The U.S. Ball and Roller Bearing Industry Since World War II

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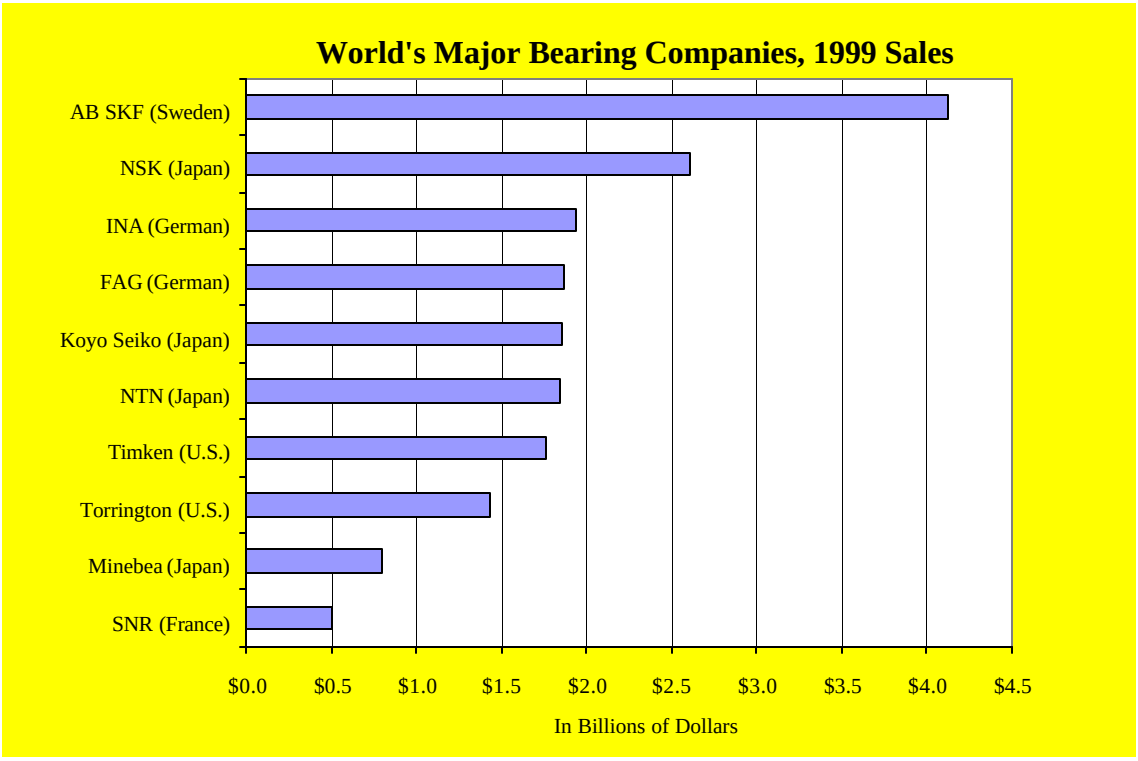
(author's view)

World Overview

In 1999, global shipments of ball and roller bearings were $23.4 billion, down about $507.1 million from the 1998 sales of $23.9 billion. These figures indicate that the largest ten bearing producers accounted for about 80 percent of the world's bearing business and that the United States bearing market represented roughly one-fourth of the world total. In 1999, the largest ten bearing firms reported $18.7 billion in bearing sales, and U.S. consumption was $5.8 billion. The following chart presents bearing sales by the largest ten companies.



Review of Major Bearing Company Financial Results, 1999

The following table presents 1999 bearing sales, after tax profits, and world market shares for the largest ten ball and roller bearing producers.

World's Largest Ten Bearing Companies at a Glance

The World's Top 10 Bearing Companies at a Glance							
Company	Home Country	Corporate Year	Sales ($Millions)	Net Profit	Market Share	Change 99/98 Sales	Exchange Rate**
AB SKF	Sweden	1999	$4,124.2	4.82%	17.3%	-3.5%	7.54392 SEK
NSK	Japan	Mar 1999	$2,600.6	-.87%	11.5%	-3.7%	115.202 Yen
INA	Germany	1999	$1,941.1	N/A	8.2%	+2.0%	1.653 DM
FAG	Germany	1999	$1,861.8	1.25%	8.1%	+9.9%	1.653 DM
Koyo Seiko	Japan	1999	$1,851.5	2.51%	8.1%	-2.9%	115.202 Yen
Sub-Total - Top 5			$12,379.3		53.0%		
NTN	Japan	Mar 1999	$1,838.3	1.25%	7.6	-6.4%	115.202 Yen
Timken	USA	1999	$1,759.9	2.28%	7.2	-2.1%	-
Torrington	USA	1999	$1,425.0	N/A	6.6	-1.5%	-
Minebea	Japan	Mar 1999	$795.9	3.77%	3.5	-3.6%	115.202 Yen
SNR	France	1999	$498.2	N/A	2.0	+2.0%	5.601 FF
Sub-Total - Top 10			$18,696.5	2.08%*	80.0	-2.2%*	
World Total			$23,370.6				

Source: Sales and Profits: Company Annual Reports; INA, Torrington and SNR estimates based on company employment reports and other information in the public domain.
Exchange Rates: U.S. Federal Reserve (see "http://www.federalreserve.gov/releases")
* Total profitability and sales changes compiled from values reported in company annual reports. INA, Torrington, and SNR values were not available.
** On an annual basis exchange rates may fluctuate 10 to 20 percent and misrepresent actual bearing production in foreign places. To arrive at more reasonable conversions, five-year average exchange rates (1995-1999) were developed and used in place of the one-year averages.

AB SKF of Sweden has long been the world's largest bearing company. In 1999, SKF reported $4.12 billion in sales, 17.3 percent of the world market. This was down about $150 million from 1998, when SKF reported sales of $4.27 billion. In 1998, the company lost $186.3 million (4.4 percent of sales) despite the higher sales volume. The 3.5 percent drop in sales in 1999, however, was accompanied by a recovery in profits of nearly $200 million. SKF achieved this result by selling off unprofitable businesses, reducing inventory, and lowering capital expenditures. The firm also benefited from the strengthening dollar, which allowed exports from Europe to the United States to realize higher prices in terms of European currencies.

The second largest bearing company in 1999 was NSK of Japan. In 1999, sales were $2.6 billion representing a global share of about 11.1 percent. Like SKF, NSK's sales in 1999 were below 1998's total of $2.7 billion by about $100 million. This loss was due to two-digit declines in Japan that were partially offset by gains in exports to North America and Europe. NSK's fiscal year ended in March 1999; so about three-fourths of NSK's sales actually occurred in 1998. The Japanese economy was in severe recession in 1998, and this reduced NSK's revenues. The *Yen* was weak during most of this year, averaging over 130 to the dollar. This encouraged exports from Japan as the company's external sales exceeded sales within Japan for the first time.

After SKF and NSK, the next five companies are rather closely matched in terms of sales; the third and the seventh company are separated by only $180 million. INA and FAG, both German firms, are ranked numbers three and four after SKF and NSK. INA is a private firm that holds financial data very closely. Based on employment information, however, INA's 1999 sales were estimated to be $1.94 billion, with about $1.5 billion of that derived in Europe. European auto sales improved in the second half of 1998, and increased moderately in 1999. Most other markets remained soft. INA's focus on the auto market means that 1999 sales were probably about one or two percent more than in 1998. Sales in the U.S. market also improved. INA's increase in sales and the decreases in sales by NTN and Koyo moved INA from fifth place into the third spot.

FAG sales in 1999 were $1.86 billion, up almost ten percent from 1998. FAG acquired a Korean company in October 1998 that contributed the lion's share to FAG's improved sales in 1999. The Korean economy grew ten percent, while FAG's bearing sales in Korea grew about 30 percent. With this spurt in sales, FAG moved from seventh place in 1998 past NTN, Koyo and Timken into fourth place. In 1999, FAG's profits were low at 2.3 percent of sales. They were up, however, from only 1.2 percent in 1998. FAG, generally more active in the export markets than INA, also benefited from the strengthening dollar. In addition, FAG acquired a Hungarian company that helped bolster revenues in 1999.

Rounding out the top five companies is Koyo Seiko of Japan. Koyo's 1999 sales of $1.85 billion were down almost three percent from 1998's total of $1.91 billion. Koyo also lost money, losing $1.2 million or -0.1 percent of sales. By comparison, 1998 profits were $23.4 million, 1.23 percent of sales. Like NSK, the poor performing Japanese economy, which more than offset the gains in Europe and North America, afflicted Koyo. The top five companies represent 53 percent of the global bearing market.

The second five include two American companies, Timken and Torrington, which together have about a 14 percent share of the world market. The other three include two Japanese

companies, NTN and Minebea, and the French firm SNR. The number six position is held by NTN. In 1999, NTN's sales were $1.84 billion, down from $1.96 billion in 1998. The decline was about 6.4 percent. Net profits were 2.21 percent in 1998, and 1.25 percent in 1999. Number seven Timken saw sales fall slightly from $1.8 billion in 1998, to $1.76 billion in 1999. While auto sales were up in 1999, they were not up enough to offset declines in the U.S. agricultural and construction machinery markets and other industrial markets. The stronger dollar also slowed exports. Timken's net profits fell from 4.27 percent in 1998, to 2.51 percent in 1999.

Eighth ranked Torrington's sales in 1999 were estimated at $1.43 billion; also down about one percent from 1998. Minebea, ranked number nine, had sales of $796 million in 1999, about $30 million below 1998's sales. Ninth ranked Minebea is the world's dominant producer of ball bearings under 30 mm in diameter. The company is also a leader in spherical plain bearings or rod-ends. The firm is also the major exporter/importer of bearings to Japan, primarily from its large export platforms located in Thailand and Singapore. The Japanese recession slowed these exports. Thailand and Singapore represent Minebea's major production areas. Ranked tenth, SNR's estimated sales in 1999 were about $500 million. Most of SNR's sales and nearly all its production are in France. Owned by Renault, SNR's sales probably advanced slightly in 1999 from the year before. The second five companies, with combined sales of $6.3 billion, share about 27 percent of the global market. This is roughly half the share of the top five.

Company Profiles

A. AB SKF; Goteborg, Sweden

SKF is the world's largest ball and roller bearing producer, with over $4.12 billion in 1999 sales and 34,500 employees. Bearing sales represented 84.8 percent of the business. Established in 1907, the company has more than fifty bearing factories located in twenty countries. Over half of SKF's production base is in Europe from which the firm supplies about one-third of the European market and exports substantial quantities to points beyond, including to the United States. Major facilities are located in Germany, Italy, France, Sweden, and the United Kingdom. SKF is the fourth largest producer in the United States with five factories, and has manufacturing operations in Mexico, Argentina, and Brazil. The company has also aggressively expanded into the developing markets of China, India, Indonesia, and Eastern Europe.

SKF invested about $85 million in bearing-related research and development (R&D) in 1999, conducted primarily at its dedicated research facility in the Netherlands. Note that this is more than the entire U.S. industry (estimated at $70 million). SKF also owns Ovako Steel with steel production facilities in Hofors, Sweden. SKF plans to sell its steel subsidiary in a strategy to reduce vertical integration and increase its focus on bearings. Ovako is one of the world's leading producers of bearing quality steel. The firm further processes the steel it makes with forging, rolling and turning operations in Sweden, Germany, Italy, France, the U.K., and the United States.

SKF purchased Marlin Rockwell Corporation (MRC) in Jamestown, New York in 1987 from TRW for a reported $35 million and proceeded to invest over $50 million to return the operation to world-class status. The operation probably would not have survived otherwise. Today, MRC manufactures and refurbishes a full line of main shaft bearings for gas turbine engines and gearbox bearings and is a key defense supplier.

In the past thirty years SKF restructured its bearing production on an international basis. Factories that made multiple types and sizes of bearings in less than optimal quantities to supply then single country markets were specialized to supply all of Europe. The European Community facilitated SKF’s specialization by lowering internal tariffs and other trade barriers between member states in the 1960s and 1970s. The emergence of the Japanese companies, who entered Europe with astonishingly low bearing prices during this time, added urgency to SKF's restructuring. This had a profound impact on reshaping the world bearing industry.

B. NSK Ltd.; Tokyo, Japan

NSK is the largest Japanese bearing company with worldwide bearings sales of about $2.6 billion. Bearings represent 63.4 percent of the company's total sales. Established in 1914, NSK has been building an international presence since the early 1970's. The company's manufacturing presence in the United States is heavily focused on the auto industry. The firm has four factories, and a design and test facility in Ann Arbor, Michigan. It currently ranks number seven in the U.S. NSK does not directly support Defense.

In 1990, NSK purchased RHP, the leading supplier of aerospace bearings in the United Kingdom. RHP produces bearings for gas turbine engines made by Rolls Royce and others. The firm is one of five in the world that makes the full range of main shaft bearings. RHP supplies the main shaft bearings for the Harrier. In 1998, NSK acquired FLT Iskra in Poland, a producer of ball bearings, and renamed it NSK Iskra.

In the last decade, NSK has also established production capabilities in China, South Korea, Indonesia, and Malaysia NSK is a major supplier to the world's automakers; and is the second largest supplier of small ball bearings (under thirty mm) for the hard disc drive and other markets. NSK invested about $76 million in bearing R&D. The firm is a leader in ceramic bearings.

In the year ending March 1999, NSK reported 53 percent of its bearing sales were outside Japan. While most of NSK's production capacity (about 60 percent) is located in Japan, an increasing portion is exported with a large portion of the export sales destined for the United States.

C. INA Walzlager Schaeffler AG; Herzogenaurach, Germany

INA, established in 1946, is a privately held firm with estimated 1999 bearing sales of $1.94 billion. Bearings represent about two-thirds of the company's business. The company also makes auto parts, including auto carpeting. INA employs 24,000 people overall; about 16,000 make bearings. Sixty percent of INA's workforce is concentrated in Germany and another 25 percent in other European countries. INA accounts for about 20 percent of the European market. The company specializes in needle bearings, although it produces other types as well. Needle bearings are used in transmissions, universal joints, cam followers, and other applications on motor vehicles. The company has four factories (a fifth is under construction) in South Carolina that also specialize in needle bearings.

