PRICEWATERHOUSECOOPERS

China's Impact on the Semiconductor Industry

2005 Update

*connectedthinking

A Technology Center Publication

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Introduction

This annual update to *China's Impact on the Semiconductor Industry*, first published in December 2004, assesses the current status of the industry in China and how it has changed during the past year. To accomplish this analysis, we have compared and contrasted metrics on China's semiconductor demand growth with semiconductor production growth in the country. We then reviewed the three production forecast scenarios developed in 2004 with actual production and consumption growth realized during the period.

Our report also examines the composition of the semiconductor value chain in China and compares it with the worldwide value chain. As part of this analysis, it reviews demand for semiconductor equipment in the country and the primary equipment suppliers to the market.

The original 2004 report explored in detail the overall dynamics of the global semiconductor industry and various issues that make China's part of that industry different or even unique. The fundamental analysis of the 2004 report is still valid; readers who would like to gain a better understanding of these fundamentals should refer to the original report available at www.pwc.com/techcenter.

Download the original 2004 version of *China's Impact on the Semiconductor Industry* at www.pwc.com/techcenter

Chinese Semiconductor Market

For years, a growing number of buyers in the semiconductor market have tended to be less vertically integrated than traditionally organized electronics companies. Electronics systems vendors who buy many of the chips now have adopted a more disaggregated approach, one in which electronics manufacturing services (EMS) providers and original design manufacturers (ODMs), a dynamic Asia-Pacific, and a more open China play a much larger role. Disaggregation has accelerated the shift of electronics production to China, and this shift in turn has caused semiconductor consumption in the country to rise rapidly. Though domestic production of semiconductors is itself growing quickly, the gap between domestic demand and supply continues to widen.

Impact of Electronics Manufacturing

Because of its low labor cost, improvements in education, and focus on attracting foreign direct investment with incentives and fewer governmental restrictions, China has echoed and expanded upon what has happened in electronics systems manufacturing in other parts of Asia Pacific. It has attracted massive amounts of contract electronics manufacturing plant capacity. This trend has had a substantial impact on semiconductor consumption in the country.

Findings

The following is a summary of our findings for this 2005 update. These findings are based upon secondary research, interviews with industry executives, and our own analysis.

Sharp Rise in Consumption for Local Market

2004 saw a surprising increase in semiconductor consumption for local Chinese market end products, resulting in an increase in the domestic share of total consumption to 40 percent from 34 percent in 2003

Shifts in Capacity to China Continue

The rise of the fabless/foundry model continues to facilitate the transfer of semiconductor manufacturing to China. China was responsible for 19 percent of new potential worldwide wafer fab capacity added in 2004. Current wafer fab capacity in China is 69 percent foundry/ dedicated. However, the potential for one or more large integrated device manufacturers (IDMs) to emerge in China is still significant, and this possibility could shift the balance back toward a more traditional model.

Semiconductor Industry Development Continues to Be a Strategic Priority for the Chinese Government

Chinese government interest in fostering growth of the domestic semiconductor industry continues unabated. In April 2005, the Ministry of Finance and the Ministry of Information Industries announced the establishment of a research and development (R&D) fund for the industry. Though the fund can be used for most any kind of semiconductor R&D, a stated goal of the fund is to stimulate development of integrated circuit (IC) design houses.

Rising Demand for Domestic Sources of Supply

Despite the country's substantial growth in production, the gap between consumption and production of integrated circuits in China continues to widen. From 2003 to 2004, this gap increased $7.7 billion to $25.8 billion. Part of the sharp growth in IC consumption is due to domestic end-market demand.

Some Potential for Oversupply

China did not contribute to an oversupply situation in 2004 or 2005. By the end of 2006, China could develop enough fab capacity to affect long-term worldwide supply and create a degree of volatility.

More Chinese Companies Gaining Visibility

At least five new Chinese fabless companies emerged that reported revenues between $30 million and $56 million in 2004.

Two of these Chinese fabless companies (Vimicro and Actions Semiconductor) completed NASDAQ IPOs in 2005 and others are expected to follow. Assembly, and test revenues were much higher at several facilities in 2004 than in 2003.

In this report, we use the following definitions:

Semiconductor market refers to the semiconductors purchased or consumed. In other words, it refers to demand.

Semiconductor industry, by contrast, refers to companies that design, develop, manufacture, package, or test semiconductors. Therefore, the term "industry" refers to production.

Domestic consumption refers to the portion of China's semiconductor consumption that is incorporated in end products sold in China.

