Part 2
US PERSPECTIVES ON TECHNOLOGY TRANSFERS TO CHINA

US GOVERNMENT POLICIES AND PERSPECTIVE ON TECHNOLOGY TRANSFER

Although the US government, and the US Department of Commerce in particular, generally prefers a laissez-faire approach to US business and trade abroad, the technology transfer or offset requirements of numerous foreign governments are a serious concern for several US government agencies. The US Government (USG) has identified "three areas of global trade and technology transfer that are occurring with increasing frequency and that have the potential for broad national security or economic impact. Sales and contracts with foreign buyers imposing conditions leading to technology transfer, joint ventures with foreign partners involving technology sharing and next-generation development, and foreign investments in US industry that create technology transfer opportunities may raise either economic or national security concerns."[1] It is clear from analysis in Part 1 of this study that at least the first two of these three criteria are areas of serious concern with regard to China.

The effects of technology transfer and offsets in the commercial sector, however, are not yet well understood or tracked, especially in developing countries such as China. Furthermore, technology transfer requirements are merely one of many barriers to market access about which the USG and US industry are concerned. Several bilateral agreements have been reached with China in an effort to address various trade issues and practices, the most important of which is the 1992 Memorandum of Understanding (MOU) signed by the United States and the People's Republic of China on market access.[2] Although China has made efforts to further liberalize its trade and investment policies in accordance with this agreement and in efforts to join the World Trade Organization (WTO), much progress remains to be realized.[3]

Since the end of the Cold War, US export controls on dual-use high-technology items have decreased significantly and across a range of modern technologies. The Coordinating Committee for Multilateral Export Controls (COCOM) regime has been replaced by the Wassenaar Arrangement and supported by a system of export controls based on national discretion. In the United States, this has resulted in large-scale decontrol of technologies mainly in the electronics, computer, and telecommunications sectors, primarily for use in the civilian sector. As a result, export licenses are required for countries of concern such as China according to the end user or end-use, depending on whether they are civilian or military, as well as according to set technological standards or levels of sophistication (which, by necessity, are changeable). This has two consequences for US commercial technology transfers to China. On the one hand, as discussed above, determining the nature of either the end use or the end user is a very difficult task, one which is now primarily the responsibility of the licensee. On the other hand, the decontrol of information technology hardware and software has facilitated an enormous amount of trade and investment in these sectors between the United States and China over the last few years. Given the size of the US trade deficit with China, this new influx of trade and investment may serve to alleviate some of the current imbalance.

Chinese officials, however, contend that the current trade imbalance is due mostly to remaining US export controls. This may explain a small portion of the deficit with China, but certainly not the bulk of bilateral trade. As the analysis in Part 1 makes clear, China's trade and foreign investment policies are aimed at export growth, and in this they are succeeding.

Nevertheless, US export controls remain in place for China for potential dual-use items, and licenses are reviewed on a case-by-case basis. As a result, the number of dual-use export license applications is down but the percentage of denials has increased. Despite the existing review process, however, the potential for significant levels and types of commercial technology transfers to China as the price of market access remains quite high.

US BUSINESS PERSPECTIVES

The potential of China's market is simply unparalleled, and the prospect of selling most anything to over one billion people, in one place, is irresistible for most companies. This popular way of thinking about the China market, however, overlooks one critical fact: China's market is not as open as it would appear. Numerous tariff and non-tariff trade barriers exist that, in addition to restrictive foreign investment regulations, make selling a foreign-made product directly to China's 1.2 billion consumers a difficult, if not an impossible, prospect.

The dynamism of China's relatively rapid economic liberalization since 1978 has overshadowed in large part China's industrial goals and policies that are explicitly designed to restrict and manage foreign investment in order to protect and bolster China's domestic industries. As a result, foreign investment has until recently been limited to China's coastal regions and is only now being allowed into some central and Western regions in accordance with central government plans. Furthermore, the technologies accompanying foreign investment are increasingly advanced as China's foreign investment and import regulations become more restrictive and selective.

China's is a buyer's market. As such, the leverage of an enormous potential market allows Chinese officials to frequently play foreign competitors against one another in their bids for joint venture contracts and large-scale, government-funded infrastructure projects in China.[4] While numerous complaints have been registered by US companies with the USG (formally and informally) regarding unfair trade practices in China, many companies are hesitant, if not unwilling, to complain publicly or even privately about the numerous difficulties inherent in doing business in China.[5] It is not surprising then, that despite the fact that the majority of industry representatives interviewed for this study clearly stated that technology transfers are the price of doing business in China, most also were optimistic about their future business prospects in China in the future and did not think the entry "price" had yet become too high.

What is not in dispute is the enormous *potential* of China's market. However, the various Chinese policies restricting foreign investment in certain industrial sectors, in particular regions, and to sophisticated technical levels result in missed opportunities and lost benefits for both foreign and domestic entrepreneurs in China. A key restriction in many industrial sectors is the requirement to establish manufacturing joint ventures in China in order to sell to the China market, and then only indirectly as distribution channels are often available only to Chinese companies. Even where this is not the case, the combination of high tariffs and numerous non-tariff trade barriers make the prospects of selling many US-made products to Chinese consumers commercially impractical. Mandated export quotas based on the percentage of total output in sectors such as electronics also make it extremely difficult to sell products in or to China. As a result, the USG estimates that more liberal Chinese trade policies would probably permit an additional $500 million a year in US exports

to China, which would make at least a small dent in the over $50 billion US trade deficit with China.[6]

Furthermore, US companies, including high-tech firms, seem to believe that it is more important to establish a foothold in China than to make profits or even gain more than limited access to its market. Thus, if Chinese policies mandate a manufacturing joint venture and commercial technology transfers in exchange for market access in China, many companies are ready to do so. This is not to say that these firms are wholly unaware or unconcerned about giving away proprietary information, infringements of intellectual property rights, or various other dangers inherent in foreign joint ventures. Rather, most companies seem to think that these problems are either 1) easily prevented by taking proper precautions or 2) worth the risk. Even in industry sectors such as software, where piracy is above the 90 percent range, American and other foreign firms are not deterred from trying to manufacture or develop and then sell their products in China.

According to a recent joint survey conducted by *Business China* and AT Kearney, foreign investors in China are finding it tougher to realize a profit or return on investment, with 3.6 years the average time expected for break-even revenues and 6.4 years on average expected before realization of global return on investment. Furthermore, almost half the companies surveyed (47 percent) found their expectations for the China market "were not just different but lower than those in other countries." Finally, the survey concludes as well that despite 1) the increasingly complex investment environment now in place in China; 2) the low expectations of foreign investors for return in the near-term; and 3) the survey result that shows foreign investors view advanced technology as increasingly important over the next half decade, the authors also note that market leaders "appear willing to invest their best technology and products — an approach that appeals to Chinese officials and companies which are often only interested in dealing with industry leaders and their best products."

For survey data, see "Local Heroes," Business China, June 9, 1997, pp. 1-3.

There are certainly some benefits for US firms in having a high-tech joint venture in China, such as low labor costs for more simple manufacturing or assembly processes and the opportunity to work with Chinese workers in developing products specific to the China market (such as Chinese-language software). More US firms and other multinationals (MNCs) are reportedly turning toward "off-sourcing," which entails preliminary production conducted in China in order to take advantage of low labor costs, but with final production occurring in the US.[7] However, the risks associated with production in China would seem to outweigh the benefits in the high-tech sector, which does not necessarily require what China's economy naturally serves best: labor- or land-intensive industries or low-tech, high-volume products.

So, why are US and other foreign high-tech firms in China? The answer heard most often in our interviews and survey of press reports is that one cannot *not* be in China, lest a competitor get a foothold first. China desires and certainly needs advanced technologies, and many US high-tech firms appear willing to pay the price — commercial technology transfers — in exchange for limited market access.

China has captured the imagination of entrepreneurs around the world. China's potentially enormous market may not, however, materialize as expected or hoped for, at least not for foreign enterprises currently manufacturing products in China. As the following

industry case studies show, being in China does not necessarily open all doors to China's market.

INDUSTRY CASE STUDIES: Automotive, Aerospace, Electronics & Telecommunications

Below is a brief look at the current status of each of these high-tech industry sectors in China. Each of these industries is assessed on the number, type, and practices of US joint venture manufacturing enterprises in each sector as well as the overall technological level achieved by each industry in China. However, economic and financial data regarding China are notoriously difficult to attain and often contradictory, if not wholly suspect. Thus, the degree to which China has developed indigenous capabilities in these sectors is not absolutely clear and may better reflect the advances made by Sino-foreign joint ventures. Nevertheless, in these important high-tech sectors, it is often the Chinese partner(s) who maintains an equal or majority share of the joint venture. Any technological advances made by the joint enterprise, therefore, can appropriately be considered beneficial to the Chinese partner as much or more than for the foreign partner.

The first industry sector studied is China's auto industry. Although not generally considered to be "high-tech," this industry was chosen because of the critical infrastructure and dual-use technologies necessary to develop this industry, the existence of a published auto "industrial policy" in China, and the relatively early entry of US auto companies into China. Moreover, this industry is strategically and economically important due to the dominant role this industry plays in supporting a range of other critical industries (e.g., the steel, machine tool, bearings and other industries). This section is followed by similar case studies on China's aerospace and electronics industries.

Automotive

China's auto industry provides a good example of the policies and difficulties with which foreign investors in China must contend. These include the following: 1) status as a "pillar industry," which affords preferential treatment in terms of government resources and funding for new or existing facilities in this sector; 2) an official, published auto "industrial policy" designed to develop an indigenous auto industry by utilizing technologies acquired from foreign companies; 3) numerous trade barriers; 4) competition from the large state-owned enterprise sector; and 5) problems related to China's infrastructure as it relates to this industry.

"Pillar Industry" Status

China's leaders view the auto industry as strategically important (as does the USG) given the upstream technologies necessary in automaking. Chinese officials have thus proclaimed the auto industry to be among China's "pillar industries." This label confers the benefits of increased government funding and assistance to China's struggling domestic auto industry, much of which

TABLE 16
Goals for China's Automotive Market

All vehicles	1.28 million units	1993
	1.6 million units	1996
	2.7-3 million units	2000
	6 million units	2010
Cars:	1.2-1.5 million	2000

has emerged from converted defense industrial enterprises. The PRC government plans to merge and consolidate the existing state enterprises, and to give preference to eight Chinese companies partnered with foreign automakers, in order to establish autos as a "pillar" of the Chinese domestic economy by 2010.[8] The ultimate goal is to create a Chinese version of the "Big Three" American automobile makers.[9]

In order to meet the goals set out in China's auto policies, however, growth in China's automobile industry will need to average over 12 percent growth per annum to reach the production level of three million vehicles by the year 2000.[10] If realized, this type of growth would represent a significant growth spurt in China's auto industry, which is unlikely given the current overcapacity in China's own market as well as in the global auto industry.[11]

China is currently ranked 11th in terms of world auto production. China is also the world's largest producer of motorcycles (since 1995), due in part to production from converted defense industrial enterprises[12]; other parts of the auto sector and other industries may soon follow this trend. China's production capacity for passenger cars is already two to three times as much as current production levels. This low utilization of capacity is in part a result of an austerity program over the last few years restricting capital (and thereby limiting government purchases of vehicles, by far the largest customer) as well as low market demand (though not desire) among China's emerging middle-class to purchase a car. The market demand for passenger cars is low due to auto prices that remain out of reach for most Chinese consumers (and that are set by the central government for all cars — foreign and domestic). Nevertheless, reports show that Chinese consumers' *desire* to drive and own automobiles is surprisingly large, evidence being the number of people applying for drivers' education and licenses. Autos have become one of the "must-have" items among China's emerging middle class, despite the impracticality of owning a car. Environmentalists argue that this is just as well — for China and the rest of the world— given the pollution factor of so many additional vehicles on the worlds' roads.

China's auto overcapacity is also a consequence of redundant and widespread state/provincial investment in the auto sector in response to defense conversion and foreign investment incentive programs. The result has been a fragmented domestic industry that produces comparatively low quality and low-tech, though perhaps durable, automobiles. Although China's converted defense industrial enterprises produce higher quantities of motor vehicles (mostly trucks), the non-state sector plants produce higher-quality vehicles using less labor and are therefore more efficient and likely more profitable.[13]

Industrial Policy

In February 1994 China's State Planning Commission adopted the "Automotive Industry Industrial Policy" (AIIP), which was published on July 4, 1994 in the *People's Daily* (*Renmin Ribao*).[14] The auto industrial policy was the first such document to be published by Chinese officials in an effort to provide more transparent investment guidelines for prospective foreign investors. What it made clear, however, was the extent to which Chinese state planners are managing the development of China's auto industry, which is largely dependent upon the acquisition of foreign technology.

TABLE 17
Requirements for Establishing an Auto Manufacturing Joint Venture in China

*	"An office responsible for technological research and development must be set up within the enterprise. The office will have the capacity to update products"
*	"The enterprise must have a capacity for manufacturing products which attain the international technological levels of the 1990s"
*	"The joint venture enterprise will obtain the foreign exchange it needs mainly through exporting its products"
*	"The joint venture must give priority to locally made spare or component parts when they need them"

Source: Article 31, Chapter Six: "Policy on Using Foreign Funds," of China's 1994 Auto Industrial Policy.

The plan includes, for instance, very explicit mandates for high levels of local content: 40 percent local content at start up (that had previously been required only after the third year in operation), 60 percent by the second year and 80 percent by the third year for passenger cars. Similar local content requirements exist for auto components, and the levels for trucks are even higher. Local content requirements are not unknown in developing nations, but they are rarely so high. The USTR notes that the AIIP "explicitly calls for production of domestic automobiles and automobile parts as substitutes for imports, and establishes local content requirements, which would force the use of domestic products, whether comparable or not in quality or price."[15]

Nevertheless, Chrysler's joint venture, along with several other foreign automotive joint ventures, had already reached greater than 80 percent local content by end of year 1994.[16] In order to reach this degree of quality local content, however, a foreign business has two options: to either encourage their suppliers to also come to China (as does Ford Motor Co., among others) or to train local workers to produce quality products (as many foreign companies opt to do). Either way, technological know-how is transferred to China.[17] Thus, the publication of this industrial policy served to make China's intentions and motivations for allowing foreign investment more clear, but not more comforting for prospective investors. The local content provisions would also appear to violate provisions eliminating import substitutions under the Sino-US 1992 MOU on market access.[18]

Trade Barriers

Even before publishing its auto industrial policy, the PRCG was (and still is) able to protect its domestic auto industry while still attracting foreign investment and technology. This is accomplished mainly through foreign joint venture manufacturing facilities in China coupled with prohibitively high tariffs and non-tariff barriers on foreign autos and auto parts. In addition to the 17 percent value-added tax (VAT) imposed on all imports, foreign autos are tagged with an excise or "consumption" tax as well as tariffs reaching up to or over 100 percent for passenger cars, 30-80 percent for commercial vehicles, and anywhere from nine to 100 percent on parts.[19]

Infrastructure

A key factor restricting China's market demand for automobiles is limited infrastructure. Traffic gridlock already exists in China's major cities, and there are very few

parking lots, street parking, or gas stations to be found on the Mainland. The auto industrial policy attempts to rectify these critical shortages by mandating that new or renovated buildings have sufficient parking and for new gas stations to be built. These shortages can only be alleviated over a long period of time, probably a decade or more.[20] A lack of good roads is also a problem in China. As of 1994, China's entire high-speed expressway system would not span the distance from New York to Chicago.[21]

US Experience

China continues to attract foreign investment in its automotive industry, despite mandated technology transfers (in the form of local content, import substitution, and technology development center requirements) included in China's auto industrial policy; limits on foreign auto investors to certain auto sectors; an extremely limited infrastructure necessary for a sizable auto industry; and the fact that China's contribution to the global overcapacity in auto manufacturing is of growing international concern. American automakers have been no better able to resist the draw of the China market than have businessmen in any other industry.[22]

US auto companies in the China market include Chrysler, General Motors, Ford Motor Co., and several of their suppliers. These three major automakers have had quite different experiences in the China market, however, and their investment and technology transfer strategies provide a useful means of comparison.

The Chrysler Corporation

The Chrysler Corporation has been in China longer than most, beginning with the acquisition of their only joint venture, the Beijing Jeep Corporation in 1987. Despite almost a decade of relative success in producing both the Jeep Cherokee and a wholly locally produced military-style jeep (the BJ2020 series), by 1995 Chrysler had pulled out of its bid to build a new minivan joint venture enterprise in Shanghai out of complete frustration. According to press accounts, Chrysler executives were expressly concerned over licit and illicit technology transfers. Chinese officials were demanding more advanced technology than seemed appropriate or necessary to Chrysler.[23] Chrysler's concerns were amplified when Chrysler CEO Robert Eton was made aware that knock-offs of Chrysler's Jeep Cherokee had been seen on the streets of Beijing. When complaining about this to Chinese officials, he reportedly was told that this (the ability to copy Chrysler's Jeep Cherokee) was a good sign of progress in China's auto industry, about which he should be pleased.[24] Apparently he was not, and Chrysler soon canceled plans to go ahead with the Shanghai plant. According to interviews conducted for this study, given the experience in Beijing, Chrysler executives were made even more wary of the technology transfers, proposed licensing deal, and export quotas being requested as part of the Shanghai deal and decided that the risk was simply too great when it came to what was for Chrysler a relatively new car (the minivan) and, therefore, advanced technology.[25] Chrysler currently has no plans to expand its investment ventures in China.

General Motors Corporation

General Motors has a bold and ambitious strategy for the China market. GM beat out other prospective foreign partners with a more than $1 billion bid to produce a variation of Buick sedans with the Shanghai Automotive Industry Corp. (SAIC) in Shanghai's Pudong

District, the only automobile joint venture deal expected to be approved by Chinese officials before the year 2000.[26] One of the major factors, if not the main impetus for the subsequent contract award, was GM's willingness to transfer a good deal of "state-of-the-art" technology. The Buick sedan variation has been described in press reports as "more or less current technology."[27] The fact that technology transfer was, indeed, the price extracted from GM for the joint venture contract is confirmed by internal GM documents.

GM's technology transfers are primarily in the form of joint research and development projects as well as training of Chinese workers and managers. GM's Chief Technology Officer for GM China noted in at a 1996 industry conference that, "As part of the agreement [with SAIC], technology institutes have been set up in conjunction with the vehicle programs...[adding that] GM's technical center in Warren, Michigan, is acting as the technology integrator for research being done at six Chinese universities and through seven joint ventures."[28] This accords with China's 1994 Auto Industrial Policy, which states that Sino-foreign automotive industry joint ventures are required to "set up within the enterprise" a research institute devoted to developing technology.[29] Both GM and Ford have established a number such institutes in China, and often at the same universities.[30] It is unclear to what extent these and similar institutes, centers, or labs are involved in actual research and development or simply training of local hires.

Ford Motor Company

Ford has also been willing to establish research and development centers in its efforts to invest in China's auto industry. The only vehicle joint venture Ford has established in China to date is with Jiangling Motors (in Nanchang, Jiangxi Province) to produce "Transit" minibuses, for which production began in December 1997 as planned.[31] Locally manufactured content for the Transit minibuses will start at 50 percent and grow to the 90 percent local content target.[32] Ford also has established several joint ventures for auto parts and has reportedly entered into a joint research project with the State Science and Technology Commission (SSTC) to develop alternative fuels (as has GM).[33] Ford's strategy for building a presence in China is based on much more dispersed and smaller investments than is GM's, though this may be of necessity rather than by choice. Nevertheless, Ford seems content to maintain a presence in China without expending enormous capital or technology for the privilege.

