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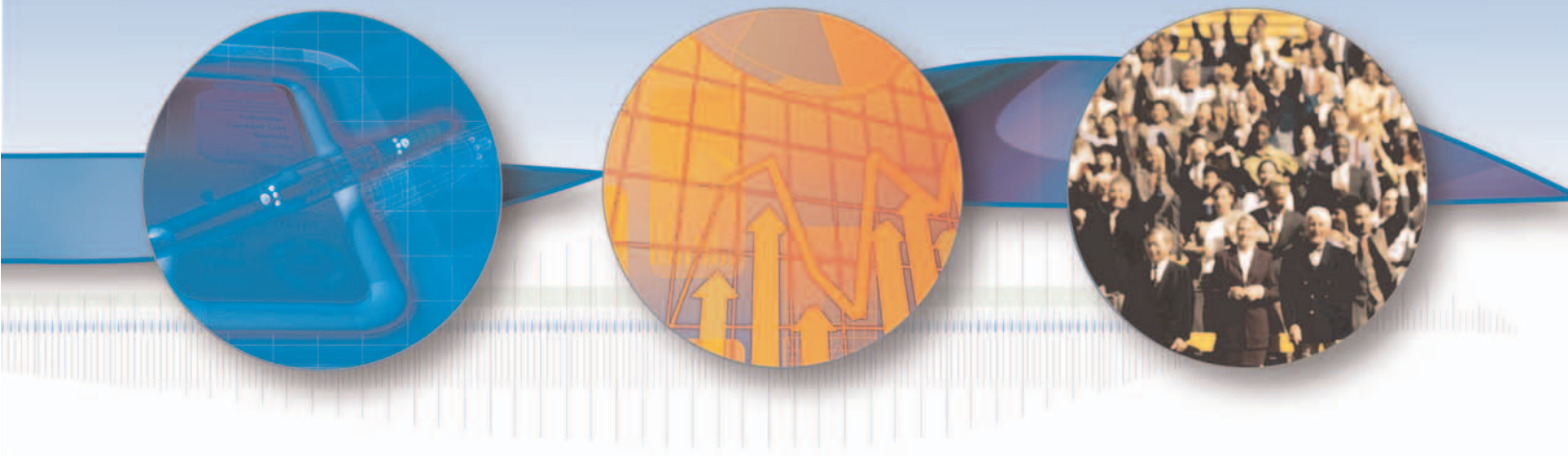

Role of China in Competitiveness of U.S. CE Industry

CONSUMER ELECTRONICS ASSOCIATION | 2500 WILSON BOULEVARD | ARLINGTON, VA | 22201-3834
TOLL FREE (866) 858-1555 | (703) 907-7600 MAIN | (703) 907-7601 FAX | Research@CE.org | www.CE.org

Role of China in Competitiveness of U.S. CE Industry

Executive Summary

China plays a critical role in the competitiveness of the U.S. consumer electronics (CE) industry. This role increases as the pace increases for the development of new and ever more cutting edge CE products, and as consumers demand that prices for CE products drop still more to stimulate sales. This report examines the contribution of China to the competitiveness of the U.S. CE industry so that policy makers can devise appropriate responses.

- The U.S. CE industry is highly competitive, and global production is an integral part of the industry's strategy for quickly developing new products at affordable prices.

- U.S. CE production supports a network of global production. The United States remains a strong producer of CE components and parts, most notably semiconductors and related devices, and software. As the global network of production expands and deepens, U.S. manufacturers focus on the production of higher-end consumer electronics as well as the design and marketing of CE products manufactured elsewhere.

- The product and country composition of U.S. CE exports and imports, as well as recent trends in CE exports and imports, reflect the growing internationalization of U.S. CE production. They also reflect the increasing importance of China to the competitiveness of U.S. manufacturers. Growing imports from China are largely replacing imports from other Asian suppliers, which are declining. Large shares of U.S. CE imports come from suppliers abroad to whom the U.S. importer is related in some way.

- CE investment abroad supports the competitiveness of U.S. CE manufacturers. U.S. CE investments in China, in particular, contribute positively to the competitiveness of U.S. CE firms and their U.S.-based support operations. These investments serve two purposes: to supply the growing Chinese market with locally-produced CE products, and to help U.S. companies lower costs of CE products sold around the world, including in the highly price-competitive U.S. market.

- CE trade and investment support high-skilled jobs in the United States. By relying on foreign suppliers for the manufacture of competitively-priced finished CE products, U.S. companies are better positioned to devote scarce financial resources to what they do best: research and development, design, marketing, software development and production. CE sectors are more R&D intensive than other manufacturing sectors. They employ a greater proportion of scientists and engineers, and generally pay higher wages than other manufacturing industries.

- U.S. CE imports from China also support good jobs in the United States. We estimate that CE imports from China support more than 66,000 U.S. jobs across a range of sectors. Every U.S. state has a net positive employment stake in CE imports from China.

- Global CE production keeps CE prices affordable to American families. The availability of competitive production facilities in Asia generally and China specifically has permitted U.S. CE producers to meet consumer demand for lower-cost CE products without abandoning U.S. production altogether.

- Public policy has a role to play in supporting the competitiveness of the U.S. CE industry. Policy makers should support efforts to liberalize international trade and investment, and to protect U.S. intellectual property rights both at home and abroad. Policy makers should also support the promotion of science and math education in American schools. Policy makers should consider expanding the number of visas available for foreign scientists and engineers to work in the United States. Last but not least, policy makers should avoid restrictions on U.S. imports, including imports of CE products from China. These imports are job-supporting; import restrictions would cost jobs and raise prices.

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About the Sponsor and the Authors

This study was prepared by Laura M. Baughman and Dr. Joseph Francois for the Consumer Electronics Association (CEA). CEA is the preeminent trade association promoting growth in the consumer technology industry through technology policy, events, research, promotion and the fostering of business and strategic relationships. CEA represents more than 2,100 corporate members involved in the design, development, manufacturing, distribution and integration of audio, video, mobile electronics, wireless and landline communications, information technology, home networking, multimedia and accessory products, as well as related services that are sold through consumer channels. Combined, CEA's members account for more than $128 billion in annual sales. CEA's resources are available online at www.CE.org, the definitive source for information about the consumer electronics industry.

Laura M. Baughman is President of Trade Partnership Worldwide, LLC (TPW, www.tradepartnership.com). Ms. Baughman follows closely the impacts, both prospective and actual, of trade policies and programs on the U.S. economy and the trade flows of U.S. trading partners. Under her direction, TPW produces detailed economic assessments of these policies and programs based on traditional economic modeling. Ms. Baughman has particular expertise in evaluating the impacts of trade policy on American retailers, for whom she has worked since the mid-1980s. Ms. Baughman holds degrees in economics from Columbia and Georgetown Universities.

Dr. Joseph Francois is Managing Director of Trade Partnership Worldwide, LLC, and professor of economics at Erasmus University. He also holds numerous research fellowships and professorships at think tanks and universities around the world. Dr. Francois formerly was the head of the Office of Economics at the U.S. International Trade Commission, and a research economist at the World Trade Organization. Dr. Francois is a widely published author of books and articles focused on modeling trade policy questions. He holds a PhD in economics from the University of Maryland, and economics degrees from the University of Virginia.

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Executive Summary

I. Introduction

The American consumer electronics (CE) industry is no different than many other U.S. industries. Intense competition drives innovation, growth and contraction, productivity improvement, employment change, increased trade (both exports and imports), and public policy confusion. This report seeks to clarify each of these dynamics, and suggest appropriate public policy responses. We pay particular attention to the growing role China plays in the competitiveness of the U.S. CE sector, and estimate the impact on the U.S. employment of CE imports from China.

II. An Industry Embracing Change

The CE industry has always been and remains today highly competitive. U.S. manufacturers have risen to meet this intense competition in a variety of ways. Computer manufacturing, for example, began with integrated firms like IBM and Digital Equipment producing products, from design to delivery, in house. As certain parts became standardized or, in other cases more specialized, these large integrated producers began to outsource[1] production to specialized producers of software (Microsoft), parts (Intel) and other hardware.

The outsourcing of production evolved even further in the 1990s with the growth of firms performing still more pieces of the design-to-market process. These subcontractors first sprang up as small firms in Silicon Valley, but soon increasingly included much larger companies that are global in scope. Today, the "American" CE industry is difficult to define as 100 percent "American" or 100 percent "foreign." U.S. production remains, be it actual manufacturing or product design, development and marketing. But U.S. production is intertwined with foreign input of some type — most commonly assembly or manufacturing, but increasingly R&D and design as well.

