 1990, pp. 31-33. U.S. Department of Commerce officials have stated that there are no official, publicly available documents regarding the cooperation plan.
[73] AMT—The Association for Manufacturing Technology, *Position Paper on Trade Issues*, Nov. 1993, p. 3.
[74] For a discussion of the development of U.S. component industries, see the DOC's denial of Hurco Co.'s request to import additional machining centers and subassemblies from Taiwan in 58 F.R. 3536-3538.

FOREIGN TRADE MEASURES

Tariff Measures

The major U.S. trading partners for MMTA are Canada, Japan, the EU, Mexico, and Korea. Tariffs rates for these countries are presented in the following tabulation:

Country/ Area	Rate of duty on MMTA
	(Percent ad valorem)
Canada	Free-9.3
CFTA	Free-3.7
NAFTA	Free-2.5[1]
Mexico	10.0-20.0
NAFTA	Free-16.0[2]
EU	2.2-5.5
Japan	Free-6.0
Republic of Korea	8.0

[1] The duty on one item, multi-station transfer machines, is staged over 5 years, and as of Jan. 1, 1994, became 2.0 percent ad valorem.
[2] Of 165 tariff items, duties were eliminated on 125 items immediately, with 5-year staged reductions on the remaining 40 items.

Nontariff Measures

Since 1988, there have been no specific nontariff barriers affecting U.S. exports of MMTA known to the Commission.[75] Although not directly affecting U.S. exports to the EU, monitoring of Japanese imports by the EU may have caused Japanese firms to restrain exports to the European market. Since early 1982, the EU has monitored machine tool imports from Japan.[76] As of the end of 1992, this EU monitoring regime was still in force.[77] More recent information is not readily available. In order to alleviate European fears regarding Japanese imports, the Japanese Government, in accordance with the country's Export and Import Transaction Law, since the early 1980s has permitted exports of machining centers and NC lathes to the EU only if certain price standards are being met.[78]

Both France and the United Kingdom have restricted imports of Japanese MMT. Beginning in November 1981, France restricted imports of certain Japanese NC machine tools by imposing predetermined quotas, which were implemented through the limited issuance of import licenses.[79] In 1983, an industry-to-industry VRA on machine tools was implemented between the United Kingdom and Japan limiting Japan's market share for NC lathes and machining centers in the United Kingdom. According to officials of the United Kingdom's Machine Tool Trades Association, the VRA ended in mid-1989.

Although Japan has virtually no tariffs on imports, the European machine tool association, CECIMO warned Japan in October 1989 that further informal restrictions on imports from the EU would not be tolerated, citing the trade imbalance in machine tools between Japan and the EU.[80]

U.S. MARKET

Consumption

Apparent U.S. consumption of MMTA rose from an estimated $8.0 billion in 1988 to $9.3 billion in 1989, before declining to $7.6 billion in 1992 (table 17).[81] The small decrease (5 percent) in U.S. consumption of these items during 1988-92 is attributable principally to irregular capital investments by the U.S. automobile and truck industries and reduced capital expenditures by most other heavy machinery industries. Figure 4 shows new capital expenditures for new machinery and equipment by the major consumer industries of MMTA contrasted with apparent U.S. consumption of MMTA during 1982-91, the most recent years for which data are available. Capital expenditures peaked for the transportation industry, SIC 37, in 1987, before declining sharply in 1988. Expenditures subsequently rebounded, rising through 1991.

In 1988, U.S. automotive producers substantially reduced their capital investment budgets because of excess capacity in 1986 and 1987, but placed substantial orders for new machine tool models for delivery the next year. In 1989, however, the automotive industry delayed 1990 deliveries of new machine tools because of uncertainty over corporate average fuel economy (CAFE) mileage standards, weak demand in the automotive market, and a re-evaluation of their needs based on foreign competition.

[75] For a discussion of general nontariff measures affecting U.S. exports, see Office of the U.S. Trade Representative, *National Trade Estimate Report on Foreign Trade Barriers* (Washington, DC: GPO).

[76] These included lathes, boring-milling machines, milling machines, drilling machines, jig boring machines, and certain other metal-cutting machine tools. *Council Regulation (EEC) No 288/82, Official Journal of the European Communities,* No. L 35 (Feb. 9, 1982), p. 1; *Commission Regulation (EEC) No 653/83, OJ,* No. L 77 (Mar. 23, 1983), pp. 8-9.

[77] *Commission Regulation (EEC) No 3748/91, OJ* No. L 352 (Dec. 21, 1991), p. 60.

[78] GATT, *Trade Policy Review: The European Communities 1991* vol. I, (Geneva, Switzerland: GATT, 1991), p. 211.

[79] GATT, *Review of Developments in the Trading System, September 1988-February 1989* (Geneva, Switzerland: GATT, 1990), p. 165.

[80] "Europe Demands Japan Open Doors," *American Machinist,* Oct. 1989, p. 35.

[81] Data for metal-cutting and metal-forming machine tools and parts, and work holders, tool holders, and dividing heads can be found in appendix B.

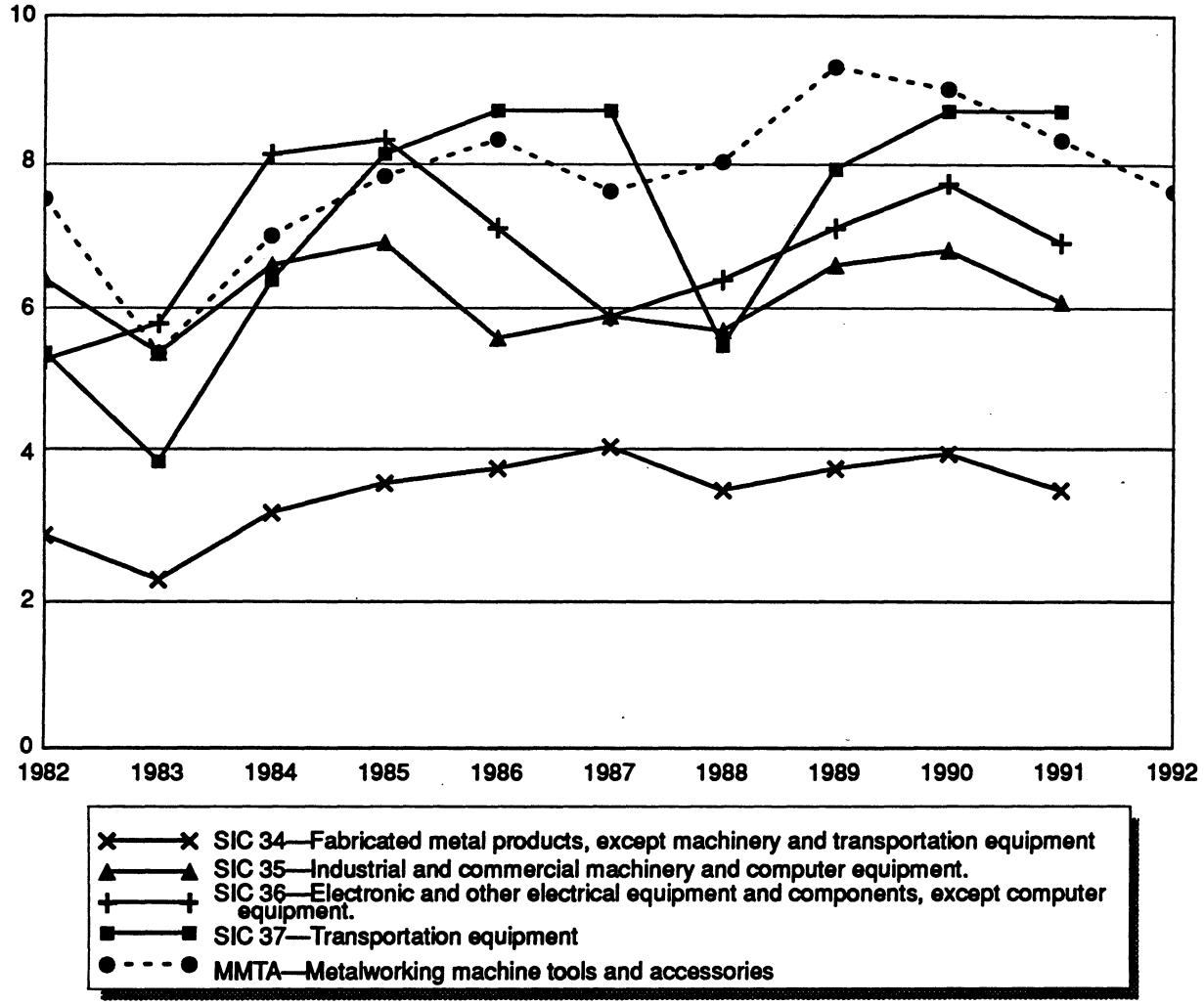
Table 17
Metalworking machine tools and accessories: U.S. producers' shipments, exports of domestic merchandise, imports for consumption, and apparent U.S. consumption, 1988-92