INA's major competitor in needle bearings is Torrington. The two companies major production bases are located in their home countries. Little direct competition is carried on, however, across the ocean.

D. FAG Kugelfischer Georg Schafer Aktiengesellschaft; Schweinfurt, Germany

FAG, established in 1883, recorded sales of $1.86 billion in 1999. Bearings represent 89 percent of the company's business. Additionally, FAG makes sewing machines and other textile handling equipment. FAG has plants in Germany, France, Italy, the United Kingdom, Portugal, Austria, Hungary, India, China, South Korea, Brazil, the United States, and Canada. FAG's Schweinfurt factory is the largest in Europe. At one time the firm employed more than 12,000 in Schweinfurt. Today, about 7,000 work in the plant. Such concentrated production requires participation in widely dispersed markets throughout Europe and beyond to keep the plant fully loaded. The company produces bearings from nineteen millimeters to one meter in diameter in its Schweinfurt factory. SKF has a similar factory that employs about 5,000 workers within walking distance from FAG's plant. Combined, the two facilities account for more than one-quarter of Europe's bearing production.

FAG makes military/aerospace bearings at Schweinfurt, including a full range of main shaft bearings for gas turbine engines and gearboxes. The company also makes these bearings in Stratford, Canada. A new plant opened in Stratford in September 2000, which will be dedicated to the production of aerospace bearings. The management plans to expand capabilities to a full range of main shaft bearing sizes from its current capability of fifteen inches, and a full line of gearbox bearings. Stratford is a key supplier to the U.S. Defense Department. FAG also purchased the Barden Company in Danbury, Connecticut in 1990. Barden makes run-quiet bearings for submarines, some gearbox bearings, as well as miniature and instrument bearings for defense.

FAG nearly went bankrupt shortly after the German reunification when the Deutsche Bank pushed interest rates up and drove the European economy into a severe recession. The firm dropped from 34,000 employees to about 13,000 at its low point. Since that time, FAG has recovered much of its previous stature in bearings. Today, the company ranks fourth in the world, compared to second before the crisis.

E. Koyo Seiko Company, Ltd.; Osaka, Japan

Koyo recently passed NTN to become Japan's second largest bearing company. In the year ending March 1999, Koyo reported bearing sales of $1.88 billion. Established in 1921, today bearings represent about 61 percent of the company's total business. In addition, the firm makes vehicle steering systems, other machinery components, and a line of machine tools for the bearing industry. The auto market accounts for about 60 percent of the firm's sales. Toyota holds a 22 percent equity interest in Koyo's stock. Koyo has an R&D center in Nara, Japan and technical centers in Europe and the United States.

Koyo has manufacturing operations in Japan that account for about 70 percent of the firm's production. Koyo also has factories in the United States, Brazil, and the United Kingdom. In developing areas the company has production plants in China and Thailand. In 1998, Koyo acquired Romanian bearing maker S.C. Rulmenti Alexandrias S.A., which was renamed Koyo Romania S.A. Koyo's U.S. plants are in Orangeburg and in nearby Blythewood, South Carolina. Both plants are high volume operations that concentrate on a relatively few part numbers for automotive applications. The firm makes ball bearings and tapered roller bearings at these facilities. Koyo is not a direct defense supplier.

F. NTN Toyo Bearing Company, Ltd.; Osaka, Japan

NTN, established in 1934, reported bearing sales of $1.86 billion for the year ending March 1999 (only $13 million less than Koyo). Bearings represent about 65 percent of NTN's business. In addition, the firm makes automotive components. NTN has production facilities in Japan, the United States, Canada, and Europe. NTN is the third largest bearing producer in the United States with seven factories. In 1987, NTN purchased the Bower Division from Federal Mogul with roller bearing plants in Hamilton, Alabama and Macomb, Illinois. In 1998, NTN purchased Federal Mogul's remaining two plants in Lititz, Pennsylvania and Greensburg, Indiana as Federal Mogul exited bearing production. NTN also maintains a technical center in Ann Arbor, Michigan. NTN does not directly support the Defense Department.

NTN's Kuwana factory in Japan produces a full line of gas turbine engine bearings. The plant supports commercial General Electric engines and supplies main shaft bearings to the Japanese Defense Industry.

G. The Timken Company; Canton, Ohio

Timken is the largest U.S. bearing company. Established in 1898, Timken's 1999 worldwide bearing sales were $1.76 billion. Bearings represent about 71 percent of Timken's business. Timken also makes steel in the Canton, Ohio area, and Latrobe, Pennsylvania. Latrobe supplies specialty steels to bearing companies in the aerospace sector. The company supplies an estimated 50 to 60 percent of the steel used in the U.S. bearing industry. Timken is the inventor of tapered roller bearings and remains the world's largest producer, representing about one-third the world's total. Timken has twelve bearing plants in the United States and a dedicated R&D facility in Canton, Ohio. Additional plants are located in Canada, the United Kingdom, France, Poland, Romania, South Africa, India, China, Singapore, and Brazil.

Timken is the largest U.S. defense supplier. Most aircraft made in North America and Europe land on Timken bearings. In 1990, Timken purchased the Miniature Precision Bearing (MPB) Company, with two key defense factories in New Hampshire. Along with MRC (see SKF profile), MPB makes a full range of main shaft bearings for gas turbine engines and gearboxes at its Lebanon factory. At its Keene facility, MPB makes a full range of miniature and instrument bearings used in guidance and targeting systems. Timken allocates about $50 million a year for R&D. Roughly $35 to $40 million is focused on bearings.

H. The Torrington Company; Torrington, Connecticut

Torrington, founded in 1866 as the Excelsior Company, has produced bearings for more than 80 years, and is the second largest bearing producer in the United States. In 1999, bearing sales were estimated at $1.43 billion. Torrington became part of Ingersoll-Rand (IR) in 1968, and today represents roughly one-fifth of IR's business. Torrington has twenty-seven bearing plants worldwide and employs more than 12,000 people. Ten plants are located in the United States, mostly in the Carolinas, Georgia, and Tennessee. The company also has factories in Canada, the United Kingdom, Germany, Brazil, and China. Torrington has joint ventures with NSK in Japan and SNR in France to produce needle bearings. The company is also a minority equity partner in Industria Cusinetti of Italy, which produces spherical roller bearings.

Torrington merged with Fafnir in 1985. Fafnir had been the largest supplier of military/aerospace bearings in the United States, but was crippled by two major labor strikes, the first in 1979, and another in 1985. Torrington was unable to revive this part

of Fafnir's business, in part because of declining defense sales. This division was sold to Timken's MPB subsidiary in 1993. Torrington later sold Fafnir's former Wolverhampton (U.K.) factory to Timken in 1998. The Wolverhampton factory makes military/aerospace bearings including smaller diameter main shaft bearings, complimenting MPB's product line (see Timken profile).

Torrington has a research facility in Norcross, Georgia that was originally established to improve the bearing production process; additional R&D is conducted in Torrington, Connecticut. Research and development expenditures are unknown, but probably amount to about $30 million, or roughly two percent of sales.

I. NMB Minebea Company, Ltd.; Tokyo, Japan

Minebea, established in 1951 as Nippon Miniature Bearing, is the world's largest producer of small diameter ball bearings, and represents about two-thirds of the global market (in units). Minebea is also a major factor in rod-ends and spherical plain bearings. In 1999, bearing sales were $796 million. About 30 percent of the company's total sales are bearings. The company also produces small motors for computer disc drives and fans, and various items for motor vehicles. Minebea constructed major export platforms for small bearings in Singapore in 1973 and Thailand in 1984 that account for nearly 75 percent of the firm's total bearing production. The Thailand plant employs nearly 7,000 people, of whom 85 percent are women in a very labor-intensive segment of the industry. The company also has operations in Europe and the United States.

Minebea's three factories in the United States operate under the name of New Hampshire Ball Bearing (NHBB); a former U.S. company which Minebea acquired in 1984. The factory in Chatsworth, California was purchased from SKF in 1971 soon after domestic sourcing requirements were added to the DFAR for miniature and instrument bearings. The other two plants, in Peterborough and Laconia, New Hampshire, came with the acquisition in 1984. Chatsworth makes small ball bearings for Defense and other applications. Peterborough makes military/aerospace bearings, including smaller sizes for main shafts and gearboxes. Laconia makes spherical plain bearings, often called rod ends used on the control surfaces of aircraft. Minebea is the fourth leading supplier to the U.S. Defense Department.

J. SNR Roulements; Annecy, France

SNR was established shortly after WW II by consolidating five factories around Annecy, France. SNR is a subsidiary of Renault, and Renault is partially owned by the French Government. In 1999, the company's sales were estimated to be about $498 million. The company has 4,700 employees, nearly all in France. SNR has five factories in France, and three others in a joint venture with Torrington under the name Nadella (needle bearings). In addition, SNR has a minority interest in Industria Cusinetti in Italy.

SNR produces main shaft bearings for the SMECMA CFM-56, the world's best selling commercial gas turbine engine and gearbox bearings. The main shaft line ranges up to about fourteen inches in outside diameter. SNR also supplies the French defense establishment.

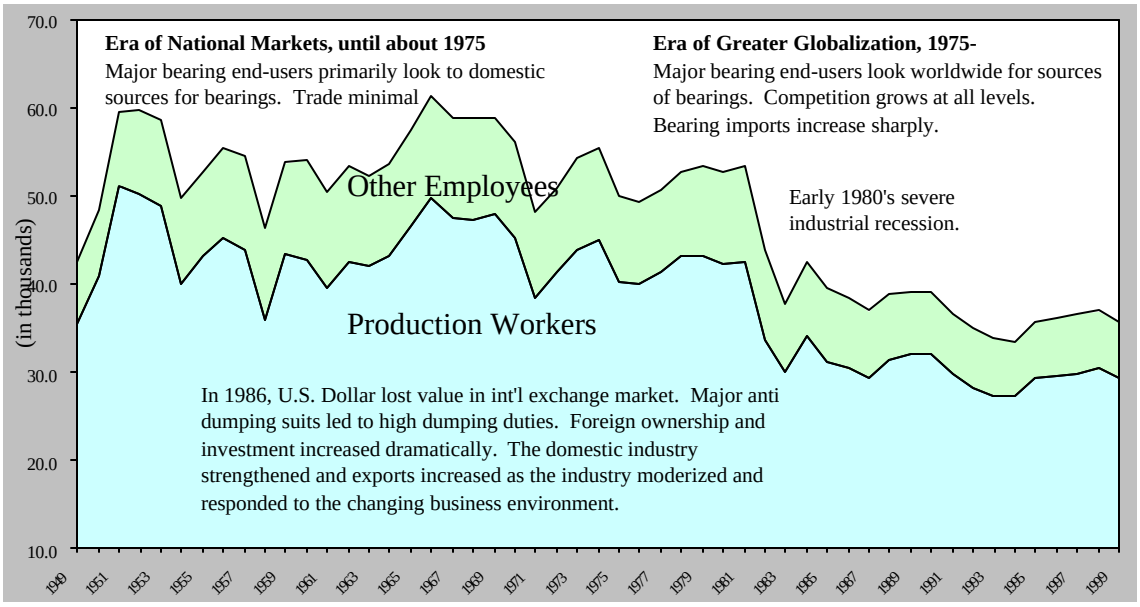
The U.S. Ball and Roller Bearing Industry

Employment and Productivity

Major technical advances have occurred in the bearing industry since the end of World War II. Many of these changes can be indirectly evidenced by the long-term employment changes displayed on the chart below. Employment fluctuated wildly during the booms and busts of the period, especially prior to the early 1980's.

In the more recent period the fluctuations have been milder. Compared to today, the industry was far more labor intensive in the earlier years. In the earlier period, many more people were needed in semi- or unskilled tasks, such as material handling and assembly. Robots, conveyor lines, real-time inspections, statistical process controls, and much-improved total systems layout and workflow have replaced these jobs. An increase in imported bearings that began in the 1960's and major advances in bearing production technology gradually transformed the industry into a more capital-intensive sector. This lowered the labor content, yet increased the skill requirement. Today, the skill quotient is higher, and people are not as easily hired and fired. The investment in training and knowledge almost makes the person a fixed asset. In the last 50 years, it is apparent the workforce has moved from predominantly a variable cost to a somewhat fixed cost or human asset.