These three strategies — Chrysler's cautiousness, GM's boldness, and Ford's middle-of-the road approach — have not resulted in significantly different returns. Despite large investments in China's auto sector, US automakers have yet to realize significant gains in terms of market share in China's passenger car industry. Furthermore, according to numerous press reports and interviews conducted for this study, few if any foreign automakers in China are realizing a profit or even a return on their investment.[34] Statistics for 1994 also show that US automakers averaged no more than 10 percent market share compared to Japanese and European auto ventures in China who have achieved up to 40 percent shares.[35] US market shares have, if anything, declined since then.

As the new GM and Ford plants begin producing vehicles over the next few years, their market shares may increase. However, it is interesting to note that the US automaker with the longest experience in China is the most cautious with regard to manufacturing modern vehicles in China under current government policies. Nevertheless, the consistent

answer to why these and other foreign firms persist in attempting to penetrate the Chinese auto market is the fear that a competitor (foreign or domestic) will benefit by being in China when China's market potential becomes a reality. The question and the concern for US industry in terms of China's auto sector, however, should not only be when, but whether, the market potential and stated goals will be realized. That is, by the time this happens, China's auto makers could well have garnered most, if not all, of this market for themselves, using capital and technologies supplied by foreign investors along the way to develop a substantial domestic auto industry.

TABLE 18
Research in China by US Automotive Industry

General Motors

GM has set up three R&D centers in China to date (at least two more are expected):

- The "GM in China Technology Institute" at Qinghua University in Beijing for R&D, post-graduate education and training in auto-making (1995). R&D work includes fuel quality studies, piston ring package development, crash injury and airbag module studies, and pedestrian protection test modeling[36]
- The "Powertrain Technology Institute" with Jiaotong University (1995)
- A new, $4 million center for R&D with its Shanghai joint venture partner

Ford Motor Company

Ford has established R&D centers and Labs as part of its joint venture with Jiangling Motors:

- Two R&D centers: one with Qinghua University in Beijing (China's equivalent of MIT) and one with Jiling University in Xian
- Two "Labs": one with Jiaotong University (Ford's C3P Laboratory involving the latest software for advanced computer-aided design, manufacturing, design; product information management; and training of PRC employees) and a recent agreement with Fudan University's Institute of Electronics in Shanghai to establish a "Joint Research Institute of Automotive Electronics."[37]

State of China's Automotive Industry

China's auto industrial policy clearly outlines China's plans for a self-sufficient and export-oriented auto industry. This has had a clear effect on China's auto trade balance. According to Chinese statistics, in 1986, 80 percent of all cars in China were imports, whereas currently less than 10 percent of China's automobiles are imports. By 2010, China hopes to achieve zero imports of foreign automobiles and auto exports of ten percent of auto production.[38] In the meantime, China continues to maintain extremely high and prohibitive tariffs (150-180 percent) on fully assembled foreign vehicles, and Chinese joint venture

partners, who are often chosen by the PRCG, must hold a majority share in the enterprise. The apparent strategy, therefore, would seem to be a continuation of tariff and non-tariff trade barriers while protecting and supporting the domestic auto industry. Negotiations with regard to China's accession to the WTO may alleviate the problem of trade barriers in this sector but are unlikely to alter China's plans to develop as quickly as possible an indigenous auto industry.

An emerging trend in foreign investment in China's auto sector is a rise in auto part manufacturing joint venture enterprises. US component manufacturers in China include GM subsidiaries Delphi Automotive Systems (with 14 joint ventures in auto components), Delco Electronics, Hughes Electronics (electronics for autos and more), and although recently spun-off from GM, Electronic Data Systems (information technologies). Borg Warner Automotive/Beijing Warner Gear Co. (transmission cases), the Dana Corporation (axles),[39] and TRW (components, which include seatbelts, engine valves, "switches, control systems and other electrical/electronic products" and possibly steering gears, air bags, crash sensors, and fasteners as well)[40] are also in China as is Meritor Automotive (formerly Rockwell, truck axles), and others.[41]

US trade figures indicate that US imports of auto parts from China have risen dramatically since 1992, almost tripling in value by 1996-97 and far outpacing growth in global US auto imports. The majority (about 70 percent) of US auto parts imports during this period consisted of brake drums, rotors, radiators, and parts as well as other miscellaneous auto parts (see table below for figures). China's overall share of total US auto parts imports, despite being small compared to total US auto parts imports, has grown as well.

"Productivity levels in the PRC auto parts industry, in particular, have benefitted from foreign investment."
Source: Wayne W.J. Xing, "Shifting Gears," The China Business Review," November-December 1997, pp. 8-17.

Although the import statistics do not clearly indicate a direct connection to US joint venture production and exports, given the high percentage of exported product required of foreign auto joint ventures in China, it is likely that some, if not many, of these imported parts are produced by US plants in China. If so, this could have serious implications for the auto industrial base in the United States in the future as more suppliers follow the "Big Three" into China. Given the high requirements for local content, it is likely, too, that foreign auto parts manufacturers in China will be increasingly involved in producing more sophisticated products (for example, airbags).

TABLE 19
US Imports of Auto Parts from China: 1992-1997 ($Thousands)

Category	Description	1992	1993	1994	1995	1996	1997
HTS 8708	**Total Motor Vehicle parts**	**$58,276**	**$62,672**	**$95,291**	**$129,303**	**$154,765**	**$188,310**
HTS 870839	Brakes and Parts thereof	$8,188	$16,724	$33,933	$50,966	$58,203	$74,194

HTS 870891	Radiators	$3,643	$4,390	$10,565	$13,285	$15,245	$11,478
HTS 870899	Parts and Accessories, NESOI	$33,660	$29,296	$30,983	$40,720	$48,373	$58,748
Subtotal for HTS Categories Above		$45,492	$50,410	$75,480	$104,971	$121,821	$144,421
Percentage of Total Auto Imports from China		**78.1%**	**80.4%**	**79.2%**	**81.2%**	**78.7%**	**76.7%**

Source: US Census Bureau

Chinese automakers control the distribution system for autos (primarily through former military and defense industry channels) and seem to have mastered the basic manufacturing and assembly of vehicles. However, they remain dependent on foreign components and have an insufficient understanding of the complete auto-making process from cradle to grave (i.e., management and marketing skills, customer service, quality control and reliability, etc.). The International Trade Administration (ITA) estimates that "with the exception of the Tianjin Automobile Industrial Corporation, which produces 60,000 passenger cars a year on a licensing arrangement with Daihatsu, all production in any scale and with any real quality has been done with the help of a foreign partner in a joint-venture agreement. As with most investment in China, the foreign partner is expected to contribute money and technology."[42]

Although China's auto sector may be overcrowded and fragmented and its products of lesser quality than foreign-made products, there are indications of development. According to PRC domestic auto industry data, "altogether, there are now 122 automobile plants, 516 refitting enterprises, 109 motorcycle plants and more than 2,000 component manufacturers [in China]. There are also 32 technological centers and research institutes, three car testing centers and 12 quality control centers for auto products."[43] Foreign enterprises have also contributed to developing China's auto sector. According to Chinese sources, "By 1995, the [foreign] sector has introduced 313 foreign technological items, including 26 for whole car production, 30 for motorcycles, 25 for main assembly, and 153 for spare and component parts. Also in this period, 350 automobile and motorcycle joint ventures were set up, employing US$1.5 billion. All these efforts helped improve the industrial structure."[44] The number of new enterprises and institutions may or may not connote real development in China's auto industry, but the addition of technological research and development centers are sure to assist in advancing China's auto sector. The unveiling of China's first, domestically produced family car, the "Lucky Star," may provide a concrete indication of just how advanced China's indigenous automaking capabilities have become. [45]

Conclusion

Although the influx of foreign investment and technology into China's auto industry have assisted in upgrading China's domestic auto-making capabilities, China's auto sector does not currently pose a direct competitive threat to

"Foreign investment generally has helped the PRC auto sector upgrade its technology and efficiency levels...Other foreign firms have helped diversify China's auto market. *Source: Wayne W.J. Xing, "Shifting Gears," The China Business Review," November-December 1997, pp. 8-17.)*

the US auto industry as a whole. The current output of all of China's auto plants would not equal that of one of America's "Big Three" automakers.[46] However, the rapid development expected in China's indigenous auto sector is not only a question of market share or production levels. As noted above, much of the development of China's auto industry is the result of defense conversion programs and other industrial reform efforts. The application of auto manufacturing technology and processes to the defense sector (spin-ons) is possible, but not a likely scenario in the near future, particularly given the China's lack of external threats at present.

Demand in China's auto industry, however, is not expected to outpace production capacity any time soon, thereby providing time for China's domestic auto industry to develop and for Chinese auto exports to grow. Asia is currently the largest auto-producing region in the world. The result is that all of Asia is now witnessing overcapacity in the auto industry, approximately 15 percent of which is due to overcapacity in the China market. As China's auto sector develops, the global problem of excess capacity will only continue to worsen, by which time, most if not all foreign investors may have abandoned the China market.[47] The point to be made here, however, is that a good deal of technology transfer could occur in the interim with slim near-term returns to US companies.

Although initially attracted by China's potential auto market, several foreign automakers (including Peugeot, Toyota, Mercedes Benz, and Chrysler) are now reconsidering, slowing, or pulling out of their investments in China. GM is the obvious exception, as they intend to make their new Shanghai joint venture the hub of GM's Asia auto system. The UAW, however, has sounded a note of caution, stating that "most industry analysts predict that demand in the PRC will lag behind production capacity significantly in the years ahead, creating the potential for exports of automotive vehicles and parts from the PRC that compete with US production."[48]

Finally, the difficulties experienced by foreign automakers in China and the strategies developed by Chinese officials to manage the industry in a way that restricts and discriminates against foreign investors (but does not appear to significantly stem foreign investment or technology transfers) are not unique to the auto sector and may foreshadow problems and areas of concern for future high-tech foreign investment in China.

Aerospace

Not an Official "Pillar Industry" Nor an Official Industrial Policy

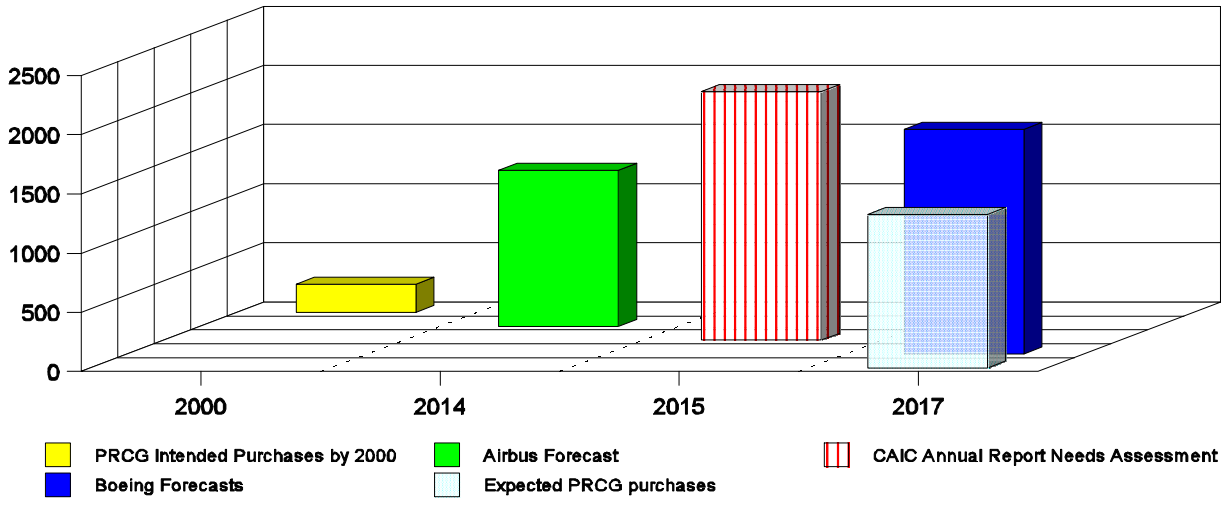
China's aerospace market also demonstrates the effects of managed foreign investment focused on technology acquisition. Although the aerospace sector has *not* been officially designated a "pillar" industry, Chinese officials certainly regard this as a strategically important sector and have allocated significant funds for development of its civilian aviation industry (along with other infrastructure projects). It should be noted also that there is no official, published policy requiring technology transfers in the aerospace sector. However, analysts argue that no such status or policy is necessary. Foreign aerospace technology is available to China and is likely to grow. As with other industry sectors, Chinese officials pursue a strategy of playing foreign investors off one another.[49] There is no better example of this than in the competition for China's aviation market between the United States' Boeing Company and the European Airbus consortium.

Sources: China Aviation Industrial Corp, under Civil Aviation Administration of China (CAAC); "The Boeing Company and China."; "And Then There Were Two," Asian Wall Street Journal (HK), December 17, 1997; "Boeing Takes Most of 1996's Aircraft Orders," South China Morning Post (HK), January, 4, 1997; "Airbus Makes Bid for 100 Planes," Reuters (UK) report, March 4, 1997; Annual Report by China Aviation Industrial Corp, under Civil Aviation Administration of China (CAAC), cited in "China's Needs for Planes Increases," China Economic Information (PRC), March 15, 1997 all cited in China Commercial Quarterly, Dec. 10, 1996-April 1997; Tony Carter, "Strategic Customer Development in China," The Columbia Journal of World Business, vol. xxxi, no. 4, Winter 1996, pp. 56-64;60.

Unlike the auto sector, the projections for China's demand for commercial aircraft are more realistic, although the estimates cover a wide range over the next 20 years (see chart below). The demand for air travel in China — both foreign and domestic travelers — is enormous and will surely require numerous Chinese purchases of foreign aircraft. Accordingly, Chinese officials plan to spend over $1 billion on infrastructure projects, including airport construction, and "technological renovation projects" (such as upgraded ticketing systems). This figure is in addition to monies set aside for purchasing aircraft and local airport-related projects.[50] It is not surprising, however, that PRC officials are concerned about dependence on one aircraft manufacturer, Boeing, whose planes comprise approximately 80 percent of all planes flying in China today (279 out of 354 jetliners in mid-1997). For this reason, as well as for political leverage, Chinese officials have increasingly alternated purchases of civilian aircraft between Boeing and Airbus.[51]

Trade, Trade Barriers, and Technology Transfers

Chart 2
Projections for Chinese Commercial Aircraft Demand



One in every ten Boeing planes produced is intended for sale to China, making Boeing the largest single US exporter to China.[52] This ratio is likely to increase as Asia, led by China, is the fastest growing market for US aerospace exports, comprising almost 14 percent of total US aerospace exports in 1996.[53] Despite the obviously enormous opportunities present in China's aviation sector, however, US aerospace companies, represented now primarily by Boeing (due to the recent merger with McDonnell Douglas) and several parts suppliers, appear to be willing to make significant

concessions to Chinese state planners in co-production agreements in return for increased market access.[54]

According to the United Auto Workers (UAW), "US-based aerospace firms have already agreed to onerous conditions in order to win access to the market in the PRC by acceding to co-production deals and technology transfers."[55] The UAW is not alone in its criticism of the apparent *quid pro quo*.[56] Examples of commercial offset agreements by US aerospace firms include donations by Boeing of two multi-million dollar simulators to the Civil Aviation Flying College (CAFC) for training as well as other pilot training programs, a spare parts center in Beijing, and millions of dollars worth of "infrastructure development" in China.[57] Boeing is also not alone. Rockwell (purchased by Boeing in 1997) has also set up automation training centers with three Chinese universities.[58] In addition, a senior representative of AlliedSignal noted in a media interview the importance of offsets as a means of getting a foothold in the China market. With regard to China he stated that, "Obviously, we're hopeful that our presence there and all the technology transfer will have an impact on equipment selection for the AE-100. We'd like to leverage our presence into higher content, but it's more of a recognition by senior management that there's just a tremendous future market potential for aerospace in China, and we need to be there."[59] Arguably, these agreements also benefit Boeing, AlliedSignal and the traveling public as a whole. However, contracts based on co-production in China and accompanied by commercial offset provisions will likely increase in number and in terms of advanced technology transfers over time.[60]

TABLE 20 US Aircraft Parts Co-Produced by Chinese Joint Venture Partners	
737	vertical fins, horizontal stabilizers, forward access doors, tail sections
747	trailing edge ribs
757	cargo doors, empennage
MD80	nose section
MD82	plane co-production and "kit" assembly (up to 20 percent Chinese content)
MD90	final plane assembly in Shanghai; nose section, component fabrication, and "significant sub-assembly production" (up to 80 percent Chinese content)
Airbus Industrie Aircraft Parts Co-Produced by Chinese Joint Venture Partners	
A300	access doors, machined parts
A310	access doors, machined parts
A320	fin-ribs, emergency exit doors
A330	access doors
A340	access doors
AE31X/AE100	assembly line production [program has since been cancelled]

Source: Boeing Company press releases; for Airbus information, "Airbus Equity-Sharing Wins Chinese AVIC Partnership," Countertrade & Offset, vol. xv, no. 17, September 8, 1997, p. 3.

Competition from the State-Owned Enterprise Sector, Infrastructure Concerns, and the Status of the Chinese Aerospace Industry

Aerospace and Aviation

Growth projections for China's civilian fleet are high due to the increasing demand for air travel in Asia and in China. The current size of China's civilian fleet is thought to be comparable to that of the United States in the 1950s.[61] Most of China's civil aviation market was "corporatized" in the early 1990s, and air traffic control (ATC) is increasingly coming under civilian control.

Boeing has done business with China since President Nixon's first initiative in 1972 to renew ties with the PRC and has collaborated in industrial co-production since 1980. As a result, Boeing claims that "there are approximately 2,000 Boeing airplanes currently flying worldwide that include major parts built by China." Other US aerospace firms are now in China as well. Pratt & Whitney (P&W), whose jet engines currently power almost half (45 percent) of China's civil aircraft, became in February 1996 the first foreign company to

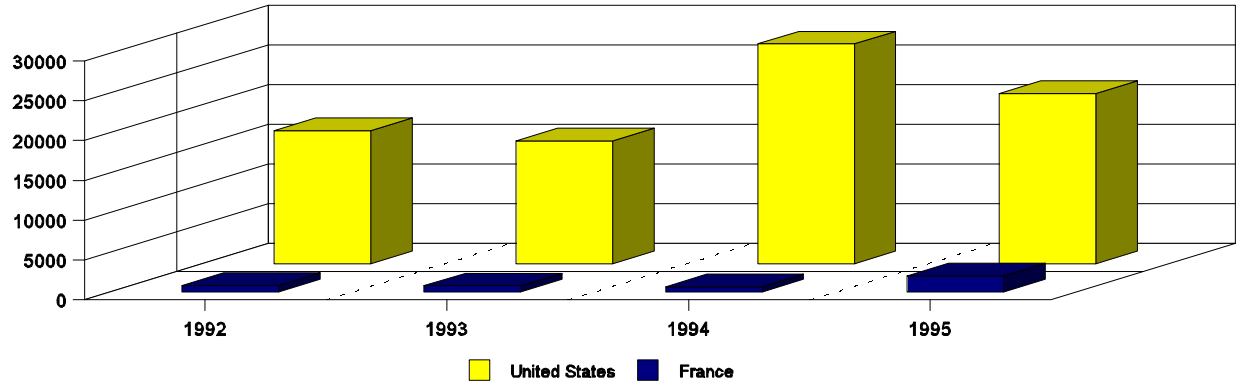
establish an aviation parts manufacturing joint venture in China (with the Chengdu Engine Company) to produce manufactured parts and assemble engine parts.[62] In addition, AlliedSignal Aerospace has a parts repair joint venture that refurbishes advanced technology carbon brake disks. As of May 1997, Raytheon had contracted to install nine air traffic control (ATC) radar systems, the latest of which "includes primary and secondary surveillance radars, communications, training, and spares for the new airport in the southern city of Guangzhou."[63]

It is not only from US aerospace companies such as Boeing (and McDonnell Douglas) but also European companies such as the Airbus Industries consortium and their respective suppliers from whom China is gaining aircraft manufacturing know-how. Chinese aircraft companies engaged in these co-production and manufacturing projects do appear to be learning from these experiences. Taking Chinese industry export statistics as an example, of the transport and equipment category (SITC 79), airplane or helicopter parts were the top Chinese export item to both the United States and France for each year running from 1992 to 1995 according to Chinese trade statistics submitted to the United Nations, although the US far outpaces France in this category (see chart above). US trade figures (for HTS 8803300610) confirm these figures but show that although US imports of aircraft parts from China increased between 1992 and 1995, the percentage of total US imports in this category remained at about one percent through 1997.