Two types of firms dominate the CE industry today.[2] Brand manufacturers focus on brand and product development, marketing, distribution and after-sales services, largely from U.S. locations. Contract firms, referred to as "electronic contract manufacturers" (ECMs), focus on selling pieces of the design-to delivery-process that the brand manufacturers want to outsource. This ECM category of firms includes a group of mostly U.S.-owned firms that focus on manufacturing and related services like component purchasing and inventory management, testing, final assembly and logistics (called "electronics manufacturing services" (EMS) contractors[3]), performed in part abroad (increasingly in China) and in part in the United States, in Silicon Valley and in high-tech corridors in, for example, Boston. Another group of Taiwan-based contract manufacturers often referred to as original design manufacturers (ODMs), focuses primarily on the design of personal computer products. Much of the ODM production of CE products takes place in China, and some of the design operations are beginning to shift from Taiwan to China as well. In short the CE production process has become globally networked and varies considerably from product to product and firm to firm. U.S. value added is part of that process.

Table 1
Global Top EMS Firms, 2005

Company	Headquarters	Net Sales (billions)
Hon Hai Precision (Foxconn)	Taiwan	$16.9*
Flextronics International	Singapore	15.7
Sanmina Sci	California	11.7
Solectron	California	10.4
Celestica	Canada	8.5
Jabil Circuit	Florida	7.5
Elcoteq Network	Finland	4.0
Synnex	California	5.6
Benchmark Electronics	Texas	2.2
Plexus	Wisconsin	1.2

* 2004
Source: Company annual reports.

To understand the U.S. CE industry and the likely impact on it of U.S. policy actions, policy makers need to appreciate the dynamics of the marketplace that shape CE industry decisions about such key variables as what to make, how and where to make it, who to hire, and how best to launch, deliver and support a product in the marketplace. CE manufacturers today face a multitude of pressures.

- **Price pressures** that require lean operating costs. The current economic environment is highly competitive and price sensitive. CE companies need flexible, cost-efficient manufacturing capabilities.

- **Ever shortening product life cycles** that demand CE companies invest heavily in R&D, have access to leading design and engineering capabilities, and produce cutting edge new technologies that are increasingly integrated with products and services across a wide range of uses.

- **Time-to-market pressures** that necessitate a highly efficient supply chain, one in which components arrive on a just-in-time, as-and-when needed basis.

- **Maintaining strong brand awareness and company reputation,** which requires a talented and well-funded marketing department and product performance backed up with warranties.

- **Customer service,** from retail to post-purchase assistance, and sometimes even financial assistance with the purchase itself.

While individual CE firms address these pressures in different ways, most have one reaction in common: they have "gone global." That said, U.S.-based CE production has not disappeared. Rather, today U.S. CE production is increasingly integrated into a global marketplace, a transition mandated by the pressures listed above. This is an industry that embraces change.

[1] "Outsourcing" is different than "offshoring. Outsourcing is the transferring of some (or all) of production to another firm, which may be located in the United States or abroad. Offshoring is the transfer of some (or all) of production to a firm outside the United States.

[2] Actually, a third type also operates today, largely in Europe and Japan: the traditional, fully integrated CE producers, although some believe the "tide is shifting" here as well. The description of the industry that follows is a summary of and elaboration on the excellent synopsis offered by Richard Lester, "China, America, and the Global Competition for Industry," Working Paper 03-007, Massachusetts Institute of Technology Industrial Performance Center, October 16, 2003.

[3] EMS companies provide "full package" production for CE companies. The larger among them contract with CE brands to build their products or to obtain services related to product design, manufacturing and post-manufacturing requirements. They design, build and service products that carry the brand names of their customers. Six of the ten largest EMS firms are American. They have dozens of manufacturing facilities around the world, most concentrated in Asia (Malaysia, Thailand and China). Mexico is also a prime location, as are Hungary, Poland, the Czech Republic and Romania. Contract manufacturers account for about 15-20 percent of global value added in information technology manufacturing. Boy Luthje, "Global Production Networks and Industrial Upgradiing in China: The Case of Electronics Contract Manufacturing," East-West Center Working Papers, Economics Series, No. 74, October 204, p. 3.

III. U.S. CE Production Has Evolved to Support a Global Production Platform

The United States produces a number of consumer electronics products: parts, finished products and related software.[1] This chapter presents five case studies of CE products - semiconductors, computers and peripherals, televisions, audio/video products and software - to demonstrate the variety of activities taking place within U.S. borders that are supported by global production platforms.

Semiconductors

The United States is a major producer of semiconductors, a basic ingredient of most consumer electronics products today. The major U.S. semiconductor manufacturers are global companies with production facilities located in the United States and overseas. Seventy-seven percent of U.S. semiconductor companies' manufacturing capacity is located in the United States, with U.S. employment exceeding 225,000.[2] Over 17 percent of workers in this sector are R&D-focused scientists and engineers.[3]

The value of U.S. production of semiconductors has been increasing at an average annual rate of 7.0 percent since 2001 (see Table 2). Table 2 also shows that the destination for U.S. output is about equally split between the U.S. market and foreign markets. The U.S. industry has foreign operations in several locations, Taiwan and China in particular.[4]

While some suggest that such "offshoring" is a "negative," in fact it has enabled U.S. producers to remain technological leaders by providing them with the financial resources to focus their domestic activities on R&D and design, at which U.S. labor excels. Not only are U.S. manufacturers thriving thanks to high-skilled U.S. labor, but foreign semiconductor manufacturers are drawn to establish facilities in the United States to avail themselves of that labor talent as well.[5]

Table 2
U.S. Production, Imports, Exports and Market for Semiconductors,* 2001-2005
Millions of Dollars

	2001	2002	2003	2004	2005
U.S. Production	$55,285	$57,547	$62,349	$68,306	$72,295
Exports	33,031	31,605	35,811	35,494	34,306
U.S. Shipments	22,254	25,942	26,538	32,812	37,989
Imports	30,826	26,577	25,146	27,382	26,670
U.S. Market	53,080	52,519	51,684	60,194	64,660
Percent					
Exports' Share of U.S. Production	59.7%	54.9%	57.4%	52.0%	47.5%
U.S. Shipments' Share of U.S. Market	41.9%	49.4%	51.3%	54.5%	58.8%

* Products classified under NAICS product code 334413.

Source: U.S. Census Bureau (production data from Current Industrial Report: *"Semiconductors, Electronic Components, and Semiconductor Manufacturing Equipment," MA334,* various issues; trade data from U.S. International Trade Commission Dataweb).

"As of year-end 2005, 77 percent of our wafer manufacturing … was conducted within the U.S. at our facilities in New Mexico, Oregon, Arizona, Massachusetts, Colorado and California. Outside the U.S., nearly 23 percent of our [manufacturing of the same products] was conducted at our facilities in Ireland and Israel… We expect to increase the capacity of certain facilities… through additional investment in capital equipment. In addition to our current facilities, we are building facilities in Arizona and Israel…"

Intel Corporation

Computers, Peripherals and Parts

The U.S. computer, peripherals and parts sector is a major U.S. manufacturing sector that is highly globalized. U.S. production totaled $88.7 billion in 2005 (see Table 3), surpassing the value of U.S. production of semiconductors. According to the U.S. economic census, more than 400 companies produced these products in the United States in 2002.[7] Production facilities are located in 15 states. Employment totaled 206,500 in 2005. Nearly 8 percent of workers in this sector are R&D-focused scientists and engineers.[8]

U.S. government data for this sector combine computers and peripheral equipment purchased for business use and such equipment purchased by consumers. Thus, it does not show the fact that, while the business segment of the market is mature, the consumer market for computers is growing. This is due in large part to the declines in prices and the increasing integration of computers with other CE products in the home (see Chapter VII below).