Integrated device manufacturers (IDMs) have at least some of their own fab capacity. IDMs have traditionally had their own semiconductor packaging, assembly, and test (SPA&T) plants, although some contract with semiconductor assembly and test services (SATS) companies for this purpose.

Fabless companies have no wafer fabs of their own, preferring instead to contract with foundries for this purpose. As a general rule and as referred to in this report, fabless device makers use SATS and have none of their own SPA&T capacity.

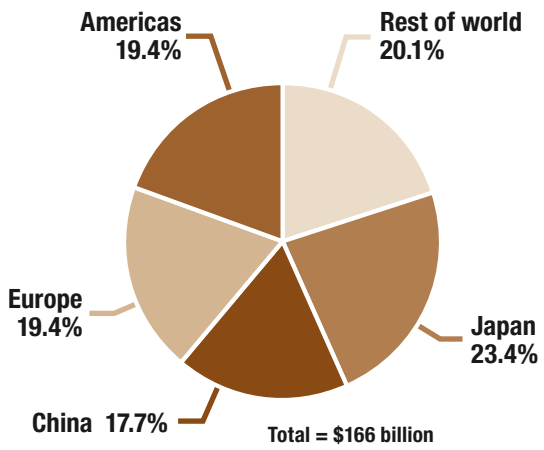
The Semiconductor Market in China

Overall Consumption

By 2004, China alone accounted for nearly 20 percent of the worldwide semiconductor market, gaining almost 2 percent share over its 2003 levels and surpassing both the Americas and Europe for the first time. By 2010, The Chinese semiconductor market could exceed 30 percent of the $318 billion worldwide total, according to Gartner Dataquest.

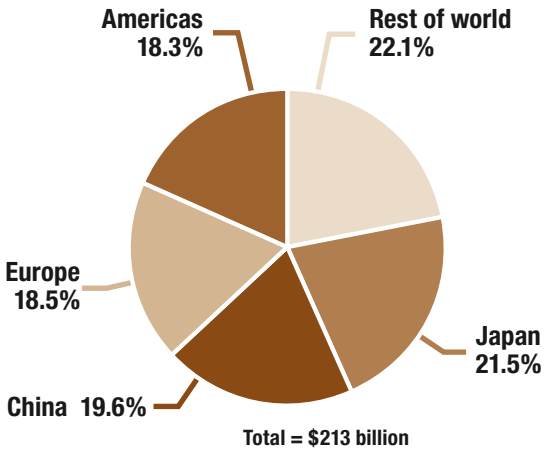
Figure 1: Worldwide Semiconductor Market by Region

2003



Source: CCID, CSIA, 2005

2004

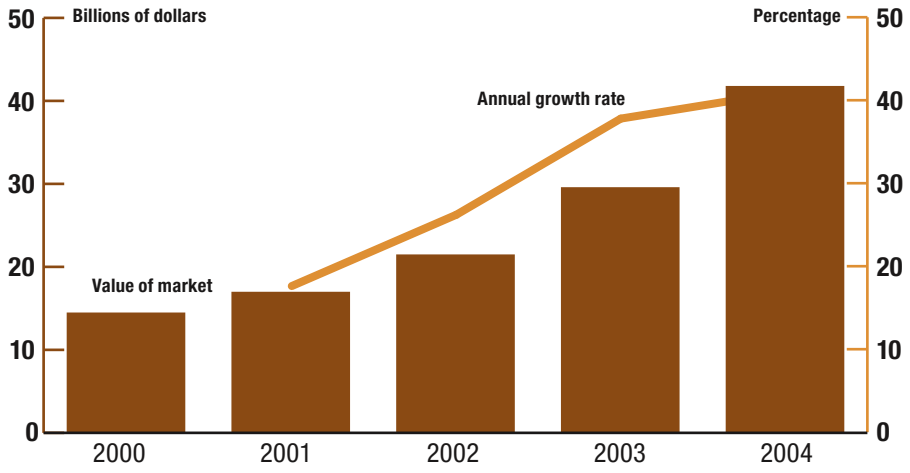


Source: CCID, CSIA, 2005

The Market for ICs and Discretes

China's semiconductor market growth in 2004 can be attributed to a combination of factors resulting from the continuing shift of worldwide electronic systems production to China. Electronic systems production in China grew by 32 percent in 2004, almost three times the worldwide growth. The semiconductor content of China's electronic systems production grew from 20.1 percent in 2003 to 25.2 percent in 2004