Year	U.S. producers' shipments[1]	U.S. exports	U.S. imports	Apparent U.S. consumption[1]	Ratio of imports to consumption[1]
	Million dollars				*Percent*
1988	6,857.6	1,362.1	2,548.7	8,044.2	31.7
1989	7,915.0	1,678.1	3,097.4	9,334.3	33.2
1990	7,904.5	1,815.0	2,911.3	9,000.8	32.3
1991	7,320.6	1,770.2	2,794.8	8,345.2	33.5
1992	7,139.5	2,034.3	2,505.2	7,610.4	32.9

[1] Estimated by the staff of the U.S. International Trade Commission.

Source: Compiled from official statistics of the U.S. Department of Commerce, except as noted.

Figure 4
New capital expenditures for machinery and equipment by certain SIC industries, and apparent U.S. consumption of MMTA, 1982-92
Billion of dollars



Source: Compiled by the staff of the U.S. International Trade Commission from data of the U.S. Bureau of the Census, *Annual Survey of Manufactures,* and staff estimates of apparent U.S. consumption of MMTA.

Investments by other industries, such as the construction and agricultural machinery industries, also remained weak due to excess production capacity. However, in 1990, the Caterpillar Corp., purchased a substantial number of machine tools for its "Plant With A Future" program. In 1988 and 1989, consumption of MMTA by U.S. aerospace companies was strong, but has fallen dramatically since 1991 because of declining defense budgets and reduced demand for commercial transports that adversely affected orders received by aerospace parts producers.

U.S. imports as a share of apparent U.S. consumption for MMTA ranged from 32 to 34 percent during 1988-92. Imports of MMT as a share of apparent U.S. consumption accounted from 42 percent to 45 percent during 1988-92, but only 9 percent of the consumption of machine tool accessories. In 1992, imports accounted for 48 percent of apparent U.S. consumption of metal-cutting machine tools and parts and 37 percent of consumption of metal-forming machine tools and parts (see tables B-1 and B-2, in appendix B). U.S. imports continue to account for a significant share of apparent U.S. consumption because the United States is no longer self-sufficient in meeting the demand for many types of standardized machine tools. For example, in 1992, imports accounted for 51 percent of the value of apparent U.S. consumption of machining centers; 58 percent of gear-cutting machines; 52 percent of grinding machines; 65 percent of horizontal NC lathes; and 74 percent of non-NC lathes.[82]

[82] For MMT valued over $3,025. Data are from AMT—The Association for Manufacturing Technology, *1993-1994 Economic Handbook of the Machine Tool Industry,* (McLean, VA: AMT, 1993), pp. A1-A20.

Production

U.S. producers' shipments of MMTA rose from an estimated $6.9 billion in 1988 to $7.9 billion in 1989 and 1990, before declining to an estimated $7.1 billion in 1992. U.S. producers' shipments of metal-cutting machine tools and parts increased from $2.7 billion in 1988 to $3.4 billion in 1990, before declining to $2.5 billion in 1992. U.S. producers' shipments of metal-forming machines and parts rose from $1.8 billion in 1988 to a peak of $1.9 billion in 1989, and then declined to $1.7 billion in 1992.[83] Shipments of machine tool accessories rose from $2.2 billion in 1988 to $2.8 billion in 1990, before declining to $2.5 billion in 1992.

Exports accounted for a significant portion of the increase in U.S. producers' shipments of MMT. Exports of MMT as a share of U.S. producers' shipments rose from 26 percent in 1988 to 40 percent in 1992. Exports of metal-cutting machine tools accounted for 25 percent of U.S. producers' shipments in 1988 and rose to 36 percent in 1992. Exports of metal-forming machine tools accounted for 28 percent of U.S. producers' shipments in 1988 and rose to 45 percent in 1992. In contrast, exports accounted for about 7 to 8 percent of U.S. producers' shipments of machine tool accessories. Foreign customers have found specialized U.S. machine tools attractive because of their technology and price competitiveness. The rise in U.S. producers' shipments, particularly of MMT, was also attributable to several Japanese and European machine tool subsidiaries, which either began or expanded their U.S. production and began exporting.

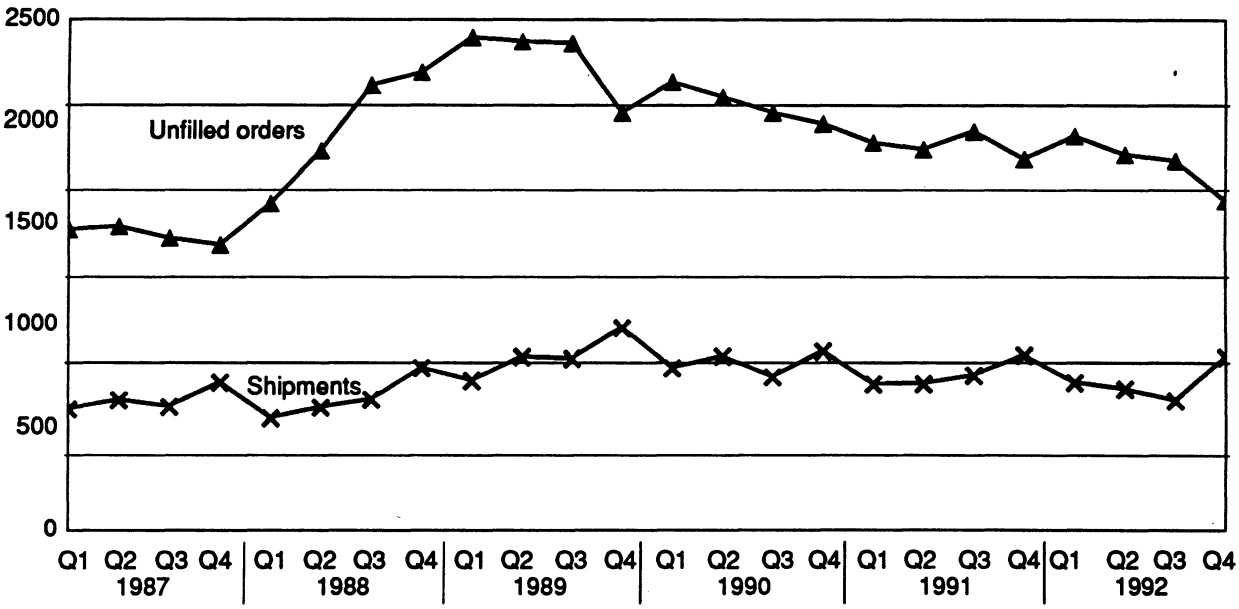
Only a small percentage of U.S. producers' shipments were of rebuilt machine tools, which were valued at $223 million in 1987,[84] the most recent year for which data are available. Rebuilding generally saves between 30 to 60 percent of the replacement cost of a new machine tool. The rebuilt MMT is usually retrofitted with advanced electronics and components made of modern materials, so that the machine's technology and capabilities are enhanced.