> "In the digital home, people want to hook things together…. [The personal computer] continues to be the major point of influence in the use of this information in the home, whether it's music or pictures. I think you'll see the same thing happen with video… [A]ll companies in this digital home are going to be forced to fit into this framework where consumers want things to hook together."
>
> *Michael Dell, Dell*

Table 3
U.S. Production, Imports, Exports and Market for Computers, 2001-2005
Millions of Dollars and Percent

	2001	2002	2003	2004	2005
Computers					
U.S. Production	$48,541	$40,448	$38,271	$39,850	$49,225
Exports	8,803	7,349	6,204	6,283	6,867
U.S. Shipments	39,738	33,099	32,067	33,567	42,358
Imports	12,197	15,582	19,713	24,337	28,733
U.S. Market	51,935	48,681	51,780	57,904	71,091
U.S. Shipments' Share of Market	76.5%	68.0%	61.9%	58.0%	59.6%
Peripherals and Parts*					
U.S. Production	$53,589	$42,408	$37,536	$37,018	$39,497
Exports	27,159	20,900	20,857	20,079	20,913
U.S. Shipments	26,430	21,508	16,679	16,939	18,584
Imports	61,015	58,234	55,021	62,717	62,624
U.S. Market	87,445	79,742	71,700	79,656	81,208
Total, Computers and Peripherals and Parts					
U.S. Production	$102,130	$82,856	$75,807	$76,868	$88,722
Exports	35,962	28,249	27,061	26,362	27,780
U.S. Shipments	66,168	54,607	48,746	50,506	60,942
Imports	73,212	73,816	74,734	87,054	91,357
U.S. Market	139,380	128,423	123,480	137,560	152,299

* Printed circuit assemblies, computer storage devices and equipment, parts for storage devices and subassemblies, computer terminals, parts for computer terminals, parts for I/O equipment. Products classified under NAICS product codes 334418B, 3341121, 3341124101, 3341131, 3341134101, 3341191, 3341194101.

Source: U.S. Census Bureau (production data from Current Industrial Report: Computers and Peripheral Equipment," MA334, various issues; trade data from U.S. International Trade Commission Dataweb).

Televisions

The television story is another globalization story for U.S. manufacturing. Seven companies produce televisions in the United States.[10] Seven plants are located in five states (three plants in Tennessee alone).[11] Over time, U.S. production has been shifting to concentrate on large televisions, which can be more competitively produced in the United States, and away from smaller televisions that are more competitively supplied by producers located largely in Asia. The average unit value (at factory cost) of televisions produced in the United States is nearly three times greater than the average unit value (based on customs value) of an imported television (see Table 4). And even though the number of televisions produced in the United States has been declining, their average unit value - and therefore the total value of sales - of domestically-produced televisions has been increasing.

Table 4
U.S. Production, Imports, Exports and Market for Televisions, 2001-2005

	2001	2002	2003	2004	2005
Millions of Dollars					
U.S. Production	$3,039	$3,285	$3,499	$3,705	$3,836
Exports	667	636	380	399	337
U.S. Shipments	2,372	2,649	3,119	3,306	3,499
Imports	6,245	7,617	7,949	9,585	12,398
U.S. Market	8,617	10,266	11,068	12,890	15,896
Thousands of Units					
U.S. Production	8,264	8,811	7,796	7,658	7,133
Exports	2,065	1,754	914	886	794
U.S. Shipments	6,199	7,057	6,882	6,772	6,339
Imports	33,625	40,703	38,741	51,418	43,844
U.S. Market	39,824	47,761	45,622	58,190	50,183
Unit Value ($/TV)					
U.S. Production	$368	$373	$449	$491	$538
Exports	323	363	416	451	231
U.S. Shipments	383	375	453	497	552
Imports	186	187	205	186	282
U.S. Market	216	217	243	222	317

Source: U.S. Census Bureau (production data from *Current Industrial Report: "Consumer Electronics,"* MA334, various issues; trade data from U.S. International Trade Commission Dataweb).

Audio/Video Products

U.S. brand manufacturers are important players in the audio and video product segment of the CE industry. Intense price competition has forced many of them overseas in search of lower manufacturing costs. Today, they concentrate their U.S.-based operations on higher-end activities that includes product design, engineering and testing, sales training, in-store display design, installation training and technical support, product repair services and warranty, and warehousing.

U.S.-based audio and video production is not as significant as production of other major CE products, but such manufacturing continues to take place within the United States, and its trend is stable (see Table 5). Some U.S. firms, like Harman International Industries, have chosen to compete in the higher-quality, higher-priced segments of the market. These companies produce both domestically and internationally, with international production concentrated in Europe rather than Asia (although China figures in their production platforms as well).

Table 5

U.S. Production, Imports, Exports and Market for Audio & Video Products,* 2001-2005

(Millions of Dollars)

	2001	2002	2003	2004	2005
U.S. Production	$2,997	$3,002	$3,128	$2,926	$3,416
Exports	1,485	1,316	1,232	1,358	1,452
U.S. Shipments	1,512	1,686	1,896	1,568	1,964
Imports	5,871	7,131	6,919	7,657	7,075
U.S. Market	7,383	8,817	8,815	9,225	15,039
Key Product, U.S. Production					
Speakers	$1,358	$1,237	$1,064	$1,011	$1,078

* Speakers, microphones, compact and video disc players, equalizers, amplifiers, receivers, tuners and other consumer audio equipment, earphones, headsets, parts and other consumer audio/video equipment.

Source: U.S. Census Bureau (production data from *Current Industrial Report: "Consumer Electronics,"* MA334, various issues; trade data from U.S. International Trade Commission Dataweb).

> "The audio and video products markets that we serve are fragmented, highly competitive, rapidly changing and characterized by intense price competition… In order to increase sales in current markets and gain footholds in new markets, we must maintain and improve existing products, while successfully developing and introducing new products. Our new and enhanced products must respond to technological developments and changing consumer preferences."
>
> *Harman International Industries, Inc.*

Software

According to the 2002 economic census, nearly 10,000 establishments in the United States produced software in 2002. Sales totaled $103.7 billion (see Table 6). The bulk of the economic activity in this sector taking place in the United States focuses on software publishing. In 2005, U.S. employment in the software publishing sector totaled 238,700. One third of those are R&D scientists and engineers.[13]

Software design and publication remains a largely U.S.-based sector, although some countries, including China, are focusing more and more attention to promoting the development of R&D capabilities. Unless U.S. policy makers take actions that would favor the location of R&D activities in the United States (for example, by increasing the number of visas available for foreign nationals to work in the United States), the shift of such activity abroad may accelerate.

> "Most of our software products are developed internally… We contract most of our manufacturing activities to third parties. Outside manufacturers produce the Xbox, various retail software packaged products, and Microsoft hardware."
>
> *Microsoft Corporation*

Table 6
U.S. Software Publishing Product Line Receipts, 2002
(Billions of Dollars)

TOTAL	$103.7
Application software publishing	47.3
General business productivity and home use apps.	25.9
Cross-industry application software	8.0
Game software	4.3
Vertical market application software	3.5
Other application software	5.2
System software publishing	40.1
Operating system software publishing	16.4
Database management software publishing	8.2
Network software publishing	7.5
Development tools & programming languages software publishing	4.9
Other system software publishing	3.1
IT technical support	7.3
IT technical consulting services	4.0
Custom computer application design & development	1.8
Application service provisioning	0.3
Business process management services	0.2
Other	2.7

Source: Bureau of the Census

[1] For the purposes of this report, data for "CE products" and "CE parts and components" cover products that are used by consumers and parts and components that are key ingredients in consumer electronics. Thus, some data may report larger estimates for the market for a particular CE product than provided in other CEA publications because they include finished goods (like computers) that are used by businesses as well as consumers, or parts and components (like semiconductors) that are used in CE products or in information technology products generally.

[2] U.S. International Trade Commission, *Industry & Trade Summary: Semiconductor Manufacturing Equipment,* USITC Pub. No. 3868, June 2006, p. 16.

[3] A National Science Foundation survey reports that R&D scientists and engineers in companies that performed industrial R&D in the United States in 2002 (the most recent year available) totaled 83,300 in the semiconductor and components sectors. Total employment in the sectors in 2002 was 524,500. See National Science Foundation, *Research and Development in Industry: 2001, Funds, 2001, Scientists and Engineers, January 2002, Detailed Statistical Tables, Table* A-37.

[4] U.S. Government Accountability Office, "Offshoring: U.S. Semiconductor and Software Industries Increasingly Produce in China and India," GAO-06-423, September 2006, p. 8.

[5] Ibid., p. 23.

[6] Intel Corporation, Form 10-K for the Fiscal Year Ended December 31, 2005, p. 8.