The opportunity for US technological know-how to indirectly assist the PLA Air Force (PLAAF) modernization efforts does exist. Foreign aerospace joint ventures are typically established with or located near China's military aerospace factories, namely the Xian, Shenyang, and Chengdu Aircraft Factories (this includes Boeing and former McDonnell Douglas ventures) in addition to various other locations such as Shanghai.[64] For example, in addition to co-producing the parts for Boeing, the Xian Aircraft Company manufactures China's H-6 bomber (first produced in the late 1960's under license from the USSR) and various civilian passenger aircraft. These three companies are each attempting to manufacture new-model fighter/combat aircraft for indigenous use as well as for export. Foreign partners and components are being sought for co-development but are having to depend largely on domestic technologies due to the break off of military assistance beginning in 1989. However, state-owned military aerospace industry corporations have shown a preference for focusing on commercial, profit-making endeavors rather than devoting energy, time or resources to the primary task of defense production.[65] Chinese President Jiang Zemin's July 1998 directive that the PLA dissociate from its commercial enterprises is expected to affect the type of work these enterprises focus on in the future.

There are also significant barriers to China's ability to realize military gains from civilian aircraft-related US commercial technology transfers. Chief among these, of course, is the fact that sanctions stemming from reactions to the Tiananmen Square incident in 1989 prohibiting military sales to China remain in place.[66] Internally, China's abilities and reputation in terms of military aircraft manufacturing and reverse-engineering capabilities is notoriously poor and does not seem to have improved. According to a survey of China specialists conducted by Robert Sutter in 1997, "Chinese military engineers and other technicians have endeavored to develop their own technologies and weapons, in the process new Chinese weapons systems have often taken a long time to move from the planning stage to deployment, and many have not made it to deployment."[67] Since Sino-foreign co-production projects only really began in the late 1980s, it is unlikely that much

Chart 3
Chinese Exports of Airplane or Helicopter Parts: 1992-1995
($Thousands)



significant progress in attempting to spin-on this technical know-how to military purposes has occurred thus far. Another factor that is likely to impede military benefits accruing from foreign aviation co-production agreements is the fact that Chinese airlines have been rapidly deregulated and have been made more autonomous in their dealings with foreign aircraft suppliers. Thus, decisions as to which foreign aircraft and aircraft parts manufacturers are chosen for Chinese joint venture agreements have become more political and commercial in nature rather than decisions based primarily on military objectives.
Source: United Nations

Nevertheless, despite the overall modest capabilities of China's military air force, some of the technologies involved in Sino-US joint ventures could potentially assist China's military as well as commercial aviation sector. The areas in which China's air force is seriously lacking coincide with some of the high-tech foreign investment areas in China. For example, among the PLAAF's most serious deficiencies are high-volume, high-quality production of aircraft and a limited command and control network. Foreign (including US) joint ventures in the aerospace and telecommunications sectors are involved in manufacturing technological products that could potentially be used to improve these military capabilities (e.g., air traffic control or global positioning systems). In late 1996, Rockwell announced plans to form a company to design, develop and build commercial GPS navigation receiver systems with Chinese partners in Shanghai (Rockwell press release). An agreement was signed in 1986 between the Federal Aviation Administration (FAA) in the United States and the Civil Aviation Administration of China (CAAC) for technological assistance in the civilian aviation sector, mainly in terms of air traffic control. [68]

Foreign technology transfers will do little to alleviate the chronic problems of China's existing antiquated military aircraft, limited training and combat experience, or the PLA's bureaucratic and logistical problems. Nevertheless, the long-term effect of foreign commercial technology transfers in the aerospace sector (as well as telecommunications, discussed below) could potentially be of greater benefit to the PLA than is either expected or desirable.[69]

Chinese Satellite and Space Programs

Satellite technology is another area in which US businesses are restricted by US trade sanctions stemming from the Tiananmen era, although three US companies (Lockheed Martin, Hughes, and the Loral Space and Communications Co.) have been allowed under Presidential waiver to sell or launch American-made satellites in China. At present, the United States maintains
a 50 percent market share in China for satellites and related parts despite the restrictions. A bilateral agreement on commercial space launches was reached in 1989 (and updated in 1997) to allow limited numbers of satellite launches by China at set costs. Because, by US law, US satellite launches and equipment in China must be very carefully controlled and supervised by
American representatives, the opportunities for significant technology transfers to China are limited in this sector.

Confidence in China's launch capabilities was severely strained following a series of accidents in 1995-1996. Perhaps for this reason, the category for "parts for spacecraft and associated equipment, launch vehicles (nesoi)" is among the relatively few categories in which US imports from China have declined, according to data supplied by the PRC to the United Nations.[70] After almost a year delay, China seemed in 1997 to have recovered from these technical difficulties.[71] China's launch services will be in greater demand due to the implementation of various Low Earth Orbit (LEO) satellite-based projects such as the McCaw-Gates Teledesic, which must out of practical necessity rely on a wide range of launch providers.

According to a recent report on the industry, US and European global market shares for international commercial satellite launches are 32 and 52, respectively, with China and Russia currently maintaining eight percent each.[72] If China is able to retain international confidence in its ability to launch commercial satellites, China's share of this important market is certain to increase due to China's comparatively low pricing for such launches and the number of commercial satellite launches expected over the next five to ten years.

The issue of technology transfers may become more critical if and when the Tiananmen sanctions are eased or ended completely. Satellite technology is dual use but also in high demand and commercially available around the world.[73] As in most industries, however, China endeavors to become fully self-sufficient in this sector.In fact, it is the expressed goal of the Chinese government to "continuously try to catch up with and exceed the advanced world level in remote-sensing science and technology under China's high-tech research and development program."[74] Accordingly, the desire for "co-development" is among the "four principles for international cooperation" set by Chinese leaders. This principle applies to the satellite industry as well.[75]

China also has ambitious plans for its space program. Chinese leaders hope to develop a space vehicle and to begin manned space flights by the year 2010. According to Chinese press reports, some recent progress has been made in this effort, with Chinese-made space vehicles descrobed as "smaller than those of the United States and less expensive to maintain." However, talk of ambitious space programs has been heard in China dating back to at least the mid-1980s, with little known progress reported.[76]

Finally, it is important to note that China views the space and satellite industries as key to its overall economic and industrial modernization plans. The plan for the 1990s is that "satellite applications and manned space flight technologies will promote high-tech industries, including mobile and optic-fiber communications, biology and marine

engineering, and new energy sources, thereby creating another leap forward in these areas." It should also be noted that despite foreign expectations, China's scientific community has in the past been successful in rapidly developing advanced technologies when provided with strong government support, funding, and motivation. If made a priority, this could also be applied to the space and satellite industries. International prestige and 'face' also potentially play an important role in this high-tech sector.[77]

Conclusion

A 1982 internal feasibility study for the Chinese military based on China's aerospace technology at the time concluded that "China should import from foreign countries certain critical technologies and actively modify the aircraft in service and develop new types of aircraft."[78] This is exactly what Chinese military/civilian aerospace companies appear to be trying to accomplish, by establishing joint ventures with foreign aerospace firms. Co-production agreements and other commercial offsets (such as Boeing's and Rockwell's training centers) can be expected as part of future aerospace contracts in China.

The number of contracts is also expected to increase as China's civilian aviation market grows and foreign aerospace firms move more manufacturing into the Asia-Pacific region.[79] However, if the largest US exporter to China — Boeing — begins to move significant manufacturing to China due mainly to commercial offset or technology transfer requirements, then this would probably hasten China's advancement in its plans to develop an indigenous aircraft manufacturing base intended to serve its own market and to provide exports to the rest of Asia. This could also have a more immediate and adverse effect on American jobs and competitiveness in the aerospace industry and for the US economy as a whole.[80] China is, in fact, listed in the US Industry and Trade Outlook among those nations with the potential to become a manufacturing competitor to the United States in the aerospace field.[81] Lastly, the cumulative effect of these technology transfers could potentially be significant advances in China's military aviation and aerospace capabilities that would likely not otherwise be possible over the same period of time.

Electronics & Telecommunications

This is the most difficult industry sector to analyze given the fast pace at which advances are made and new technologies emerge. What constitutes "state-of-the-art" technology one week may be outdated in six months or a year later. Simultaneously, however, the electronics sector also allows "fast followers." In other words, latecomers to this industry are not as disadvantaged as they are in other industries (such as auto or aerospace) and can — given basic capabilities, sufficient resources, and motivation — catch up rather quickly to the industry leaders. Although China lags behind its neighbors as well as the United States, there are indications that China is catching up in some electronics-related sectors as a result of technology transfers. Most technology transfers are in the form of component co-production and assembly as well as access to "soft" technologies (processes, management techniques, accounting methods, etc.) derived from foreign technical assistance and training.

"Pillar Industry" Status

Chinese leaders declared electronics to be a "pillar" industry in 1994. As with other pillar industries, China has developed an internal industrial policy designed to create an

indigenous electronics industry. This effort is receiving a great deal of assistance from foreign firms; "Today, every major international component vendor ... is establishing advanced capabilities in China."[82] Shanghai was chosen as the preferred location and hub for this new industry, but the planned growth has not yet materialized as expected. That may change with the existence of new government-sponsored projects, particularly in the semiconductor manufacturing sector (such as the recently awarded "Project 909" to the Japanese firm, NEC). Nevertheless, it is Guangdong and Fujian Provinces that are attracting the majority of both foreign and domestic electronics firms. The majority of Sino-foreign electronics joint ventures are located in these southern regions, including ventures with China's leading domestic electronics firms, such as Legend and China Great Wall. Both are based in Beijing but have established subsidiaries in Guangdong.[83] Primarily as a result of the dynamic interchange among Hong Kong, Taiwan, Japan, and the southern Chinese provinces, there has been a significant flow of foreign technology, capital, and know-how in this sector.[84]

Industrial Policy

Although the exact terms of an official electronic industrial policy have yet to be published, an industrial policy "outline" for the electronics sector is, nevertheless, being implemented by Chinese officials. Numerous Chinese press reports over the last several years state that the policy includes provisions that call for the following: advanced and continuous technology transfers as part of future joint venture agreements; preferential policies for foreign investors in China's electronics sector[85]; export of 70 percent of joint venture-manufactured products; high-level review and approval of certain electronics joint ventures (such as for production of color televisions, fax machines, computers and monitors, camcorders, mobile phones, etc) that must "conform to the state's industrial policies"; and the export of 100 percent of the products resulting from labor-intensive joint ventures or wholly foreign-owned enterprises in this sector. Lastly, joint ventures will be especially welcome by Chinese officials in "new generation" electronics such as broadband telecommunications as well as digital mobile communications products.[86]

The fact that an industrial policy for the electronics sector has not been officially published (as it has for the auto sector, for instance) leaves US and other foreign firms open to arbitrary decisions and pressure by local, provincial, and central government Chinese officials for technology transfers or commercial offset arrangements in exchange for market access. Member companies of the American Electronics Association (AEA) "have expressed concern about what is commonly referred to as 'market share for technology transfer.' While such technology transfer requirements are not spelled out in Chinese law, the government's practice is to persuade foreign firm[s] to transfer technology for market share."[87] Chinese officials are allegedly unambiguous, however, in making clear during negotiations that market access is available only in exchange for technology transfers and regularly try to play one foreign corporation against another.[88]

The lack of transparency also adds to start-up costs for new firms, who generally attempt to abide by established practices and legal standards at startup in order to prevent problems down the road under the assumption that the policy being implemented will in time become official, published policy. China's industrial policy for the electronics industry (as well as for other key sectors), however, is intended to be continuously updated in terms of investment, trade, and technology transfer provisions by the government as needed. In fact,

the policy of China's Ministry of Electronics Industry is reportedly that "China will not encourage technology transfers or establishment of joint ventures in China if out-of-date technologies are involved."[89] For example, China has reportedly issued new technical requirements for more advanced, domestically produced program-controlled switching devices for its telecommunications industry and announced an end to imports of program-controlled switching devices in order "to support the development of domestic enterprises and joint ventures."[90]

China's emerging electronics industry is largely concentrated in the Southern coastal region (primarily Guangdong and Fujian provinces, where China's SEZs were first established) and dominated by non-state sector Chinese enterprises involved in joint ventures with foreign companies. This was not necessarily Beijing's plan. Shanghai was expected to become the main hub for China's new electronics industry. The success and number of electronics firms in the southeastern provinces, however, is due to the regional shift in electronics production from Hong Kong, Taiwan, and Japan to Mainland China but also, ironically, to the ineffectiveness of Chinese industrial policies in the electronics sector.[91] That is, the very success of the electronics industry in these southern provinces is primarily due not to explicit trade and investment provisions included in an industrial policy designed to protect and bolster domestic firms but to the geographical, and more importantly, political distance from Beijing that allowed both foreign and domestic firms more leeway in conducting business.

Chinese leaders have designated six SOEs as key enterprises in the electronics sectors to receive preferential government assistance.[92] The more liberal political and commercial environment found in the Southeastern provinces and SEZs, however, has encouraged more market-oriented behavior among China's more successful state and non-state sector electronics firms such as Legend, Founder Electronics, the China Great Wall Group, and Stone, all of whom have channeled much of their production to the southern areas while maintaining offices in Beijing.[93] Thus, although the protection provided by China's industrial policy no doubt has assisted Chinese firms in competing against foreign electronics firms, the lack of a heavy government hand in managing these firms in the free-wheeling southeast region has allowed them to benefit from foreign competition, more so than for the selected SOEs.[94] In turn, foreign firms have been more willing to invest in this region, to establish joint ventures or collaborations with the non-state sector enterprises such as Legend and Stone, and to transfer a good deal of technology in the process.[95]

Trade Barriers

China has opened its electronics sector to foreign investment, especially over the last few years in terms of more advanced electronics. In fact, the electronics sector has received more foreign investment overall than any other industry in China, which is evident in the rise in Chinese exports and production of electronics items.[96] By 1994, the category of "electric machinery, tv equipment" (HTS85) had become the number one US import category from China (up from seventh place in 1986).[97]

Significant trade barriers remain, however, for foreign companies seeking to do business in China. In the computer hardware/software sector, China currently maintains a 17 percent VAT on hardware (13 percent on manuals) in addition to a 10 percent withholding tax and nine percent tariff on software and hardware (a 9-20 percent range exists for the latter).[98] High tariff rates (6-12 percent) exist in the semiconductor sector as well. According to the

Semiconductor Industry Association, “Chinese tariffs tend to be higher on low-end semiconductors which China can make domestically, and lower on complex devices which must be imported.”[99] Once again, this makes the prospect of exporting US products to China a costly one.

A new barrier to trade and a potential technology transfer concern has emerged in the form of inspection certificates for products to be made or sold in China. Chinese officials have periodically updated the list of items requiring safety certificates, the most recent revision of which includes technologically sophisticated items. According to the US-China Business Council, “There is also some evidence that domestic firms are not always subject to the same inspection procedures required of foreign companies. Foreign companies in a number of sectors are finding that many of the PRC's standards, licenses, and inspection procedures interfere with their ability to market their goods in China and, in effect, pose significant non-tariff trade and investment barriers.”[100] These problems with licensing and inspection are also included in areas of concern in the *1997 National Trade Estimate Report on Trade Barriers*. As the list below shows, the items requiring certification are increasingly concentrated in the electronics sector.

In a recent interview, a representative of Dell Computer Co. spoke frankly about the impractical option of exporting directly into China. In answer to a reporter’s question asking, “could you right now put up a website in China and have people order PCS directly from you?,” the Dell representative answered: “If I wanted to just import product and then buy/sell it myself as a trading company inside of China and pay full import duty because I’m a public corporation and there’s the Foreign Corrupt Practices Act that I need to comply [with] —you could do that, in theory, providing the government approved you to do that. But the price points that you would achieve would probably not be competitive.”
Don Tennant (Computerworld), “Interview: Aiming Direct at China’s PC Market—Dell’s Phil Kelly,” Market News Update, IDG China, August 12, 1997.

TABLE 21
Foreign Products Requiring Safety Licensing Certification[101]

First Catalogue of Imported Commodities Requiring SACI Certificate (Effective May 1990)	*Second Catalogue of Imported Commodities Requiring SACI Certificate* (Effective October 1996)	*Second Catalogue - Addendum* (Effective October 1997)
1. Automobiles 2. Motorcycles 3. Motorcycle engines 4. Refrigerators (including food processors) 5. Compressors for refrigerators 6. Air conditioners 7. Compressors for air conditioners 8. Television sets (b&w/color) 9. Kinescopes	1. Household washing machines 2. Vacuum cleaners 3. Appliances for skin/hair care 4. Electric shower units 5. Roasters and the like 6. Microwave ovens 7. Electric rice cookers 8. Electric irons 9. Cooking ranges 10. Food processors 11. Appliances for heating liquids 12. Video-cassette recorders 13. Audio equipment 14. Personal computers 15. Visual display units 16. Switching power supplies 17. Printers 18. Electric tools 19. Low voltage apparatus 20. Electric welding machines	21. Telecommunications terminal equipment 22. Security technology protection commodities 23. Fire alarm 24. Medical diagnostic equipment 25. Haemodialysis equipment 26. Hollow fiber dialysers 27. Extracorporeal blood circuits for blood purification equipment 28. Electrocardiographs 29. Implantable cardiac pacemakers 30. Ultrasonic diagnosis equipment and ultrasonic therapy equipment 31. Automotive safety glasses 32. Automotive pneumatic tyres 33. Motorcycle tyres 34. Automotive safety belts 35. Boilers 36. Moveable pressure vessels 37. Fixed pressure vessels 38. Safety accessories for boilers and pressure vessels

Source: Kristin Dubinski, "Certification Scheme of the People's Republic of China," Brochure prepared by Underwriters Laboratories, Inc., updated 1997.

The requirement for such certification does not, in and of itself, constitute a major trade barrier (though it may deter trade and likely contradicts WTO provisions). The problem in this particular case is that in applying for certification, foreign firms reportedly have been required to submit very detailed and even proprietary or confidential information, including

technical specifications, manufacturing processes, designs, blueprints, formulas, patents, etc. According to Underwriters Laboratories (UL), the certification process is also extremely complicated, may involve approval from numerous Chinese government ministries (depending on the product), and does not allow for initial US inspection and certification on behalf of US companies. Such provisions/conditions add significant costs to foreign firms (in terms of time required for certification and reimbursement of travel expenses for Chinese inspectors). These requirements particularly affect those companies wishing only to export their products without setting up manufacturing joint ventures in China. Products in the categories listed not receiving certification cannot be imported into, exported from, or sold in China.[102]

Furthermore, the telecommunications sector as a whole poses a significant problem for prospective foreign investors due to severe restrictions on investment. Foreign investors are not permitted to establish wholly foreign-owned enterprises (WFOEs) in the telecommunications sector,[103] the commercial side of which is controlled by a monopoly, formed by joining the former Ministry of Posts and Telecommunications (MPT) and its former state-run competitor, Unicom, established in 1994.[104] As of 1997, joint ventures are permitted with Unicom, but the foreign partner must hold no more than a 50 percent share in the enterprise. Limits on services and distribution are also areas of concern for foreign investors.