Historic Employment in Ball and Roller Bearing Industry
1949-1999

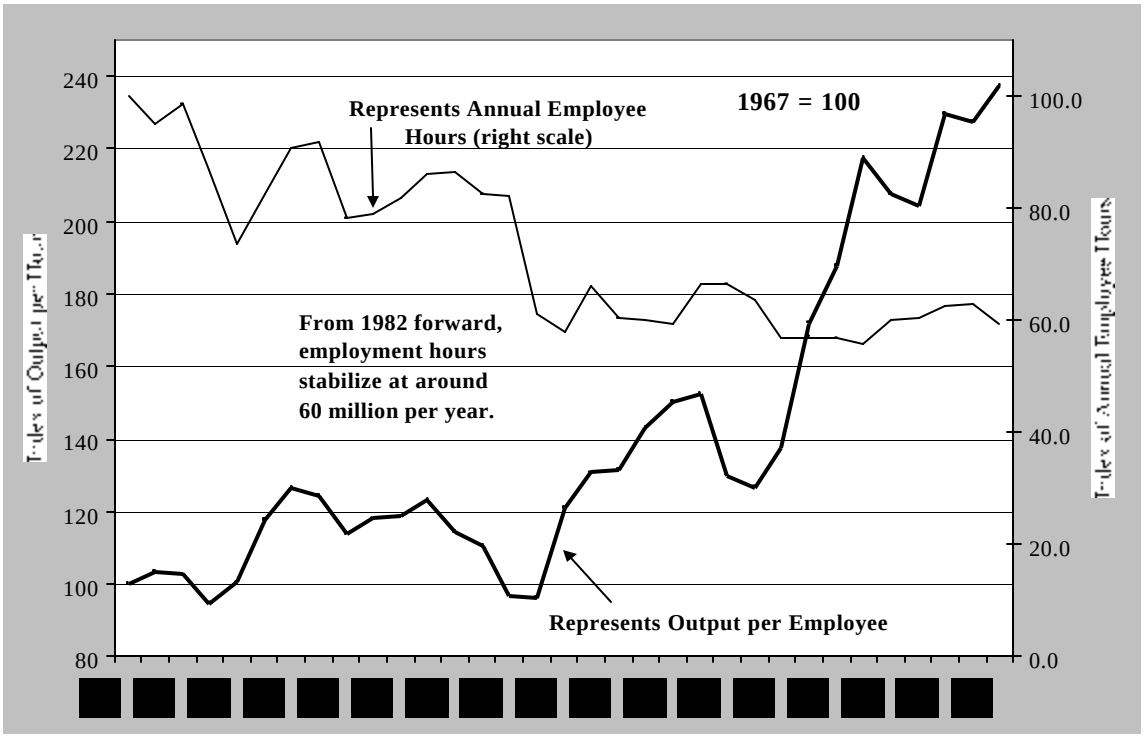


Source: Dept. of Commerce, Bureau of the Census

The total workforce averaged about 48 thousand during the period from 1949-1999. Post-war employment peaked at 61.4 thousand for the year 1966. As a footnote, the Bureau of Labor Statistics employment report, which is compiled differently from the Census Data to include auxiliary facilities, reported an industry employment peak of 64.7 thousand for the 2nd Quarter, 1967. These high levels were related in part to the Vietnam conflict, but also to an expanding economy. By 1999, employment declined from the peak by 42 percent, although bearing shipments grew by 60 percent. Most of the workforce drop occurred during the steep industrial declines of the early 1980's. However, employment reached its lowest post-war level in 1994 at 33.4 thousand (and 27.5 thousand production workers). By 1999, employment returned to 35.7 thousand.

As measured by output per employee hour, labor productivity in the ball and roller bearing industry increased by 137 percent (almost a 2.4 fold gain) in the 32 years from 1967-1999. This is equivalent to an average compounded yearly increase of 2.74 percent. The chart shows the growth in output per employee hour (1967 equals 100). The index for annual employee hours for the same period shows a declining trend until 1982. After 1982, the index was generally stable at or near 60, reflecting in part a less volatile and growing economy.

U.S. Ball and Roller Bearing Manufacturing
Productivity Trends in Output per Employee Hour
1967-1999

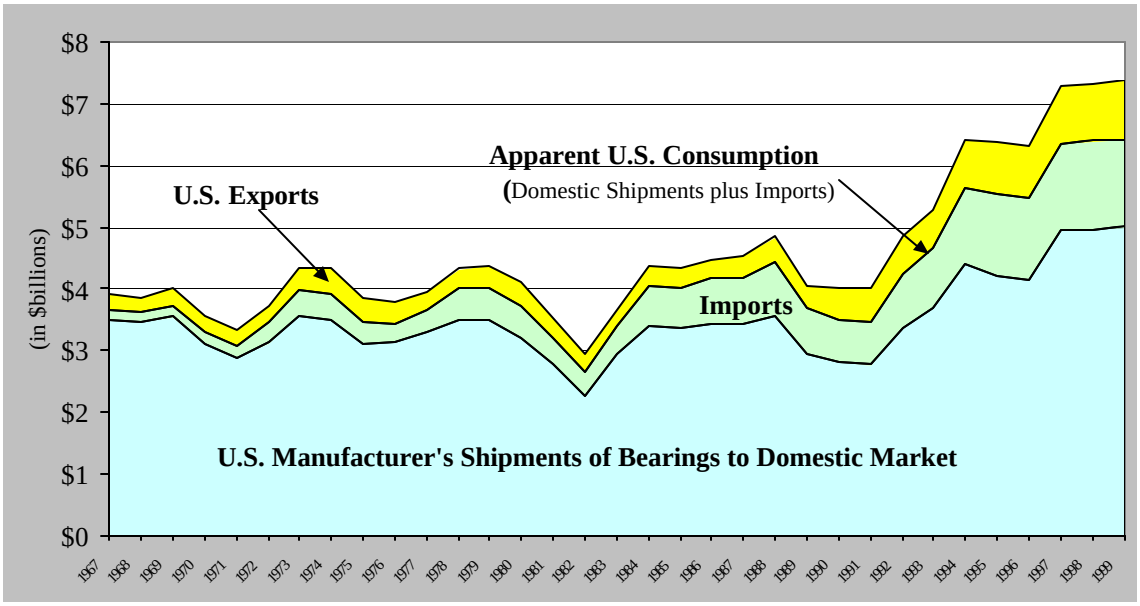


Source: U.S. Dept. of Labor, Bureau of Labor Statistics and Dept. of Commerce, Bureau of the Census

U.S. Bearing Market

Bearing consumption in the United States showed a gradual increase from 1967 to 1999, rising by a total of 75 percent measured in constant dollar values. Shipments of U.S. manufactured ball and roller bearings increased by 60 percent. Shipments into the domestic market rose 43 percent, despite major import pressures. These import pressures were not just on bearing companies directly, but also indirectly in bearing end-markets, especially on producers of motor vehicles, off-road equipment, and machinery. From a small base in 1967, imports of bearings rose more than 750 percent by 1999. Exports, mostly to Canada and Mexico, increased by 294 percent to nearly $1 billion at the end of the period. During this period, the U.S. economy grew nearly 2.7 fold in constant 1999 dollars, from $3.47 to $9.3 trillion, while the population increased from about 198 million in 1967 to more than 270 million in 1999.

Market for Ball and Roller Bearings, 1967-1999
(in Billions of 1999 Constant Dollars)



Source: U.S. Dept. of Commerce, Bureau of the Census

Factors Affecting the Bearing Market

The new interstate highway system and cheap gasoline expanded demands for cars and helped drive bearing output through much of the 1960's and early 1970's and allowed bearing companies to make more efficient use of facilities. However, the business environment of the 1970's deteriorated. It featured floating exchange rates, a devalued

dollar, two oil price explosions, double-digit inflation, runaway interest rates, rising labor costs, rising employer-paid social compensation, and rising imports of bearings. In addition to these problems, imports of big-ticket producer durables increased, which made up bearing end-markets and were previously mostly unchallenged by foreign concerns in U.S. markets.

An important long-term trend was the migration of bearing plants to the South Atlantic states, where right to work laws, lower labor cost, favorable state government policies, and a traditionally strong work ethic were, and remain, strong attractions. This trend began around 1960, accelerating during the next 20 years, and is still occurring today. Between 1958 and 1996, the South gained more than 16,000 employees. In contrast, the Northeastern corridor from Pennsylvania and New Jersey through New England lost nearly 20,000 people, while the Great Lakes states lost a more moderate 2,000.

The South, especially in the Carolinas, Georgia and Tennessee, opened 43 new bearing factories. Some of the new facilities were state-of-the-art, but others, mostly in the 1970's, were simply transplants of equipment from the North and resumed production as before. In the last decade or so, new facilities are again being constructed in the Great Lakes states. The Northeastern states were disproportionately affected by the rising service economy and urban sprawl, which made bearing production more expensive, and manufacturing jobs less desirable. Hardest hit were Connecticut, down over 11,000, New Jersey, down over 4,000, and Pennsylvania, down nearly 4,000.

The 1973 peak in bearing shipments was short-lived as the economy slumped in the mid-1970's. The second half of the 1970's saw a recovery as bearing shipments reached another plateau in 1979. The years following the 1979 peak began with the second oil price shock, which precipitated a move by consumers toward smaller, more fuel-efficient motor vehicles. Vehicle imports from Japan rose quickly. High rates of inflation during those years led to high interest rates and pushed up the dollar’s exchange value on international markets. This drove the economy into its worst slump of the post-war period during the early 1980's.

These developments were extremely severe in the manufacturing sector. In 1982, domestic motor vehicle sales dipped below six million, the lowest level in over 30 years. Big machinery makers like International Harvester, Allis-Chalmers, John Deere, and Dresser vacated markets, closed plants and reorganized. Chrysler nearly went out of business. American Motors shutdown permanently. With major declines in market opportunities, the bearing industry slid sharply. Average production volumes declined, plants closed, equipment lay idle, and over 30 percent of the workforce was laid off.

In 1981, the Japanese auto companies agreed to limit motor vehicle sales to the United States for three years, called Voluntary Restraint Agreements. This encouraged them to build U.S. assembly plants, which in turn led to an increase in auto parts imports including bearings.

Between 1978 and 1987, the Commerce Department counted at least 31 bearing factories closings that totaled more than $1 billion in capacity. Many of these facilities were antiquated with high cost labor in America's Northeast. Factors that contributed to these closings included the deep recession of the early 1980s, rising imports, and technological obsolescence. Since 1987, however, more than a dozen state-of-the-art greenfield plants have opened, and many others have been refurbished.

Trends since the early 1980's included some especially positive developments. For example, the drop in bearing industry employment was more than offset by major increases in bearing production productivity. Additionally, expanded use of just-in-time inventory management worked its way into the industry, which reduced inventory costs and increased production efficiency. The industry has seen improvements in materials quality, machining precision, and manufacturing process controls. The increased use of the computer in nearly all phases of the bearing business improved information flow and made many advances on the factory floor possible.

Noticeable increases in the use of smaller sized bearings, especially ball, needle, and tapered roller bearings, were brought on by structural shifts and emerging industries in the economy. The growth in computers and peripheral equipment; the greater use of fractional electric motors in automatic windows, seat adjusters, and windshield wipers in the auto industry; in-line skates; and home appliances, among other things, have driven an increase in the use of smaller ball bearings. The use of trans-axle transmissions and planetary gears has boosted the use of needle bearings, and quantum improvements in steel processing have so improved the material used to make bearings that less is needed to carry the same load.

In addition, an important trend occurred in factory size, which moved the industry toward smaller, more specialized plants with fewer employees. In 1979, for example, 35 plants had more than 500 employees; these were the old workhorses of the industry. Eight years later, in 1987, only 19 were left. Many closed down, while others downsized. In addition to becoming obsolete, imports severely impacted many of these larger plants. To make in-roads into the American market, foreign companies targeted the biggest

customers in the United States, notably the auto companies and other big-ticket producers like Caterpillar, which the larger bearing factories had previously supplied.

This caused havoc in the U.S. bearing marketplace and combined with the strong dollar dealt a major blow to the U.S. bearing industry. The emphasis shifted rapidly to narrower product ranges and increased factory efficiency. During the period 1979-1987, factories with between 100-500 employees increased in number from 44 to 64, while average plant size declined from 456 people to 308. Plants between 500 and1,000 employees dropped from 24 to 14, and plants employing more than 1,000 fell from 11 to five.

ANTIFRICTION BEARING PLANTS, 20 AND MORE EMPLOYEES (1978-1999)

Year	# of Factories	Employment Info		Number of Factories by Employment Range					
		Total (in 000s)	Average	20-49	50-99	100-249	250-499	500-999	1000+
1978	114	52.7	462	17	20	23	22	22	10
1979	117	53.3	456	20	18	23	21	24	11
1980	120	52.6	438	23	17	21	24	27	8
1981	118	53.3	452	19	18	26	21	25	9
1982	116	43.8	378	18	21	23	22	23	9
1983	129	37.7	292	25	25	35	23	15	6
1984	113	42.4	375	16	18	27	25	21	6
1985	115	39.6	344	14	21	27	28	19	6
1986	118	38.4	325	19	15	35	26	18	5
1987	120	36.9	308	18	19	37	27	14	5
1988	121	38.8	321	21	18	31	30	16	5
1989	120	39.1	326	18	20	28	32	15	7
1990	120	39.0	325	20	21	26	29	21	3
1991	126	37.6	298	23	20	30	29	21	3
1992	127	35.6	280	25	24	29	28	18	3
1993	126	34.2	271	20	28	28	31	16	3
1994	123	33.5	272	20	23	31	31	15	3
1995	122	35.3	289	18	23	30	30	18	3
1996	129	35.9	278	25	21	32	31	17	3
1997	133	36.6	275	23	21	37	33	16	3
1998	138	37.9	275	24	24	36	33	18	3
1999	136	35.9	264	27	21	35	30	20	3

Source: U.S. Department of Commerce, Bureau of the Census, County Business Patterns, *U.S. Summaries*, 1978-1999

After 1987, factory size remained basically the same, except that the number of factories increased from 120 to 136, as bearing shipments increased by more than $1 billion with the growing economy. By 1999, plants with more than 500 employees stood at 23, four more than in 1987, while those in the 100-500 range reached 70 in 1997, before slipping back to 65 in 1999. Plants between 20-100 employees increased from 37 to 48. Average employment per facility was below 300 the last eight years (1991-1999), reaching its lowest, 264, in 1999.