[7] U.S. Department of Commerce, Bureau of the Census, "Electronic Computer Manufacturing: 2002," *2002 Economic Census,* Manufacturing: Industry Series, December 2004; U.S. Department of Commerce, Bureau of the Census, "Computer Storage Device Manufacturing: 2002," *2002 Economic Census,* Manufacturing: Industry Series, December 2004; U.S. Department of Commerce, Bureau of the Census, "Computer Terminal Manufacturing: 2002," *2002 Economic Census,* Manufacturing: Industry Series, December 2004; U.S. Department of Commerce, Bureau of the Census, "Other Computer Peripheral Equipment Manufacturing: 2002," *2002 Economic Census,* Manufacturing: Industry Series, December 2004.

[8] National Science Foundation, op. cit.

[9] Karen Southwick, "The pragmatic radical," C/Net News.com, November 21, 2003, http://news.com.com/2102-1001_3-5110303.html?tag=st.util.print.

[10] According to the International Trade Commission, prior to 1972, all domestic production of televisions was by U.S.-owned companies. In 1968, a petition alleging the dumping of color televisions by Japan was filed. In response to this and subsequent trade cases, foreign-owned companies began building factories in the United States or buying U.S. color television producers. As of 2003, only one U.S. producer was not owned by a foreign parent. U.S. International Trade Commission, *Certain Color Television Receivers from China,* Inv. No. 731-TA-1034 (Final), Pub. No. 3695, May 2004, footnote 5.

[11] *Ibid.,* p. III-2.

[12] Harman International Industries, Inc., Form 10-K for the Fiscal Year Ended June 30, 2005, p. 24.

[13] National Science Foundation, op. cit. In 2002, NSF estimates 81,100 workers in the software sector were R&D scientists and engineers, and employment in the sector that year totaled 253,300.

[14] Microsoft Corporation, Form 10-K for the Fiscal Year Ended June 30, 2005, p. 7.

IV. U.S. CE Trade Patterns Reflect the Growing Internationalization of CE Production

Not surprisingly, recent trends in CE exports and imports, reflect the growing internationalization of U.S. CE production, as well as the product and country composition of U.S. CE exports and imports. They also reflect the increasing importance of China to the competitiveness of U.S. manufacturers. Indeed, one research group estimates that China's share of global electronics production has increased from 3 percent in 1995 to 16 percent in 2005.[1]

Many major U.S. CE companies derive large shares of their total net sales from customers outside the United States. Table 7 shows that for many the share is well over half of total net sales. In other words, foreign sales, which may include exports of U.S. parts and products as well as receipts from customer sales of foreign affiliates of U.S. firms, matters importantly to the "bottom line" of many U.S. CE firms. This chapter focuses on U.S. CE exports and imports; the next chapter focuses on the role foreign investment plays in the competitiveness of U.S. CE producers.

Table 7
Globalization of Major U.S. CE Company Sales
(Percent of Total Net Sales)

	International	U.S.
Texas Instruments	84%	16%
Qualcomm	82	18
Intel	81	19*
Advanced Micro Devices	79	21
Harman International	79	21
Freescale	71	29
Micron Technology	66	34
Hewlett-Packard Company	65	35
Motorola	41	59
Apple Computer Company	41	59
Dell Inc.	35	65*
Microsoft Corporation	33	67
Gateway	7	93*

* North America, rather than United States alone.
Source: Most recent company 10-Ks.

Trade Trends

U.S. CE producers export U.S.-made parts, components and finished CE products around the world. Although exports have declined in recent years,[2] they nevertheless remain substantial, totaling $77 billion in 2005 (see Table 8). CE parts and components exports represent the bigger share — three quarters — of total U.S. exports. Semiconductors are the most significant U.S. CE parts exported, claiming 63 percent of total U.S. parts exports in 2005.

Exports of finished U.S.-made CE products are relatively small, demonstrating that U.S. production of finished products is focused on supplying the U.S. market. U.S.-made finished CE products that are exported are a diffuse set, including burglar and fire alarms, telephones, microphones, speakers and headphones. This is not to say that U.S. manufacturers are not supplying foreign markets with U.S.-branded CE products, they are. They are doing so, however, from facilities they own or lease in local foreign markets, frequently tailoring their products abroad to local tastes and languages. Naturally, manufacturers want to produce next to the market.

U.S. imports of finished CE products are estimated at $191.5 billion in 2005 (see Table 8), and have been growing at an average annual rate of 4.8 percent since 2000. Major finished CE products imports include laptop computers ($19.4 billion in 2005), other computers and peripherals ($46.3 billion), televisions ($12.2 billion), cameras and camcorders ($7.4 billion). Major parts imports include parts for microphones, speakers and headphones ($197 million).

Table 8
U.S. Trade of CE Products, 2005
(Billions and Shares of Total)

	Exports		Imports	
	Parts and Components	Finished Goods	Parts and Components	Finished Goods
Total	$58.4	$19.3	$83.9	$107.6
NAFTA[a]	12.0	5.4	11.6	15.5
Mexico	6.9	1.9	7.0	14.2
"Traditional Asia"[b]	14.1	3.1	28.2	21.7
Japan	2.5	1.4	10.9	10.1
Taiwan	3.5	0.3	7.7	4.8
Singapore	3.4	0.9	3.9	4.3
Korea	4.7	0.5	5.7	2.5
"New Asia"[c]	18.2	1.8	33.7	65.9
China	3.8	0.8	17.5	46.5
Greater China[d]	6.6	1.4	17.9	46.9
Malaysia	5.5	0.2	10.1	13.0
Thailand	2.1	0.1	2.1	3.9
Philippines	4.0	0.1	3.2	0.9
Indonesia	nil	nil	0.4	1.1
EU-25	8.7	5.2	7.6	3.7
Other	5.4	3.8	2.8	0.8

a = Imports from Mexico and Canada in total, NAFTA-eligible and otherwise
b = The previous longstanding major foreign sources of U.S. CE imports
c = The newest major foreign sources of U.S. CE imports
d = China and Hong Kong

Source: Bureau of the Census

Sourcing Shifts

The parts and components export trend data illustrate the global shift in CE production. U.S. manufacturers increasingly supply parts and components to CE producers in China, Malaysia, Thailand and Indonesia, new locations for CE manufacturing in Asia (and aggregated as "New Asia" in Charts 1 and 2 and Table 8), in lieu of producers in Mexico, Japan, Singapore and Korea who had for many years traditionally dominated Asian CE production (referred to as "Traditional Asia" in Charts 1 and 2 and Table 8). This is because finished CE product manufacturers in Traditional Asia are themselves shifting production of finished CE products to China.[3] U.S. exports of parts and components to New Asia now account for a significantly-increased share of total U.S. parts and components exports.

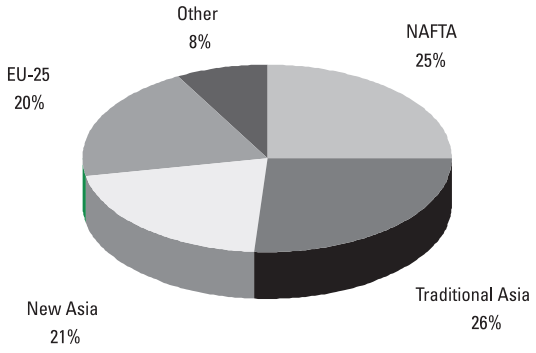
Trends in both finished products and parts imports, like exports, show significant changes in just the last five years. Imports of finished CE products from our NAFTA partners and suppliers in "traditional Asia" have dropped from 60 percent of total imports in 2000 to just 35 percent in 2005. Imports from "new Asia" suppliers, which include producers in China, have replaced those sources of supply, with their share of total imports increasing from 33 percent in 2000 to 61 percent in 2005. China is now the single largest source of finished U.S. CE imports, accounting for 43 percent of total finished CE imports in 2005 (up from 16 percent in 2000).

The trends for regional sourcing of parts imports are similar, although less pronounced. Imports from NAFTA partners and "traditional Asia" have dropped from 63 percent of total imports in 2000 to 37 percent in 2005, while imports from "new Asia" have risen from 29 percent of total parts imports to 40 percent over the same period.