During Chinese President Jiang Zemin's visit to the United States in October, 1997, it was announced that China intends to join the Information Technology Agreement (ITA) as quickly as possible, which means that all Chinese tariffs on information technology products must be eliminated by the year 2000 (or 2005 at the very latest, and only if consent is granted by other ITA members). This is a very welcome sign for US investors in this sector, and may go a long way toward changing Chinese attitudes on adopting market-oriented policies as well as having practical effects on trade. As has been witnessed in the past, however, it is entirely possible that tariff barriers in this sector will be replace by various non-tariff barriers.[105] For this reason, it is incumbent upon US investors and government officials to continue to press China on liberalizing this most vital and dynamic industry.

In May 1997, the State Council announced a "trial" program allowing foreign joint ventures to be established with Unicom in the telecommunications sector provided the foreign partner hold no more than 50 percent equity. Thus, "the scheme does not signal an end to China's ban on foreign ownership and operation of telecommunications networks in China, but it is a further step in that direction." *(See "Industry Monitor," Business China, May 12, 1997, p. 11.)*

Foreign companies are currently not permitted to *operate* telecom networks in China (which are controlled by the Chinese state/military) but are allowed to sell equipment and provide limited after-sales service.

In August 1998, the State Council announced a ban on so-called "Chinese-Chinese-Foreign" (zhongguo-zhongguo-wai) arrangements between foreign telecom

Lastly, the problems of piracy, smuggling, and intellectual property rights infringement persist, especially in the southern province of Guangdong. Although part of China's national anti-crime and corruption campaign, piracy is having deleterious effects on foreign investors, mainly in terms of lost revenue. A Chinese software firm estimates the level of overall software piracy in China to be about 70 percent while the Software Publishers

Association (SPA) lists China's piracy quotient at 96 percent (compared to 27 percent in the United States) as among the top IPR violators in the world.[106] As Chinese software firms grow, however, they too are becoming more interested in China's anti-piracy enforcement policies.[107]

Competition from the State-Owned Enterprise Sector

As in other industrial sectors in China, foreign investors in the electronics industry often find themselves up against competition from China's state-owned, heavily subsidized enterprises.[108] Software programming, for example, has been identified by Chinese officials as a key sector warranting government support. There are at least 200 domestic software development enterprises and over a million software professionals in China that enjoy some degree of government support in their competition against foreign companies (e.g., Microsoft) for market share.[109] Leading Chinese computer and software companies such as Legend, China Great Wall and the Founder Group all originally hail from the state sector (and maintain ties to their former institutions) but are now working with Microsoft, IBM, Oracle, Intel and others in designing software for the China market. In press reports, Microsoft's representative in China, Bryan Nelson, has characterized some of China's domestic software firms as "world class," mainly in terms of their software application programs. Similarly, Intel's China director has termed Chinese computer products as "very advanced systems and very competitive with multinationals."[110] Thus, according to *The China Business Review*, "compared to their counter parts in other emerging sectors in China, foreign firms in the software sector seem willing to impart some (if not all) of their advanced technical know-how to domestic [Chinese] companies, especially in cases where the foreign firm supplies underlying software, such as operating systems or database engines, on which applications tailored to the China market must rely." By doing so, however, the software industry is gambling that technology transfers in software development — despite concerns over IPR infringements and creating competitors — will lead to more gains than losses in the long-term. To date, however, "many foreign software firms have yet to turn a profit, and continue to risk considerable resources on China's market potential."[111] The danger lies in the fine line between collaborator and competitor. With the backing of China's government, Chinese partners may soon prove capable of absorbing the technology, programming skills, and processes needed to move ahead of their mentors. (See Appendix E for a list of recent US-China collaborations on software).

Foreign electronics firms may also be in for increased competition from China's defense-industrial electronics sector. In a 1997 announcement, a top military leader (Liu Huaqing) stated his intention to open up China's defense electronics sector to foreign investment in 1998.[112] Presumably, the idea is to bolster this sector with foreign capital and technologies as well as to entice foreign governments to end Tiananmen-era sanctions on exports of military equipment to China.[113] Chinese officials have designated US$60-70 billion dollars through the year 2000 for the development of a state-of-the-art electronics sector, in large part motivated by Chinese analysis of the contribution of sophisticated electronics-based "smart weapons" and other revolutionary military capabilities demonstrated during the 1991 Gulf War.

How sophisticated is China's defense electronics industry? While some experts characterize China's present defense electronics sector as extremely weak (even as compared to the commercial side), others describe it as being very strong.[114] The

disagreement stems from the extremely secretive nature of China's military sector, which makes a definitive assessment impossible. It seems clear, however, that whether or not China's defense electronics capabilities can be considered advanced, the PLA has yet to demonstrate a high degree of integration or upgrading of its forces (air, naval, or ground), and is certainly not up to Western or US standards. The exceptions to this assessment may be in some "pockets of excellence" within the PLA — areas that have received extraordinary support and resources (i.e., nuclear and missile fields). That said, US investors in China's electronics industry must be aware of Chinese defense objectives and the contribution that American commercial technologies could have in assisting China's military modernization efforts.

Infrastructure

Unlike other sectors of the economy, China's severe lack of information and telecommunications infrastructure is, in fact, an advantage. It is much less an expensive prospect, for instance, to build a new, modern, fiber-optic telecommunications network throughout China than it would be if, as in other developing or developed countries, a system were already in place that would require dismantling or replacement of old equipment. As a result, the lack of such an infrastructure actually allows China in many cases to "leapfrog" over old technologies to install "state-of-the-art" equipment supplied by foreign enterprises.

Distribution of product and services, however, is a problem for foreign investors in this sector as in others. The telecommunications sector poses a particular concern with regard to technology transfers in that the Chinese military has jurisdiction — along with the MII — over a wide range of radio frequencies upon which communications networks in China are heavily dependant.[115] Thus, in order to gain access to these basic frequencies, foreign investors in this sector are having in some cases to deal with enterprises and officials of the PLA. The Chinese partner for a GTE joint venture to build a national paging network, for instance, was the Guangzhou Guangtong Resources Co., reportedly a PLA-affiliated company. The partnership was necessary to gain access to the required radio frequencies and distribution system that only a PLA-affiliated partner could provide.[116]

The Year 2000 problem (referring to the problem computers will have recognizing the date upon the turn of the century) will likely pose fewer problems in China than in the United States for instance given the recent infusion of information technologies into China. However, this approaching problem has not garnered much interest or concern among Chinese programmers, businessmen, or government officials until very recently. China is likely to experience difficulties in terms of its banking, financial, and telecommunications sectors as well as the insurance industry, which could seriously hinder China's ongoing reform efforts.

For a discussion of this issue, see Jared Peterson, "China Lacks Awareness of Year 2000 Problem," Market News Update, IDG China, April 7, 1997.

It is not clear to what extent investment in and revenues from PLA-related enterprises are directly channeled into the military budget and modernization effort. Most of the money collected from these enterprises is thought to go toward improving living standards and providing basic needs for military personnel. Nevertheless, as US investments in this and other high-tech sectors increase, so too will the opportunities for the Chinese military to benefit from US commercial technology transfers.

Lastly, if one considers human resources to be a fundamental infrastructure in terms of the electronics field, China is well-equipped. China's "Open Door" policy has brought increasing numbers of students (mostly at the graduate level) to the United States for training primarily in the scientific, engineering, and mathematics fields. Furthermore, the brain drain from China since 1989 seems to be reversing, with more of these students finding their way back to work in emerging high-tech fields in China. According to *The China Business Review*, "Some foreign companies are reportedly hiring students of science and mathematics universities like Qinghua to undertake programming projects. This practice tended to be informal until a couple of years ago, when the Chinese government apparently began to broker such employment arrangements and require companies to contribute on behalf of the student employees to China's social insurance funds."[117] This practice would seem to fit with the overall trend toward commercial offsets in the form of training, research or development as a part of joint venture contract agreements in China.

US Experience

The US experience in China's electronics and telecommunications sectors dates back only to the early 1990s for many US investors. These sectors, however, have experienced the most rapid growth in China and, arguably, the highest level of US commercial technology transfers. Of the top US investors in China, half are involved in joint ventures producing electronics, telecommunications or computer-related equipment (though not necessarily as the primary enterprise).[118] This is particularly interesting given the fact that the telecommunications industry is currently closed to foreign telecommunications network operators.

What is driving the rush to China? The motivation does not appear to be profits. Even the American giant, Motorola, appears not to be making much return on its huge investments in China, and is reinvesting in China whatever revenues are realized from its joint ventures. The primary motivation is also not necessarily the availability of labor at low cost, although this is a big factor. Rather, it is to be nearer to the fastest growing electronics markets, which are now in Asia, and where the market demand and government support for electronics is significant. According to a recent study on China's electronics sector, "In fact, all US electronics companies are increasing their Asian investments in R&D to take advantage of favorable industrial-government partnerships and engineering workforces that are highly motivated and well trained (frequently in the United States)."[119]

A key to US market penetration in China in this, as in other sectors and despite the many policy hurdles, is standards. The software industry provides a good example of achieving market share based on early entry into an immature market, where it is still possible to introduce standard technologies likely to be adopted throughout the country and the industry. This is what Microsoft has tried to do in China with its Windows 95 operating system.[120] However, Microsoft has been able to establish itself as a standard operating system in China only in exchange for assisting Chinese programmers in creating a Chinese-language version of the Windows software, a significant transfer of technological know-how.[121] The payoff: foreign companies account for 95 percent of the market for operating systems and 60 percent market share in software. [122] Intel, too, is the standard bearer in China (with an 83.8 percent market share in CPUs in China) as are Oracle, Informix and Sybase in the database sector.[123] These successes, however, are not due solely to product

superiority, but are typically accompanied by numerous cooperative development and commercial offset agreements in exchange for market access.

Other US companies such as IBM and Digital, however, have met with mixed results in attempting to spread company standards throughout China. In telecommunications, Motorola attempted to have its preferred standard, the Code Division Multiple Access (CDMA) network (originally designed by Qualcomm) to become China's mobile phone standard as well. But even the largest American investor in the China market was unable to get its way. China Unicom, the one and only competitor to the former Ministry of Posts & Telecommunications adopted the Global Systems Mobile (GSM) network (the dominant global standard) for its new networks. This is not surprising, despite Motorola's commanding presence and investments in the Chinese electronics industry. As stated earlier, Chinese officials are wary of becoming too dependent on one foreign source of technology. The leverage resulting from playing one standard-bearer against another also provides Chinese enterprises with more technology and commercial offset agreements than might otherwise be forthcoming.[124]

TABLE 22
Top US Companies in China
Total Investment (spent/committed)

Rank	Company	$Millions (end of year '96)	Sector(s)
1	**Motorola**	$1,200*	telecommunications (networks & equipment), computers
2	**Atlantic Richfield**	$625	petroleum/energy
3	**Coca-Cola**	$500	food/drink
4	**Amoco**	$350	oil/energy
5	**Ford Motor Co.**	$250	autos (parts, small trucks, vans, minibus)
6	**United Technologies**	$250	elevators/escalators, air conditioners, aviation (P&W engines)
7	**Pepsico**	$200	food/drink
8	**Lucent Technologies**	$150	telecommunications
9	**General Electric**	$150#	medical equipment, lighting manufacturing; aircraft engines
10	**General Motors**	$130	autos & auto parts; electronics
11	**Hewlett-Packard**	$100	computers, medical products, analytical chemical equipment
12	**IBM**	$100	computers, advanced electronics, software

* Projected (end of year 1998); # figure does *not* include $1billion+ Shanghai joint venture.
Source: Adapted from Karl Schoenberger, "Motorola Bets Big on China," Fortune, vol. 133, no. 10, May 1996.

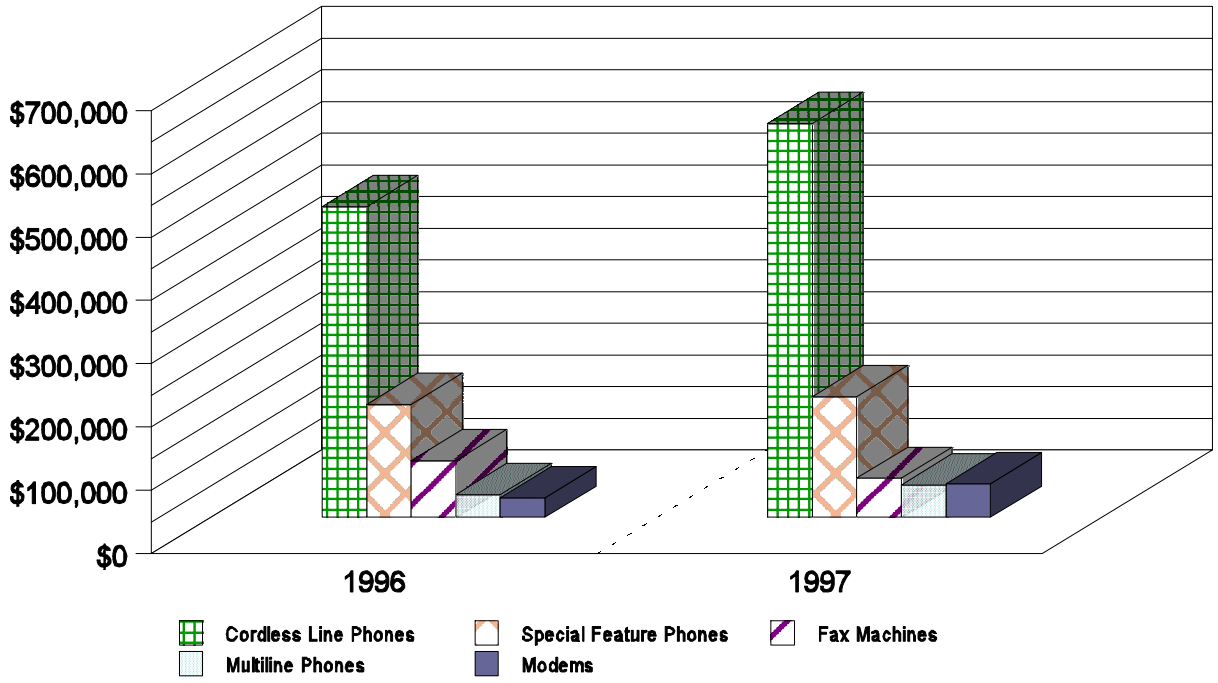
Status of Chinese Electronics Industry

A recent study conducted by the National Science Foundation's World Technology Evaluation Center (WTEC) characterized China's electronics sector as "extremely weak in the early 1990s." By 1997, however, China's electronics industry had improved significantly to the point where the report concluded that "plants in China are now assembling a growing number of final products," and that Chinese enterprises are moving up the technological ladder quickly. This is an important point in an industry with incredibly short "generations" of new technologies. Nevertheless, China still trails its neighbors in this industry sector and relies on foreign inputs in terms of design, marketing, and R&D.

Electronics

According to Chinese statistics, as of 1996 China exports more electronics than it imports.[125] Most of these are relatively low-tech electrical or electronic products such as televisions, refrigerators, radios, electric fans, etc. and this growth due in large part to China's capacity to produce high-volume (though not necessarily high-quality) products. Chinese press reports, however, claim that among electronic exports, "those containing more advanced technologies enjoyed fastest growth," citing computers (including components/parts), mobile telecommunications equipment, CD players, and fax machines as examples.[126] US data shows that the biggest US import line items from China in 1996 were cordless line phones, followed by special feature phones, fax machines, multiline phones, and modems. The fastest growing US electronic imports (HTS85) from China over the period from 1992 to 1997 were video recording or reproducing apparatus, followed by semiconductors (other than photosensitive), television cameras, fixed carbon resistors, and aluminum electrolytic fixed capacitors which are among the top five.[127] Nevertheless, much of this growth is almost certainly due to production of joint ventures with foreign firms. Thus, the question is whether China's growing exports of electronics translates into real technological advancement. Are commercial technology transfers in the electronic sector having a significant effect on China's indigenous capabilities in this sector? The answer: in some sectors, yes; in others, not yet.

Chart 4
Top U.S. Imports of Electrical Apparatus for Telephony/Telegraphy ($Thousands)



Source: US Census Bureau

Semiconductors

Only a decade or so ago, there was virtually no semiconductor industry in China of which to speak. Today, domestic Chinese semiconductor manufacturing capabilities are generally considered to be relatively advanced at the 1.0 micron level (though 3.0-4.0 levels are reportedly still in domestic production). Foreign joint venture fabrication plants (including Motorola's plant in Tianjin) are beginning to manufacture submicron chips at the 0.8 micron level with plans to go to 0.5 micron levels over the next couple of years.[128] The current standard among leaders in the semiconductor industry is 0.3 microns or below.

China's current Five-Year Plan (1996-2000) calls specifically for development of advanced integrated circuits (ICs) with the express goal of achieving the 0.3 submicron level by the year 2000 (see chart below). The acquisition of foreign technology plays a prominent role in this strategy. Foreign capital and technological know-how is necessary to advance China's domestic IC manufacturing capabilities and to meet the 75 percent of domestic demand for ICs that Chinese firms are currently not able to meet.[129] The result, according to the Semiconductor Equipment & Materials International (SEMI) group, is that "joint venture approval is often restricted to those companies that promise a certain level of technology transfer."

TABLE 23
Goals for China's Semiconductor Sector by the Year 2000

Current Goal	Mass production of the 6-inch, 0.8 micron level of technology
Mid-Term Goal	Industrial production of 8-inch, 0.5 micron technology
Long-Term Goal	Research and development toward the 0.3 micron level, and design and production of advanced ICs to supply domestic electronics demand

Source: Bernard Levine, "China seeks top firms as IC partners," Electronic News (1991), vol. 43, no. 2160, March 24, 1997, p. 1.

As a means of implementing state plans for the semiconductor industry, a new government-funded program designed specifically to advance China's semiconductor manufacturing capabilities, Project 909, was awarded to Japan's NEC in early 1997.[130] The new Shanghai fabrication plant is scheduled to begin production in 1999 at the 0.5 micron level and advance to the 0.35 micron level chips "relatively quickly." Thus, although China's capabilities in the semiconductor sector will continue to rely heavily on foreign capital, technology, and know-how, at the submicron level China will soon be producing chips that approximate those produced today in Korea (assuming Project 909 remains on schedule).[131] China is not likely to surpass or even match the technological leaders in ICs in the near future, but China has matched Taiwan's approximately 10-year learning curve to reach the 1.0 micron level. With efficient use of the vast amounts of foreign investment and R&D support, China could potentially make up the technological gap quickly.[132] If one press report is accurate, the Chinese may have even begun to innovate in this area, reportedly having developed a process that "could produce a low cost route to light-emitting silicon."[133] At present, however,

China's semiconductor industry is described as consisting of “relatively small-scale manufacturers with low productivity and low-level process technology.”[134]

TABLE 24
Examples of US Semiconductor Firms in China

US Company	Product or Service in China	Location
Advanced Micro Devices	Flash memory and Programmable Logic Devices (PLDs) assembly	Jiangsu Province
Digital Equipment Corp.	Application-specific integrated circuits (ASICs)	Hunan Province
E.I. duPont de Nemours & Co.	Photomask ICs	Shanghai Municipality
Eaton Corp.	Electrical circuit protection devices	Jiangsu Province
Harris Corp.	Complete digital microwave radio system; semiconductor assembly and testing; R&D, manufacturing, sales and support for digital telephone switches and other telecommunications systems; and low- to medium-capacity digital microwave radios	Heilongjiang Province; Jiangsu Province; Guangdong Province; Shenzhen SEZ
Hewlett-Packard Co.	R&D center with SSTC	Beijing
Intel	Flash Memory and Microprocessor assembly and testing facility	Shanghai Municipality
Lucent Technologies, Inc.	Telecommunications ICs	Shanghai Municipality
Micro Electronics	Multi-layer ceramic items	Jiangsu Province
Motorola	Mobile telecommunications ICs (0.8 microns) and semiconductor manufacturing, assembly, and testing facilities; PC production and assembly; R&D for advanced communications and computers.	Tianjin Municipality (WFOE) and Sichuan Province (semiconductors); Jiangsu Province; Beijing
Texas Instruments	Design technology center	Beijing

Sources: Adapted from a table on "Foreign-Invested Projects in the Semiconductor Sector (1995)," by Denis Fred Simon, The China Business Review, November-December, 1996, p. 12; Also, Bernard Levine, "China Seeks Top Firms as IC Partners," Electronic News, vol. 43, no. 2160, March 24, 1997, p. 1.