The value of unfilled orders for MMT rose rapidly in 1988, before declining in late 1989 through 1992 (figure 5). As an indicator, the decline in orders wouldforecast reductions in employment, excess capacity, and a lower volume of shipments. It may also indicate that the U.S. industry is reducing its leadtimes to customers, resulting in quicker deliveries and lower inventories.

[83] For further detail, see tables in appendix B.

[84] U.S. Bureau of the Census, *1987 Census of Manufactures:* Metalworking Machinery and Equipment, Industry Series MC87-I-35C, (Washington, DC: GPO, Mar. 1990), pp. 35C-23 and 35C-24.

Figure 5
MMT unfilled orders vs. shipments, by quarter, 1987-92



Source: Compiled by the staff of the U.S. International Trade Commission from data of the U.S. Bureau of the Census, as published in the *Current Industrial Reports: Metalworking Machinery,* MQ35W, quarterly.

U.S. Imports

During 1988-92, U.S. imports of MMTA rose from $2.5 billion in 1988 to $3.1 billion in 1989, before declining to $2.5 billion in 1992 (table 18).[85] During the period, U.S. import demand fell in anticipation of a weakening economy and the postponement of investment plans, paralleling the declines in U.S. consumption and production (figure 6).

U.S. imports of MMTA are concentrated in the most commonly used types of MMT, such a machining centers, lathes, and milling machines, as well as certain niche-type machines, such as grinders, EDMs, and bending and forming machines. In 1992, U.S. imports of lathes, valued at $372 million, and machining centers, valued at $352 million, accounted for 16 percent and 15 percent, respectively, of MMT imports. The concentration of imports in these product areas is greater than that found in the U.S. production mix. U.S. imports of transfer machines (transfer lines) accounted for 3 percent of MMT imports compared with about 11 percent of U.S. producers' shipments. This disparity is due in part to the high level of engineering and customer support required for such systems. U.S. imports of previously used machine tools were valued at $61 million in 1992. Imports of

[85] Data for metal-cutting and metal-forming machine tools and parts, and accessories can be found in appendix B.

Table 18
Metalworking machine tools and accessories: U.S. imports for consumption, by principal sources 1988-92

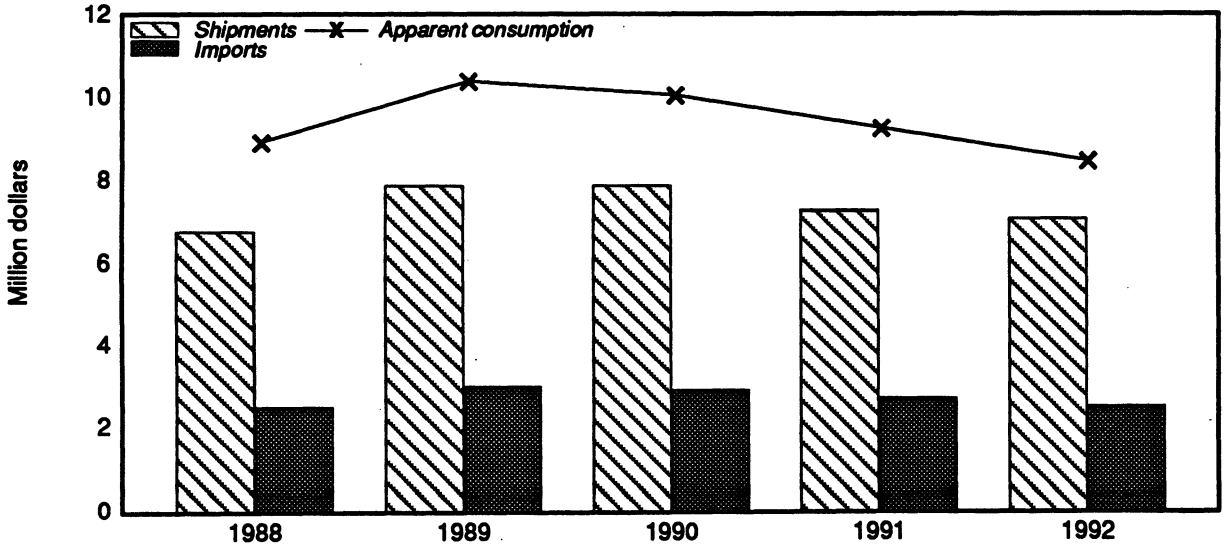
(1,000 dollars)

Source	1988[1]	1989	1990	1991	1992
Japan	1,275,617	1,544,488	1,250,867	1,216,539	1,066,681
Germany	391,851	486,777	543,802	583,184	459,092
Canada	82,120	179,723	154,351	139,960	177,412
Switzerland	130,037	145,682	159,589	149,501	152,249
Taiwan	158,843	169,670	153,032	134,357	133,514
United Kingdom	148,079	146,196	173,898	140,803	117,968
Italy	93,912	102,116	115,880	106,249	78,996
Sweden	40,344	36,841	66,430	43,382	38,763
Austria	13,508	14,959	18,900	18,508	32,443
France	24,104	40,937	39,947	34,306	30,407
All other	190,238	232,284	237,094	228,018	217,662
Total	2,548,653	3,097,065	2,911,297	2,794,807	2,505,187

[1] Country data are presented for 1988 as there is direct comparability between the former Tariff Schedules of the United States (TSUS) and the HTS.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Figure 6
U.S. metalworking machine tools and assessories: U.S. imports, producers' shipments, and apparent consumption,[1] 1988-92



[1] Apparent Consumption = Producers' Shipments + Imports - Exports.

Source: Compiled by the staff of the U.S. International Trade Commission.

machine tools valued under $3,025[86] totaled $95 million, with Taiwan accounting for 54 percent of these imports, or $51 million. Other major suppliers of these machines were Japan and China.

In 1992, the principal suppliers of U.S. imports of MMTA were Japan, Germany, Canada, Switzerland, Canada, Taiwan, and the United Kingdom; these countries together accounted for 84 percent of total MMTA imports. During 1988-92, Japan was the largest U.S. supplier; in 1992, Japan accounted for 43 percent of U.S. MMTA imports.