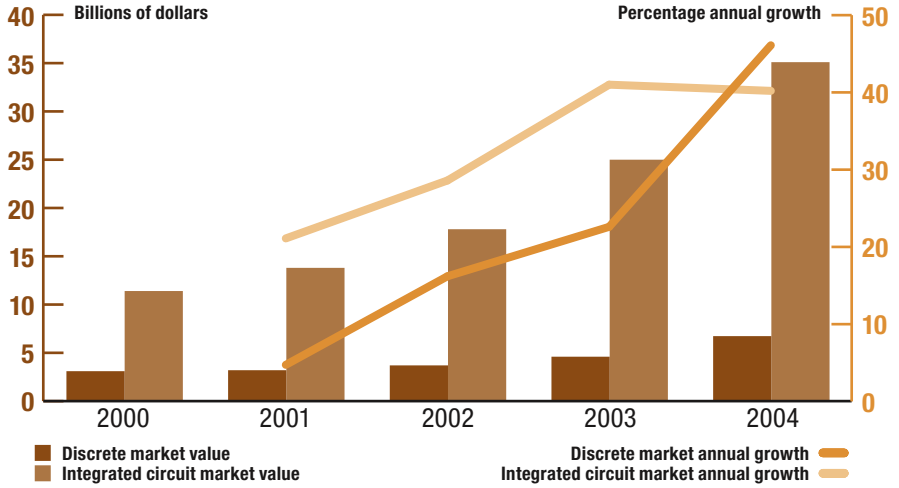
Figure 2: China's Semiconductor Market Growth



Source: CCID, CSIA, 2005

Overall, China's semiconductor consumption grew by a substantial 41 percent in 2004 to reach $41.8 billion. China's 2004 semiconductor market growth was notably greater that the worldwide market growth of 28 percent.

Figure 3: China's Integrated Circuit and Discrete Market Growth



Source: CCID, CSIA, 2005

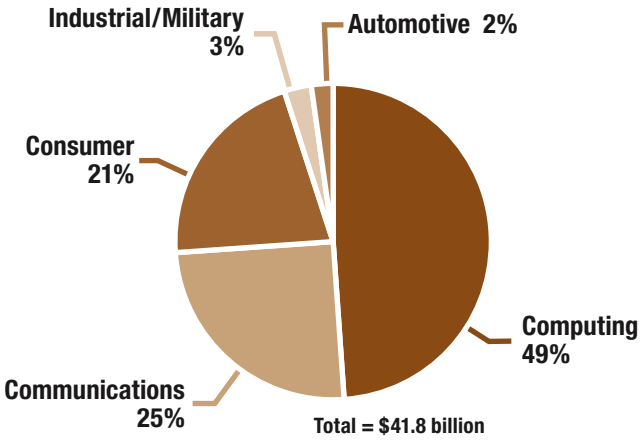
Discrete includes discrete devices and optical semiconductors

China's discrete device market in 2004 grew at a greater rate, 46 percent, than its IC market, which grew by 40 percent over 2003 levels. This is the first time in many years that China's discrete device market grew faster than its IC market. Discretes continue to be used in many electronic systems product categories, and the Chinese demand may reflect large production volumes in communications and other high analog-content electronic systems such as wireless devices, flat panel displays, digital cameras, mobile handsets, and set-top boxes.

Market by Application

Figure 4: China Versus Worldwide Semiconductor Market by Application, 2004

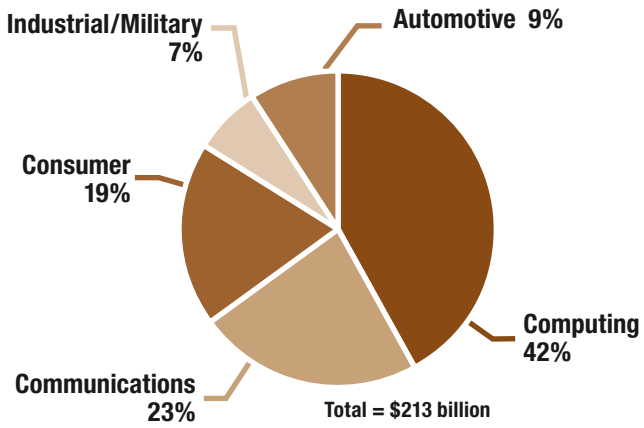
China



Source: CCID, Gartner Dataquest, CSIA, 2005

Compared to the worldwide semiconductor market, the distribution of China's 2004 semiconductor market is somewhat more concentrated in the computing, communications, and consumer device sectors and less in the industrial/military and automotive device sectors. Low-volume industrial/military chip consumption remains concentrated primarily in Europe, Japan, and the United States.