The lure of what may be the biggest semiconductor industry bonanza ever has brought the world's leading semiconductor companies to China, including leading American firms (e.g., Intel, Motorola, Texas Instruments, IBM, National Semiconductor, et al.). China's internal demand for semiconductors is enormous and growing quickly as more and more chips are needed to supply China's own electronics, computer, and telecommunications markets. As a result, China's domestic semiconductor market is projected to more than double by the year

2000, which would make China the third largest semiconductor market after only the United States and Japan. China is currently ranked as the sixth largest market.[135] By 2010, however, the American Electronics Association projects China could become the world's second largest semiconductor market.

Computer Hardware and Software

Of all the electronic sectors, China's domestic industry is probably most advanced in computer hardware (primarily PC assembly) and software. The growth in this sector has surprised even Chinese officials and entrepreneurs as well as outside observers. However, foreign market share in PCs is declining due to lower-priced, domestically produced computers that are increasingly similar in sophistication and quality to foreign-made brands. In terms of software as well, the US Department of Commerce's International Trade Administration characterizes China's software industry as "the only major source of competition to US firms [in China]. Their products are of varying quality, and improve as the firms gain experience. The technical ability of the best Chinese engineers is first-rate."[136]

The number of domestically produced PCs doubled in 1996 over the previous year, making up almost half (1.3 million) of the three million PCs sold in China. In 1997, China's leading domestic personal computer manufacturer, Legend, took the lead in the fiercely competitive PC market, besting foreign powerhouses such as Hewlett-Packard, IBM, and Compaq in PC sales.[137] Although much of Legend's prowess is in assembling imported computer components and selling the PCs at comparatively low prices, this is still an impressive achievement. The combination of a Chinese-brand name on a high-tech item such as a PC and a low price is what has catapulted Legend to the top of the PC sales list in China. This trend could certainly be followed by other domestic firms who are not far behind the leaders. Meanwhile, China's PC market grew by over 40 percent in 1996, and projections for future growth are even higher. With this extraordinary growth, China's PC market now outranks South Korea's, making China's the largest PC market in Asia according to a recent report.[138]

This rapid pace is all the more surprising given the fact that many foreign-invested enterprises in the PC market did not arrive in China until the early 1990s, most around 1993 (IBM, DEC, Wang and a few others set up shop in the mid-late 1980s but were hampered in China during the post-Tiananmen era). As a result, the majority (over 74 percent at the end of the year 1996) of PCs sold in China today use Pentium processors, which is a sharp increase from just the year before when the majority of PC sales were 486 processors.[139] The more sophisticated PC components (such as the CPU, chips, motherboard, disk drives and CD-ROMs) are typically contributed by foreign companies, with the Chinese partner supplying the monitor, power supply, casing, and other more basic parts. There are exceptions to this general rule, however. For instance, Legend's Hong Kong and Shenzhen subsidiaries are involved in the more sophisticated task of building and designing motherboards and add-on cards.[140]

Legend is not the only shining star among Chinese PC makers.[141] Other well-known Chinese firms or conglomerates in the computer industry are the China Great Wall Group, the Founder Group, and the Stone Group. Each of these enterprises originated (directly or indirectly) from China's state-run research sector. Legend was originally spun off from the Chinese Academy of Sciences, China Great Wall from the Ministry of Electronics Industry, Founder from Beijing University, and the Stone Group (arguably the most independent of the

enterprises) from a mix, its founders having come from the CAS, Qinghua University, and a Beijing-based SOE (the Beijing No. 3 Computer Factory).[142] Interestingly, the Chinese enterprise with perhaps the weakest connections with its Beijing institutional roots — Legend — is in the lead, currently outselling both foreign and domestic firms in PCs. Although the fortunes of each of these enterprises have both risen and declined over the years, they remain among the leading companies in China's computer industry and are competing with the world's best computer manufacturers.

TABLE 25
Growth of China's Computer Industry

Hardware	1990	Exports of computer parts & components	$200m
	1995	Exports of computer parts & components	$3.78b
Software	1990	Sales revenue from software	$22m
	1995	Sales revenue from software	$1.3b
Manufacturing	1990	Chinese hardware manufacturers	191 (+ few software firms)
	1995	Chinese hardware manufacturers	1,000 (+ 1,000 software firms)
Workforce	1990	Chinese workers in computer companies	100,000
	1995	Chinese workers in computer companies	300,000
R&D Workers	1990	Additional workers in R&D institutions	n/a
	1995	Additional workers in R&D institutions	1,500 workers in 50 R&D institutes

Source: China Infoworld, 1995, cited in "China's Electronic Industry," in Electronics Manufacturing in the Pacific Rim, Ch. 3, WTEC Report, NSF, May 1997.

Lastly, the degree to which China has made advancements in supercomputer manufacturing is difficult to ascertain, although it would seem that significant progress has been made over a relatively short period of time. Press reports in 1997 have mentioned an indigenously produced supercomputer, the "Yinhe [Galaxy] III," developed by the University of the Science and Technology for National Defense (USTND, under COSTIND) that is capable of 10 billion or perhaps even 13 billion calculations per second [10,000/13,000 MTOPS].[143] Development of this computer was reportedly begun in 1992, and it was exhibited to the public at about the time as controversy in the United States broke out over the export of numerous US supercomputers to China.[144] A previous Chinese-made supercomputer, the Galaxy II — which was developed in 1992 and, China claims, is capable of one billion theoretical operations per second — is mentioned in the 1995 *China White Paper on Arms Control and Disarmament.*[145] Although these operating levels exceed the current USG limits on sales to either civilian or military entities in China, these operating levels are not particularly

impressive compared to current US capabilities in this area.[146] Thus, it would seem that directives from the central government to Chinese military researchers in this area have resulted in significant improvements over two periods. These operating levels, however, still do not appear to rival those of US supercomputers, the high-end of which were at clocked at 20 billion theoretical operations per second back in 1993.[147]

TABLE 26 Chinese Advancements in Supercomputers		
Year	**Supercomputer**	**Capability**
1983	Galaxy I	100 MIPS
1992	Galaxy II	1 billion TOPS
1997	Galaxy III	10-13 billion TOPS
MIPS: million instructions per second; TOPS: theoretical operations per second; MTOPS: million theoretical operations per second		

Telecommunications

Chinese officials have had to constantly revise upward their estimates in the telecommunications sector as growth in this industry has consistently outpaced even Chinese expectations.[148] China claims to already have the third largest mobile telecommunications market in the world today, after the United States and Japan.[149] More importantly, this has occurred despite very limited liberalization or government deregulation in this sector. This enormous growth is mostly due to Chinese government policies that give preference to telecomminications projects. At least $40 billion a year is expected to be spent through the year 2000 on telecom networks, described in one report as "the equivalent of a Bell Canada-sized network each year."[150]

The "Golden Projects," which are coordinated by a Chinese company (Jitong) under the former Ministry of Electronics Industry (now the Ministry of Information Industry), constitute the most prominent of China's telecommunications programs. China reports to have "70 plants specialized in the production of fiber optic cables and ten of them are equipped with imported production lines, capable of producing high quality optic cables.[151] However, the technologies needed to complete these ambitious projects will come primarily from numerous foreign sources, including and perhaps most prominently, Motorola.[152]

As discussed earlier, China's severely limited telecommunications infrastructure has proved to be an advantage in allowing China to "leapfrog" to the latest technologies. As *The China Business Review* reports, "Whenever possible, China has taken advantage of its dearth of mainframe-based systems to 'leapfrog' past generations of outdated technology and, from the start, implement cutting-edge systems."[153] This is a key point in that much of this technology is dual-use and is fundamental to modern warfare capabilities. A 1996 report by the US General Accounting Office states that "the Chinese military is seeking to acquire ATM and SDH [broadband telecommunications] equipment, which may benefit their command and control networks by the end of the next

China's Golden Projects

China's goals for its nationwide information technology infrastructure and networking are laid out in its ambitious "Golden Projects" plan, which some Western analysts compare to development of the nationwide railway system in the US in the late 1800s. The five major "Golden" projects begun in 1993-94 are: "Golden Bridge" (information superhighway); "Golden Card" (bank & credit card system); "Golden Customs (customs offices network); "Golden Taxes" (government tax information and collection network); and "Golden Macro"

decade."[154] Several foreign companies are involved in joint ventures and/or contracts to provide ATM and/or SDH equipment to China.

Conclusion

China's electronics sector, more than the other sectors studied herein, has emerged rapidly and achieved some technological successes. This is because of the sheer size of China's market, the learning curve in the electronics industry (the potential for "fast followers"), the dual-use nature of much of the fundamental technologies used in this sector, the potential for "leapfrogging" to the most advanced technologies (which China's comparatively immature electronics market makes more likely). China's capacity and increasing sophistication in the electronics sector could, if current trends continue, easily make China a leading producer in electronics in the next decade or two.[155] According to a recent study, this potential competition may already be having an effect in that 29,000 American jobs related to consumer electronic devices were reportedly lost due to the US trade deficit with China and Hong Kong.[156] However, China's electronics industry remains heavily dependent on foreign inputs for crucial design, marketing, and R&D.

The *US Industry and Trade Outlook 1998* reports that "as semiconductor companies have increased their offshore investments and entered into more joint ventures, [semiconductor manufacturing equipment] SME companies have followed their customers into the new markets." During the 1970's-1980's, the US supplier base of electronics components became dependent on Japanese supply of underlying electronic technology and components. Some experts have suggested that a similar process could occur in with regard to China as more American electronics companies set up manufacturing ventures on the Mainland.[157]

As the above section details, US electronics firms in China are transferring significant commercial technologies and/or know-how to China through joint ventures. The question, therefore, is how much is too much? Although sophisticated technologies are being manufactured, assembled, and tested in China as part of Sino-US joint ventures, most industry experts (as well as corporate representatives themselves) feel that US companies have a healthy respect for the risks involved in doing business in high-tech sectors in China and, as a result, leave development of the most advanced products at home. An assessment of successful companies in China (in terms of market share and revenues) concludes that companies with the best records have, among other things, "learned how to transfer technology without giving their crown jewels away."[158]

Nevertheless, the key to the US remaining a global competitor in this important sector will be in supporting domestic research and development toward new and more advanced products. According to the the Semiconductor Industry Association (SIA), US firms are investing a healthy 12 percent (on average 1990-95) of revenues into R&D and 14 percent in new electronics equipment and facilities.[159] What is not clear, however, is how much of this capital re-investment and R&D is moving to, and will be concentrated in, China, a trend that is already apparent. As pressure from Chinese officials continues for increasingly sophisticated technology transfers from US firms in return for limited market access, it is incumbent upon these same firms and the USG to maintain a strong US industrial base in electronics as well as domestic R&D capabilities.

In the near future, moreover, it would seem that the reality of foreign firms succumbing to "the Chinese policy of 'technology in exchange for market' that targets the world's largest

electronics multinationals, is likely to reinforce the tendency for such high-tech [multinational corporations] MNCs to invest and manufacture in China."[160]

THE VIEW FROM EUROPE AND JAPAN

In an effort to provide a more global perspective, our research also looked at the approaches taken by other governments and economic regions or states toward the China market. Following is a brief analysis on the approaches taken by the advanced economies of the European Union (EU) and Japan.

On the question of whether technology transfers are a means toward gaining increased access to the China market, the governments and multinational corporations of the European Union, Japan, and the United States have come up with three distinct answers: yes, no, and maybe. While the EU has fully embraced technology transfers to China, Japan has been comparatively much more conservative, while the United States' approach has been somewhere in the middle.

The European Union

As a matter of formal policy, the European Union has decided to embrace the transfer of technology to China. The Commission of the European Union's long-term strategy states that "initiatives to promote economic and social reform should offer training and technical assistance to support modernization and market oriented policies in key economic sectors."[161] In practice this has meant that, by mid-1996, over 3,297 technology-transfer contracts worth $26.5 billion had been signed with Chinese officials. According to EU figures, this makes the EU the "main supplier of advanced technology" to China.[162]

A Formal Policy for Technology Transfers

Many of these transfers are conducted via a program called the "Community Framework Programme for Research and Technological Development." By 1996, this program consisted of fourteen different joint research projects, involving collaboration in sectors ranging from agriculture to information technology. Chief among these continuing efforts are the international fora for the automobile and aerospace industries that were set up by the EU government (though run by EU firms), to conduct meetings with their Chinese counterparts.[163] The stated long-term goal of European officials and industry representatives in their meetings with Chinese government ministries is to strengthen trade ties between Europe and China. One of the ways through which this is happening is "industrial training in manufacturing as well as management." In this manner, the European automotive industry is systematically transferring technology to Chinese manufacturers.

Moreover, in 1996 the European automotive and aerospace organizations signed a pact (as part of the EU-China Industrial Cooperation Program) wherein the Chinese government would contribute $53,000, the EU government $177,000 and EU auto manufacturers $532,000 to "assist in the harmonisation of technical standards, to assist industrial training in manufacturing as well as management, [and] to level up quality awareness."[164] It is difficult to say how this translates into actual sales for European auto manufacturers (i.e., whether clear cause and effect are evident). That said, it should be noted that European car makers dominate the Chinese market. The Volkswagen family of cars alone occupies 62 percent of production in China's car market.

The European Association of Aerospace Industries (AECMA) is also in the midst of a two-and-a-half year joint aerospace development program with the General Administration of Civil Aviation of China (CAAC) and the Aviation Industries of China (AVIC). The goals of this program are similar to those in the auto sector: "to build closer ties" and "provide training" for

the Chinese. The companies comprising the AECMA will donate $1.2 million to this effort, which will be doubled by the EU government and added to by the PRCG with $760,000.[165] As this program is currently ongoing, one can only speculate as to the benefits accruing to the EU aerospace industry as a result. At the very least, however, these efforts will give EU companies greater exposure in China and to their Chinese counterparts. In return, PRC companies will not only receive advanced technologies in key industries, but will also receive training on how to utilize this technology.

Financial Assistance

Technology transfers are one part of a two-pronged European approach to the Chinese market. The other part is direct financial aid, of which the EU has given $67 million since 1995. EU aid focuses on five areas: human resource development, support to economic and social reform, business and industrial co-operation, protection of the environment and rural development. Many of these programs are educational in nature, again an example of trading knowledge for exposure and access in China. EU aid is provided to China under various programs, as described in the table below.

TABLE 27
EU Aid to China

Program	EU Contribution ($USmillions)	Program	EU Contribution ($USmillions)
Training / Instruction		***Agriculture / Health***	
China Europe International Business School	16.78	Dairy Development Project II	33.9
China Invest	11.3	Environment Management Cooperation	14.69
Junior Managers Program	11.23	China Europe Cooperation Agriculture	13.9
Higher Education Cooperation	11.02	Support to Village Governance Reform	12.06
Norms and Standards	5.88	Qinghai Potato Development	3.5
IPR Cooperation	5.4	Qinghai Livestock Development	3.5
Training in STD & HIV/AIDS Prevention	3.14	Water Buffalo Project	3.14

Source: European Commission Delegation in China

As with technology transfers of equipment, it is difficult to measure the direct benefit from programs like these for EU firms. This is due in part to the fact that the amount of money

being used to create the programs, while significant, is small relative to the size of the private sector funds in the market. In that sense it may seem that EU aid to the PRC has only symbolic value. If so, however, it also fosters goodwill for EU-related firms in China and a greater knowledge of the EU among Chinese citizens. Thus, to answer the key question: will exporting or transferring of technology now provide one with greater market access in China down the road? As a whole, the European Union is clearly gambling that it will.

The EU strategy of transferring technology in return for market share in China may be working (as in the case of Volkswagen). However, almost all of the nations comprising the EU have recently maintained a trade deficit with China (all but Finland and Sweden).[166] See Table 26.

TABLE 28
EU Nations Trade with China (1996, in millions of ECU)

Country	Imports from China	Exports to China	Trade Balance
Belgium/Luxembourg	1,775	685	-1,090
Denmark	635	236	-399
Germany	8,844	5,694	-3,150
Greece	370	37	-333
Spain	1,565	431	-1,134
Finland	293	459	166
France	3,705	1,978	-1,727
Ireland	221	40	-181
Italy	3,175	2,209	-966
Netherlands	2,233	578	-1,655
Austria	487	219	-268
Portugal	183	26	-157
Sweden	847	1,096	249
United Kingdom	5,593	904	-4,686
EU Total	29,926	14,592	-15,344

Source: EUROSTAT

Japan

In contrast to the EU, Japanese firms seem to think that exporting technology now will gain them comparatively little in the future. This is difficult to confirm, however, since there is relatively little information available on Japanese technology transfers to China. That said, in the vast majority of high-technology sectors, Japanese exports to China are about half that of the United States.

Sino-Japanese Relations

Japan's relationship with the PRC is significantly more complex than that of either the EU or the US for both geographic and historical reasons. Geographically, Japan's close proximity to China makes its economic future inextricably linked to that of the Mainland. This has two effects. First, it forces Japan to prioritize stable economic and political relations with China at all times. Second, it causes Japanese leaders to be especially wary of the possibility that China will become a powerful competitor that will compete for the same resources, customers, and influence in the region. Historically speaking, Japan's invasion of China during World War II still casts a long shadow over present-day relations. Specifically, both the PRC and Japan continue to feel that Japan needs to make amends for its past abuses. On many occasions, this has taken the form of large Yen-based loans to China that include very generous terms, grants, and technological aid to the Chinese government. In recent years China has pushed hard to have these technology transfers increased as part of a formal package of compensation for Japanese actions in World War II.

The result of these two factors — geography and history — has been 1) a Japanese industry sector that, while anxious to enter the China market, is quietly reluctant to transfer advanced technologies; and 2) a Japanese government that aggressively uses Official Development Aid to smooth over relations with China.[167]

Reluctant Industry Initiatives

Just five years ago one would have been hard pressed to find a high-tech sector in China in which Japanese firms had a significant presence. It has only been in the last few years that the Japanese have begun to make inroads into the China market, and even then they continue to lag far behind US high-tech firms.[168] For example, by late 1996 General Motors had invested over $2 billion in the Chinese market, and won a billion dollar contract to produce luxury cars in Shanghai, whereas Japanese carmakers have been content until recently to mostly license auto technology to Chinese partners.[169] This situation is in stark contrast to Japan's presence in Southeast Asia, where Japanese carmakers are not only engaging in on-site production, but also dominate the market.

For reasons such as this, many observers (including some Chinese officials) believe that Japan is intentionally withholding its technologies from the China market. Furthermore, as one researcher notes, "most of the products made [in China] by using Japanese technology are restricted to sales in the Chinese market and are unlikely to be exported...Japanese companies only wish to offer technology which is no threat to their overseas markets. They take risk-proofed and cautious attitudes towards their investments."[170] Furthermore, as one American businessman put it, "There's a good reason why they are stingy with their technology, Japan is afraid of creating another Japan."[171] That is, the Japanese are worried that the Chinese will be able to use imported technology to become an industry leader — much as the Japanese did in the 1960s &1970s, and as the US did in the early 1800s. If that is the Japanese sentiment, Japan's desire to maintain good relations with the PRC prevents it from saying so outright. Thus, observers are left to speculate. The statistics however, while not shedding any light on Japanese intent, do confirm the effect.

With the exception of transport equipment (which in Japan's case consists primarily of tankers and other shipping vessels), Japanese industry lags behind US industry in every major technology sector surveyed. Insofar as high-tech exports are an indicator of technology

transfers, this data would seem to confirm that the Japanese are keeping their technology from the China market, presumably to stop or at least delay a competitor from developing in their backyard.