The decline in U.S. imports from Japan reportedly was due to a reduction in orders for MMT by Japanese auto transplants, intense price competition from U.S. producers, and increased production by Japanese MMT subsidiaries in the United States. The import limits imposed by the VRAs during 1987-93, in part, prompted the shift in Japanese production to the United States.

Germany was the second largest supplier, accounting for 18 percent of U.S. MMTA imports in 1992. Imports from Germany rose in the late 1980s principally because of demand by the motor-vehicle industry for sophisticated MMT. Aside from the decline in demand in 1992 by the motor-vehicle and aerospace industries, German MMT tended to cost more than what U.S. users were willing to pay.

Taiwan fell from being the third largest supplier in 1988 to the sixth largest in 1992. The decline in U.S. MMTA imports from Taiwan is, in part, attributable to the limitations of the VRA quotas. In other product areas, Taiwan lost U.S. market share to low-cost producers in Korea and China. Since the recession of 1990, U.S. machine shops and consumers of hobby-type MMT have also slowed their consumption. In 1992, about 38 percent of MMTA imports from Taiwan were of MMT valued under $3,025. Part of the decline in U.S. imports from Taiwan was offset by an increase in imports of tool holders.

Relatively new suppliers showing rapid growth in the U.S. import market are China, Korea, Brazil, Poland, and Thailand. China is principally supplying metal-cutting machine tools at the low-end of the market based on old designs that have been retrofitted with computer controls. Imports from Brazil are mainly presses produced for Schuler, a German press builder; other imports are lathes from Romi, S.A., sold by Bridgeport Machines, Inc. Poland is principally supplying work holders and tool holders. Imports from Thailand are machines produced by Japanese and Taiwan firms that have located production facilities in Thailand in order to better serve the markets in Southeast Asia and reduce overall production costs.

Duty-free imports of MMT accounted for 4 percent, or $93 million, of all U.S. imports of MMTA in 1992, compared with almost 2 percent during 1989-90, and 4 percent in 1988. In 1992, the principal suppliers of such imports were Canada, Brazil, Israel, Poland, Thailand, and the Czech and Slovak Republics. Duty-free imports under the Generalized System of Preferences (GSP) were valued at $67 million.[87] The U.S. content of imports receiving duty-free treatment under HTS subheadings 9802.00.60 and 9802.00.80 was valued at $18 million. Imports under these subheadings were principally from Canada and the United Kingdom. U.S. imports entered under the U.S.-Israel Free Trade Area Implementation Act of 1985 totaled $3 million in 1992, and those under the Caribbean Basin Economic Recovery Act (CBERA) totaled $244,000. Imports eligible for reduced duties under the U.S.-Canada Free Trade Area Implementation Act were valued at $151 million in 1992 and accounted for 85 percent of total U.S. imports of MMTA from Canada.

Generally, U.S. importers of machine tools have been foreign machine tool builders, U.S. machine tool builders, and U.S. distributors. During 1988-89, Japanese automobile and automotive parts transplants were also substantial importers of machine tools.

FOREIGN MARKETS

Foreign Market Profile

The principal foreign markets for U.S. exports of MMTA during 1988-92 were Mexico, Canada, Japan, and Korea. The EU was also an important market for U.S. MMTA exports. Canada and Mexico are major markets because of their proximity to the United States and because of corporate relationships favoring purchases of U.S. machine tools. Japan, Germany, and the United Kingdom are major markets for specialized U.S. machine tools, especially for the automotive and aerospace industries. Korea has also sought specialized U.S. machine tools for its automotive industry.

Technology and competitive prices continue to be the most important factors influencing the demand for U.S. exports. Other significant factors in the growth of exports have been the increased export-oriented business strategies of U.S. machine tool builders, increased exports by foreign-owned U.S. builders, new consumer and corporate relationships, and a relaxation of U.S. export controls. However, the AMT cites a lack of U.S. Government export promotion and export financing, tied-aid, and the Foreign Corrupt Practices Act as factors detrimental to the industry's capability to increase exports.[88]

The U.S. MMT industry is competitive in computer-controlled machine tools, and is the

[86] Statistical breakouts valued under and above $3,025 have been provided for most machine tool types in both U.S. producers' shipments data collected under the U.S. Bureau of the Census' *Current Industrial Reports* series and in U.S. trade data. Machine tools valued under $3,025 are viewed as being for use in home or for hobby use. This value limit was $2,500 through 1990.

[87] Beginning in 1989, Taiwan, Singapore, Hong Kong, and Korea were removed from the GSP program. However, in 1988, imports under the GSP from these countries accounted for 64 percent of all GSP imports of MMTA, or $41 million.

[88] Albert W. Moore, President, AMT - The Association for Manufacturing Technology, testimony before the U.S. House of Representatives, Committee on Foreign Affairs, Subcommittee on International Economic Policy and Trade, July 22, 1992.

undisputed leader in certain types of these machines. These include spiral level gear-making machines, broaching machines, transfer lines, large milling machines, and certain large presses. Products having either advanced machine tool controls or new design features are particularly attractive to foreign buyers. For example, one U.S. manufacturer has introduced a compact NC lathe that requires less factory floor space, which has become a "hot" product in Europe.

Since 1988, U.S.-built machine tools have become more price competitive with foreign machine tools in part because of the depreciation of the U.S. dollar relative to the currencies of major U.S. trading partners. The price competitiveness of U.S. exports has also been furthered in Canada as Canadian tariffs have fallen, under the United States-Canada Free Trade Area Implementation Act of 1988.

U.S. machine tool producers are placing greater importance on exports in their corporate strategies, and in some instances, exports account for up to 50 percent of an individual firm's total revenue. U.S. manufacturing subsidiaries of foreign MMT builders have also incorporated exports into their business strategies. Many large U.S. machine tool builders derive a significant portion of their revenues from their foreign manufacturing subsidiaries, located principally in Western Europe.

Corporate relationships between U.S. automotive and aerospace companies and their subsidiaries in Canada and Mexico have facilitated U.S. exports of machine tools to these markets. These U.S. subsidiaries tend to purchase machine tools from the United States because of their familiarity with U.S. technology. Canadian machine tool builders reportedly have a competitive disadvantage because of higher materials and labor costs than U.S. producers. Imports from the United States accounted for 60 percent of total Canadian imports of machine tools and accessories in 1992.

Mexican imports from the United States accounted for approximately 60 percent of the Mexican market for machine tools in 1990. Mexico has only a few, small builders of machine tools that mainly produce basic models and therefore do not compete with U.S.-made equipment. The principal competition for U.S. builders in the Mexican machine tool market is from Japan and the EU.[89]

Generally, the cost and availability of transportation is not a problem for U.S. machine tool builders, except where markets are quite distant. U.S. builders are at a slight price disadvantage when exporting to Southeast Asia or Europe because their competition is closer to those markets.