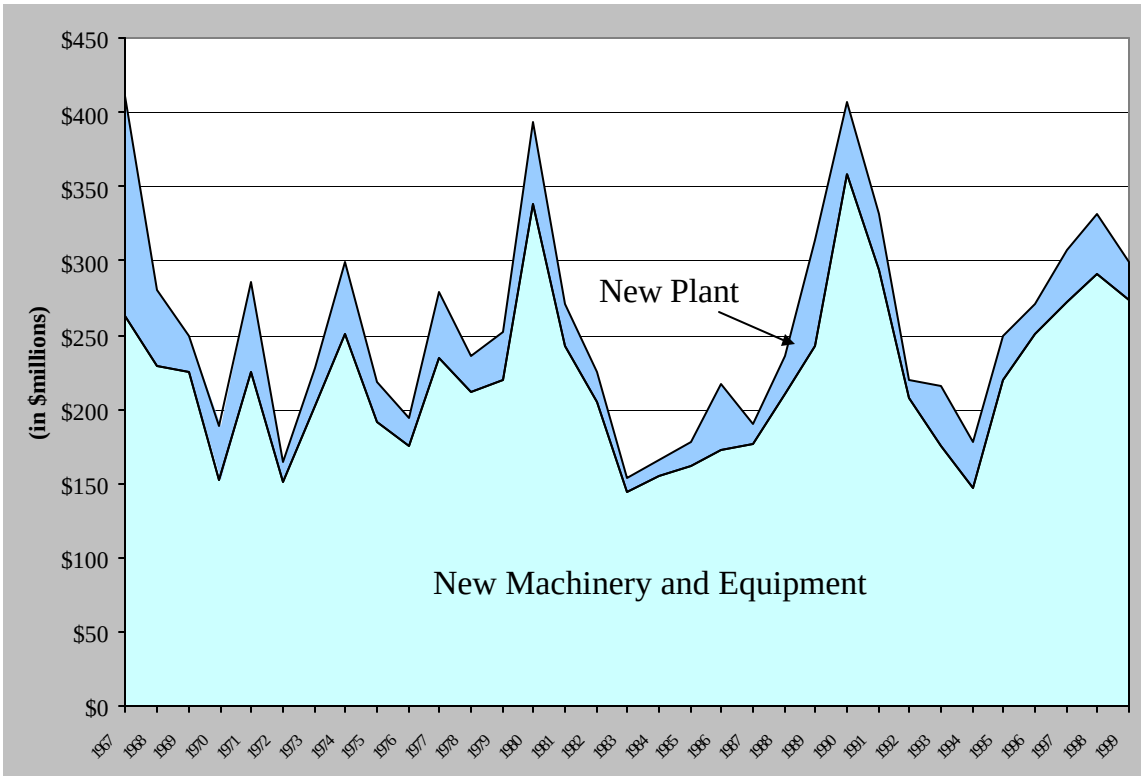
Competitive Issues

The four pillars of competition in the bearing industry are cost, quality, on-time delivery, and market access. All are vital to the success of a bearing company. Quality and on-time delivery have become givens, and most companies are roughly equal in these categories. Market access, however, is not equal internationally, yet it plays a far more important role in this time of global trade. The strength of the bonds between bearing companies and bearing end-users of the same nationality are weaker in the United States than in most other countries, at least, to the degree profits and stock values are paramount. This is a disadvantage to U.S. bearing firms, but also a stimulus to do better in other areas. Trends in the cost of bearings depend on capital investments, labor compensation and productivity, and inventory management.

Capital Expenditures

Capital expenditures are key to innovation and incorporating the latest and most productive technologies. U.S. bearing industry investment lagged somewhat in the 1970's and first half of the1980's, before picking up the rate of investment rather spectacularly in the latter 1980's. The devaluation of the dollar on international markets during 1986 served as a catalyst for this investment. The imposition of major anti-dumping duties in the late 1980's against major foreign bearing firms greatly accelerated foreign investment and provided increased cash flow to the domestic industry with which to invest. The movement toward just-in-time inventory management, which can be better handled by local production, a surge in market demand, and finally, the need and opportunity to update facilities after the major shakeout of the previous decade also contributed to the surge.

Capital Expenditures on New Plant and Machinery and Equipment
1967 to 1999



Source: U.S. Dept. of Commerce, Bureau of the Census

Between 1970 and 1979 investment averaged 7.62 percent of value added. In 1980, investment shot up to more than 12 percent, but this surge was quickly cut short by deteriorating economic conditions. The period from 1982 to 1988 saw investment drop to only 7.29 percent of value added, and marked the low ebb for the industry.

During the four years from 1989 to 1992, a record amount of $1.3 billion was invested. Industry expenditures averaged 11.4 percent of value added. From a historic average of less than $5,000 per employee until that time, the industry invested $10,454 per employee in 1990 and more than $9,000 in 1991. In a survey by the Commerce Department, many firms were investing for the first time in CAD/CAM, flexible cells, just-in-time, and TQM. Others were introducing statistical process controls, concurrent engineering, and induction heat treatments.

The year 1987 proved pivotal. Capital expenditures from 1967 to 1987 averaged 7.93 percent of value added, compared to 8.75 percent after 1987. Investment per employee averaged $4,864 in the earlier period, and $7,474 in the latter, demonstrating a 54 percent

increase. Annual investment averaged $242 million during the 1967-1987 period and $273 million in the 1987-1999 period. Expenditures on new machinery and equipment averaged $206 million in the earlier period and $240 million in the latter, demonstrating a 16.4 percent increase.

The machines purchased since 1987 far exceeded the capabilities of their forebears. They were faster, sturdier, more precise, and quicker and easier to set-up. Machines were linked by conveyor systems, so that a bearing ring, for example, could move through the process untouched by human hands. Many machines had real-time laser measuring and monitoring devices, as well as computers controlling the cutting or grinding and flow of materials. Also, cubic boron nitride (CBN) grinding, while expensive, came into wider use where high volume production justified it. CBN removed something on the order of 500 times the amount of material as conventional grinding materials with the same amount of wear.

Advances in bearing processing technology were brought on by the computer and its integration into all aspects of bearing manufacturing. State-of-the-art machines cost more, but fewer machines could operate for longer periods and actually do more work, and in fact, do it better. Factories needed less floor space and ran multiple shifts. The new technologies have already yielded their greatest gains; the future may not be as spectacular, but incremental improvements should continue.

Bearing Industry Workforce Compensation (1967 to 1999)

Total workforce compensation is an important element of cost. As a portion of value added, workforce compensation has demonstrated a clear downward trend. This shows that the industry has moved toward more capital intensity as capital was substituted for labor. The graph on the following page displays total workforce compensation as a percent of value added from 1967 to 1999. Compensation is shown for payroll and other compensation, which includes employer payments to social security and other such payments as medical insurance premiums, pensions, and other benefits.

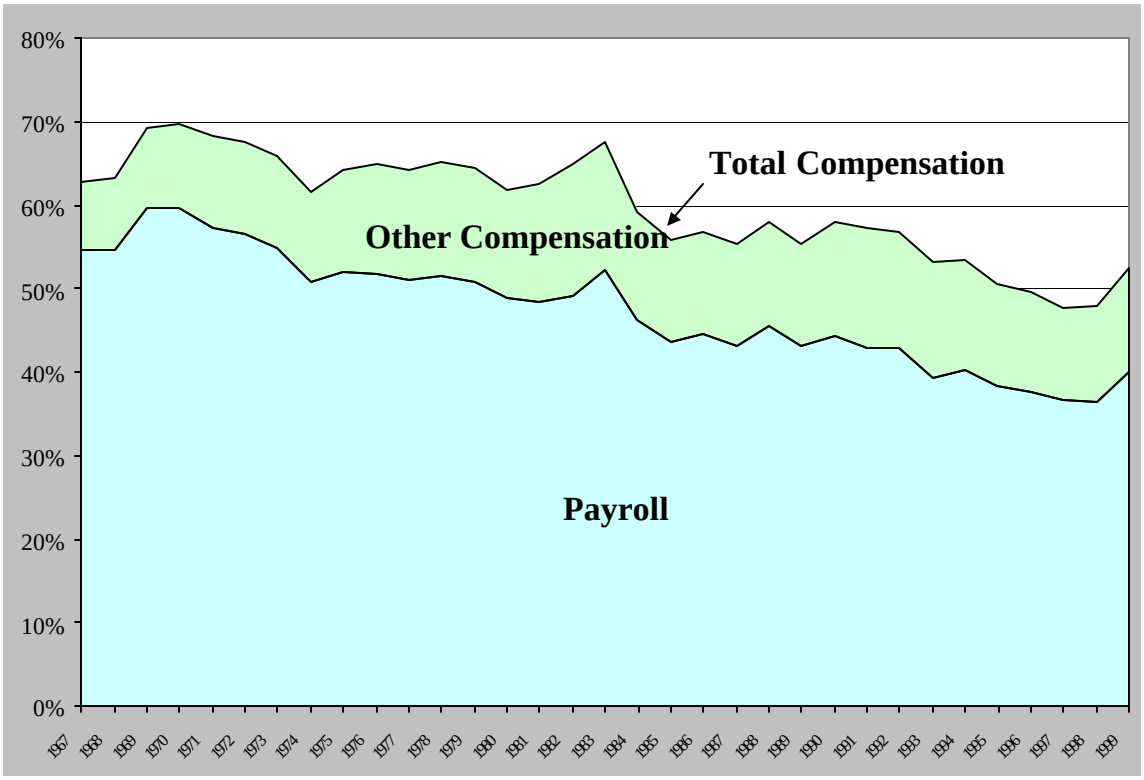
Total compensation as a percent of value added peaked at about 70 percent in 1970, hovered around the mid-60 percent range during most of the 1970's, and then reached another plateau at almost 68 percent in 1983. Since 1983, the ratio fell to less than 50 percent by 1996, before rising to 52.5 percent in 1999. This reflects improvements in labor productivity. An absolute drop in value added brought on the sudden rise in the indicator in 1999. Bearing prices were under downward pressure and the market

softened. Slightly higher overall payroll was also a factor, despite a 3.3 percent drop in employment. In 1999, production worker wages rose by more than 7 percent.

The largest component of compensation is payroll. Payroll slipped from almost 60 percent of value added to about 40 percent over the period. Other compensation climbed from just eight percent of value added in 1967, to a peak of 15.7 percent in 1982, and then eased off to just 11 percent by 1997.

While total compensation declined as a component cost of value added, payroll declined as a percentage of total compensation, due to faster increases in other compensation. In 1967, the first year shown on the graph, payroll was over 87 percent of total compensation, but by 1999 this percentage dropped to about 76 percent. Most of the relative drop occurred by the early 1980's.

Bearing Industry Labor Compensation
as a ratio of Value Added, 1967-1999



Source: U.S. Dept. of Commerce, Bureau of the Census

The closing of larger operations during the consolidations of the 1980's, the move toward smaller more specialized factories, and the more than doubling of productivity in the process made this possible. The migration South also helped to moderate labor costs over the period.

The cost of labor inputs in nominal dollars to the industry was $563.3 million in 1970, or $10,058 per employee. It rose to $1.405 billion in 1981, up nearly 150 percent during the inflationary 1970's, as average costs rose to $26,364 per employee, and then rose to $1.86 billion in 1999, up only 32.4 percent, while average payments per employee (note there were many fewer employees) were up almost 100 percent to $52,101 per employee. Payroll per employee rose somewhat less. In 1970, the average payroll was $8,607 per employee. It rose 138 percent by 1981 to $20,477 per employee; and rose another 94 percent by 1999 to $39,712 per employee.

Bearing Industry Inventory Trends (1967 to 1999)

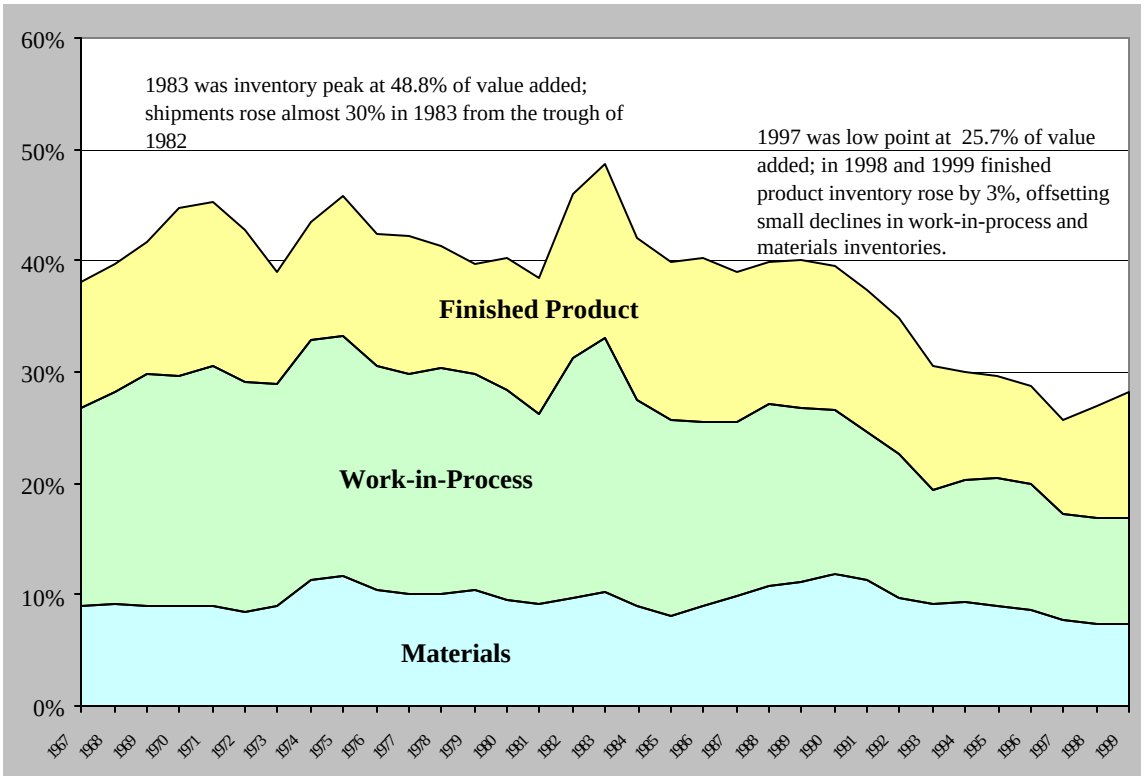
End-of-year total inventories measured as a portion of value added ranged from the high 30's to high 40's prior to 1983. After 1983, inventories declined steadily from their peak level of 48.7 percent of value added in 1983 to 25.7 percent in 1997. In 1998, the level returned to 28.3 percent primarily because of a backup of finished product inventories. Until recently, the bulk of inventories were composed of work-in-process inventory, which dropped from about half of total inventories to one-third of the total over the period. Work-in-process involves converting materials into finished product. Note that this measure fell from about 22.8 percent in 1983 to 9.4 percent of value added in a sharp downward trend. Translated, this means the industry previously took an average of about 45 days to process bearings, while by 1999 it required only 20 days. This is a definite sign of productivity improvement.