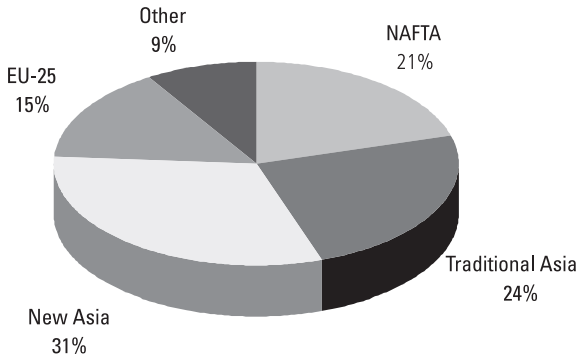
The finished product and parts data thus clearly show the shifts in regional sourcing that have been going on in recent years in Asia. Growing imports into the United States from China are largely supplanting U.S. imports from other Asian suppliers, which are declining. Focusing on increased CE imports from China alone leads to a misperception that China's exports of CE products to the United States are "surging" and in need of public policy attention. Moreover, restricting imports from China will not bring sourcing back to the United States. It will, instead, simply shift it to other suppliers in Asia, be they former producers in Traditional Asia or, more likely, other suppliers in new Asia.

Chart 1

Shares of Total U.S. CE Parts & Components Exports, 2000



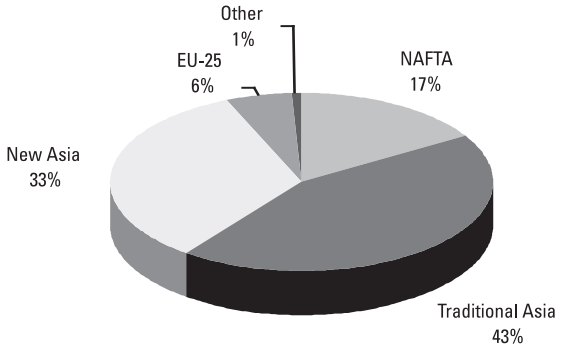
Shares of Total U.S. CE Parts & Components Exports, 2005



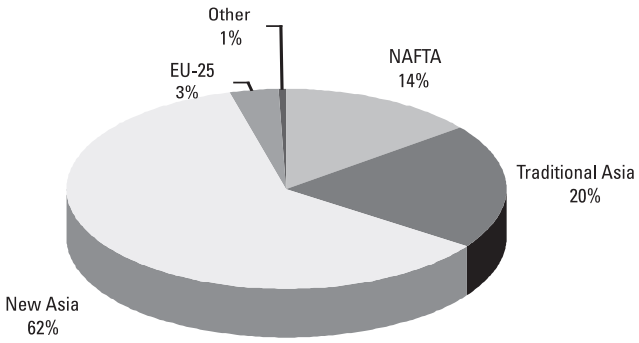
Source: Bureau of the Census

Chart 2

Shares of U.S. CE Finished Products Imports, 2000



Shares of U.S. CE Finished Products Imports, 2005



Source: Bureau of the Census

"Our products and services are available worldwide. We believe this geographic diversity allows us to meet demand on a worldwide basis…, draws on business and technical expertise from a worldwide workforce, provides stability to our operations, allows us to drive economies of scale, provides revenue steams to offset geographic economic trends and offers us an opportunity to access new markets for maturing products. In addition, we believe that future growth is dependent in part on our ability to develop products and sales models that target developing countries…. Over 60 percent of our overall net revenue in fiscal 2005 came from outside the United States."

Hewlett-Packard Company

CE Trade Balance

The temptation to calculate bilateral "trade balances" or to be concerned about "surges" in imports from any given country should be avoided because trade statistics only show direct imports and exports between countries. However, because the CE production process is multi-country, direct imports and exports only tell part of the trade story. For example, suppose that U.S. semiconductors are exported first to Taiwan, where they are incorporated into a Taiwanese subassembly that is then exported to China. From China the subassembly with the U.S. semiconductors is made into a finished CE product. The Chinese producer then exports the finished CE product to the United States. U.S. export data would show the semiconductors exported to Taiwan but not their subsequent transfer to China. The U.S. import data also would not reflect the fact that the value of the finished CE product imported from China included the value of U.S. semiconductors.

Integrated global production therefore means that a fixation on bilateral U.S.- trade imbalances, and the imbalance with China in particular, is misleading. "The principal cause of the growing imbalance is not the nature of China's exchange rate system or Chinese protectionist measures that keep out foreign goods. It is rather that China has become a leading location for the assembly of a broad range of manufactured goods, most of which were previously assembled elsewhere in Asia." The next section of this paper explains an additional source of U.S. value in the value of imports, and in particular in the value of imports from China: U.S. foreign investment.[5]

[1] Reed Electronics Research, in "38% of global electronics output now produced in Asia Pacific," emsnow, July 14, 2006, http://www.emsnow.com/npps/story.cfm?id=20545.

[2] The U.S. dollar rose against other major currencies in the late 1990s and continued to rise until early 2002. The sharp rise in the U.S. dollar was a contributing factor to the broad-based decline in exports by U.S. manufacturers during 2000 to 2003. The U.S. export decline was also affected by slower rates of GDP growth experienced by some U.S. trading partners during that time, including the EU and Japan. Since 2002, the dollar has fallen 12.5 percent and U.S. CE exports immediately stopped their precipitous declines and have since stabilized.

[3] See for example U.S. Government Accountability Office, "China Trade: U.S. Exports, Investment, Affiliate Sales Rising, but Export Share Falling," GAO-06-162, December 2005; Lester, op. cit., and Rene Belderbos and Jianglei Zou, "Foreign Investment, Divestment and Relocation by Japanese Electronics Firms in East Asia," *Asian Economic Journal,* 2006, vol. 20, Issue 1, pages 1-27.

[4] Hewlett-Packard Company, Form 10-K for the Fiscal Year Eneded December 31, 2005, p.9

[5] Nicholas Lardy, "United States-China ties: Reassessing the Economic Relationship," Testimony before the House Committee on International Relations, U.S. House of Representatives, Washington, DC, October 21, 2003.

V. U.S. CE Investment Abroad Promotes U.S. Competitiveness

Clearly, then, U.S. CE production and trade patterns are highly interconnected. Foreign CE investments support related operations maintained in the United States. This is particularly apparent from CE import data. In 2005, for example, related parties (the U.S. importer and foreign supplier are related to each other) accounted for about two-thirds of imports of key CE products (see Table 10). IT exports (semiconductors and other electronic components) also show a relatively high degree of transfer between related parties.

CE companies around the globe have found that these relationships enable them to expand sales in foreign markets more efficiently and profitably. Having a foreign investment that purchases inputs from the home country enables the CE producer to supply products that are fine-tuned to local tastes and needs, but still incorporate inputs from, in this case, the United States. Equally significant, the use of related foreign investments that supply components and finished goods to U.S.-based firms enables those U.S. firms to lower their production costs and focus their U.S.-based activities on higher-value added activities, like design and marketing. Related party trade thus makes U.S. CE companies more competitive U.S. producers and exporters.

Table 10
Share of CE Trade with Related Parties,* 2005
(Percent of Sector Imports)

	Related Party	Unrelated Party
Imports		
Computer equipment	67.6%	32.4%
Communications equipment	67.2	32.8
Audio & video equipment	61.9	38.1
Semiconductors and other elect. components	65.0	35.0
Exports		
Computer equipment	35.1%	63.2%
Communications equipment	19.1	79.9
Audio & video equipment	26.0	69.8
Semiconductors and other elect. components	41.1	57.9

* "Related parties" include trade by U.S. companies with their subsidiaries abroad as well as trade by U.S. subsidiaries of foreign companies with their parent companies.

Source: U.S. Department of Commerce, U.S. Census Bureau, "U.S. Goods Trade: Imports & Exports by Related Parties; 2005," U.S. Census Bureau News, CB-06-69, May 12, 2006.

U.S. CE investments in China, in particular, contribute positively to the competitiveness of U.S. CE firms and their U.S.-based support operations. These investments serve two purposes: to supply the growing Chinese market with locally-produced CE products, and to help U.S. companies lower costs of CE products sold around the world, including in the highly price-competitive U.S. market. In 2003, U.S. majority-owned affiliates of CE companies located abroad sold about $14 billion of their goods and services to consumers in the Chinese market (see Table 11). Again, as noted in the previous chapter, U.S. export data do not fully capture the true level of U.S. commercial sales in China.