U.S. exports of machine tools have been restricted by U.S.[90] and COCOM[91] export regulations, particularly to the former Soviet Union, China, and Central and Eastern Europe. Under the Machine Tool Domestic Action Plan, the U.S. Department of Commerce began in 1987 to selectively relax export restrictions and streamline the processing of export licenses for machine tools. In June 1990, a revised list of machine tools that were subject to export controls was agreed upon by the United States and its COCOM allies. In July 1991, the list was further liberalized.[92]

According to industry sources, U.S. export controls and foreign policy controls have hampered U.S. machine tool builders in overseas sales more significantly than their competitors in other COCOM countries.[93] In October 1993, the United States and its COCOM allies decided to abolish COCOM on March 31, 1994; however, U.S. export controls on MMT will remain as new legislation for export controls is debated in the U.S. Congress.[94] In 1988, U.S. exports of MMTto the Soviet Union totaled $1.3 million compared with over $600 million of exports by Japan and Germany.[95] Industry sources have alleged that some COCOM member countries have been lax in their enforcement of export regulations.[96] For example, in May 1987, Toshiba of Japan and Kongsberg of Norway were investigated for exporting advanced machine tools to the Soviet Union for use in submarine propeller fabrication. This violation prompted Japan to increase its policing of exports to conform to COCOM regulations. Other issues cited by U.S. industry sources as hampering U.S. exports include U.S. foreign-policy-based export controls,[97]

[89] For an analysis of the Mexican machine tool market, see U.S. International Trade Commission, *Potential Impact on the U.S. Economy and Selected Industries of the North American Free-Trade Agreement* (investigation No. 332-337), USITC publication 2596, Jan. 1993, pp. 6-1 to 6-4.

[90] U.S. export controls are administered under the Export Administration Act of 1979, as amended in 1981, 1985, and 1988 (50 U.S.C. app. 2401). The Export Administration Regulations implement the Export Administration Act (15 CFR 774.1).

[91] COCOM is the Coordinating Committee on Multilateral Export Controls, made up of Australia, Belgium, Canada, Denmark, France, Germany, Greece, Italy, Japan, Luxembourg, the Netherlands, Norway, Portugal, Spain, Turkey, the United Kingdom, and the United States. The group's purpose is to limit the spread of certain advanced technologies to Communist and terrorist- supporting countries. However, Switzerland, the 6th ranked producer in 1992, is not a member.

[92] 56 F.R. 30798.

[93] Albert W. Moore, President, AMT - The Association for Manufacturing Technology, testimony before the U.S. House of Representatives, Committee on Foreign Affairs, Subcommittee on International Economic Policy and Trade, July 22, 1992, pp. 11-12.

[94] See H.R. 3937, entitled the "Export Administration Act of 1994."

[95] Albert W. Moore, p. 12.

[96] Ibid.

[97] Foreign policy-based export controls in effect during 1988-92 relate to countries engaged in human rights abuses, terrorism, regional stability, the indiscriminate transfer of equipment and technical data used for missile technology purposes; and the production or indiscriminate transfer of chemical and biological agents for use in weapons of mass destruction. Because of certain practices, certain countries were also subject to export controls: South Africa, Libya, and certain embargoed communist countries. 55 F.R. 51300-51301.

which do not exist in most other countries, lengthy licensing review times, and more stringent interpretations of export regulations by the U.S. Government. In some instances, reviews have lasted almost a year.[98] In other instances, export licenses were denied by the U.S. Government because the U.S.-built machine tool was more sophisticated than what the foreign buyer needed.[99]

Although technology controls have allegedly hampered exports, the U.S. industry is now working with the U.S. Government in other areas and participating in Government-sponsored export promotion programs. Exports have also increased somewhat because of the pressure exerted by the U.S. Government on Korea and Taiwan to purchase more U.S. goods.

U.S. industry sources anticipate that the U.S.-Japan Machine Tool Cooperation Plan will generate future exports, or increase U.S. builders' access to contracts from Japanese automotive and other transplants in the United States. According to industry sources, in the mid-1980s, Japanese automotive transplants did not invite machine tool companies other than Japanese builders to bid on contracts.[100] However, reportedly due to industry pressure since 1989, some U.S. producers have received orders from Japanese automotive transplants, particularly formetal-forming stamping presses.[101] U.S. subsidiaries of Japanese companies have rarely purchased metal-cutting machine tools from U.S.-owned firms. The AMT reported that at the end of 1991, only $400,000 of orders for U.S. machine tool builders had directly resulted from the program.[102] The operation of the U.S.-Japan Machine Tool Cooperation Plan resulted in $24 million of U.S. machine tool purchases in 1992 and $13 in the first half of 1993.[103] The AMT has stated that Japanese transplants "systematically discriminate" against U.S. suppliers that have bid on contracts.[104]

[98] Robert Knutter, "How 'National Security' Hurts National Competitiveness," *Harvard Business Review*, vol. 69, No. 1 (Jan.-Feb. 1991), p. 143.

[99] Ibid., p. 146. See also David M. Yarborough, "Controlling Export Controls," *Harvard Business Review*, vol. 69, No. 4 (July-Aug. 1991), pp. 169-170. Mr. Yarborough was President of Elox Corp., the only U.S. manufacturer of electrical discharge machines.

[100] U.S. International Trade Commission, *Mechanical Transfer Presses From Japan* (investigation No. 731-TA-429 (final)), USITC publication 2257, Feb. 1990, p. A-15.

[101] In March 1991, Danly Machine of Chicago, IL, received an order for seven presses from Nissan Motor Co.'s Smyrna, TN, plant. "Danly Machine Sells $40 Million In Presses to Asian Automakers," *Metalworking Weekly Report*, Apr. 1, 1991, p. 51.

[102] Albert W. Moore, President, AMT - The Association for Manufacturing Technology, testimony before the U.S. House of Representatives, Committee on Foreign Affairs, Subcommittee on International Economic Policy and Trade, July 22, 1992, p. 6.

[103] AMT—The Association for Manufacturing Technology, *Position Paper on Trade Issues*, Nov. 1993, p. 3.

[104] Albert W. Moore, President, AMT - The Association for Manufacturing Technology, testimony before the U.S. House of Representatives, Committee on Foreign Affairs, Subcommittee on International Economic Policy and Trade, July 22, 1992, pp. 4-5.

The AMT is also conducting trade promotion programs under an Export Trade Certificate as authorized by the Export Trading Company Act of 1982 (ETC Act).[105] Under the ETC Act, the AMT has conducted export trading programs in China and Egypt. The Act allows AMT members to discuss strategy and pricing. The China program resulted in orders for machine tools valued at $8 million, while the Egypt program netted only one minor order.

A major impediment to increased U.S. exports, in the opinion of the AMT, is the lack of time-responsive, competitive export financing. U.S. machine tool builders have used some Export-Import Bank of the United States ("EX-IM Bank") programs to help finance their exports, but industry sources state that generally financing from the EX-IM Bank has been limited to certain industrial sectors, excluding machine tools. When financial assistance has been available, either from the EX-IM Bank or the U.S. Overseas Private Investment Corporation (OPIC), administrative delays in processing have resulted in lost contracts to foreign competitors, who have access to more time-responsive financing. Industry sources believe that the current lack of financing support from the U.S. Government for U.S. exports to Eastern Europe and the former Soviet Union will be detrimental to U.S. machine tool builders in these markets, because neither the U.S. builder nor the customer has the necessary financial resources.[106] The U.S. industry has also noted the lack of support for its exports from the U.S. Government in the areas of tied aid and soft loans. Some U.S. industry sources have indicated that Italy and Spain have been able to expand exports with soft-loan programs.[107]

The Foreign Corrupt Practices Act (FCPA) also reportedly has hindered U.S. machine tool builders in securing export sales. The Act forbids U.S. exporters from accepting "black money," or domesticated funds, in payment for goods and services because this would reduce the domestic customer's domestic tax or duty exposure.