A Low-Tech Approach?

Some analysts have said that one way that Japanese companies may be trying to profit from the market without giving up their advanced technologies may be to focus on "low-tech" products.[172] This is confirmed by the data. The sectors in which Japanese companies have made the most progress are decidedly "low-tech" in nature. The sectors where they are the most competitive with the US are in "Transport Equipment" and "Electrical Machinery"[173]— sectors that are relatively low-tech in nature. Conversely, the sectors where Japanese companies are weakest are in "Office and Data Processing Machines" and "Sound Recording and Broadcast Equipment," which tend to be more complex in nature. These examples are particularly striking in light of the Japanese strength in these same sectors in the US market.

Finally it should be noted that while Japanese companies have recently stepped up their operations in the China market, their frustrations with the market have risen accordingly. Surveys by *Toyo Keizai* (a leading economic journal in Japan) and by the Export-Import Bank have shown that Japanese businessmen have more problems in China than in any other region or country in which they have invested.[174] These frustrations are compounded by the possibility of political turmoil that could follow a Japanese aid and investment withdrawal from China. So bad are the frustrations for some companies that they have even looked to the US government for support. A former senior adviser to the Ambassador at the US Embassy in Tokyo reports that there has been at least one occasion when a Japanese company has come to a US Consulate in China to ask for assistance.[175] This is indicative of a new phenomenon: both Japanese and US companies have found that by teaming up they can multiply their powers of persuasion with Chinese officials. Joining forces has the dual qualities of greatly increasing the amount of leverage brought to bear on Chinese officials and making it more difficult for the Chinese to play one nation or corporation off another. Of course, these sorts of alliances are not always feasible, but companies like Exxon, Raytheon, Dupont and Union Carbide have all teamed up with Japanese companies in China at one point or another.[176]

Government Aid

Whereas Japanese industry may be wary of a Chinese competitor, the Japanese government is concerned about maintaining stable relations. Thus, while the Japanese government does not like to discuss Japan's role in World War II, it can be shamed into action, and the Chinese are masters of this process. China regularly demands war reparations in the form of economic and technological aid, and increases these calls when Japan does something China finds offensive. The result has been a steady stream of financial and technological aid that flows from Japan to China every year. In 1995, China was the number one recipient of both technological assistance ($304 million) and bilateral aid ($1.4 billion) from Japan. By mid-1996 the Japanese government had agreed on another $24.55 billion in direct investment (beyond the $11.9 billion already invested), plus loan packages worth another $140 million. In fact, for all of the 1990s, Japan has been the number one donor to China.[177]

In addition to alleviating Sino-Japanese animosity, this money serves much the same purpose as does aid from the European Union. Indeed, in the past, Japan's Official Development Aid (ODA) has been derided as just another way for Japanese companies to get

more business. Nevertheless, it increases exposure to and knowledge of Japanese companies in the China market. Because such a large part of Japanese assistance consists of technical aid, this too must be considered a source of technology transfer to the Chinese.

Conclusion

While the US Government is supportive of US industries' efforts to crack open the China market and is cognizant of its potential, there are limits to how much USG support is possible or desirable. The USG does provide financial assistance to China in the form EX-IM Bank Loans, for instance, but this aid has also been restricted by Congress in certain areas (e.g., the Three Gorges Dam Project) while other aid programs such as the Overseas Private Investment Corporation (OPIC) have been discontinued due to the Tiananmen sanctions of 1989/90. Various USG departments (Commerce, State, and the Office of the US Trade Representative) provide direct aid and advice to US firms doing business in China. However, the USG is loathe to take too broad a role in managing international trade. Nor do US corporations desire a large USG role, except in terms of promoting and enforcing standard business and legal practices abroad. Thus, the most prominent role for the USG is in providing legal advice and support in terms of negotiating with Chinese officials over removing the numerous trade barriers affecting US firms exporting to or doing business in China (such as the Joint Commission on Commerce and Trade). As a result, the USG plays a relatively defensive or passive role in assisting the entry of US firms into the China market. This contrasts sharply with the role of the EU and Japanese governments, which are comparatively more aggressive and pro-active in support of their respective industries in China.

The broad roles played by the governments of the EU and Japan have had the practical effect of gaining market share for EU and Japanese industries in China where this might not otherwise be possible or likely through true international competition. However, the result, at least in the EU case, is probably that more technology is transferred in return for market access than in other contract agreements. This is not to say, however, that European or Japanese firms are faring any better in China than are US firms. All foreign investors in China are becoming increasingly wary of China's industrial policies, emerging domestic industries, and significant trade barriers. It is also not only US firms that are having difficulty making a profit in China or dealing with trade deficits. Nevertheless, these are long-term strategies and may bear out in the long-run. In the meantime, the support of EU and Japanese governments for their respective industries in China is certain to translate into goodwill and *guanxi* (connections), two keys to market access in China.

Lastly, the trend toward international cooperation in prying open China's market with the least amount of offsets is a positive sign. Although this type of arrangement is perhaps not possible across all industries, where it is, there will likely be less technology being transferred or coerced from foreign firms.

1. *The National Security Science and Technology Strategy* (1996), p. 23.

2. The two bilateral MOUs reached with China are the *Memorandum of Understanding Between the Government of the united States of America and the Government of the People's Republic of China Concerning Market Access, 1992* and the *Memorandum of Understanding Between the Government of the People's Republic of China and the Government of the United States on the Protection of Intellectual Property, 1992.* The former is the result of threatened trade sanctions while the latter has been, since its signing, the basis for threatened sanctions (in May 1996), which were averted upon verification in June 1996 of Chinese efforts at compliance. In February 1997, the United States and China renewed a bilateral agreement on textiles. See USTR*, 1997 National Trade Estimate Report*, p. 43 and Susan Esserman, Testimony Before the US House of Representatives Committee on Ways and Means Subcommittee on Trade, November 4, 1997.

3. The USTR's annual report on foreign trade barriers is harsh in its assessment of China's trade barriers and concludes that "there remains a great deal of work to be done before China's market is sufficiently open to US exports." See United States Trade Representative, *1997 National Trade Estimate Report on Foreign Trade Barriers* (Washington, DC: USTR, 1997).

4. According to Chinese analysts, however, this can cut both ways: "It is unfortunate that when a transnational company comes to China to invest in a particular project, in order to ensure its success it will often choose to conduct simultaneous negotiations with several potential partners. The potential Chinese partners are scattered over different regions or across different departments, and out of their own economic self-interest, they will often engage in internal competition and cut down the price. This is also injurious to the Chinese partner's interests." The researcher goes on to point out, however, that by so doing, foreign investors are also liable to anger their "matchmaker" local government hosts and risk having their products made with another enterprise closed out of the local market. See Wang Zhile, "An Investigative Report on Transnational Corporations' Investment in China," Guanli Shijie, May 24, 1996.

5. This cautiousness is due largely to the concern among company officials that these complaints may negatively affect current or future investment prospects in China. The result, however, is that many of these abuses remain undocumented, and research into this problem is based largely on anecdotal information (and so it is with this study as well).

6. This $500 million figure is used in the *1997 National Trade Estimate Report on Foreign Trade Barriers* (Washington, DC: Office of the US Trade Representative, 1997).

7. David Dinell, "Manufacturers say China is Top Global Contender," *Wichita Business Journal*, July 28, 1997.

8. "China to Invest Billions in Auto Industry," *Xinhua News Agency*, March 1, 1997 in *China Commercial Quarterly*, John Hendryx and Jeffrey Shih, eds., December 10, 1996 to April , 1997; "Automotive Market Fact Sheet: China," US Department of Commerce, ITA, 1994.

9. "China to Use Example of Big 3," *China Daily Business Weekly*, March 2, 1997 in *China Commercial Quarterly*, John Hendryx and Jeffrey Shih, eds., December 10, 1996 to April, 1997.

10. This figure includes production of trucks and other vehicles (see chart). For Chinese auto industry statistics and goals, see "40 years of Chinese Auto Industry," *Beijing Review*, vol. 40, no. 7-8, February 17,-March 2, 1997. The growth rate of more advanced auto markets is generally considered to be less than two percent growth per year. Kathleen Kerwin, "GM's New Promised Land," *Business Week*, June 16, 1997; "China's Auto Plans: Dream Machines," *Business China*, The Economist Intelligence Unit, January 22, 1996, p. 12; Richard Johnson, "Chrysler Favored to Get China Minivan Deal," *Automotive News*, June 27, 1994; "Long March to Mass Market," *The Financial Times*, June 25, 1997, p. 13.

11. Western analysts estimate China's current capacity to be high compared to actual production but low when compared to Chinese production goals. China's current vehicle production capacity is thought to be about 850-860,000 vehicles per year, while actual production is assessed at 350-380,000 vehicles for 1996. See estimates by A.T. Kearney in "The Long Drive Into the Middle Kingdom," *The Economist*, June 8, 1996; and "Call for Halt on New Investments in Overcrowded Auto Market," *Business China*, April 8, 1997. One estimate for China's capacity for car production by the year 2000 is two million cars, which exceeds China's goal. "China's Auto Supply Continues to Outpace Demand," *Business China* (UK), March 3, 1997.

12. China's defense industrial sector produces about nine percent of domestic autos and fully 60 percent of China's motorcycles. *China White Paper on Arms Control and Disarmament*, Xinhua News Agency, November 16, 1995 [issued by the Information Office of the State Council of the PRC].

13. Feng-Cheng Fu and Chi-Keung Li, "An Economic Analysis," *Mixed Motives, Uncertain Outcomes: Defense Conversion in China*, John Frankenstein and Jorn Brommelhorster, eds. (Boulder, CO: Lynne Reinner Publishing Co., 1997), pp. 47-64.

14. For the text of the auto industrial policy, see “Commission Publishes Car Industrial Policy,” *Renmin Ribao*, July 4, 1994, p.2. For analysis, see “Automotive Market Fact Sheet: China,” US Department of Commerce, ITA, 1994.

15. *1997 National Trade Estimate Report on Foreign Trade Barriers,* p. 48.

16. See “Industry Sector Analysis” on China’s automotive industry by Gwen Lyle, US Department of Commerce, ITA, June 1995

17. According to a study on technology transfers via foreign investment, an official of the International Economic Cooperation Research Institute of MOFTEC notes that “An important goal of transnational corporate investment strategy in China is to achieve localization, not only parts localization, but technology development localization as well.” The example he uses is Volkswagen’s automotive joint venture in Shanghai, which he says “after 10 years of absorption and digestion attained an 87-percent localization rate for its Santana model. Chinese and foreign scientific and technical workers have successfully developed a new generation of Santanas after a few years’ effort.” See Wang Zhile, “An Investigative Report on Transnational Corporations’ Investment in China”, *Guanli Shijie*, May 24, 1996.

18. This is according to the *1997 National Trade Estimate Report on Foreign Trade Barriers* (Washington, DC: Office of the US Trade Representative, 1997). For an overview of the China auto market, see Wayne W.J. Xing, “Shifting Gears,” *The China Business Review*,” November-December 1997, pp. 8-17.

19. “Automotive Market Fact Sheet: China,” US Department of Commerce, ITA, 1994.

20. Articles 53 and 54 of China’s Auto Industry Industrial Policy. “Commission Publishes Car Industrial Policy,” in FBIS-CHI-04-136, July 15, 1995, p. 30.

21. This information is included in an “Industry Sector Analysis” on China’s automotive industry by Gwen Lyle, US Department of Commerce, ITA, June 1995. A similar statistic: “for every 1m Chinese, there are 900 km (560 miles) of roads, 11% of them paved, compared with 24,000 km (42% of them paved) for every 1m Americans.” “The Long Drive Into the Middle Kingdom,” *The Economist*, June 8, 1996.

22. The following is an example of the thinking that is so prevalent among businessmen when discussing the potential of the China market. An American auto parts supplier on expanding into the China market: "Some people regard these numbers [PRC projections for auto industry growth] as overly optimistic. But the fact remains: there is clearly a need for more vehicles in China. The country is home to about 1.2 billion people — nearly a fifth of the world's total population. This means there is only one vehicle for every 500 people in China. By comparison, there is one car or truck for about every two people in the United States." This logic prevails in many market analyses regarding China. “Destination: China,” *Autosmart*, Fall 1995.

23. This accords with a US Embassy comment on China’s science and technology plans, which states that “China has consistently rejected digestible technology that is offered which is appropriate to the Chinese market in favor of technology that China cannot absorb and support (this is especially true in the automotive industry).” State Science and Technology Commission (SSTC), “China’ S&T Policy: A View from Within,” in *Science and Education for a Prosperous China* (text available on US embassy China website).

24. This account is included in John Templeman and David Woodruff, "How Mercedes Trumpted Chrysler in China," *Business Week*, July 31, 1995.

25. Richard Johnson, “Chrysler Favored to Get China Minivan Deal,” *Automotive News*, June 27, 1994. See also John Templeman and David Woodruff, “How Mercedes Trumpted Chrysler in China,” *Business Week*, July 31, 1995.

26. For information on foreign auto investments in China, see “No Price Too High,” *Business China*, The Economist Intelligence Unit, August 19, 1996, pp.1-3; Richard Johnson, “Chrysler Favored to Get China Minivan Deal,” *Automotive News*, June 27, 1994; “China’s Auto Plans: Dream Machines,” *Business China*, The Economist Intelligence Unit, January 22, 1996, p. 12; “Chrysler Corp to Continue Investing Millions in China,” *Reuters* (U.K.), February 13, 1997; “Joint Venture Project with GM,” *China Daily* (PRC), February 25, 1997; “Volkswagen to Take Control of Sales in China,” *South China Morning Post*, (HK), February 27, 1997; and “Long March to Mass Market,” *The Financial Times*, June 25, 1997, p. 13.

27. According to one press report, GM has “offered more than any other foreign automotive firm ever has for a slice of a Chinese joint venture that is not yet even approved...GM won a 50% stake in a US$1 billion joint venture to make a two-litre variant of its Buick sedan by offering what other automotive multinationals were loathe to. The company will licence a broad range of component technologies through a series of 'joint ventures with state-owned companies... In addition, GM has thrown in other technology transfer sweeteners that are not linked to individual productive ventures. The American auto giant has pledged US$40m for five technology training institutes, with promises of significant technology transfers in electronics via its Hughes Electronics subsidiary and in information technology via its Electronic Data Systems subsidiary. A large but unspecified part of the design work for the China Buick is to take place in China. In short, as GM’s president of China operations, Rudolph Schlaus Jr., put it: 'Through our joint venture, China is going to learn how to design and build a car'.” (“No Price Too High,” *Business China*, August 19, 1996, p. 1.)

28. Christopher C. Green, “Challenges and Opportunities for R&D in the Global Market,” delivered before the SAE Global Vehicle Development Conference, December 3, 1996. Dr. Green is also the Executive Director General Motors Research and Development Center.

29. Article 31, section one of the Automotive Sector Industrial Policy, adopted by the SPC in February 1994 and published in the *People’s Daily* (*Renmin Ribao*) on July 4, 1994. See “Commission Publishes Car Industrial Policy,” FBIS-CHI-94-136, July 15, 1995, p. 29.

30. Presumably Chrysler, whose joint venture was established prior to implementation of the AIIP, is exempt from this provision. Our research has not revealed any Chrysler-sponsored R&D centers.

31. Ford had also bid on the Shanghai sedan project. “Ford Beats GM to be First to Make Cars in China,” *Wall Street Journal*, December 2, 1997, p. A17.

32. “Ford Begins Manufacturing in China,” *PRNewswire*, December 2, 1997.

33. “General Motors is considering a methanol vehicle venture with SSTC.” Raymond Champagne, "China: A 1996 Automotive Sampling (Industry Overview), *Automotive Engineering*, vol. 104, no. 12, Dec. 1996, p. 24.

34. According to a recent survey of foreign automakers in China, the majority of firms “admitted they were disappointed by their performance in China.” For a good review of the current decline in foreign automakers’ confidence in the China market, see “The China Syndrome,” *The Economist*, June 21, 1997, pp. 63-64.

35. See “Industry Sector Analysis” on China’s automotive industry by Gwen Lyle, US Department of Commerce, ITA, June 1995.

36. Tai L. Chan, “Global Technology Integration - A Cornerstone to Globalizing Business Operations,” presented to the Technology-Application-Market International Forum, Tsinghua University, Beijing, China, November 7, 1997.

37. For an overview of Ford’s approach to the China market and the pressures to transfer technology as part of foreign investment in China, see Richard Pastore, “Emerging Markets: Motor Skills,” *CIO Enterprise*, Section 2, September 15, 1998, pp. 50-58, particularly p. 58.

38. This data can be found in “China’s Auto Plans: Dream Machines,” *Business China*, The Economist Intelligence Unit, January 22, 1996, p. 12.

39. “No Price Too High,” *Business China*, The Economist Intelligence Unit, August 19, 1996, pp. 1-2; “Booming Automobile Parts Market,” *Beijing Review*, vol.40, no. 25, June 23-29, 1997. According to one report, “Ford encourages its suppliers to come to China” (Raymond Champagne, “China: A 1996 Automotive Sampling (Industry Overview),” *Automotive Engineering*, vol. 104, no. 12, December 1996, p. 2.

40. “TRW Announces First Two Joint Ventures in China,” *AutomotiveWire*, April 17, 1996; “TRW, Shanghai Clutch Factory Form Chinese Seat Belt Joint Venture,” *Business Wire*, Jan. 16, 1997; and “TRW Expands Scope of China Activities,” *Business Wire*, June 27, 1996.

41. Information garnered from Rockwell website.

42. The author of the report goes on to say that “As overseas companies are lining up to get a piece of, potentially, the world’s largest automotive market, the Ministry of Machinery Industry is becoming more and more demanding in the ‘price of admission’ to this market. Companies may find this a very difficult place to negotiate a deal or make a profit in the short-term.” Gwen Lyle, “Industry Sector Analysis,” June 1995.

43. “40 Years of Chinese Auto Industry,” *Beijing Review*, vol.40, no.7-8, February 17-March 2, 1997.

44. See “40 Years of Chinese Auto Industry,” *Beijing Review*, vol.40, no.7-8, February 17-March 2, 1997.

45. According to a press report, “The Lucky Star uses a 90 percent localized version of the Suzuki engine and chassis with a new body and only had marginal involvement from foreign manufacturers, a surprise in itself.” “Beijing’s Family Car Program,” EIU Electronic (U.K.), March 3, 1997, in *China Commercial Quarterly*, John Hendryx and Jeffrey Shih, eds., December 10, 1996 to April, 1997.

46. According to a 1995 report, the 100 or so Chinese vehicle models produced in over 100 Chinese complete-car factories would not equal the output of Ford, GM, or Chrysler in the United States. Gwen Lyle, “China: Automotive Industry,” Industry Sector Analysis (ISA), US Department of Commerce, International Trade Administration, June 1995.

47. The dangers of global excess capacity in the auto sector are outlined in *The World Automotive Outlook, 1996-2001.* See “Global Excess Capacity to Top 20 Million,” *Autofacts - Early Warning Report*, November 1996.

48. “Comments of the International Union, United Automobile, Aerospace and Agricultural Implement Workers of America (UAW) to the Trade Policy Staff Committee on The People’s Republic of China’s Accession to the World Trade Organization,” UAW Office in Washington, DC.

49. Chinese history is rife with examples of this sort of divide-and-conquer strategy and tactic being used against invading “foreign devils.” For a description of a more recent example, see Nigel Holloway, “Hostage to Fortune,” *Far Eastern Economic Review*, November 14, 1996, pp. 66-67.

50. “China to Boost Investment in Civil Aviation,” CBNet (PRC), January 29, 1997.

51. The purchase in October, 1997 of $3 billion worth of 50 more Boeing planes follows several purchases of Airbus planes in previous years.