Table 11
U.S. Foreign Affiliate Sales in China
(Millions and Percent)

	2003 Value	Annual Rate of Growth, 2000-2003
Computers and electronics	$13,223	35%
Electrical equipment, appliances, and components	873	28%
Other (non-CE sectors)	11,052	11%
TOTAL	25,154	26%

Source: U.S. General Accounting Office, "China Trade: U.S. Exports, Investment, Affiliate Sales Rising, but Export Share Falling," GAO-06-162, December 2005.

VI. CE Trade and Investment Support High-Skilled Jobs in America

The highly interrelated trade and investment relationship in the CE sector allows U.S. companies and their employees to do what they do best: research and development, design, marketing, software development and production. CE sectors are more R&D intensive than other manufacturing sectors (see Table 12). They employ a greater proportion of scientists and engineers, and generally pay higher wages than other manufacturing industries. Table 12 shows that the R&D intensity of CE manufacturing is three to five times greater than other sectors of the U.S. economy. While R&D spending represents just 2.6 percent of non-CE sector net sales, it represents almost 9 percent of computer/electronics products firm net sales, and almost 14 percent of computer-related services firms net sales.

The number of U.S. workers holding high-skill, high-wage R&D and engineering and related jobs in the computer sector alone is impressive. Table 13 shows that the number of these workers in 2005 exceeded 2 million, earning hourly wages ranging up to $45. Growth in the number of jobs for these specialists has been strongest since 2001 for network systems and data communications analysts, computer applications software engineers, and computer systems software engineers.

Table 12
R&D Intensity of CE Manufacturing, 2003
(Billions of Dollars and Percent)

	R&D Spending	Share of Net Sales
Computer/electronic products	$39.9	8.8%
Computer-related services	27.4	13.6
Other sectors	136.5	2.6

Source: National Science Foundation

Table 13
Employment and Hourly Wages for U.S. Computer Specialist Occupations
May 2005

	Number	Wage
Computer support specialists	499,860	20.86
Computer systems analysts	492,120	33.86
Computer software engineers, applications	455,980	38.24
Computer programmers	389,090	32.40
Computer software engineers, systems software	320,720	40.54
Network and computer systems administrators	270,330	30.39
Network systems and data		
Communications analysts	185,190	31.23
Database administrators	99,380	31.54
Computer and information scientists, research	25,890	45.21

Source: Bureau of Labor Statistics, Occupational Employment Statistics Survey, in GAO (September 2006)

"A key factor affecting Microsoft's growth is innovation. In fiscal year 2005, we filed for more than 3,000 U.S. patents for new technologies."

Microsoft Corporation

U.S.-based sales, marketing and technical support jobs are an increasingly important source of employment in the CE sector. These jobs are also high-paying, even those at retail establishments as they require the employee to have a high degree of technical knowledge about the CE product's features and capabilities. For example, according to data from the U.S. Bureau of Labor Statistics, in 2005 the average hourly wage for retail workers selling computers, software, cameras and photography supplies was $21.64, nearly double the average hourly wage for retail workers generally ($12.36).

CE manufacturing employment is significant and high-paying because U.S.-based workers generally concentrate on the manufacture of higher-end CE products, outsourcing lower-value products to manufacturers abroad. In 2004, CE products manufacturing represented about 10 percent of total U.S. manufacturing employment. CE manufacturing wages were on average 1.5 times higher than manufacturing wages overall (these data reflect wages paid to non-CEO employees in the industry) (see Table 14).

"[Apple] believes that sales of its innovative and differentiated products are enhanced by knowledgeable salespersons who can convey the value of the hardware, software, and peripheral integration, demonstrate the unique digital lifestyle solutions that are available only on Macintosh computers, and demonstrate the compatibility of the Macintosh with the Windows platform and networks… [H]igh-quality sales and after-sales support experience is critical to attracting and retaining customers."

Apple Computer Company

Table 14
U.S. CE Employment, 2004
(Thousands and Dollars)

	Employees	Wages
All Manufacturing	14,257.4	$47,861
CE Products Manufacturing	1,314.9	73,673
Computer and peripheral equipment	210.2	96,183
Computers	113.9	108,039
Communications equipment	145.3	75,901
Audio and video equipment	32.7	55,347
Semiconductor and electronic components	449.6	67,270
Magnetic media and reproducing	47.5	64,474
Software reproducing	16.1	92,783

Source: Bureau of Labor Statistics

"Competition for key technical personnel in high-technology industries is intense. We believe that our future success depends in large part on our continued ability to hire, assimilate, retain and leverage the skills of qualified engineers and other highly-skilled personnel needed to compete and develop successful new products."

Motorola, Inc.

"We operate in intensely competitive industries that experience rapid technological developments, changes in industry standards, changes in customer requirements, and frequent new product introductions and improvements. If we are unable to respond quickly and successfully to these developments, we may lose our competitive position and our products or technologies may become uncompetitive or obsolete. To compete successfully, we must maintain a successful R&D effort, develop new products and production processes and improve our existing products and processes at the same pace or ahead of our competitors…"

"We perform a substantial majority of our research and development of semiconductor components and other products in the U.S. … We also maintain R&D facilities in the U.S. focused on developing and improving manufacturing processes as well as facilities in the U.S., Malaysia and the Philippines dedicated to improvements in assembly and test processes."

Intel Corporation

U.S. CE imports from China also support good jobs in the United States. As Trade Partnership Worldwide noted in a study released earlier this year, a range of American jobs is directly and indirectly linked to importing goods into the United States from China. These include, as already noted, U.S. scientists and engineers, new product designers, sales teams, wholesale employees and retail workers, and manufacturing workers making products ranging from paper boxes to CE parts, as well as computers to cash registers needed to sell the imported CE goods. Dockworkers unload CE imports at the ports, Customs agents process the paperwork, and truckers and other transportation workers take the goods to warehouses or other points of distribution. All of this activity generates economic activity that is job supporting.

We build on our earlier research to quantify the overall impact of CE imports from China on U.S. employment. We estimate both the "winners" and "losers" from imports of CE products from China to arrive at a net effect on employment, given current U.S. labor market conditions. The result is an estimate of net employment that owes its existence to CE imports from China. In other words, we estimate the net number of U.S. jobs, given the current structure of the U.S. economy, that would be lost (i.e., not transferred to U.S. manufacturers or to other sectors) if CE imports from China were completely shut out of the U.S. economy. This figure reflects the jobs gained in U.S. manufacturing as a result of the transfer of production of some goods back to the United States from China, and a transfer of sourcing of others to other foreign countries when China is no longer an option.

The results are impressive. CE imports from China support more than 66,000 U.S. jobs across a range of sectors. The net impact on U.S. manufacturing is also positive. Over 6,000 U.S. manufacturing jobs, net of any losses, exist thanks to CE imports from China. CE products contribute to growth, which supports jobs in a host of industries that demand more from U.S. manufacturing, which in turn support more manufacturing jobs in other manufacturing sectors than are lost when U.S. CE jobs shift overseas. For example, stronger retail sales of consumer electronics creates needs for everything from cash registers to floor displays, all of which support output - and manufacturing jobs - in various U.S. sectors. The jobs supported outnumber the jobs lost when CE

Table 15
Net U.S. Jobs Related to CE Imports from China, 2004
(Number)

Total Net U.S. Jobs Supported by	
CE Imports from China	+66,297
Private services*	+30,146
Public services**	+15,224
Retail trade	+6,961
Manufacturing	+6,013
Wholesale trade	+2,296
Construction	+2,773
Transportation and warehousing	+1,988
Agricultural, forestry, fishing, mining	+896

* Includes services such as finance and insurance, management, employment, information, real estate, advertising, accounting, legal, rental and leasing, computer system design, and travel.
** Includes government, health and education services.
Source: Trade Partnership Worldwide, LLC.