Industry sources indicate that China is the best future market for increased U.S. exports of MMTA. Continued industrial development in Mexico would also drive demand for U.S. MMTA. The prospects of previously strong U.S. exports to the EU have diminished, as the EU restructures its industries and attempts to reduce costs. Because of declining sales of motor vehicles and other important industrial products in that market, demand for MMTA is expected to be weak for the near future. Tariff reductions under the GATT Uruguay Round and under NAFTA are expected to benefit U.S. exporters of MMTA.

U.S. Exports

U.S. exports of MMTA grew rapidly from $1.4 billion in 1988 to $2.0 billion in 1992, or by 49 percent

[105] Public Law 97-290.

[106] John F. Townsend, Vice-President, Marketing, Giddings & Lewis, Inc., testimony before the U.S. House of Representatives, Committee on Foreign Affairs, Subcommittee on International Economic Policy and Trade, July 22, 1992.

[107] Ibid., p. 7.

(table 19).[108] Exports have represented an increasing share of U.S. shipments, rising from 15 percent in 1986 (the year in which the United States began negotiations for the VRAs) to 20 percent by 1988, and then jumping from 24 percent in 1991 to 29 percent in 1992. The increase in exports of MMTA is largely due to strong demand in the automotive sector in Mexico in 1992; in Canada during 1990 and 1992, and in Korea in 1992. Mexico accounted for 18 percent of U.S. exports of MMTA in 1992, compared with 15 percent for Canada and 9 percent for Korea. Exports to Japan rose slightly in 1992, despite a deepening recession, accounting for only 9 percent of U.S. exports.

In 1992, China became the sixth largest market for U.S. MMTA exports. The rise in exports to China reportedly is due to strong Chinese demand for MMTA products, coupled with a relaxation in U.S. export controls and U.S. trade association export promotion programs. Offsetting these gains in exports was a 14-percent decline in exports to the EU, due to the recession in Europe.

For the most part, the composition of U.S. exports resembles that of U.S shipments. The single largest category of exports is parts of machine tools, followed by miscellaneous types of metal-forming machine tools, including presses and highly-engineered custom-designed machines. Most other U.S. exports are concentrated in market niches, such as grinding machines, gear-making machines, bending and forming machines, and high-performance lathes. U.S. exports of machining centers and transfer machines account for a disproportionately low percentage of the value of total MMTA exports, relative to the corresponding large shares of U.S. producers' shipments that equipment represents. Used or rebuilt machine tools represented about 8 percent of total U.S. exports of MMT. However, such machines accounted for 11 percent of total U.S. exports of MMT to Mexico; 11 percent to Canada; and 7 percent to Korea.

U.S. exporters have principally been either large U.S. machine tool builders, or those builders with distinct market niches. European and Japanese machine tool builders with assembly or manufacturing facilities in the United States have also begun to export, principally to Canada, Mexico, Europe, and Latin America.

U.S. TRADE BALANCE

During 1988-92, the U.S. trade deficit in MMTA declined from $1.2 billion to $471 million, but the trade deficit with Japan remained substantial (table 20). The deficit with Japan declined from $1.2 billion to $898 million during the period. Preliminary U.S. trade data for 1993 indicate that deficit with Japan in these products rose by about $90 million over the deficit in 1992. In the absence of trade with Japan, the U.S. MMTA industry would have had a trade surplus of more than $400 million in 1992. Japan accounted for only 9 percent of U.S. MMTA exports, yet accounted for 43 percent of U.S. imports in 1992. In comparison, the EU accounted for 21 percent of exports and 30 percent of imports. The deficit with the EU rose from $396 million in 1988 to $422 million in 1991, before falling to $308 million in 1992. The U.S. trade deficit with Switzerland remained around $138 million, and the deficit with Taiwan declined from $117 million to $68 million.

[108] For further detail, see appendix B.

Table 19
Metalworking machine tools and accessories: U.S. exports of domestic merchandise, by principal markets, 1988-92

(1,000 dollars)

Market	1988[1]	1989	1990	1991	1992
Mexico	193,102	165,844	156,405	172,946	374,630
Canada	196,834	229,375	358,964	271,589	298,567
Korea	109,108	140,290	123,334	122,042	176,375
Japan	115,733	153,132	158,845	160,411	168,972
Germany	89,991	120,252	157,560	166,460	124,513
United Kingdom	115,070	186,649	157,358	116,182	103,294
China	44,912	62,242	45,728	78,057	83,473
Taiwan	41,766	47,262	40,913	44,744	65,703
France	28,089	38,567	53,187	74,112	55,724
Italy	34,610	39,543	45,139	46,108	49,999
All other	392,872	518,038	518,071	517,072	533,055
Total	1,362,123	1,680,535	1,815,554	1,769,693	2,034,306

[1] Country data are presented for 1988 as there is direct comparability between the former Tariff Schedules of the United States (TSUS) and the HTS.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 20
Metalworking machine tools and accessories: U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by selected country and country group, 1988-92[1]

(Million dollars)

Item	1988	1989	1990	1991	1992
U.S. exports of domestic merchandise:					
Japan	116	153	159	160	169
Germany	90	120	158	166	125
Canada	197	229	359	272	299
Mexico	193	166	156	173	375
United Kingdom	115	187	157	116	103
Korea	109	140	123	122	176
Taiwan	42	47	41	45	66
Switzerland	11	13	14	13	14
Italy	35	40	45	46	50
China	45	62	46	78	83
All other	408	523	557	578	575
Total	1,362	1,681	1,816	1,770	2,034
EU-12	335	464	515	501	432
LAIA[2]	291	262	251	274	478
ASEAN	44	57	74	85	93
U.S. imports for consumption:					
Japan	1,276	1,544	1,251	1,217	1,067
Germany	392	484	541	583	459
Canada	82	180	154	140	177
Mexico	2	3	4	3	5
United Kingdom	148	146	174	141	118
Korea	10	31	20	21	26
Taiwan	159	170	153	134	134
Switzerland	130	146	160	150	152
Italy	94	102	116	106	79
China	3	20	30	27	23
All other	222	247	296	265	265
Total	2,549	3,097	2,911	2,795	2,505
EU-12	731	852	951	923	740
LAIA[2]	36	17	18	33	34
ASEAN	18	27	31	27	27
U.S. merchandise trade balance:					
Japan	-1,160	-1,391	-1,092	-1,056	-898
Germany	-302	-364	-384	-417	-335
Canada	115	50	205	132	121
Mexico	189	162	153	170	369
United Kingdom	-15	41	-17	-25	-15
Korea	92	109	103	101	151
Taiwan	-117	-122	-112	-90	-68
Switzerland	-137	-133	-146	-136	-138
Italy	-59	-63	-71	-60	-29
China	42	42	16	51	60
All other	155	253	249	305	310
Total	-1,187	-1,417	-1,096	-1,025	-471
EU-12	-396	-388	-436	-422	-308
LAIA[2]	255	245	233	241	443
ASEAN	26	30	43	59	65

[1] Import values are based on customs value; export values are based on f.a.s. value, U.S. port of export. U.S. trade with East Germany is included in "Germany".