Finished inventory also fell from 15.7 percent in 1983 to 8.5 percent in 1997, and then rose to 11.5 percent. A cancellation or slowdown in auto orders can cause a sudden finished product accumulation. The 8.5 percent low attained in 1997 may be difficult to improve upon for the industry and still optimize sales opportunities. Also, 1997 saw a surge in sales that tended to lower finished product inventories. Some bearings are produced and stored in anticipation of future sales or as a courtesy to certain customers that will need them.

Material inventory has remained around 10 percent of value added during most of the 1967-1999 period, although it fluctuated around 2 percent up or down. More recently,

the level dropped to 7.4 percent. The material represents about a 50 to 100 day supply of materials, mostly steel, which is bought cheaper in quantity. Materials also represent cheaper inventory, since they are still unprocessed. The material inventory dropped from a 12 percent high in 1990, to 7.4 percent between 1999. This may be a trend downward, as just-in-time works its way back to material suppliers.

Bearing Industry Inventories
1967-1999

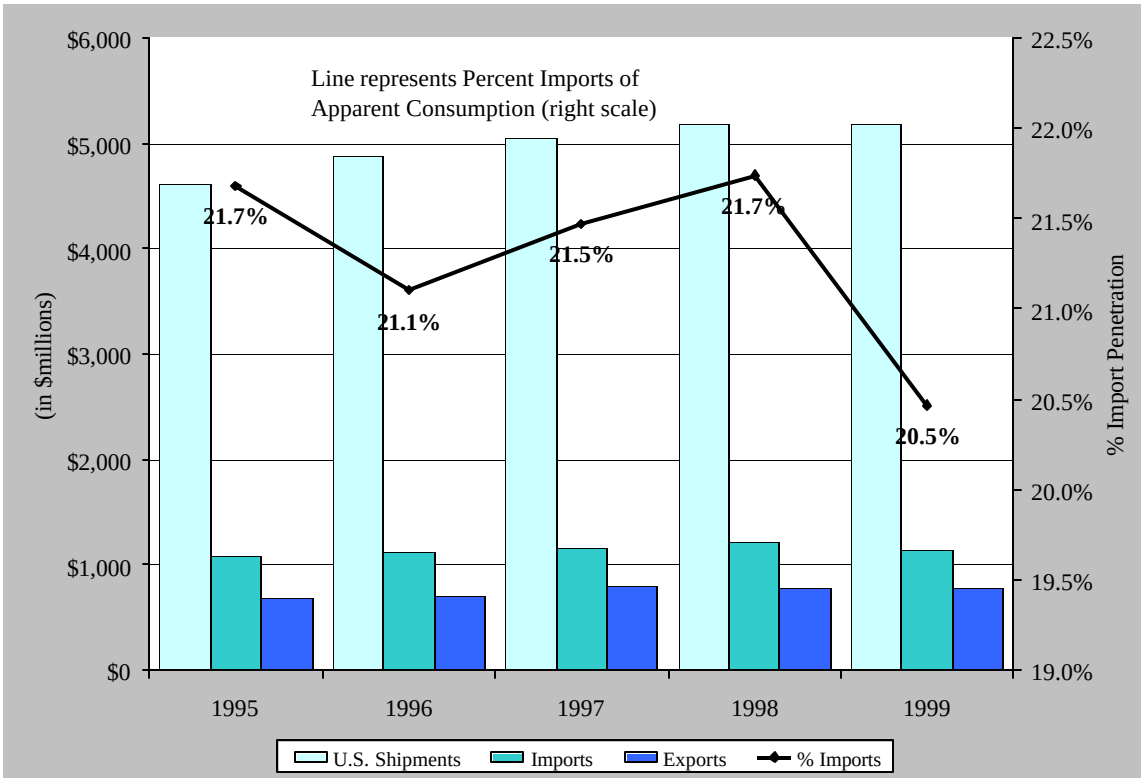


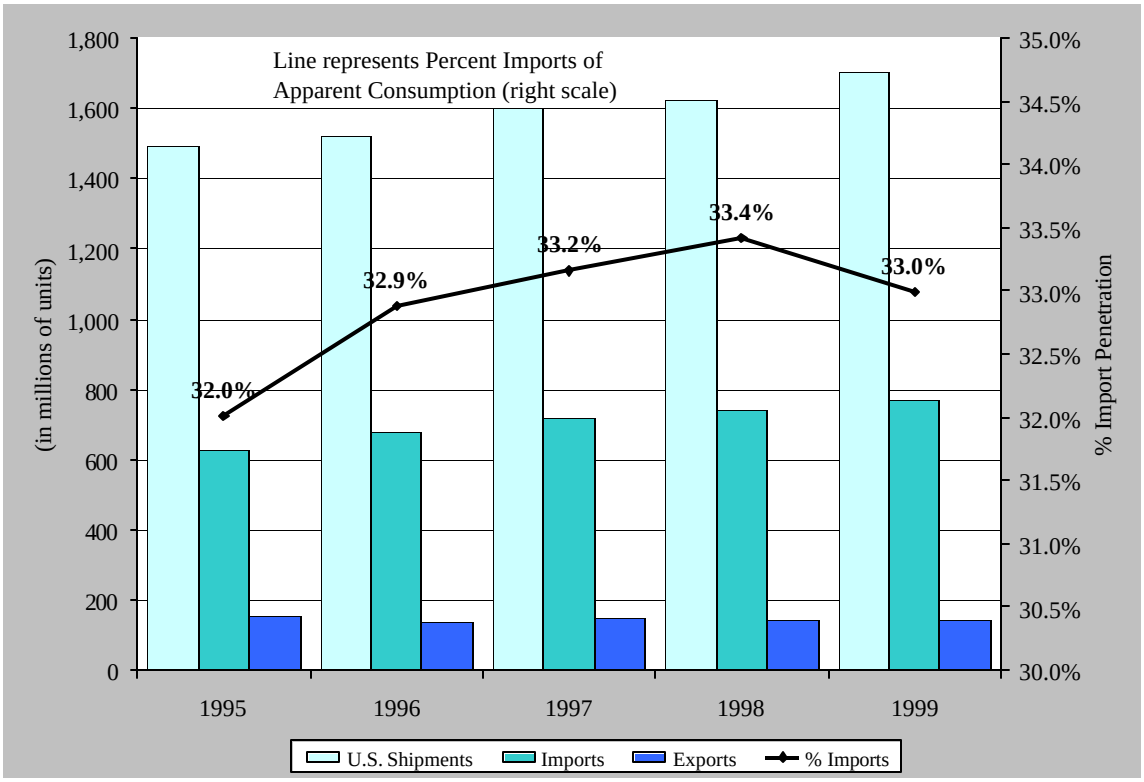
Source: U.S. Dept. of Commerce, Bureau of the Census

Bearing Industry Trade Trends

The U.S. market for completed ball and roller bearings (excluding parts) reached an all time high of $5.63 billion in 1998; this fell back to $5.55 billion in 1999 as prices slumped. In 1999, consumption was comprised of $5.19 billion in U.S manufacturer's shipments, $1.14 billion in imports, and $775 billion in exports. Import penetration of the U.S. market for complete bearings was 20.5 percent, and the trade deficit was $361 million.

Apparent Consumption and Import Penetration
1995-1999





Source: U.S. Dept. of Commerce, Bureau of the Census

In terms of quantity, the U.S. bearing market totaled 2,330 million bearings in 1999; this was an all time high. U.S. shipments were 1,704 million, imports 769 million, and exports 142 million bearings. Import penetration based on quantity was 33 percent.

The United States had a positive trade balance from 1957 to 1971, although exports and imports were not significant. In 1971, imports were only 7.1 percent of the American market. Three years of deficits followed, then in 1975 and 1976, America had two more surpluses. After 1976, deficits have persisted to the present.

The rise in imports has been a gradual but steady process. Import penetration (in dollar terms) of the U.S. market, including parts, first reached 5 percent in 1969, 10 percent in 1973, 15 percent in 1982, 20 percent in 1988, and about 23 percent in 1999. When the dollar lost value on the international market in 1986, U.S. exports (including parts) began to increase. From a low in 1986 of only $283 million, exports climbed to over $1 billion in recent years. The import levels fell in 1990 following the imposition of anti-dumping duties, but crawled higher as China bearings, unhindered by dumping duties, soared, and Japan, with a depressed home market, sent additional quantities to the U.S. market. Large trade deficits persist with some countries. In 2000, the largest deficits were recorded with Japan ($393 million), China ($113 million), Germany ($55 million), Italy ($32 million), Singapore ($21 million), and Thailand ($21 million). The United States ran trade surpluses with Canada ($190 million) and Mexico ($93 million).

Beginning in 1989, Canada counted imports from the United States and reported the results to the U.S. government for publication as U.S. exports. This partially explains a large surge in exports shown for 1989, and casts doubt as to the magnitude in years prior to that. However, higher valued wheel hub units started to be shipped to Canada from the U.S. in larger numbers during the 1980's, which may also explain the disparity.

Japan and China

Japan and China are not equal opportunity traders. The United States and other major trading economies continue to have large trade deficits with Japan and China in numerous products, not just bearings. The deficits in ball and roller bearings, however, are particularly lopsided. Japan has the second largest bearing market in the world, but major bearing companies in the United States and Europe have very minor market shares in Japan. While the Japanese bearing companies are world class, the large trade imbalance cannot be explained by normal competitive factors.

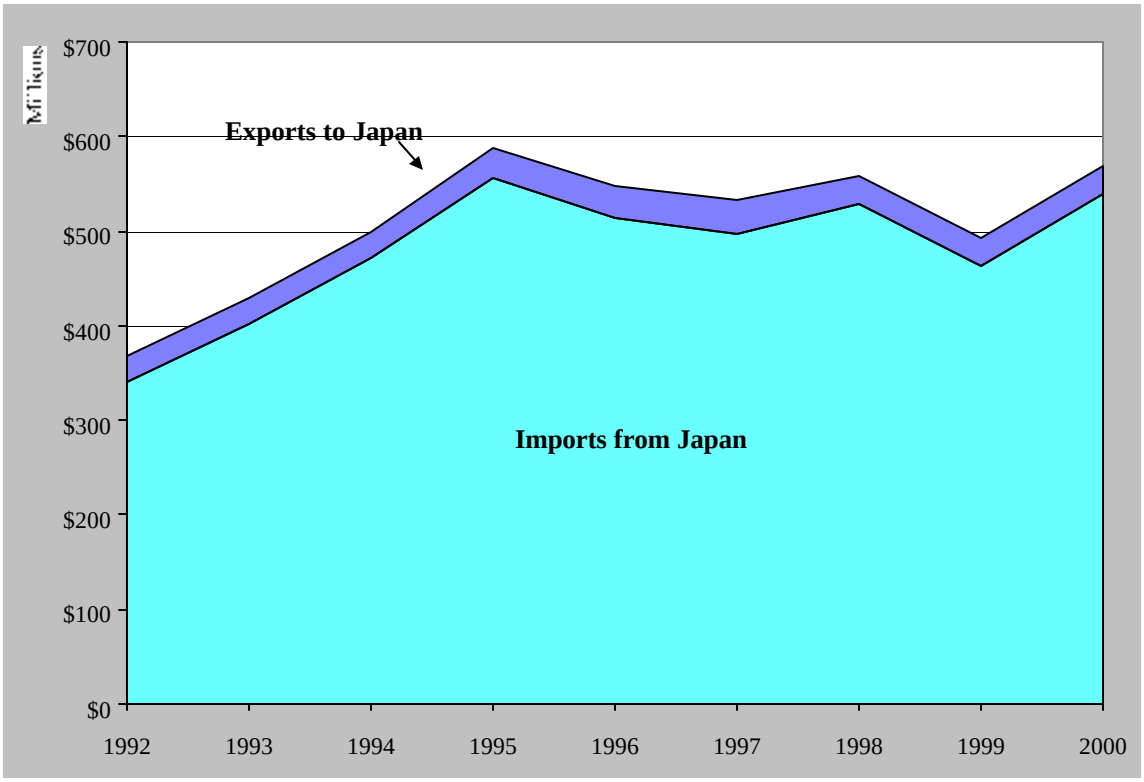
This in part is related to the *keiretsu* structure of their major industry, which promotes exclusive arrangements with corporately affiliated companies, as well as a national preference for sourcing in Japan. This structure, usually with a bank at its center, allows profit levels for Japanese bearing companies (and member companies) to be minimal by world standards and debt loads much higher. This is possible because home markets in Japan are all but guaranteed, and the companies exist somewhat as extensions of the banks. Koyo Seiko, for example, sells more than half its bearings to Toyota. Within the keiretsu, emphasis is placed on loyalty, long-term relationships, quality, and up-to-date technology. The capture of outside market share is encouraged. High volume production leads to lower per unit costs.

The Japanese bearing companies oversee a rather unique set of parts vendors that specialize in a very narrow range, sometimes a single item, of bearing rings or other parts. The vendors often deal exclusively with their corporate overseer, who will supply them steel and equipment as needed. The vendors operate in the subterranean economy as cottage producers, not as employees on the payroll of the bearing company. For the bearing company, the arrangement takes advantage of the cheaper labor, and reduces its overhead and direct workforce.

Through what amounts to a captive market in Japan, Japanese bearing firms are able to leverage exports to the United States and European markets, much to the detriment of existing bearing firms in those areas. After 1986, based on a much stronger *yen*, labor and material factor costs in Japan no longer conferred a cost advantage on Japanese companies. However, exports continued to rise until lower cost Chinese bearings began displacing them.