Table 16

Net Number of American Jobs Linked to CE Imports from China, By State

Alabama	+943	Montana	+222
Alaska	+161	Nebraska	+452
Arizona	+1,188	Nevada	+573
Arkansas	+569	New Hampshire	+323
California	+7,961	New Jersey	+1,940
Colorado	+1,178	New Mexico	+395
Connecticut	+830	New York	+4,191
Delaware	+191	North Carolina	+1,941
District of Columbia	+310	North Dakota	+169
Florida	+3,845	Ohio	+2,641
Georgia	+1,970	Oklahoma	+762
Hawaii	+315	Oregon	+828
Idaho	+314	Pennsylvania	+2,744
Illinois	+2,886	Rhode Island	+214
Indiana	+1,424	South Carolina	+892
Iowa	+726	South Dakota	+199
Kansas	+662	Tennessee	+1,380
Kentucky	+882	Texas	+4,881
Louisiana	+927	Utah	+562
Maine	+313	Vermont	+160
Maryland	+1,269	Virginia	+1,778
Massachusetts	+1,612	Washington	+1,370
Michigan	+2,161	West Virginia	+335
Minnesota	+1,336	Wisconsin	+1,332
Mississippi	+551	Wyoming	+127
Missouri	+1,359	Total	+66,297

Source: Trade Partnership Worldwide, LLC

manufacturing shifts abroad.

CE imports from China support a significant number of jobs, on net in every U.S. state. Every state has a positive stake in the process of importing CE products from China It should be noted that these employment calculations understate the job impact of CE trade with China broadly, because they reflect only the number of U.S. jobs related to CE imports from China. They do not reflect the additional jobs that are related to CE direct and indirect exports to China. As noted above, ascertaining the total value of U.S. exports to China (direct plus indirect) is difficult if not impossible. Yet, this is the type of data that are required to calculate an accurate estimate of the total number of jobs related to CE trade with China. But this much is certain: the estimated impact on U.S. jobs of total CE trade with China would be greater than 66,000 if the requisite export data could be obtained.

1 GAO (September 2006), op. cit., p. 34.

2 Microsoft Corporation, op. cit., p. 8.

3 Apple Computer Company, Form 10-K for the Fiscal Year Ended September 24, 2005, p. 27-28.

4 Motorola, Inc., op. cit., p. 24.

5 Intel Corporation, op. cit., p. 18.

6 Trade Partnership Worldwide, LLC, "The Impact of Imports from China on U.S. Employment," study prepared for the National Retail Federation, November 2005.

7 The methodology used is explained in the Appendix.

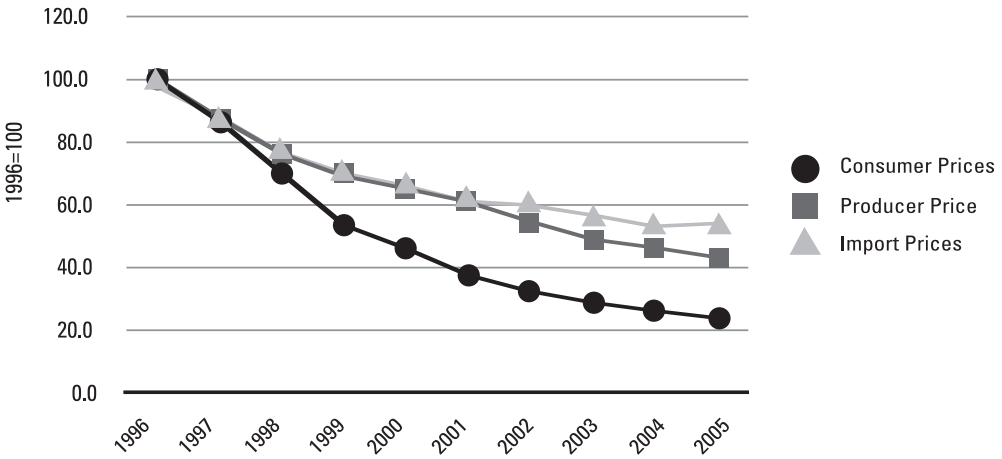
VII. Global CE Production Keeps CE Prices Affordable to American Families

As noted, the U.S. CE market is a highly price-competitive industry, with strong downward price pressure from consumers. The shift of sourcing to China grew from the need to cut costs so that U.S. prices could respond to this consumer pressure. Most importantly, the availability of competitive production facilities in Asia generally, and China specifically, has permitted U.S. CE producers to meet consumer demand for lower-cost CE products without abandoning U.S. production altogether.

Price trends in computers and peripherals, and televisions, are illustrative. Declines in U.S. producer and import prices have tracked each other since 1996, and yet consumer prices for computers and peripherals have fallen even more (Chart 3). The story is similar for televisions (Chart 4). Consumers have been the clear winners.

Chart 3

Computer & Peripheral Price Indices

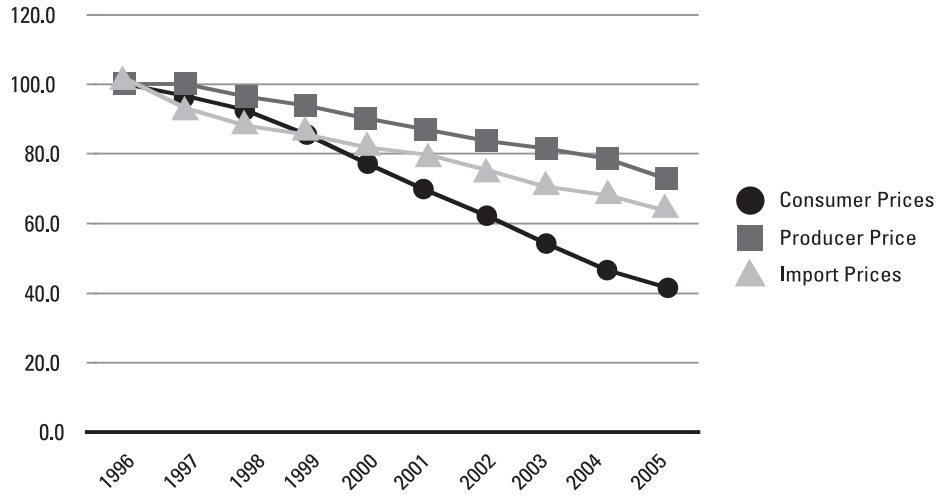


Source: Bureau of Labor Statistics, re-benched to 1996 by Trade Partnership Worldwide, LLC

> "Over the past several years, price competition in the market for personal computers has been particularly intense. [Apple's] competitors who sell personal computers based on other operating systems have aggressively cut prices and lowered their product margins to gain or maintain market share."
>
> *Apple Computer Company*

Chart 4

Televisions Price Indices



Source: Bureau of Labor Statistics, re-benched to 1996 by Trade Partnership Worldwide, LLC

As the prices of key components of CE products, like semiconductors, for example, have fallen in recent years, the ability of U.S. CE producers to lower the prices of finished products containing those inputs has improved. In addition, lower costs have enabled U.S. producers to develop new products and different uses for existing products (e.g., greater use of computers at home rather than only at the office) that have expanded CE sales. Globalization of production has played a key role in delivering a higher variety of products at lower prices.

Indeed, thanks to the globalization of production which has permitted U.S. CE manufacturers and brands to develop and introduce an ever-expanding array of affordable CE products targeted at families, consider how lower costs mean that, today, multiple family members carry cell phones (many capable of taking pictures), many families have replaced their film cameras with digital cameras that are capable of linking up to in-home printers or computers, which in turn permit consumers to e-mail pictures to family members and others around the world.

[1] Data for imports of computers and peripherals, and televisions, from China, specifically, are not available.

[2] Apple Computer Inc., op. cit., p. 13.

VIII. Conclusion: Public Policy That Supports U.S. CE Competitiveness

The increasing globalization of CE production means that the competitiveness of the U.S. CE manufacturing industry – including both manufacturers and the highly-skilled labor force – is sensitive to changes in the global economy. It also means the industry can be greatly impacted by changes in U.S. trade and investment rules. As the largest emerging economy in the world, China plays an important and complex role in the industry's future. To remain competitive, this industry must move fast, stay lean and constantly innovate.

U.S. policymakers can play a positive role in this process if they craft and implement policies designed to strengthen U.S. competitiveness, such as the following:

- Advance a market liberalization agenda that recognizes the importance to this (and other) U.S. industries of intellectual property rights in foreign markets. Without adequate IPR protection, hard-won market liberalization will be ineffective in expanding U.S. exports.

- Strengthen U.S. education standards, particularly in science, engineering and math. This includes ensuring adequate funding for teacher training, improving curriculum standards and expanding scholarships.

- Rethink U.S. limits on visas for foreign scientists and engineers to study and work in the United States. China is already making an effort to promote the growth of R&D within China. U.S. and other multinational companies are opening new R&D facilities in China or teaming up with others in China to promote the development of this capability in China.[1] The more difficult it is to bring foreign scientists and engineers to the United States to help develop and design new CE products in the United States, the greater the need for U.S. firms to "outsource" this activity abroad.