Worldwide

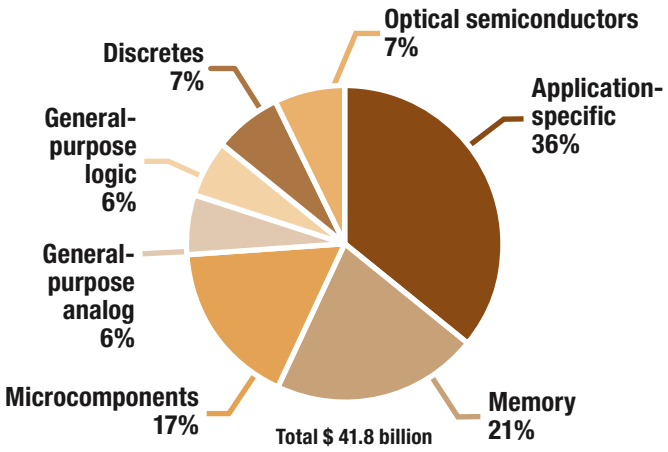


Source: CCID, Gartner Dataquest, CSIA, 2005

Market by Device Type

Figure 5: China Versus Worldwide Semiconductor Market by Device Type, 2004

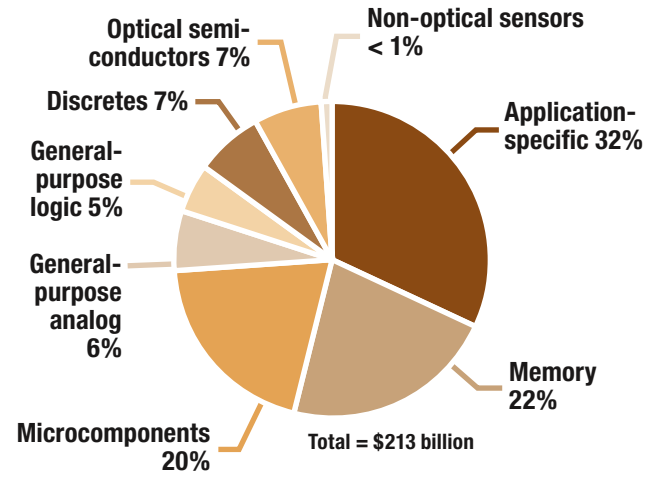
China



Source: CCID, Gartner Dataquest, CSIA, 2005

As a result of systems production demand for computer, communications, and consumer products, China's semiconductor market in 2004 was also somewhat more concentrated in the application-specific and general-purpose logic sectors. Likewise, China was less concentrated in the microcomponents and memory sectors.

Worldwide



Source: CCID, Gartner Dataquest, CSIA, 2005

Chinese Semiconductor Companies

The Chinese semiconductor companies with the largest revenues are listed below.

Table 1: Largest Chinese Semiconductor Companies, 2004

		Revenue in 100 millions of RMB			
Rank in 2004	Company	2003	2004	Change (%)	Sector
1	Wuxi CRMH Microelectronics Co. Ltd.	3.28	7.67	133.8	IDM/Foundry
2	Datang Microelectronics Technology Co. Ltd.	6.23	7.50	20.4	Design (Fabless)
3	Hanzhou Silan Microelectronics Co. Ltd.	5.35	5.09	-4.9	Design (Fabless)
4	Zuhai Actions Semiconductor Co. Ltd.		4.60		Design (Fabless)
5	China Huada IC Design Center		4.54		Design (Fabless)
6	Beijing Vimicro Semiconductor Co. Ltd.		4.20		Design (Fabless)
7	Jilin Huaxing Electronics Group Co. Ltd.	3.64	4.12		Discrete
8	GOOD-ARK (Suzhou) Electronics Co. Ltd.	3.29	3.75	14.0	Discrete
9	Inferno (Wuxi) Electronics Co. Ltd.		3.54		Discrete
10	Wuxi China Resources Microelectronics, Co. Ltd.	2.93	3.42	16.7	Discrete
11	Tianjin Zhonghuan Semiconductor Co. Ltd.	2.63	3.03	15.2	Discrete
12	Shanghai Belling	2.84	2.90	2.1	IDM/Foundry
13	Xiamen Hualian Electronics Co. Ltd.	0.52	2.86	450.0	Discrete
14	Xian Air Electronics Co. Ltd.		2.62		Discrete
15	Shaoxing Silicore Co. Ltd.		2.53		Design (Fabless)
16	Hangzhou Youwang Electronics Co. Ltd.		2.47		Design (Fabless)
17	Wuxi China Resources Semico, Co. Ltd.		2.28		Design (Fabless)
18	Hua-Yue Microelectronics Co. Ltd.		2.10		IDM
19	Shanghai Huahong IC Design Co. Ltd.		1.91		Design (Fabless)
20	Jifu Semicon Co. Ltd.		1.88		IDM
21	Beijing Sigma Microelectronics Stock Co. Ltd.		1.74		Design (Fabless)
22	Zhuhai Nanker Group		1.61		IDM
23	Fujian Fu-Shun Microelectronics Co.		1.39		IDM
24	Fudan Microelectronics Co. Ltd	0.98	1.33	35.7	Design (Fabless)
25	Jade Bird Universal Sci-tech Co.	2.00	1.21	-39.5	Design (Fabless)
26	BLX IC Design Corporation Ltd.		N/A		Design (Fabless)