Since the bubble economy burst in 1991, the Japanese economy has not grown for 10 years, despite massive infusions of deficit spending by the government. Their banks are carrying huge sums in bad loans, as the entrenched interests, including the keiretsus, have resisted making necessary adjustments. Many major industrial companies are beginning to build capacity outside Japan. Japanese bearing producers now export nearly 40 percent of their production, causing worldwide surplus capacity problems. In 1999, based on United Nation's data, Japan reported more than $2.1 billion bearings were exported, while only $337 million were imported. Imports came mostly from Thailand, Singapore, and China, comprised mainly of ball bearings less than 30 millimeters in outside diameter. Japan has a positive trade balance with China. The United States received about 23 percent of Japan's exports.

U.S. Bearing Trade with Japan, 1992-2000
(in $millions)



Source: U.S. Dept. of Commerce, Bureau of the Census

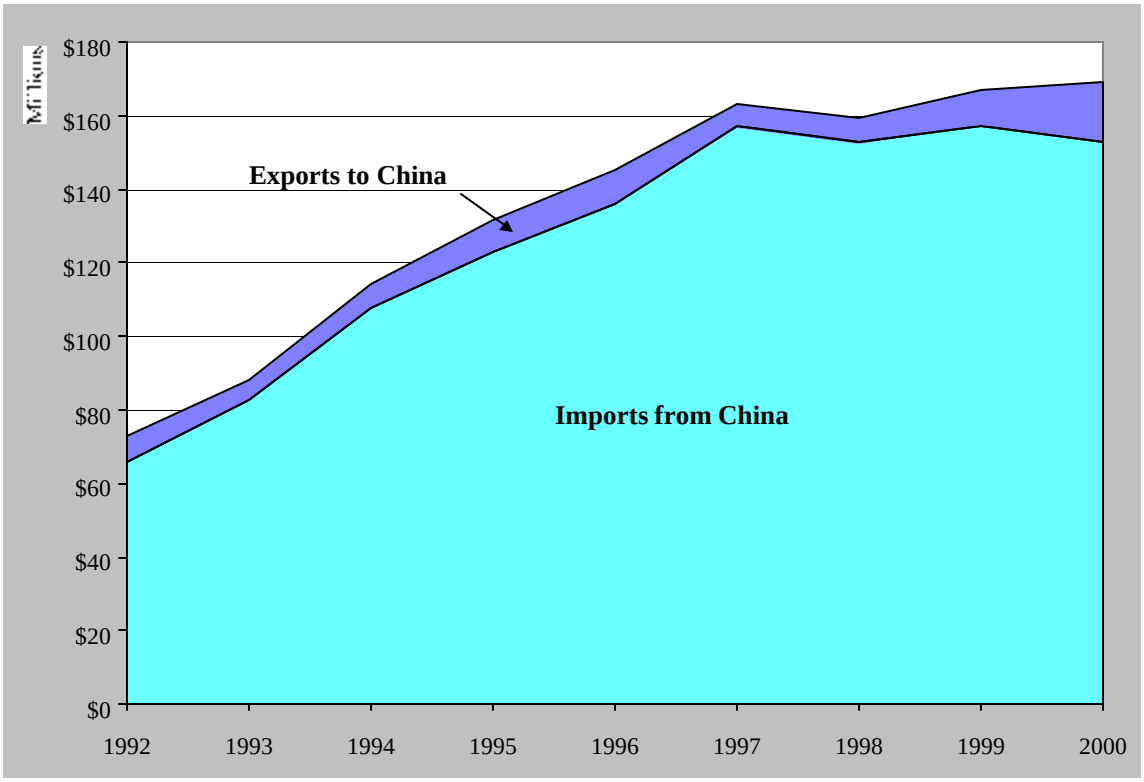
Since late 1978, China has been moving from a centrally planned economy to a more market-oriented economy, but still remains within a rigid political framework of Communist Party control. China is a developing nation that has grown about 8-9 percent per year in the last decade. Based on the World Bank's purchasing power parity (PPP) measure of economic activity, China's gross domestic product in 1999 was $4.8 trillion, making China the second largest economy after the United States ($9.3 trillion).

Purchasing power parity is based on the purchasing power of Chinese income in China. The exchange rate, however, is State controlled within a narrow band. Since 1994, when the currency was last devalued, the exchange rate has stood around 8.3 Renminbi (or yuan) per $1. Based on this exchange value, the Chinese GDP would translate to only $911 billion, or less than one-fifth the PPP estimate. The effect of this fixed exchange rate encourages capital inflows and product exports, but discourages imports. The weak currency also encourages inefficient production and misallocation of resources.

The bearing industry in China reportedly has 1,500 companies and perhaps as many as 200,000 employees. However, by Western standards, the Chinese bearings industry is extremely inefficient, often technically primitive, and the workforce is grossly underemployed. In terms of per person output, employment in China is more than 10 times that in the United States. Most companies are smaller family-run businesses of little consequence beyond their local areas. As China builds infrastructure, roads, and markets mature, many of these operations can be expected to disappear.

Five companies, all State-owned enterprises (SOE), account for half the country's output and more than 90,000 employees. Bearing output in 1999 was approaching an estimated $2 billion, and piece production about 1.8 or 1.9 billion, 80 percent of which were ball bearings. The industry produces a surplus of lower quality ball bearings and has a deficit of high quality bearings, which are needed for industrialization. The replacement market for bearings, as a consequence of lower quality, is unusually large.

U.S. Bearing Trade with China, 1992-2000
(in $millions)



Source: U.S. Dept. of Commerce, Bureau of the Census

All of the world's major bearing companies now have manufacturing facilities in China, many as joint ventures with SOE's. The U.S. and European companies that have facilities in China are focused mainly on integrating into the expanding Chinese economy. The Japanese investors, with a strong export preference, are building export platforms to maintain or establish new market share in third countries.

In 1999, exports from China totaled $512 million; 30 percent ($152 million) went to the United States. China imported $324 million, almost half from Japan ($154 million). Only about $5 million was imported from the United States. Exports from China are mostly lower quality bearings sold in large volumes. When ball bearing dumping duties were levied on Japan, Singapore, and Thailand in 1989, a window was opened for China. Imports into the United States grew very fast during the 1990's. In 2000, more than 300 million bearings, more than 90 percent of them ball bearings, mostly less than 52 millimeters in outside diameter, were imported into America. The bearings enter the U.S. at extraordinarily low prices. The average unit value was approaching 40 cents in 2000.

Imports of Ball Bearings 9-52 Millimeters in Outside Diameter

Radial ball bearings between 9 and 52 millimeters in outside diameter represent more than 25 percent of U.S. bearing imports in value, and more than 60 percent of the quantity. This bearing group is split into two distinct size ranges, 9-30 millimeters and 30-52 millimeters. The smaller group is made on smaller scale equipment, which is not suitable for manufacturing the larger group.

More than 90 percent of the 9-30 millimeter sizes are imported from East Asian countries, mostly China, Singapore, Thailand, and in recent years, Indonesia. In 1992 Singapore accounted for 61 percent of the imports, and Japan 14.5 percent. By 2000, Singapore dropped to 24 percent and Japan to only 4.6 percent. Meanwhile, China rose from 6.3 percent to 36 percent to become the leading source, and Thailand, increased its share from 1.3 to 14.5 percent.

Minebea Company (Nippon Miniature Bearing) is the world's largest producer of ball bearings under 30 millimeters. The firm has major export platforms in Singapore and Thailand, and now in China, also produces in Japan, and has production facilities in the United States under the name of New Hampshire Ball Bearing. NSK is also a major producer, with production locations in Japan, China, Malaysia, and Indonesia. Countries with advanced economies are not competitive in small bearings, except for special varieties. Japan now imports most of its needs from Thailand and Singapore, and

growing portions from China. The bearings are labor intensive and require very little material to make. Labor represents most of the cost. Additionally, transportation costs over long distances are minor and do not affect the price. Thus, real advantages go to countries with low cost labor.

The average unit value of ball bearings in the 9-30 millimeter range dropped from 62 cents per bearing in 1992, to 46 cents in 2000. Imports from China led the way, dropping from 46 cents to only 31 cents during the same time period. Imports from Thailand also dropped, falling from 86 to 45 cents, and imports from Taiwan dropped from 59 cents to 32 cents. Unit values from Japan ranged from 84 cents to $1.24 over the period.

The commercial markets for small bearings grew very fast without significant participation of U.S. firms. The growth markets have been computer disc drives and peripheral equipment, in-line skates, model airplane engines, dental drills, fractional motors, hand tools, windshield wiper blades, and numerous other applications. At the high end, small ball bearings, known as miniature and instrument bearings, are critical to Defense/Aerospace. They are used in gyroscopes, altimeters, range finders, and other navigational equipment found in missile guidance systems, aircraft, ships, and armored land vehicles.

The market for ball bearings in the 30-52 millimeter range also experienced an increase of imports. Leading import positions are held by Canada, Japan, China, and Taiwan. These four countries account for 76 percent of the value and 79 percent of the quantity. Since the early 1990's, imports from Canada, China and Taiwan expanded as shares of the total from 41 to54 percent of the value and from 52.5 to 66.3 percent of the quantity, while Japan relinquished much of its share. In terms of quantity, China now supplies 37 percent of the total, up from 15 percent in 1992, and Canada supplies 16.4 percent, down from 23 percent in 1992.

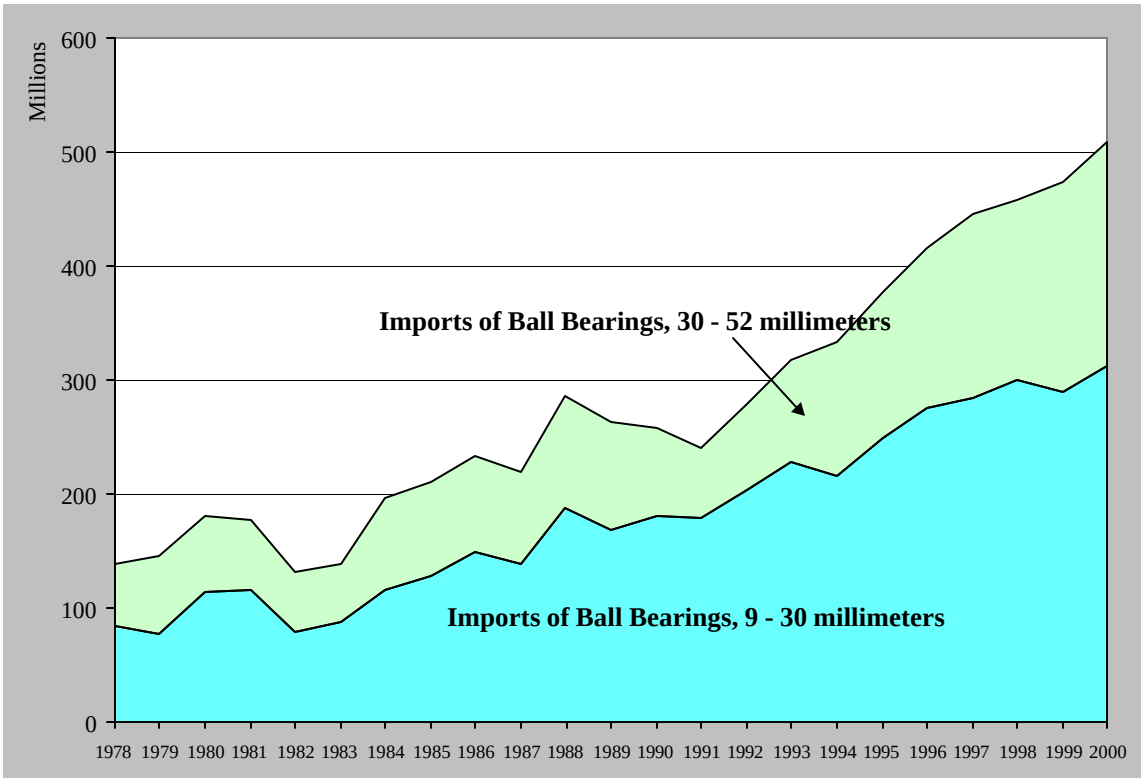
The average value of imported ball bearings in the 30-52 millimeter range declined from $1.18 in 1992 to 87 cents in 2000, primarily because of the lower cost bearings imported from China. China's bearings averaged 80 cents in 1992, and only 44 cents in 2000. Average Canadian values remained above $1 for the entire period, reaching a high of $1.30 in 2000. Canadian imports benefited from the North American Free Trade Agreement instituted in 1989; previously Canadian bearings were supplied to the auto industry in the Great Lakes region under the Automotive Parts Trade Agreement with Canada established in 1965, which was rolled into NAFTA.

China's impact has been to force bearing prices down in the United States, not just for ball bearings, but also other bearing types, simply by offering potential customers a low price option. This has the effect of setting a lower price floor from which to begin negotiating.

Ball bearings in the 30-52 millimeter range are used by the auto industry for under the hood applications, in electric motors that run home appliances, power tools, machine tools, conveyors, escalators, fans, and pumps. They are commonly made in very large quantities to a world standard, often without a particular buyer in mind.