52. Lou Cannon, "Washington State, Asia Come Together in Trade," *Washington Post*, July 7, 1997, p. A04. Between 1993-95, the figure was one in 12 Boeing planes. Nigel Holloway, "Hostage to Fortune," *Far Eastern Economic Review*, Nov. 14, 1996, pp. 66-67.

53. US aerospace exports to China have also doubled since 1990, according to David Napier, "US Aerospace Trade with China," *AIA Update* (Aerospace Industry Association), June 1997, p. 3. See also, David Vadas, *Pacific Winds Blow in US Industry's Favor*, a report by the Aerospace Industry Association, July 1997; and Barbara Opall, "Asia is Top US Market for Aerospace Exports," *Defense News*, July 28-August 3, 1997, p. 6.

54. It would appear that prior to merging with Boeing, the McDonnell Douglas Co. went to great lengths to increase its market share in China. The MD-90 co-production agreement has been described in media reports as being an important vehicle for significant technology transfer, especially in terms of shared technical data. See Richard Bernstein and Ross H. Munro, "The Coming Conflict with China (New York, NY: Alfred J. Knopf, 1997), pp. 142-143; and Joseph Kahn, McDonnell Douglas' High Hopes for China Never Really Soared," *The Wall Street Journal*, May 22, 1996. Boeing announced that the former McDonnell Douglas plants in China will continue in production under Boeing management. Michael Mecham, "Boeing Begins MD-90 Integration in China," *Aviation Week & Space Technology*, October 13, 1997, p. 30.

55. The authors are thankful to Steve Beckman of the UAW for this and other information. See Steve Beckman, Testimony before the US House Committee on Ways and Means, Subcommittee on Trade, on "The Possible Accession of the People's Republic of China to the WTO," September 19, 1996.

56. Greg Mastel, among other analysts, also makes this point in *The Rise of the Chinese Economy: The Middle Kingdom Emerges* (Armonk, NY: M.E. Sharpe, 1997), pp. 73-74. The recent deal made by Boeing with China's Taikoo Aircraft Engineering Co. in Fujian Province prompted public complaints by the International Association of Machinists and Aerospace Workers (IAM) that the agreement to modify 747 jets in China rather than in Kansas would have serious consequences for aerospace workers in the United States. However, other reports stated that Boeing workers would oversee the modifications being made in China and that all design and engineering work would continue to be done in the United States. See "Machinists Union Blasts Boeing-China Deal," *PRNewswire*, August 12, 1997; "Boeing Joins China Repair Venture," *Reuters*, August 11, 1997; and Paul Proctor, "Boeing Buys Stake in Maintenance Center," *Aviation Week & Space Technology*, August 18, 1997, p. 36. This follows a two-month strike in 1995 by Boeing workers in Kansas at least in part over job transfers to China. Paul Blustein, "China Plays Rough: 'Invest and Transfer Technology, or No Market Access'," *The Washington Post*, October 25, 1997, pp. C1-C2.

57. "Boeing v Airbus: The War in the Air," *Business China*, May 26, 1997, pp. 8-9 and Guy Norris, "AlliedSignal Reveals New Chinese Ventures," *Flight International*, vol. 151, no. 4564, March 5, 1997, p. 6.

58. Rockwell press release dated April 7, 1997. The three universities are the Harbin Institute of Technology, Zhejiang University, and Guan[g]dong University of Technology. According to Rockwell's press release, Rockwell has "provided the latest state-of-the-art automation equipment and software to these universities and training to the lecturers... to train a large number of students in this technology and establish more training centers with other universities in major cities of China."

59. Guy Norris, "AlliedSignal Reveals New Chinese Ventures," *Flight International*, vol. 151, no. 4564, March 5, 1997, p. 6.

60. Foreign co-production of certain parts of modern aircraft is increasingly being used by Boeing, a process that has been highlighted in the global manufacturing process for the new 777.

61. See "Industry Sector Analysis" on China's aerospace industry. Gail Chun, Weiming Yao, and Alison Kaufman, "Aviation, Aircraft Parts & Maintenance," Industry Sector Analysis (ISA), US Department of Commerce, December 1994.

62. The Chengdu Engine Company is listed in the aerospace ISA as follows: "affiliated with AVIC, this company makes WP6 and WP13 military turbojet engines." AVIC —the Aviation Industry of China— is "responsible for managing and allotting state-owned assets, developing new technologies, promoting exports, contracting state projects, and aligning planning for the overall industry with the State Council and the Central Military Commission. China's aircraft and aircraft component manufacturers are under the auspices of AVIC." *Ibid.*

63. Raytheon press releases.

64. *Mixed Motives, Uncertain Outcomes: Defense Conversion in China*, Jorn Brommelhorster and John Frankenstein, eds. (Boulder: Lynne Reiner, 1997);. Gail Chun, Weiming Yao, and Alison Kaufman, "Aviation, Aircraft Parts & Maintenance," Industry Sector Analysis (ISA), US Department of Commerce, December 1994.)

65. Bates Gill, "China and the Revolution in Military Affairs: Assessing Economic and Socio-cultural Factors," Strategic Studies Institute, Conference Series, National Defense University Press, May 1996. See Eric Arnett, "Military R&D in Southern Asia," *Military Capacity and the Risk of War*, pp. 260-261. China is reportedly interested

in developing a “large multi-role fighter aircraft to enter service with its air force and navy in around 2015. The XXJ fighter will emphasize air combat and incorporate a ‘reduced radar signature design’.” “China to Develop Stealth Fighter,” *Jane's Defence Weekly*, March 5, 1997.

66. The Tiananmen Square-related sanctions are found in PL101-246, February 16, 1990. According to press reports, China is reportedly receiving significant assistance in this sector from Russia in the form of sales of advanced SU-27 fighter and a co-production agreement. Israel is also presumed to have provided China assistance in developing the J-10 fighter, given the similarities between Israel’s Lavi and China’s J-10 fighter. The J-10 is being developed at the Chengdu Aircraft Corporation and is expected to be operational soon. See Yitzhak Shichor, “Converting the Military-Aviation Industry to Civilian Use,” *Mixed Motives, Uncertain Outcomes: Defense Conversion in China* (Boulder: Lynne Reiner, 1997), pp. 127-128.

67. Robert Sutter, “Foreign Military Assistance to China — Perspectives of US and Foreign Specialists,” Congressional Research Service, July 8, 1997 (also available at *http://www.fas.org/spp/starwars/crs/97-0708.htm)*.

68. See Gail Chun, Weiming Yao, and Alison Kaufman, “Aviation, Aircraft Parts & Maintenance,” Industry Sector Analysis (ISA), US Department of Commerce, December 1994.

69. China’s military aviation deficiencies explain why the PLA has turned to large purchases of modern military aircraft from Russia, but also licensed co-production of SU-27 fighter aircraft. Bates Gill and Lonnie Henley, *China and the Revolution in Military Affairs*, Strategic Studies Institute (SSI) Monograph, May 20, 1996. For the definitive study on the modern PLAAF see *China’s Air Force Enters the 21st Century*, by Kenneth W. Allen, Glenn Krumel, and Jonathan D. Pollack (Rand’s Project Air Force Project, 1995); Gail Chun, Weiming Yao, and Alison Kaufman, “Aviation, Aircraft Parts & Maintenance,” Industry Sector Analysis (ISA), US Department of Commerce, December 1994.

70. This data is derived from the United Nations trade database, SITC 79000-79490, for the years 1992-1995. According to this data, in 1992 China exported nearly $8 billion worth of such parts, but by 1995, the value had dropped to only $553,613.

71. “Two in a Row for Great Wall,” *Aviation Week & Space Technology*, July 7, 1997, p. 15. As of September 1997, China had had five successful launches of commercial satellites. “China: Sino-US Cooperation in Satellite Launch,” *Xinhua*, September 23, 1997.

72. *US Industry and Trade Outlook 1998*, pp. 21-13.

73. Defense estimates are that the PRC’s current capabilities in this area consist of launching military photo-reconnaissance satellites (using outdated technology and without real-time data); access to SPOT and LANDSAT commercially available imagery; and meteorological and geosynchronous satellite data. The report also states that “it is expected that China eventually will deploy advanced imagery reconnaissance and earth resources systems with military applications.” These assessments were given in answer to the question, “Trends that would lead the People’s Republic of China toward advanced intelligence, surveillance, and reconnaissance capabilities, either through a development program or by gaining access to commercial or third-party systems with militarily significant capabilities.” US Department of Defense, “Report to Congress Pursuant to Section 1305 of the FY97 National Defense Authorization Act,” 1997.

74.“China: National Policies, Programs on Space Technology Development, Applications for Sustainable Development,” *Beijing Aerospace China*, Summer 1997, vol. 6, no. 1, pp 8-10.

75. This point was made by Baosheng Chen, in “Overview of the Chinese Civil Space Program,” a slide presentation before the American Astronautical Society, June 1997. See Wu Bian, “Space Industry Promotes Modernization,” *Beijing Review*, vol. 40, no. 1, January 6-12, 1997.

76. Chinese officials were talking about manned space flights and about an astronaut program back in 1986 and again a decade later in 1996. It would appear, therefore, that not as much progress as expected has been made in the interim. This may, in part, be due to the break in military-to-military exchanges and/or cooperation between China and US and European governments after 1989. See Wu Bian, “Space Industry Promotes Modernization,” *Beijing Review*, vol. 40, no. 1, January 6-12, 1997; “The Role of the United States in Technology Transfer to China,” Chapter 4 in *Technology Transfer to China*, Office of Technology Assessment, 1987, pp. 92-93; and Xinhua, April 12, 1996 as cited in OTP’s “Aerospace Factoids” [http://www.ta.doc.gov/asiapac/chinaaerospace.html].

77. As mentioned earlier, China has been able to achieve significant scientific and technological feats, and more quickly than generally expected, when suitably motivated to do so (e.g., nuclear weapons development). A famous quote by Deng Xiaoping is repeated in current Chinese military analyses: “Had China not had the atomic bomb and hydrogen bomb or had it not launched a satellite since the 1960's, it could not have been called a great power with enormous clout or achieved the international standing it now has.” Thus, China’s quest for international recognition of its deserved place in the world could lead to surprising advances in this industry. However, this would also take significant resources from China’s main goal of economic growth. *China’s Defense Conversion*, China Economic Press, July 27, 1995, pp. 20-23.

78. Yitzhak Shichor, “Converting the Military-Aviation Industry to Civilian Use,” *Mixed Motives, Uncertain Outcomes: Defense Conversion in China* (Boulder, CO: Lynne Reinner, 1997), p. 125.

79. *US Industry and Trade Outlook 1998*, p. 21-3.

80. If one takes a general rule of thumb calculus that every $1 billion worth of exports is equivalent to about 10-20,000 American jobs, then the economic effects of lost exports to China in the aerospace sector could potentially be enormous. See Terence P. Stewart, Testimony Before the US House of Representatives Committee on Ways and Means Subcommittee on Trade Hearing on “The Future of United States-China Relations and the Possible Accession of China to the World Trade Organization,” November 4, 1997.

81. “A number of Pacific Rim nations (China, Taiwan, Japan, Indonesia, and South Korea) are becoming significant manufacturers in various segments of the aerospace industry and may in time present a competitive challenge to prime contractors in the United States and in Europe. Already they present competition to subcontractors and suppliers...Among Asian countries whose emerging aerospace industries could pose threats to US aerospace manufacturers are China, Taiwan, Japan, South Korea, Indonesia, Singapore, and Malaysia.” *US Industry and Trade Outlook 1998*, p. 21-3.

82. “China’s Electronic Industry,” in *Electronics Manufacturing in the Pacific Rim*, Ch. 3, WTEC, May 1997.

83. Barry Naughton, “Introduction: The Emergence of the China Circle,” *The China Circle: Economics and Technology in the PRC, Taiwan, and Hong Kong*, Barry Naughton, ed. (Washington, DC: The Brookings Institution, 1997), pp. 27-28.

84. A new book examines the emergence of an electronics sector in the “China Circle” or “Greater China” region. *The China Circle: Economics and Technology in the PRC, Taiwan, and Hong Kong*, Barry Naughton, ed. (Washington, DC: The Brookings Institution, 1997). Greater China encompasses Hong Kong, Taiwan, and Mainland China.

85. According to a study by the International Data Group (IDG), “In theory, vendors receive tax rebates of 20 percent on exported goods, however these promises have not been fulfilled by the government for the last two years (1995 -1996) due to budgetary shortfalls. Rebates are again not likely in 1997." "China's PC Makers Navigate the Pitfalls," IDG China, *Market News Update*, July 23, 1997.

86. "Policy to Standardize Electronic Joint Ventures, *Ching Chi Tao Pao* (Hong Kong), October 30, 1995, pp. 16-17.

87. See James Whittaker, Testimony on Behalf of the American Electronics Association and the China WTO High-Tech Coalition before the U.S. House of Representatives Subcommittee on Ways and Means, Subcommittee on Trade, November 4, 1997.

88. This view was expressed consistently during interviews with industry experts, company representatives, and US government officials. Furthermore, there does not seem to be an advantage or added leverage for larger companies, such as Motorola, who have experienced as much or even more pressure to transfer advanced technologies to China. Interviews conducted June through December 1997.

89. “China/WTO: AUSTR Sands Holds Industrial Policy Meeting with Ministry of Electronic Industry, December 18, 1996,” DOC Cable (U): 97BEIJIN00866, January 1997.

90. “China’s New Telecommunications Rules to Take Effect,” *Xinhua News Agency*, August 13, 1997.

91. Jean Francois Huchet, "The Circle and Technological Development in the Chinese Electronics Industry," in *The China Circle: Economics and Technology in the PRC, Taiwan, and Hong* Kong, pp. 254-285; 258. The author goes on to say that “it is widely known that the reduction of the US commercial deficit with Taiwan and Hong Kong and its growing deficit with China has occurred because of the wave of delocalization in China of Taiwanese and Hong Kong labor-intensive industries.”

92. The six SOEs do not include the leading state or non-state sector enterprises in the electronics industry, such as Stone or Legend. Scott Kennedy, "The Stone Group: State Client of Market Pathbreaker," *The China Quarterly*, December 1997, p. 767 [fn94]. Some are, however, listed among 39 SOEs chosen by the central government as preferred electronics enterprises with whom to establish joint ventures. See James Whittaker, Testimony Before House Ways & Means Committee Hearing on China's Accession to the World Trade Organization, November 4, 1997. This is not to say, however, that the leading enterprises do not receive some government support and assistance. The Founder Electronics Group, for instance, was identified in 1997 as one of six enterprises (from different industry sectors) selected to receive over $2 million in government funding.

93. B. Naughton, *The China Circle*, pp. 27-28.

94. An example of this the Nanjing Panda Electronics Group, a state-owned enterprise that is not doing quite as well as its southern competitors despite government moral and financial support. Panda is located in Nanjing’s High-Technology Development Zone; Nanjing is not far from Shanghai. Panda is a large producer of televisions and is increasingly becoming involved in more advanced electronics such as personal computers, digital switches, liquid crystal displays, and wireless phone systems through foreign joint venture projects. Motorola is also a joint

venture partner. Karl Schoenberger, “Motorola Bets Big on China: The US High-tech Company Is Doubling its Stake in What Could Become the World's Largest Electronics Market, *Fortune*, 1996.

95. Whether the companies or “groups” derived from CAS and other state-run institutions can be placed in the state or non-state sector is not clear. According to the Office of Technology Policy, “China's new “high tech enterprises” are considered to be part of the non-state sector but are not privately-owned companies. They are usually collectively owned by the local government and either a university-based research institute or a CAS-based research institute. Individuals are allowed to own shares, but the portion held by individuals as opposed to institutions is comparatively small.” See “Summary: Visit to China by Assistant Secretary Graham Mitchell,” Travel Report, July 4-17, 1997. This category would include companies such as Legend. What is perhaps more important than a state or non-state label, however, are the actual ties to the former institution, which does not appear to be a close relationship for Legend or other companies doing business in Guangdong.

96. B. Naughton, *The China Circle*, p. 25.

97. US Census Bureau data.

98. US Department of Commerce, Office of Computers and Business Equipment, August 21, 1997 [website].

99. George Scalise, Testimony Before the House Ways & Means Subcommittee on Trade on "The Future of United States-China Trade Relations and the Accession of China to the World Trade Association," November 4, 1997.

100. There are also reportedly complaints by US companies of SACI corruption. The SACI is, as currently set up, a for-profit organization. See Ian K. McDaniels and Meredith Gavin Singer, "Standard Fare: Foreign Companies Now Face a Growing Number of PRC Standards and Inspection Requirements," *The China Business Review*, May-June 1997, pp. 22-28.

101. "Issue Alert: New Requirements Affecting Sales of Information Technology Products in China," July 25, 1996, Information Technology Industry Council (ITI).

102. UL can do follow-on annual inspections/certifications but only at the request of the Chinese State Administration of Import and Export Commodity Inspection (SACI) government organization of the State Council responsible for the SACI certificate. There are two certification certificates: the CCEE Mark (a.k.a. Great Wall Mark) for electrical products either manufactured in China or imported into China; and the SACI certificate, which is more extensive and covers electronic products intended for import/export. Products for which the CCEE certificate is required (effective January 1989) include electric tools, refrigerators, freezers, electric fans, air conditioners, televisions, radio, tape recorders, leakage protectors, power cables, etc. Other items (such as cord sets, motor compressors, household appliances, microcomputers and components, VCRs, etc.) are included in a second, thus far mandatory-compliance, list. Products requiring dual certification can be approved with one inspection. UL has signed an MOU with SACI that would allow US testing and certification of products but this agreement has not been tested due to disagreements (UL concerns) over PRC data and testing standards. Negotiations on this issue are reportedly ongoing. “Certification Scheme of the People's Republic of China,” brochure provided by Underwriters Laboratories, Inc.; and Ian K. McDaniels and Meredith Gavin Singer, “Standard Fare: Foreign Companies Now Face a Growing Number of PRC Standards and Inspection Requirements,” *The China Business Review*, May-June 1997, pp. 22-28.

103. Motorola’s WFOE in Tianjin is the only exception Chinese officials have made to this policy. The exception is likely due to the *guanxi* established by then-Motorola CEO, John Galvin with Chinese leaders, including former MEI head and then-mayor of Shanghai, Jiang Zemin. The $100 million investment commitment made by Galvin to Chinese leaders surely did not hurt. The Tianjin plant was opened in 1993. Although a city located about 70 miles outside of Beijing, Tianjin is a municipality of Beijing, meaning it answers directly to Chinese leaders in the capital. Kevin Maney, “Motorola Stands by China: Patience is Key to Telecom's Fastest-Growing Market,” *USA Today*, November 3, 1997, pp. 1B&C; Carla Rapoport, “Motorola Answers the Call: Telecommunications Giant Realizes Long-Held Dream, as it Dominates China's Vast Pager Hardware Market,” *Journal of Commerce*, October 1, 1997, p. 1.

104. Unicom was a subsidiary of the Ministry of Electronics Industry. Unicom was established to provide a state-run competitor to the MPT.

105. Susan Esserman, Testimony Before the US House of Representatives Committee on Ways and Means, Subcommittee on Trade, November 4, 1997.

106. SPA estimates that losses for US software firms in China due to piracy amounted to $250million in 1995. “Global Study Shows Increase in Software Units Pirated: Nearly One in Every Two Business Applications is Pirate Copy,” SPA press release, May 7, 1997; Catherine Gelb, “Installing a Software Sector,” *The China Business Review*, September-October 1997, pp. 38-36.

107. Earlier this year a bilateral agreement was signed that will allow the USITO to verify software title authenticity for US firms conducting business in China, in accordance with China's commitments to IPR enforcement under the 1995 MOU. Matt Forney, Simon Fluendy, and Emily Thornton, “A Matter of Wording: Microsoft Moves Carefully to Shore Up China Business,” *Far Eastern Economic Review*, October 10, 1996; “Leading Software Trade

Associations Announce Contract for Joint Title Verification Authorization Office in China," USITO press release, April 23, 1997.