[2] Latin American Integration Association (LAIA), known in Spanish as Asociación Latinoamericana de Integración (ALADI), a regional free-trade association comprised of Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico, Paraguay, Uruguay, and Venezuela.

Source: Compiled from official statistics of the U.S. Department of Commerce.

APPENDIX A
EXPLANATION OF TARIFF AND TRADE AGREEMENT TERMS

TARIFF AND TRADE AGREEMENT TERMS

The ***Harmonized Tariff Schedule of the United States*** (HTS) replaced the *Tariff Schedules of the United States* (TSUS) effective January 1, 1989. Chapters 1 through 97 are based upon the internationally adopted Harmonized Commodity Description and Coding System through the 6-digit level of product description, with additional U.S. product subdivisions at the 8-digit level. Chapters 98 and 99 contain special U.S. classification provisions and temporary rate provisions, respectively.

Rates of duty in the ***general*** subcolumn of HTS column 1 are most-favored-nation (MFN) rates; for the most part, they represent the final concession rate from the Tokyo Round of Multilateral Trade Negotiations. Column 1-general duty rates are applicable to imported goods from all countries except those enumerated in general note 3(b) to the HTS, whose products are dutied at the rates set forth in ***column 2***. Goods from Albania, Armenia, Belarus, Bulgaria, the People's Republic of China, the Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Mongolia, Poland, Russia, Slovakia, and the Ukraine are currently eligible for MFN treatment. Among articles dutiable at column 1-general rates, particular products of enumerated countries may be eligible for reduced rates of duty or for duty-free entry under one or more preferential tariff programs. Such tariff treatment is set forth in the ***special*** subcolumn of HTS column 1. Where eligibility for special tariff treatment is not claimed or established, goods are dutiable at column 1-general rates.

The ***Generalized System of Preferences*** (GSP) affords nonreciprocal tariff preferences to developing countries to aid their economic development and to diversify and expand their production and exports. The U.S. GSP, enacted in title V of the Trade Act of 1974 and renewed in the Trade and Tariff Act of 1984, applies to merchandise imported on or after January 1, 1976 and before July 4, 1993. Indicated by the symbol "A" or "A*" in the special subcolumn of column 1, the GSP provides duty-free entry to eligible articles the product of and imported directly from designated beneficiary developing countries, as set forth in general note 3(c)(ii) to the HTS.

The ***Caribbean Basin Economic Recovery Act*** (CBERA) affords nonreciprocal tariff preferences to developing countries in the Caribbean Basin area to aid their economic development and to diversify and expand their production and exports. The CBERA, enacted in title II of Public Law 98-67, implemented by Presidential Proclamation 5133 of November 30, 1983, and amended by the Customs and Trade Act of 1990, applies to merchandise entered, or withdrawn from warehouse for consumption, on or after January 1, 1984; this tariff preference program has no expiration date. Indicated by the symbol "E" or "E*" in the special subcolumn of column 1, the CBERA provides duty-free entry to eligible articles, and reduced-duty treatment to certain other articles, which are the product of and imported directly from designated countries, as set forth in general note 3(c)(v) to the HTS.

Preferential rates of duty in the special subcolumn of column 1 followed by the symbol "IL" are applicable to products of Israel under the ***United States-Israel Free Trade Area Implementation Act*** of 1985 (IFTA), as provided in general note 3(c)(vi) of the HTS. Where no rate of duty is provided for products of Israel in the special subcolumn for a particular provision, the rate of duty in the general subcolumn of column 1 applies.

Preferential rates of duty in the special subcolumn of column 1 followed by the symbol "CA" are applicable to eligible goods originating in the territory of Canada under the ***United States-Canada Free-Trade Agreement*** (CFTA), as provided in general note 3(c)(vii) to the HTS.

Preferential nonreciprocal duty-free or reduced-duty treatment in the special subcolumn of column 1 followed by the symbol "J" or "J*" in parentheses is afforded to eligible articles the product of designated beneficiary countries under the ***Andean Trade Preference Act*** (ATPA), enacted in title II of Public Law 102-182 and implemented by Presidential Proclamation 6455 of July 2, 1992 (effective July 22, 1992), as set forth in general note 3(c)(ix) to the HTS.

Other special tariff treatment applies to particular ***products of insular possessions*** (general note 3(a)(iv)), goods covered by the ***Automotive Products Trade Act*** (APTA) (general note 3(c)(iii)) and the ***Agreement on Trade in Civil Aircraft*** (ATCA) (general note 3(c)(iv)), and ***articles imported from freely associated states*** (general note 3(c)(viii)).

The ***General Agreement on Tariffs and Trade*** (GATT) (61 Stat. (pt. 5) A58; 8 UST (pt. 2) 1786) is the multilateral agreement setting forth basic principles governing international trade among its 111 signatories. The GATT's main obligations relate to most-favored-nation treatment, the maintenance of scheduled concession rates of duty, and national (nondiscriminatory) treatment for imported products; the GATT also provides the legal framework for customs valuation standards, "escape clause" (emergency) actions, antidumping and countervailing duties, and other measures. Results of GATT-sponsored multilateral tariff negotiations are set forth by way of separate schedules of concessions for each participating contracting party, with the U.S. schedule designated as Schedule XX.

Officially known as "The Arrangement Regarding International Trade in Textiles," the ***Multifiber Arrangement*** (MFA) provides a framework for the negotiation of bilateral agreements between importing and producing countries, or for unilateral action by importing countries in the absence of an agreement. These bilateral agreements establish quantitative limits on imports of textiles and apparel, of cotton and other vegetable fibers, wool, man-made fibers and silk blends, in order to prevent market disruption in the importing countries—restrictions that would otherwise be a departure from GATT provisions. The United States has bilateral agreements with many supplying countries, including the four largest suppliers: China, Hong Kong, the Republic of Korea, and Taiwan.

APPENDIX B
STATISTICAL TABLES

Table B-1
Metal-cutting machine tools and parts: U.S. producers' shipments, exports of domestic merchandise, imports for consumption, and apparent U.S. consumption, 1988-92

Year	U.S. producers' shipments[1]	U.S. exports	U.S. imports	Apparent U.S. consumption[1]	Ratio of imports to consumption[1]
	Million dollars				*Percent*
1988	2,742.8	685.1	1,907.9	3,965.6	48.1
1989	3,304.0	840.4	2,248.1	4,711.7	47.7
1990	3,368.1	915.1	2,091.1	4,543.7	46.0
1991	2,963.9	899.9	1,975.5	4,039.5	48.9
1992	2,872.7	1,039.9	1,734.7	3,567.7	48.6

[1] Estimated by the staff of the U.S. International Trade Commission.

Source: Compiled from official statistics of the U.S. Department of Commerce, except as noted.

Table B-2
Metal-forming machine tools and parts: U.S. producers' shipments, exports of domestic merchandise, imports for consumption, and apparent U.S. consumption, 1988-92

Year	U.S. producers' shipments[1]	U.S. exports	U.S. imports	Apparent U.S. consumption[1]	Ratio of imports to consumption[1]
	Million dollars				*Percent*
1988	1,840.4	514.2	518.2	1,844.4	28.1
1989	1,910.6	661.6	668.4	1,917.4	34.9
1990	1,772.9	664.2	642.3	1,751.0	36.7
1991	1,672.4	656.5	589.9	1,605.8	36.7
1992	1,718.4	778.8	552.2	1,491.8	37.0

[1] Estimated by the staff of the U.S. International Trade Commission.