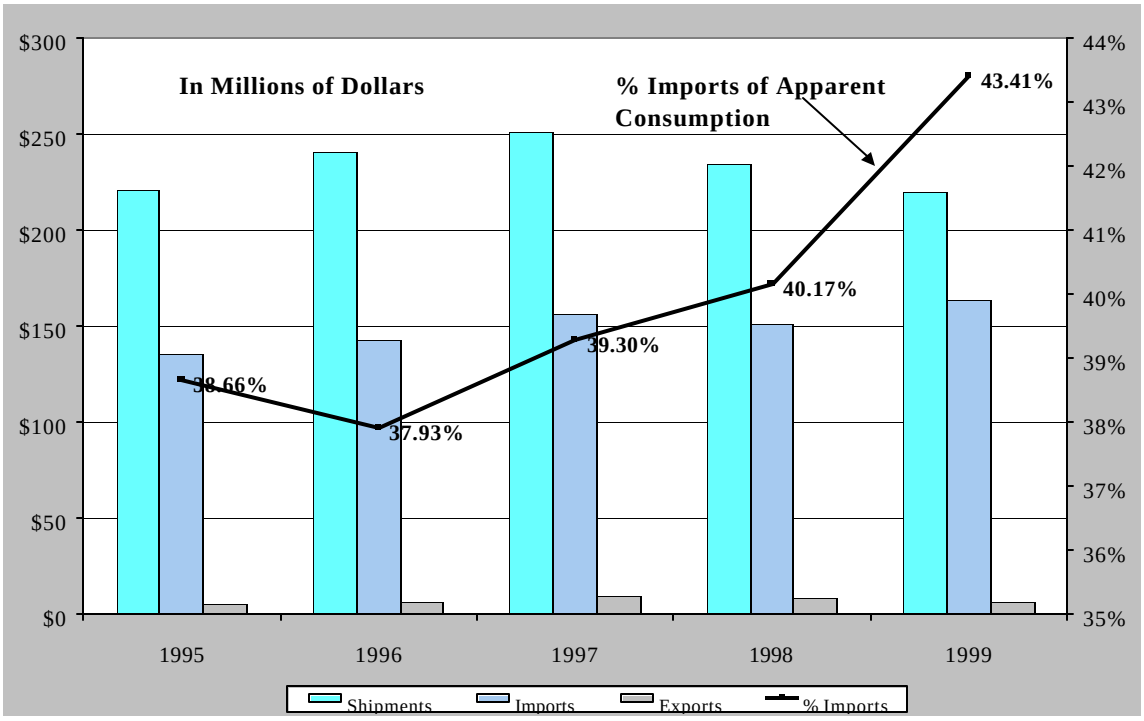
The chart shows that imports of ball bearings from 9-30 millimeters in outside diameter increased from about 84 million in 1978 to over 312 million in 2000. The imports represent about 80 percent of today's U.S. market, and accounted for 100 percent of the market growth in this product since 1978. Imports of the 30-52 millimeter sizes also increased from 55 million in 1978 to nearly 99 million in 1988. With the imposition of dumping duties and a fading American market, imports backed off to 62 million in 1991. However, since 1991 imports surged, reaching 197 million in 2000.

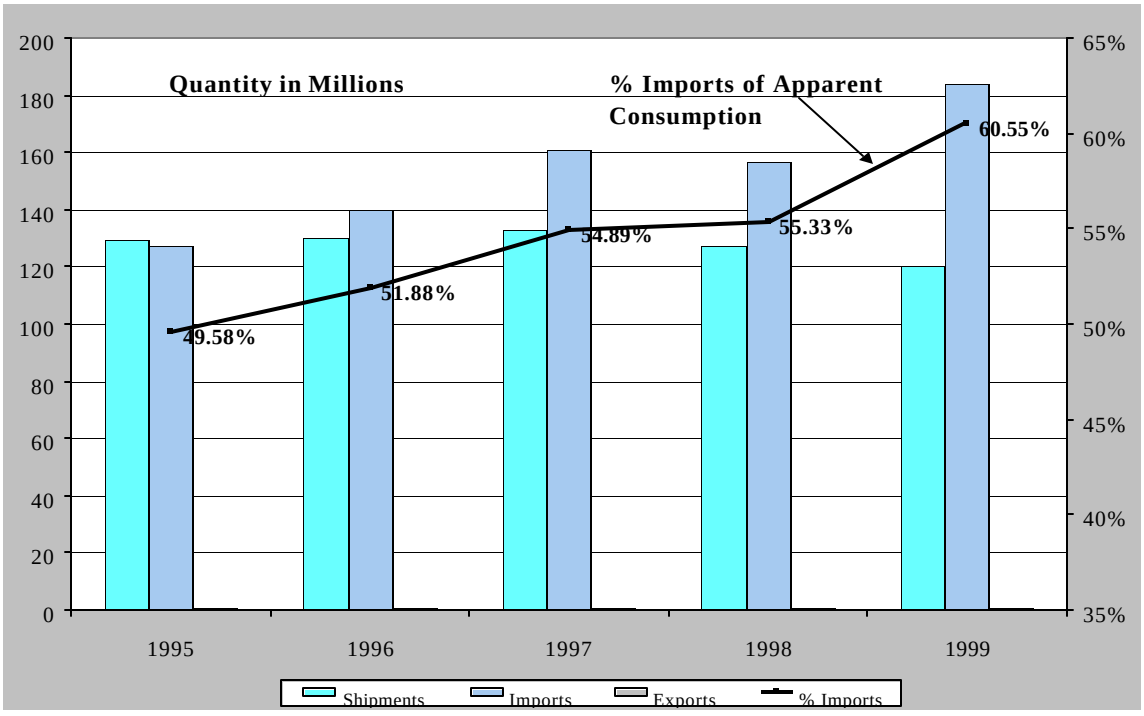
U.S. Imports of Ball Bearings, 9 - 52 millimeters diameters
1978 to 2000



Source: U.S. Dept. of Commerce, Bureau of the Census

U.S. Market for Ball Bearings, 30-52 millimeters, 1995-1999





Source: Dept. of Commerce, Bureau of the Census

A more detailed view of ball bearings in the 30-52 millimeter range is shown on the above two charts, tracking developments in import penetration from 1995 to 1999.

Import penetration in this area grew particularly after 1997. The overall market grew in value until 1997, and then eased off as imports from China drove prices downward and captured more of the market. Market growth continued, however, in the number of bearings purchased. Unit imports reached a new high in 1999, at 303 million and import penetration grew to 60.6 percent.

Domestic shipments, after peaking in 1997, declined to $220 million in 1999. The quantity shipped also declined to 120 million, as it gave way to surging imports. Exports from the United States never exceeded 652,000 (in 1997). Average unit values of domestic shipments ranged from about $1.50 for regular precision and more than $60 for higher precision. The highest value observed for regular precision bearings was in 1997, when it reached $1.55. Import prices, however, dropped steadily during the period from $1.07 in 1995 to 89 cents in 1999. The sharpest drop was in 1999, when the average value fell 9 cents from the 1998 level of 98 cents.

U.S. Bearing Company Standing in the Global Bearing Market

1. U.S. bearing companies account for a declining share of world bearing production.

World bearing production was estimated at $23.4 billion in 1999, and the top ten companies accounted for 80 percent ($18.7 billion). Two U.S. companies, Timken and Torrington, ranked seventh and eighth, were among the top ten, representing about 14 percent of the total. Forty years ago the U.S. representation included six companies in the top ten (New Departure, Fafnir, Timken, Torrington, Federal Mogul, Marlin Rockwell). This was before the re-emergence of Japan and Europe in the post-World War II period.

Plagued with high labor costs, New Departure, owned by General Motors (GM), closed two of its largest factories and greatly curtailed production in a third under severe price competition from the Japanese. Currently, the company is part of the Delco family that was spun off from GM last year. Delco still makes the wheel hub bearing product line by the millions, which generates revenues of $400 to $500 million. Fafnir was also severely hampered by the Japanese and by high wages and militant labor. What remains of Fafnir (two plants) is now part of Torrington.

Federal Mogul gradually exited the bearing market as Japanese and domestic competition intensified during the 1980s. The firm was acquired by NTN in two acquisitions: first in

1987, second in 1998. A similar fate befell Marlin Rockwell, which allowed its operations to deteriorate. The firm was acquired by SKF in 1987.

The decline may be stabilizing. Recently, SKF sold four plants in the United States to Roller Bearing Company (RBC). In addition, some Japanese bearing capacity was shut down during that country's 1998 recession. In Europe, Georg Mueller, the fourth largest bearing company went out of business and FAG shrank more than 60 percent. FAG is making a come back. The future may be decided in the fast growth areas of China and Eastern Europe, where the large companies are staking out positions.

2. Bearing industry concentration levels vary by continent, but the United States is conspicuously less concentrated than its rivals.

In Europe, the top three companies (SKF, INA, and FAG) account for 75 percent of production estimated at $6.5 billion in 1999. In Japan, the top three (NSK, Koyo, NTN) account for about 90 percent of production estimated at $5.1 billion. In the United States, the top three, Timken, Torrington, NTN, account for 40 percent of production estimated at $5 billion; note that one of the three is a foreign firm (NTN, Japan). This disparity made it easier for major foreign companies to capture large chunks of the American market. The major foreign companies were all caught dumping under the anti-dumping laws. Foreign owned capacity in the United States grew from about 12 percent in 1980, to nearly 40 percent in 2000.

U.S. vulnerability was rooted in:

a. The historic tendency for U.S. firms to specialize in product types in the U.S. marketplace (e.g., Timken - Tapered Roller Bearings, Fafnir - Ball Bearings, Torrington - Needle Bearings). Each firm became proficient in their specialty, but could not offer customers a broad choice as to bearing type. In addition, they could not be a one-stop supplier to customers needing several types of bearings. Moreover, the technology and know-how synergies gained between bearing types that would be available to full-line producers, was missed by the U.S. firms. In the long run, the focus on one bearing type limited U.S. firms' potential size and left them more vulnerable to foreign companies that evolved as full-line producers.

b. New Departure's captive holding of large portions of the huge General Motors' market excluded other bearing companies from that market, especially in ball bearings and tapered roller bearings. In the past, GM alone may have represented from 15 to 20

percent of the U.S. market. The exclusion of other bearing companies from the GM market limited both their size and scope. New Departure also competed for the business of other car companies and in other industrial markets.

c. An unclear antitrust policy with uncertain guidelines made potential mergers less predictable and risky. Japan and Europe had no such constraints and quickly developed larger companies than in the United States.

d. American bearing companies mostly ignored developments and export opportunities in the rest of the world. Timken and Torrington are notable exceptions. In contrast to U.S. companies, the large foreign companies, especially SKF, have acquired market share through merger and acquisition, and aggressive salesmanship in the international sector. Older capacity is then retired and the work shifted to more efficient plants. This strategy was applied in the U.S. as assets were acquired, shutdown, and replaced with imported product.

3. North America has a large trade deficit in bearings with the rest of the world.

North America (Canada, Mexico, and the United States) had a trade deficit with the rest of the world in bearings that totaled $1.087 billion in 1999, or roughly 20 percent more than indigenous production capacity. In contrast, Asia (predominantly Japan and China) had a surplus of 1.76 billion, and Europe (mostly Germany, UK, France, Italy), a surplus of nearly $270 million. In consideration that the world's major bearing companies are roughly equivalent competitively, these trade flows appear to present a distorted picture. The effect of these trade flows has been to constrain capacity in the United States, while North America supports excess capacity elsewhere.

Continental Trade Positions, 1999

Continent	Continental Trade Surplus/Deficit
Western Europe	$229,561,952
Eastern Europe	$40,151,400
All Europe	$269,713,352
Asia	$1,757,167,466
North America	-$1,087,123,488
South America	-$446,533,435
All Other	-$487,452,375

Source: United Nations Trade Data

As noted previously, Japan limits imports from outsiders and China has a weak currency. North America's deficit with Asia alone is $878 million. Europe also had a deficit with Asia of $322 million ($283 million with Western Europe). However, North America had a deficit with Europe of $275 million ($233 million with Western Europe), which largely negated Europe's deficit with Asia. In a more ideal global market, when one market is down, bearing capacity could be redeployed to other markets. In this respect, the emerging markets in China, South America, and Eastern Europe are very important to future trade flows.

4. Competition in the bearing industry is global in nature and very intense.

Several companies usually contest every major order. In response to end-market pressures, especially from the motor vehicle companies and other large customers, bearing producers must find lower cost solutions for their customers or risk losing market share. As a result the major companies have invested heavily in productivity, rationalization of facilities, and development of innovative products. Because of our open markets, the U.S. bearing industry, comprised now of both U.S. and foreign companies, evolved in the last 15 years as the most productive, innovative, and responsive to customers.

5. Price competition rules.

High quality bearings are now the standard, and to a high degree, bearings have become commodities. Price competition has lowered economic rents and profits as companies compete to maintain market share and keep their factories fully loaded. China's entry into the world market in the last decade has depressed prices worldwide.

6. Persistent overcapacity puts downward pressure on prices.

In general, prices of bearings have hardly advanced from the levels of fifteen years ago. This impacts the global industry. The major reasons are related to:

a. Gains in productivity (i.e., better equipment, computerization, cells, etc.)
b. Specialization of bearing plants (i.e., fewer part numbers, higher volumes, fewer set-ups)

c. Capacity expansion in developing nations (i.e., frequently used as export platforms, and

d. Mounting pressures from major bearing customers to keep bearing costs as low as modern manufacturing concepts allow (Note that the customers are also confronted with an overcapacity problems.)

Investments and implementation of new production technologies continually improve productivity. With very rapid scientific advances, the bearing technology cycle has been squeezed into shorter periods so that productivity has been growing faster than bearing end-markets. This puts continuous pressure on the industry to consolidate. A surplus results from both the greater production yields and the slowness of older capacity's retirement from the field. Gains in productivity lowers per unit costs, which are passed through to large and economically powerful customers. Older, obsolete equipment, now less profitable, may be shipped-off to developing countries, where cheaper labor can extend its useful life.

The entry of China, for example, into world markets has not only created additional capacity, but also lowered prices of some bearings to levels not seen since the 1960s. The China factor has also cut into some of Japan's exports, thus impacting Japan's in-country capacity (as Thailand and Singapore did with small ball bearings) and the United States by lowering general price levels. Eastern Europe, India, and other areas are developing in a similar pattern.