108. The Semiconductor Industry Association complains that China's "state-invested enterprises already control a significant share of the trade in electronics goods into and out of China. For example, the Ministry of Electronics Industry (MEI) controls the China Electronics Corporation (CEC), which in turn owns or controls a significant share of China's electronics industry, including major consumers of semiconductors for consumer electronics and computer production...As a result of the continuing active [Chinese] government role in the electronics sector, there is a significant risk that as Chinese semiconductor production increases both in volume and quality, other state-invested enterprises will be encouraged by Chinese officials to purchase from domestic suppliers. Such discrimination could significantly burden or restrict US semiconductor sales in China in the future." G. Scalise, Testimony, November 4, 1997.

109. Helen Ho, "Buying a Piece of PRC Industry," *The China Business Review*, Jan-Feb, 1996, pp. 34-37; and US Department of Commerce, Office of Computers and Business Equipment, "Information Technologies Market II," April 5, 1996. According to figures released by the China Software Industry Association (CSIA), there are more than 13,000 software development firms (state-owned and non-state enterprises) currently in business, though some of these are firms of only one or two people. Figure cited in Catherine Gelb, "Installing a Software Sector," *The China Business Review*, September-October 1997, pp. 28-36.

110. Catherine Gelb, "Installing a Software Sector," *The China Business Review*, September-October 1997 and Dexter Roberts and Bruce Einhorn, "Going Toe to Toe with Big Blue and Compaq: Suddenly, Chinese Computer Makers are Holding their Own," *Business Week*, April 14, 1997, p. 58.

111. Catherine Gelb, "Installing a Software Sector," *The China Business Review*, September-October, 1997, p. 36.

112. A defense electronics "expo"—the China International Defence Electronics Exhibition—was held in May 1998 in China; foreign electronics firms were invited. William Kazer, "China's Military Backs Foreign Role in Defense Projects," Journal of Commerce, July 16, 1997, p. 4. Since making this announcement, Central Military Commission Vice Chairman, Liu Huaqing —China's leading voice for military reform toward high-tech modernization— has been pushed out of the top leadership by Jiang Zemin during the 15th Party Congress held in September 1997. Liu's plan, however, was likely not his alone and will, therefore, probably be implemented despite his departure. In fact, an official of the Commission on Science, Technology, and Industry for National Defense (COSTIND) reportedly requested foreign firms attend the May expo in Beijing. Nigel Holloway, "Revolutionary Defence," *Far Eastern Economic Review*, July 24,1997, pp. 24-25.

113. The Economist Intelligence Unit, July 1997.

114. See, for instance, "Government strategies (BCG 1994)," Chapter 2 in WTEC report, which states that "Within the government sector, the technology for defense production is at a high level."

115. China's military controls a large portion of the telecommunications bandwidth (particularly cellular communications frequencies) in China, which is gradually being opened to commercial uses. As a result, many of the Sino-foreign joint venture partnerships in this industry sector may be affiliated with China's defense industrial sector or its military sector (PLA). It should be understood that China's military and defense industrial sectors are under separate authorities: the Central Military Commission or PLA and the State Council (civilian authority), respectively. The defense industrial sector does *not* (as far as the experts can tell) directly subsidize the PLA, though gains in defense industries may indirectly aid the PLA modernization effort. A recent study on this concern, however, states that in order for foreign communications companies to gain access to the military-controlled bandwidth "the PLA and its [Chinese joint venture] partners expect a significant infusion of capital and technology." James Mulvenon *in Chinese Military Commerce and US National Security*, Center for Asia Pacific Policy, RAND Corporation, MR-907.0-CAPP (draft) July 1997.

116. "How You Can Win in China: The Obstacles are Huge but Surmountable," *Business Week*, May 26, 1997, pp. 66-68. Another recent example is Prodigy, the first foreign internet service provider to be allowed to establish a presence in China, is partners with among others the China North Industries Co. (better known as NORINCO). Although NORINCO is officially a state-run "corporation" under China's civilian authority (State Council), NORINCO is also known to be involved in military-related activities and the import and export of military products. The deal with Prodigy included NORINCO due to the latter's ability to provide access to satellite communications necessary for the project (i.e., limited internet access, e-mail, fax and voice messaging services). Company Press release. Jared Sandberg and Craig S. Smith, "Prodigy to Launch Internet Service in China," *The Wall Street Journal*, April 28, 1997.

117. Catherine Gelb, "Installing a Software Sector," *The China Business Review*, September-October, 1997, pp. 31-32.

118. The remaining top investors include two in auto manufacturing and auto parts, two in oil/energy, followed by one each in low-tech electronics, with only two catering to China's food and drink industry. Karl Schoenberger, "Motorola Bets Big on China," *Fortune*, vol. 133, no. 10, May 1996.

119. WTEC report.

120. Microsoft's China office is now its fastest growing branch, despite having suffered through initial difficulties in its 1994 entry into the China market. Microsoft Corp. (software) "...manufactures in-country most of the products sold in China, while foreign-language products are its main exports to the PRC." Catherine Gelb, "Installing a Software Sector," *The China Business Review*, September-October 1997.

121. "Rethinking China," *Business Week*, March 4, 1996, pp. 61.

122. This information is according to the CSIA as cited in Catherine Gelb, "Installing a Software Sector," *The China Business Review*, September-October 1997.

123. *Ibid.*

124. This situation is not unlike the Boeing-Airbus rivalry. Simon Fluendy, "Battle of the Standards," *Far Eastern Economic Review*, August 22, 1996.

125. Chinese electronics exports in 1996 were valued at US$18.41billion while imports were US$15.83 billion, according to Chinese statistics. "More Electronic Products Exported," *Beijing Review*, vol. 40, no. 15, April 14-20, 1997. According to a US-based analyst, however, the PRC witnessed its first trade surplus in electronics the year before, when exports of $17 billion exceeded imports of $16 billion. Regardless of the exact figure, however, the trend is clear. Elizabeth Schumann, "China on Fast Track for Building IC Capacity," *Channel Magazine*, SEMI, February 1997.

126. *Ibid.*

127. These categories are 852110, 854129, 852530, 853310, and 853222, respectively. This data is derived from the US Census Bureau at the 6-digit level analysis. The remaining top ten categories include turntables (851939), parts for electrical capacitors (853290), nickel-iron storage batteries (850740), transistors ex. Photosensitive, dissipation rate less <1w (854121), and "electromechanical saws for working in the hand" (850820).

128. Information is included in a SEMATECH document: "SEMI Course Highlights: Doing Business in China," dated March 18, 1997.

129. Denis Fred Simon, "From Hot to Cold," *The China Business Review*, November-December 1996, p. 16; G. Scalise Testimony, November 4, 1997.

130. A number of US high-tech firms considered investing in this project, but industry and USG concerns regarding potential dual-use applications and the need for licensing approval deterred them from pursuing this project.

131. "Who Dares, in China, Can Still Win," *The Economist*, July 6, 1997.

132. Taiwan was able to move from the 5 micron level to production of 1.0 micron chips over a ten-year span from 1980 to 1990. The PRC has made the same advances over a similar ten-year period (1985-1990) but about five years behind Taiwan and further still behind the world leaders. However, advances in this field at submicron levels are only made by devoting significant resources to research and development, which China appears willing to do. In addition, the technological assistance forthcoming from foreign firms is certain to hasten China's progress in submicron chip making, which otherwise might remain concentrated at the 1.0-0.8 micron level for some time. Chin Chung, "Division of Labor Across the Taiwan Strait: Macro Overview and Analysis of the Electronics Industry," *The China Circle: Economics and Technology in the PRC, Taiwan and Hong Kong*, pp. 164-209, see in particular page 195.

133. This is according to a report on international efforts at "discovering new techniques for confining electrons to structures at the nanometer scale, revealing new insights into electronic behavior that may one day have practical applications." The Chinese contribution to this effort was reportedly devised at Nanjing University in Nanjing. See "Confined Electrons Boost Semiconductors," *Electronic Engineering Times*, no. 919, September 16, 1997, p. 36.

134. Denis Fred Simon, "From Hot to Cold," *The China Business Review*, November-December 1996, p. 16.

135. *Ibid.* See also James Harding, "Chinese Switch on to Computer Power," *The Financial Times*, August 12, 1997.

136. Perry Mataya and Huang Zhiqiang, "China: Software Market," Industry Sector Analysis (ISA), June 1995.

137. "Local Computer Maker Takes Lead," *China Daily*, March 10, 1997. Citing figures by the State Statistical Bureau, the article states that "Legend Computer, a domestic computer brand, ranked first in China home sales in 1996 with sales of 200,000 units. This is the first time that a domestically manufactured computer has sold the highest number of units in China's increasingly competitive market that was once dominated by foreign brands. The computer has become the third electronic product with such an important role in the country's domestic market after TVs and refrigerators."

138. This information is contained in a report published by Dataquest, a market research firm. See James Harding, "Chinese Switch on to Computer Power," *The Financial Times*, August 12, 1997; "Chinese PC Maker, Hitachi Link to Fight US Rivals," *Wall Street Journal*, September 30, 1997, p. A17.

139. Key end-users of PCs in China are the PRC government and the aerospace, banking, telecommunications, and transportation industries. US Department of Commerce, Office of Computers and Business Equipment, "Information Technologies Market II," April 5,1996 and Bryan Larson and Timothy Miles, "Personal Computers and the Golden Projects," US Department of Commerce, International Trade Administration, Office of Computers and Business Equipment, March 1997.

140. WETC report; and "China's PC Makers Navigate the Pitfalls," *IDG China, Market News Update*, July 23, 1997.

141. In July 1997, Legend signed an agreement that will allow sales of its products in the US; Legend also has a small research facility located in Silicon Valley, established in 1993. Dexter Roberts and Bruce Einhorn, "Going Toe to Toe with Big Blue and Compaq," *Business Week*, no. 3522, April 14, 1997, p. 58.

142. Scott Kennedy, "The Stone Group: State Client of Market Pathbreaker," *The China Quarterly*, December 1997, p. 752. Kennedy points out that Stone is not, as is often assumed, a "private" company. Rather, it is a type of "collective" enterprise in the non-state sector, but one with more autonomy than most such enterprises.

143. According to one article, the capacity was 10 billion TOPS. The article states that, "In November 1992, when China's first giant computer capable of 1 billion calculations per second, developed by the USTND, was born and the design of the 10 times faster 'Yinhe-III' giant computer began, Comrade Jiang Zemin happily wrote this inscription: "Conquer giant computer technology and bring credit to the Chinese nation." See "China: Jiang's Interest in Defense Technology," *Beijing Liaowang*, no. 30, July 28, 1997. However, the Associated Press reported the same computer, the Yinhe III, as being capable of 13 billion TOPS, which was the level reportedly announced on national Chinese television. See "China Unveils Supercomputer," *Associated Press*, June 19, 1997.

144. "China: Jiang's Interest in Defense Technology," *Beijing Liaowang*, no. 30, July 28, 1997, pp 4-6.

145. *China White Paper on Arms Control and Disarmament, Xinhua News Agency*, November 16, 1995, issued by the Information Office of the State Council of the PRC.

146. Following a review of computer export level reforms in 1995, the 10,000 MTOPS level "emerged as the boundary for militarily significant capabilities that an export control regime might hope to deny to adversaries through 1997." The 10,000 MTOP level is presently available to most of the rest of the world. See Kenneth Flamm, "Controlling the Uncontrollable: Reforming US Export Controls on Computers," *The Brookings Review*, December 1996, pp. 22-25.

The Galaxy II is apparently a successor to China's first supercomputer, known simply as "Galaxy," and listed as having been developed in 1983. The Galaxy II is listed among China's technological achievements in the computer sector in *Technology Transfers to China*, Office of Technology Assessment, 1987, p. 96. The Galaxy series is reportedly designed and developed by the Changsha Galaxy Technology Group, a division the USTND. Min Chen, "Market Competition and the Management Systems of PLA Companies," in *Mixed Motives, Uncertain Outcomes: Defense Conversion in China*, Jorn Brommelhorster and John Frankenstein, eds., p. 213.

147. Figures are by Kenneth Flamm of The Brookings Institution as cited in Paul Blustein, "Computer Evolution: Faster than a Speeding Export Curb," *The Washington Post*, July 3, 1997, pp. E1&E2.

148. In most cases, Chinese government estimates on the amount of telecom equipment, networks, and infrastructure that could be installed by 1995 and then the year 2000 have doubled as the target date approached. See "How Has China Financed Its Telecoms Build-Out?," *Business China*, November 24, 1997, pp. 7-9.

149. Mobile phone usage in China topped 10 million in 1997, an achievement reached in less than a decade. Chinese government statistics predict mobile phone users will reach between 17 and 30 million by the year 2000 (the International Telecommunications Union also projects 30m users). Terho Uimonen, "China's Mobile Phones Push Past 10 Million Mark," *IDG China Market News*, August 8, 1997; "Telecom Growth Estimates Revised Upwards," *China Daily*, December 30, 1996.

150. WTEC report.

151. China is also reported to have begun "to develop optic cables on a large scale during the 1991-95 period." *China Economic Information*, July 1997.

152. Motorola is certainly not alone in participating in China's emerging telecommunications sector, nor are they the only US company experiencing difficulties. Nortel (Northern Telecom Ltd.), for instance, established a joint venture in 1993 to build "state-of-the-art" digital switches. Commercial offset agreements reportedly included research and development projects with government institutes. According to press reports, Nortel's profit margin is slim at best. BellSouth was reportedly planning on establishing a joint venture with China's Unicom to build cellular telephone systems. The deal was also reported to include an agreement to provide training, but a demand made during negotiations by a Chinese official for an additional $10 million investment convinced BellSouth officials to re-think pursuing the venture further. These tales are included in a recent article, "How You Can Win in China: The Obstacles are Huge but Surmountable," *Business Week*, May 26, 1997, pp. 66-68.

153. C. Gelb, *The China Business Review*, September-October 1997.

154. This assertion is reported to be made by DOD officials. United States General Accounting Office, *Export Controls: Sale of Telecommunications Equipment to China*, GAO/MNSIAD-97-5, November 1996, p. 5.

155. M. Borrus, "Left for Dead: Asian Production Networks," in *The China Circle*, p. 140.

156. The apparel industry is listed as the sector most affected, with losses of 146,000 jobs followed by toys (66,000), footwear (60,000), and textiles (58,000). Jesse Rothstein and Robert E. Scott, *The Cost of Trade With China: Women and Low-Wage Workers Hit Hardest by Job Losses in All 50 States*, Issue Brief 121 (Washington, DC: Economic Policy Institute, October 28, 1997).

157. Barry Naughton, "The Emergence of the China Circle," *The China Circle: Economics and Technology in the PRC, Taiwan, and Hong Kong*, pp. 16-13.

158. "How You Can Win in China: The Obstacles are Huge but Surmountable," *Business Week*, May 26, 1997, pp. 66-68.

159. *US Industry and Trade Outlook 1998,* p. 16-4.

160. Chin Chung, "Division of Labor Across the Taiwan Strait," in *The China Circle: Economics and Technology in the PRC, Taiwan, and Hong Kong,* p. 200.

161. "Commission Communication to the Council on a Long Term Policy for China-Europe Relations," European Commission Delegation to China, 1996.

162. By their own accounting, the EU nations were responsible for 49 percent of technology exports to China. See "EU-China Trade," European Commission Delegation to China, 1996.

163. The European automobile industry is represented by the European Automobile Manufacturers Association (ACEA) and the European Automobile Parts and Suppliers Association (CLEPA). ACEA consists of leading European car manufacturers like BMW, Fiat, Ford of Europe, GM of Europe, Mercedes-Benz, Porsche, PSA Peugeot Citroen, Renault, Rolls Royce, Volkswagen and Volvo. CLEPA represents the entire auto supply industry in Europe, comprising fully 3,000 companies. The European aerospace corporations are represented by a trade association, known as the European Association of Aerospace Industries (AECMA). AECMA is led by Airbus Industrie, but the organization also includes Sextant Avionique, DASA, Thomson CSF, Rolls Royce, Sysabel, Lucas Aerospace, Aerospatiale and Siemens Plessey, among others. Airbus, alone, has also entered into technology transfer agreements with the Chinese aviation industry. Airbus was involved in a three-way agreement to produce a 100-seat transport aircraft, the AE31X (also/formerly known as the AE-100) for which the final assembly line was to be in China. (This project has since been cancelled.) Airbus has also established a training and support center in Beijing, an $80 million investment that is reportedly an offset for the 1996 purchase of 30 planes from Airbus. "Airbus Equity-Sharing Wins Chinese AVIC Partnership," *Countertrade & Offset*, vol. xv, no. 17, September 8, 1997, p. 3.

164. EU-China Industrial Co-operation Programme in the Automotive Sector," European Delegation to China, 1996.

165. "'EU-China Industrial Co-operation in the Aeronautical Sector," European Commission Delegation in China, 1996.

166. It is possible that these trade deficits are due to investments made in China, the products of which may have been exported back to these economies, although there is no clear evidence that this is, in fact, the case.

167. Japanese reluctance and cautiousness with regard to investing in the China market may be weakening, however. The recently awarded Project 909 advanced semiconductor contract to Japan's NEC is a recent example of an possible change of mind on the part of Japanese industry to transfer advanced technology to China. Some analysts point out, however, that by the time this facility reaches the planned production of submicron chips at the 0.5-0.35 levels, the rest of the industry will have moved beyond this level anyway. If so, NEC's decision to invest may not be such a departure from previous Japanese practice.

168. UN trade data shows a marked rise in hi-tech exports from Japan in 1993 and 1994.

169. Toyota's Daihatsu and Suzuki currently have licensing agreements with Chinese ventures to produce the Charade and Alto, respectively. Honda only very recently became the first Japanese automaker to establish a manufacturing joint venture on the Mainland, having taken over Peugeot's facility in Guangzhou. Daniel Howes, "GM Trails Honda in China Deal," *The Detroit News*, November 4, 1997; Seth Faison, Honda, Beating Out GM, Plans to Build Cars in China," *The New York Times*, November 14, 1997, p. C2. This may also be a sign of Japanese industry having a change of mind with regard to the China market. According to industry experts, "Japanese car makers have been slow to commit to China because of their concerns about the stability of its market, auto executives say. Honda, in particular, is known for carefully gauging demand before building plants" (cited in Craig Smith and Lisa Shuchman, "Honda Beats GM for Deal in China," *The Wall Street Journal*, November 11, 1997.

170. Tang Shiguo, "Sino-Japanese Technology Transfer and Its Effects," *Chinese Technology Transfer in the 1990s: Current Experience, Historical Problems and International Perspectives*, Charles Feinstein and Christopher Howe, eds. (Cheltenham, UK: Edward Elgar Publishers, 1997), p. 157.

171. Harley and Iritani, *Los Angeles Times*, December 2, 1995.

172. William Chen, Director of International Trade and Service Corporation, Shanghai. Quoted in *The Los Angeles Times*, December 2, 1995.

173. “Transport Equipment” in the case of Japan is primarily tankers and other shipping vessels. “Electrical Machinery” refers to items like static convertors and circuit breakers.

174. Atsushi Yamakoshi, "Grappling With A Giant,” *Japan Economic Institute Report*, August 30, 1996.

175. Interview on October 16, 1997.

176. Atsushi Yamakoshi, "Grappling With A Giant,” *JEI Report*, August 30, 1996. This trend has also become evident among domestic industry competitors. For instance, Microsoft, DEC, and Oracle joined forces in May 1996 in their efforts to sell software in China. *The China Business Review*, September-October, 1997.

177. “List of Countries to Which Japan is Top Donor,” Ministry of Finance, Japan.