- Oppose any effort to raise tariffs on imports, particularly CE products from China. Most notably, legislation such as the Schumer-Graham bill — which sought to impose a 27.5 percent tariff on all imports from China if it fails to substantially revalue its currency — would severely erode U.S. CE competitiveness. Higher tariffs on Chinese imports would raise costs and reduce employment at every step along the stream of production, from dockworkers to retail workers, from product designers to engineers.

U.S. policymakers have a leadership role to play in developing an international trade and investment system conducive to U.S. competitiveness in CE. Making the right choices to advance U.S. economic leadership and success in an ever changing global economy – is the challenge going forward.

[1] http://www.china.org.cn/english/scitech/171915.htm.

APPENDIX

Methodology to Estimate Dynamic Output and Employment Impacts of CE Imports from China

Different options are available to estimate trade linkages to employment and output. One involves manipulation of input-output tables to map the linkages between imports to labor demand and total output across sectors. Such static, "snap shot" approach presents several problems, however. The first is that the shares in the base data basically fix the structure of production and demand. Such a view of employment related to trade would not account for job losses in such sectors as manufacturing from foregone U.S. production of similar products. In addition, there may be double counting, as the net effect imports is not the simple sum of import effects. Moreover, such an approach may overestimate effects unless the impact of substitution toward trade with the rest of the world is also included.

A more appropriate approach is dynamic in nature. It permits employment to adjust to the opportunity to source goods from other producers, be they domestic or foreign. To accommodate these issues, we applied a computable multi-sector model of the U.S. economy. Computable general equilibrium (CGE) models are characterized by an input-output structure (based on regional and national input-output and employment tables) that explicitly links industries in a value added chain from primary goods, over continuously higher stages of intermediate processing, to the final assembling of goods and services for consumption. Inter-sectoral linkages are direct, like the input of steel in the production of transport equipment, and indirect, via intermediate use in other sectors. The model captures these linkages by modeling firms' use of factors and intermediate inputs. The most important aspects of the model can be summarized as follows: (i) it covers all world trade and production; and (ii) it includes intermediate linkages between sectors.

Our analysis of the impact on U.S. employment of imports of CE products from China is an extension of earlier work using this CGE model to estimate the impact on U.S. employment generally of imports from China of all products (see Trade Partnership Worldwide, LLC 2005). Our data, both in this instance and in the earlier study, come from a number of sources, updated for this analysis. Data on production and imports are based on national social accounting data linked through trade flows (see Reinert and Roland-Holst 1997). These social accounting data are drawn directly from the most recent version of the Global Trade Analysis Project (GTAP) dataset, version 6.0. (Dimaranan and McDougall, 2002). The GTAP version 6 dataset is benchmarked to 2001, and includes detailed national input-output, trade, and final demand structures. The basic social accounting and trade data are supplemented with trade policy data, including additional data on tariffs and non-tariff barriers. The data are supplemented with data from the U.S. Department of Labor on state-level employment and from the U.S. Bureau of Economic Analysis on state level output for 2004. These data allow us to map nationwide effects to state-level changes in employment and output.

The data on tariffs are taken from the World Trade Organization's (WTO) integrated database, with supplemental information from the World Bank's recent assessment of detailed pre- and post-Uruguay Round tariff schedules and from the UNCTAD/World Bank WITS dataset. All of this tariff information has been mapped to GTAP model sectors within the version 6 database. The sectors in the model are shown in Table A-1. The GTAP regions are aggregated into the U.S., China, and rest-of-world.

Table A-1
Model Sectors

	Corresponding GTAP sectors		Corresponding GTAP sectors
Primary		Nondurable goods	
1) Agriculture, forest., fish	1-14	13) Food, beverages, and tobacco	19-26
2) Mining	15, 16, 17, 18	14) Textiles	27
Construction		15) Apparel	28
3) Construction	46	16) Paper products, publishing	31
Manufacturing		17) Chemicals, rubber, plastics	33
Durable goods		18) Petroleum products	32
4) Lumber & wood	30	19) Leather products	29
5) Stone, clay, glass	34	Services	
6) Primary metals	35,36	Transportation & utilities	
7) Fabricated metals	37	20) Transportation	48, 49, 50
8) Industrial machinery	41	21) Communications	51
9) Electronic equipment	40	22) Electric, gas, & sanitary	43, 44, 45
10) Motor vehicles	38	23 Trade	47
11) Other transport. equip.	39	Finance and Insurance	
12) Other manufacturing	42	24) Finance	52
		25) Insurance	53
		26) Other Private Services	54, 55, 57
		27) Public Services	56

Aggregate demand in each region is modeled through a composite regional household, with expenditures allocated over government, personal consumption, and savings. The composite household owns endowments of the factors of production and receives income by selling them to firms. It also receives income from domestic taxes, tariff revenues, and rents accruing from import/export quota licenses (when applicable). Part of the income is distributed as subsidy payments to some sectors, primarily in agriculture.

On the production side, in all sectors, firms employ domestic production factors (capital, labor and land) and intermediate inputs from domestic and foreign sources to produce outputs in the most cost-efficient way that technology allows. Capital stocks are fixed at a national level. Firms are competitive, and employ capital and labor to produce goods and services subject to constant returns to scale.[1] Products from different regions are assumed to be imperfect substitutes in accordance with the so-called "Armington" assumption. The trade elasticities used to model Armington demand for imports are shown in Table A-2.[2]

Table A-2
Armington Elasticities

	lower	upper
1. Agriculture, forest., fish	2.42	4.93
2. Mining	5.75	13.45
3. Construction	1.90	3.80
4. Lumber & wood	3.40	6.80
5. Stone, clay, glass	2.90	5.80
6. Primary metals	3.42	7.16
7. Fabricated metals	3.75	7.50
8. Industrial machinery	4.05	8.10
9. Electronic equipment	4.40	8.80
10. Motor vehicles	2.80	5.60
11. Other transport. equip.	4.30	8.60
12. Other manufacturing	3.75	7.50
13. Food, beverages, and tobacco	2.49	5.04
14. Textiles	3.75	7.50
15. Apparel	3.70	7.40
16. Paper products, publishing	2.95	5.90
17. Chemicals, rubber, plastics	3.30	6.60
18. Petroleum products	2.10	4.20
19. Leather products	4.05	8.10
20. Transportation	1.90	3.80
21. Communications	1.90	3.80
22. Electric, gas, & sanitary	2.80	5.60
23. Trade	1.90	3.80
24. Finance	1.90	3.80
25. Insurance	1.90	3.80
26. Other Private Services	1.90	3.80
27. Public Services	1.90	3.80

Source: Hummels and Hertel estimates from GTAP.

While the model, at the macro level, follows the basic GTAP structure (Hertel et al 1997, Hertel and Itakura 2000), we are ultimately interested in the impact of CE imports from China on state economies given the current U.S. wage structure. In other words, given the current wage structure of the labor force, how many jobs in the U.S. economy are linked either directly or indirectly to CE imports. This involves employing a labor market closure (equilibrium conditions) where we fix wages at current levels, and force employment levels to adjust. This provides a direct estimate of the jobs supported, at current wage levels, by the current level of imports. In addition, employment and output are mapped by a set of side equations (equations added to the core model) to capture state-level effects.

The experiments conducted with the model for total imports involve imposing changes in U.S. imports from China. This allows us to deconstruct the import relation-

ship, tracing changes at the border as they work through the U.S. economy. We reduce U.S. imports from China.[3] This involves full elimination of trade (so that we can estimate full effects) by way of a prohibitive tariff. For tariff effects, we target the level of the tariff rather than the level of trade.

[1] Compared to dynamic CGE models and models with alternative market structures, the present assumption of constant returns to scale with a fixed capital stock is closest in approach to older studies based on pure input-output modeling of trade and employment linkages. In the present context, it can be viewed as generating a lower-bound estimate of effects relative to alternative CGE modeling structures.

[2] Model results depend on the underlying trade elasticities. The elasticities used here are the standard set of elasticities for the GTAP database and model.

[3] This is accomplished by making a set of bilateral export taxes with the U.S. endogenous, while making trade quantities exogenous and then reducing them by target amounts, which is appropriate since the relevant question is the benefit of current conditions of trade.

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