In addition, bearing materials and bearing quality have improved and extended bearing life. Longer bearing life reduces the demand for replacement bearings, and thereby, further contributes to surplus capacity. Lastly, the closed Japanese market contributes to overcapacity in slow economic times elsewhere in the world. This puts added pressure, particularly on the United States, as the Asian financial crisis attests. The North American import deficit rose from less than $800 million to about $925 million in 1998. When Europe suffers economic downtime, its surplus capacity is also redeployed toward the United States, partly because the Japanese market is closed to them as well. U.S. companies do not have the same opportunity.

7. Research and development in bearing technology is not monopolized by any single company; however, company size is a critical factor in exploiting potential gains from R&D.

The U.S. bearing industry was outspent in R&D about five to one by foreign firms. This could mean further loses of market share in the future. The two largest companies, SKF ($85 million in R&D) and NSK ($76 million), each spent more than the entire U.S. industry ($75 million). Worldwide, about $450-500 million was allocated to bearing-related R&D in recent years. Straight R&D spending, however, may not capture the total picture. Nearly all bearing companies tweak their machines or bring in ideas from other industries to improve their performance. Sometimes one person can make a big difference. Today, the U.S. bearing industry imports a majority of its machine tools, which are predominantly made in Japan or Germany.

8. Motor vehicle bearings account for about one-third of the world's bearing market.

The auto market is important to the top ten as their bread and butter customers, helping them leverage other markets, including defense, and R&D and investment. In 1999, 55.5 million passenger vehicles were produced, about one third of these in North America. At roughly $150 dollars per vehicle, $8.325 billion bearings went into this market.

Defense Issues

The ball and roller bearing industry expanded more than six-fold during World War II, attaining peak production in 1944. Employment in the industry rose sharply from about 20 thousand in 1939 to more than 120 thousand by early 1944. In 1943, the War Production Board put bearings on the critical watch list because they were delaying production of aircraft engines. For a short period that year, bearings were the major bottleneck. The National Guard was called in to assist in manning the production lines. Also, women were hired in great numbers, eventually comprising about 40 percent of the workforce. Other major problems were obtaining steel, meeting the higher demand for bearings from machine tool companies, and prioritizing the deluge of military orders.

Buy American Policy

Department of Defense, Defense Federal Acquisition Regulation (DFAR) restrictions were imposed on anti-friction or rolling bearings in two independent actions. First, on April 22, 1971, the Office of the Secretary of Defense (OSD) required that DoD purchases of miniature and instrument bearings (ball bearings less than 9 mm and 9-30 mm diameter respectively) be limited to U.S. and Canadian sources. This strategically

important subsector of the bearing industry was very vulnerable to imported bearings from low labor cost areas, at the time Japan, and later also from Singapore and Thailand. Had this DFAR not been put in place, this subsector would almost certainly not survived. The DFAR remains in place.

In a second action, on August 4, 1988, DoD issued an interim rule that limited all other rolling bearing sizes and types to U.S. and Canadian, and "other authorized manufacture" with corporate headquarters in NATO countries. This DFAR was recommended by the Joint Logistics Commanders following a 1986 study that reported the domestic bearing industry was having competitive difficulties and weapons producers were rapidly qualifying foreign bearing suppliers. OSD disagreed on this remedy to the problem, and delayed implementation. Eventually, the U.S. Congress ordered the DFAR be implemented for an initial period of three to five years. On April 12, 1989, the interim rule was made final but without the other authorized manufacturers clause.

The other authorized manufacturers clause stipulated that a NATO-headquartered bearing company with a U.S. subsidiary could import defense bearings up to the value of net bearing exports from the U.S. by its U.S. subsidiary. This applied to three firms: FAG, INA, and Rothe Erde, all headquartered in Germany. This excluded SKF, the largest NATO producer, who was headquartered in Sweden. SKF vehemently opposed this position as an unfair giveaway to FAG's aerospace division in Schweinfurt, Germany. The clause was rescinded.

The DFAR was established for a three-year period, with provision for a two-year extension if necessary. In September 1991, after Congressional hearings, Deputy Defense Secretary Atwood announced an extension for 15 months to the end of 1992, during which time the industry's competitive viability and the impact of the DFAR could be assessed. In the FY 1993 National Defense Authorization Act, Congress directed that the DFAR be extended for a three-year period until October 1, 1995. In the FY 1996 National Defense Authorization Act, Congress again directed that the DFAR be extended, this time for a five-year period until 2000.

The effectiveness of the 1988 DFAR bearing restriction in meeting its national security objectives depended upon the effectiveness with which it was implemented by DoD and its contracting activities. In separate audits conducted by DoD's Office of the Inspector General (IG) in 1991 and 1992, it was found that the DFAR restriction was being incompletely implemented.

These reports found that, in some cases, the procurement restrictive clause was not included in DoD contracts. In other cases, when the clause was included, contractors often did not make the required certification that bearings were domestically manufactured, or they failed to make sufficient effort to verify that contractors actually complied with the DFAR clause. During the course of the DoD IG audits, several Army and Navy contracting units initiated immediate corrective action to include the restrictive clause in appropriate contracts. It was too soon, at the time, to determine whether these actions have made a significant difference in the effectiveness of DoD's implementation of the DFAR restriction.

In January 1992, DoD requested the U.S. Department of Commerce to assist in its study effort. In February 1993, Commerce issued a report documenting the business trends, capacity, the most defense critical bearings, and the impact of the DFAR's possible removal on the bearing industry.

Commerce Study Findings

Most bearing companies reported that the DFAR had a positive impact on their production capacity, employment, investment, R&D and profitability. In addition, the companies commented that the DFAR improved entry to defense prime contractors, increased awareness of U.S. bearing producers' capabilities, and supported U.S. maintenance of technological proficiency in superprecision bearing production. Some companies replied, however, that the effects of the DFAR were, at times, overshadowed by the negative impacts of defense cutbacks and the current economic downturn.

Companies reporting a negative impact were predominantly the U.S. subsidiaries of foreign-owned bearing producers. Others noted the DFAR was poorly implemented, which detracted from its benefits. Companies reported that U.S. bearing industry competitiveness was also significantly affected by helpful actions, such as the antidumping duties. Importantly, the DFAR helped deflect sales of imported product to the U.S. Department of Defense, which are exempt from any duty or tariff levied on imports. Thus, although delayed in its implementation, the DFAR complimented the antidumping duties at a critical juncture.

Regarding production capacity, several firms reported that the DFAR had led them to either increase or, at least, retain capacity that would otherwise be unavailable. A superprecision producer estimated that approximately 20 percent of its capacity increase could be attributed to the DFAR restriction. Another producer stated the "DFAR has contributed to the retention and increased utilization of capacity that might otherwise

have been idled." Another large producer indicated that the DFAR enabled it to more economically utilize existing capacity, although the firm had not yet added additional capacity. An additional superprecision producer noted that while DoD demand for its products has decreased 50 percent over the past four years, the DFAR has enabled them to receive orders for several DoD programs which would earlier have been supplied from offshore sources.

While a superprecision bearing company reported that it hired an additional 50 workers in response to DFAR-related business, most other bearing companies responded that the DFAR had enabled them to maintain current employment, or that it had no effect on their employment level. A leading integrated producer responded that it would have laid-off half of its defense bearing work force had the DFAR not been in place. Two other large producers reported that the DFAR enabled them to stabilize their work force without requiring layoffs.

Several leading companies reported that they increased investment in response to the DFAR restriction, while others indicated that the DFAR enabled them to maintain investment at current levels despite the economic downturn. A leading producer of defense-intensive miniature bearings, for example, stated that 20 percent of its capital investment was "fueled" by the DFAR. A leading integrated producer informed us that the DFAR, combined with the coincident imposition of antidumping duties, had given them renewed confidence to invest in U.S. bearing production facilities. A leading foreign-owned bearing producer reported that while the DFAR had no effect on its U.S. operations, it had made substantial investment in its Canadian facilities to comply with DFAR sourcing restrictions.

Regarding profitability, companies responded similarly that the DFAR had either increased profitability or helped offset losses during the economic downturn. Two producers replied that the DFAR enabled them to increase utilization of their equipment and thereby improve profitability by spreading fixed costs over larger production runs. Another producer complained that the impact of the DFAR on profitability has been limited due to the DoD's incomplete implementation of the restriction. Conversely, a leading foreign-owned producer reported that the DFAR had reduced its corporate-wide sales and profitability by removing business from its competitive and cost-efficient offshore facilities.

Following from the above, surveyed companies were overwhelmingly positive about the overall impact of the DFAR, citing, in addition to factors noted above, improved entry to defense prime contractors, increased awareness of U.S. bearing producers' capabilities,

and support for U.S. maintenance of technological proficiency in superprecision bearing production. One foreign-owned U.S. facility further replied that the DFAR had enabled it to improve its access to U.S. Government contracts and personnel. Another leading foreign-owned producer responded, however, that the DFAR had the effect of supporting the maintenance of excess U.S. defense bearing capacity while limiting U.S. access to state-of-the-art offshore bearing technology.

Consequences of Elimination of DFAR

The most detrimental impact would be on superprecision bearings. DoD is the major market for superprecision bearings, accounting for over 36 percent of superprecision shipments in 1991. Firms producing regular precision bearings for defense indicated the DFAR's elimination would have a smaller impact on their firm, but could impact their defense divisions quite severely by expanding competition in a shrinking market. Direct and indirect defense requirements for all anti-friction bearings, however, currently account for about 5-10 percent of the value of bearings produced in the United States, down from close to 15 percent in the mid-1980s.

Superprecision bearing producers are already operating at low levels (63%) of capacity, as they work down defense backlogs. Opening the defense market to foreign competition at this time would contribute to the further consolidation and downsizing of capacity, and almost certainly lead to increased DoD reliance on foreign sources for these most critical bearings. From a technology as well as a competitive standpoint, the defense market plays an important and strategic role in the sector. One firm alleged that foreign competitor firms are willing to underprice U.S. Government business for access to the technology.

For example, largely due to DoD funding, superior metal alloy was developed to extend the life of bearings in the mid-1980s. This enabled superprecision bearings for the main shafts of gas turbine engines to last 3000 hours flying time, compared to only 300 to 500 hours for bearings made in the former Soviet Union. Access to this technology provides an enormous advantage in the commercial aerospace bearings sector. New business is vitally important to this sector's long-term viability and technical capabilities. Retention of the DFAR will, therefore, provide some assurance that U.S. superprecision producers will remain viable.

Regular precision bearing producers reported their defense business would probably decline or in a few cases disappear if the DFAR is eliminated. One company, predicting a negative impact, surmised that elimination of the DFAR could have a ripple effect as displaced U.S. defense bearing producers begin to compete for commercial bearing

business held by its competitors. One subsidiary of a diversified U.S. company complained that the import of products with embedded foreign-manufactured bearings limited the DFAR's overall impact. Given the formidable nature of foreign competition, elimination of the DFAR would almost certainly result in greater imports, especially in those areas where the technology has a potentially large commercial payoff.

Nearly all the defense bearing suppliers replied that declining defense expenditures have had a negative impact on their U.S. bearing operations. One small U.S. producer noted that it had stopped replacing retiring workers as government contracts had decreased by 75 percent. A superprecision manufacturer replied that it had been forced to close one of its U.S. facilities. Both a large U.S. manufacturer and a prominent smaller manufacturer responded that they had anticipated the defense downturn, and that they had been emphasizing their efforts to further penetrate commercial bearing markets. Another smaller company replied that it had increased its export efforts. Additionally, a leading foreign-owned supplier informed us that defense cutbacks will not significantly affect its business as the DFAR had already eliminated its participation in U.S. defense programs.

In summary, most companies responding believe that the DFAR had a positive impact on their capacity, employment, investment, R&D and profitability. Most companies further believe that eliminating the DFAR would have a negative impact on U.S. defense production capability and lead to greater reliance by the military on foreign sources. At the same time, many companies replied that the effects of the DFAR were in some cases overshadowed by the negative coincident impact of defense cutbacks and the 1992 economic downturn.

Defense Summary

DFAR history

- April 22, 1971 DFAR instituted on miniature and instrument ball bearings up to 30 millimeters in outside diameter, following a national security impact import investigation under Section 232 of the Trade Expansion Act of 1962.
- As a result of Joint Logistics Commanders' Bearing Study (June 1986) and order by Congress, DoD implemented 3-5 year interim DFAR on all other antifriction bearings in August 1988; made final April 12, 1989
- Hearing called by the Congressional Bearing Caucus on September 24, 1991 to examine allegations of incomplete implementation of DFAR - DFAR extended in September 1991 for 15 months by Defense Deputy Secretary Atwood to allow time for industry assessment.
- DOD requested the Dept. of Commerce assess the competitive status of the U.S. Bearing Industry and the need to continue the DFAR on Bearings in January 1991;

Commerce reviewed 40 industry questionnaire responses representing 90 percent of 1991 industry shipments and employment. The study reported the DFAR necessary to preserve domestic capabilities.

- DFAR extended until October 1 1995, as specified in the Defense Authorization Act of 1993.
- DFAR on miniature and instrument bearings combined with all other antifriction bearings DFAR and extended until end of FY 2000 by the Defense Authorization Act of 1996.
- DFAR extended to end of FY 2005 by the Defense Authorization Act of 2001.

Defense Importance

- Defense requires between $300-400 million in bearings per annum; roughly equal to 0.5 percent of current Defense procurement. Requirement was $500-600 million in mid-1980s. About one-third of the requirement, $100-150 million, is for the procurement of superprecision bearings
- Bearings are critical components in aircraft, helicopters, tanks, missiles, submarines, and virtually all major weapon systems. Bearings are also critical components in machine tools and other capital equipment and transportation and off-road vehicles that support both defense and the civilian economy.
- Bearings can be a "pacing item" in many defense applications, particularly aerospace. Bearings also present a complex logistics problem (who does what, for whom, when?)
- Bearings are difficult to ramp-up or surge (labor skills, material availability, capacity constraints-heat treating, grinding)