Source: Compiled from official statistics of the U.S. Department of Commerce, except as noted.

Table B-3
Machine tools accessories: U.S. producers' shipments, exports of domestic merchandise, imports for consumption, and apparent U.S. consumption, 1988-92

Year	U.S. producers' shipments[1]	U.S. exports	U.S. imports	Apparent U.S. consumption[1]	Ratio of imports to consumption[1]
	Million dollars				*Percent*
1988	2,274.4	162.8	122.5	2,234.1	5.5
1989	2,700.4	176.1	180.9	2,705.3	6.7
1990	2,763.5	235.3	178.5	2,706.1	6.6
1991	2,682.5	213.8	229.4	2,698.1	8.5
1992	2,548.4	215.6	218.3	2,551.0	8.6

[1] Estimated by the staff of the U.S. International Trade Commission.

Source: Compiled from official statistics of the U.S. Department of Commerce, except as noted.

Table B-4
Metal-cutting machine tools and parts: U.S. imports for consumption, by principal sources, 1988-92

(1,000 dollars)

Source	1988[1]	1989	1990	1991	1992
Japan	972,708	1,156,010	960,647	890,371	800,298
Germany	309,616	350,873	393,342	423,556	310,137
Taiwan	146,038	153,838	135,485	113,706	110,198
Switzerland	104,096	106,754	113,392	107,288	106,206
Canada	41,097	100,854	62,055	70,374	91,919
United Kingdom	121,067	107,843	132,062	104,086	83,767
Italy	53,898	61,856	63,558	64,304	50,872
Korea	16,501	29,226	18,912	20,240	22,995
China	9,439	17,906	26,274	24,212	20,433
France	16,579	26,379	29,490	24,171	18,856
All other	116,887	139,215	158,363	133,223	119,038
Total	1,907,926	2,248,149	2,091,097	1,975,531	1,734,720

[1] Country data are presented for 1988 as there is direct comparability between the former Tariff Schedules of the United States (TSUS) and the HTS.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table B-5
Metal-forming machine tools and parts: U.S. imports for consumption, by principal sources, 1988-92

(1,000 dollars)

Source	1988[1]	1989	1990	1991	1992
Japan	257,018	317,166	230,121	209,468	166,378
Germany	57,106	103,668	115,790	123,551	107,731
Canada	33,944	71,165	80,885	59,095	72,278
Switzerland	21,451	29,448	37,706	34,796	38,804
Italy	35,605	34,159	43,764	36,901	25,027
United Kingdom	19,748	26,312	28,111	26,626	24,695
Sweden	16,992	13,543	37,919	14,470	20,073
Brazil	23,291	4,603	266	19,902	19,238
Austria	410	3,255	1,483	7,644	18,089
Belgium	17,641	26,425	25,241	13,742	14,718
All other	35,024	38,670	41,046	43,675	45,176
Total	518,236	668,391	642,334	589,892	552,207

[1] Country data are presented for 1988 as there is direct comparability between the former Tariff Schedules of the United States (TSUS) and the HTS.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table B-6
Machine tool accessories: U.S. imports for consumption, by principal sources, 1988-92

(1,000 dollars)

Source	1988[1]	1989	1990	1991	1992
Japan	45,891	71,312	60,099	116,700	100,005
Germany.	25,368	32,231	34,659	36,077	41,224
Taiwan	5,345	5,102	8,060	12,040	16,312
Canada	7,079	7,705	11,411	10,491	13,215
United Kingdom	7,264	12,062	13,725	10,091	9,506
Switzerland	4,490	9,480	8,491	7,417	7,239
Sweden	8,513	7,337	9,302	7,906	7,040
Israel	4,204	3,941	2,419	3,119	3,395
France	2,167	11,336	4,922	6,135	3,131
Poland	104	2,644	3,895	4,293	3,125
All other	12,066	17,376	20,884	15,137	14,069
Total	122,491	180,524	177,866	229,405	218,260

[1] Country data are presented for 1988 as there is direct comparability between the former Tariff Schedules of the United States (TSUS) and the HTS.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table B-7
Metal-cutting machine tools and parts: U.S. exports of domestic merchandise, by principal markets, 1988-92

(1,000 dollars)

Market	1988[1]	1989	1990	1991	1992
Mexico	112,723	82,334	71,748	79,470	241,603
Canada	92,995	148,844	191,866	165,527	164,056
Korea	75,113	51,058	68,996	62,800	89,896
Japan	45,508	69,725	80,760	77,988	73,746
Germany	48,369	54,617	84,193	87,436	57,943
United Kingdom	53,762	101,108	80,503	50,932	49,666
China	31,791	35,155	25,679	41,735	45,041
Taiwan	16,509	18,244	19,599	27,788	33,163
France	13,018	20,091	16,050	29,449	30,075
Italy	21,329	19,524	23,927	21,937	24,164
All other	174,005	241,685	252,363	254,418	230,506
Total	685,122	842,818	916,016	899,434	1,039,859

[1] Country data are presented for 1988 as there is direct comparability between the former Tariff Schedules of the United States (TSUS) and the HTS.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table B-8
Metal-forming machine tools and parts: U.S. exports of domestic merchandise, by principal markets, 1988-92

(1,000 dollars)

Market	1988[1]	1989	1990	1991	1992
Mexico	52,124	60,472	64,243	72,281	102,472
Canada	76,944	56,317	105,423	66,632	83,969
Japan	53,189	66,827	60,506	66,798	80,635
Korea	34,203	80,445	43,444	51,093	78,629
Germany	33,658	49,823	47,055	62,838	54,525
United Kingdom	43,599	72,828	63,473	41,418	40,443
China	10,484	24,191	16,483	33,802	32,854
Taiwan	21,222	26,801	19,482	13,865	29,515
Spain	12,877	6,680	9,028	7,126	22,304
France	12,670	15,841	31,920	39,605	22,228
All other	163,268	201,397	203,189	201,006	231,259
Total	514,238	661,621	664,246	656,466	778,834

[1] Country data are presented for 1988 as there is direct comparability between the former Tariff Schedules of the United States (TSUS) and the HTS.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table B-9
Machine tool accessories: U.S. exports of domestic merchandise, by principal markets, 1988-92

(1,000 dollars)

Market	1988[1]	1989	1990	1991	1992
Canada	26,895	24,214	61,675	39,429	50,542
Mexico	28,255	23,038	20,414	21,195	30,555
Japan	17,076	16,580	17,578	15,625	14,591
United Kingdom	17,709	12,912	13,382	23,832	13,185
Germany	7,963	15,812	26,312	16,186	12,045
Netherlands	3,285	1,857	2,589	6,099	10,835
Korea	5,675	8,787	10,894	8,149	7,850
Italy	3,026	5,711	7,160	6,742	5,954
China	2,638	2,928	3,568	2,498	5,578
Singapore	4,173	4,970	7,339	5,244	5,229
All other	46,067	59,288	64,382	68,793	59,250
Total	162,762	176,096	235,292	213,793	215,613

[1] Country data are presented for 1988 as there is direct comparability between the former Tariff Schedules of the United States (TSUS) and the HTS.

Source: Compiled from official statistics of the U.S. Department of Commerce.