By definition, these 26 companies are indigenous Chinese companies that design, manufacture (or have manufactured), market, and sell semiconductor devices. They are the companies that should be included in the semiconductor market share reports compiled by industry analysts. Yet, for example, only nine of these companies are included in the Gartner Dataquest report "Market Share: Semiconductors, Final Worldwide, 2004," which ranked 201 companies by their 2004 revenues, down to $10 million. The largest of these companies, Wuxi CRMH Microelectronics, was not included in the Gartner Dataquest ranking because of an oversight; if it had been it would have been ranked 146th among worldwide semiconductor companies.

The combined 2004 revenues of these 26 companies were less than $1 billion, so that in total they currently represent less than one half of one percent of the worldwide semiconductor industry. This ranking comprises 13 design or fabless companies, 7 discrete companies, and 6 IDM (IC integrated device manufacturer) companies. This is a higher concentration of fabless and discrete companies than in most worldwide listings. The higher concentration of fabless companies is the result of government strategy and promotional activities and is expected to increase. The concentration of discrete companies can be attributed to the historical development of China's semiconductor industry and is expected to decline over time.

Revenue in millions of dollars		
2003	2004	Reference
40	93	CSIA 05 & CCID 04-05
75	91	CSIA 05
65	61	CSIA 05
0	56	CSIA 05
0	55	CSIA 05
0	51	CSIA 05
44	50	CSIA 05
40	45	CCID 04-05
0	43	CCID 04-05
35	41	CCID 04-05
32	37	CCID 04-05
34	35	CCID 04-05
6	35	CCID 04-05
0	32	CCID 04-05
	31	CSIA 05
	30	CSIA 05
	28	CSIA 05
	25	CCID 04-05
	23	CSIA 05
	23	CCID 04-05
	21	CSIA 05
	19	CCID 04-05
	17	CCID 04-05
12	16	FSA
24	15	FSA
	N/A	MPR

Suppliers to the Chinese Market

Sales of the largest the semiconductor suppliers to the Chinese market increased by 38 percent in 2004, somewhat less than the growth of the overall Chinese semiconductor market. As a result, there is less concentration of suppliers in the Chinese market than in the worldwide market: These 15 suppliers had a total 49 percent share of the Chinese market in 2004. In comparison, the 15 suppliers with the largest sales to the worldwide semiconductor market had a total 60 percent share of the overall market in 2004.

All of the suppliers to the Chinese market were international semiconductor companies and not indigenous Chinese companies. In fact, there were no Chinese companies (or brands) within the top 60 suppliers to the 2004 Chinese semiconductor market. The majority of these suppliers to the Chinese market also rank among the largest suppliers in the worldwide semiconductor markets. Of this group, only Agilent Technologies, ATI Technologies, Broadcom, and Rohm were not among the 15 largest suppliers to the worldwide market.

Table 2: Semiconductor Suppliers to the Chinese Market, 2003–2004

Rank by revenue		Company	Revenue in millions of dollars			Market share	Reference
2003	2004		2003	2004	Change (%)	2004	
1	1	Intel	4727	5768	22	14	iSuppli
4	2	Texas Instruments	1184	1849	56	4	iSuppli
5	3	Philips Semiconductors	1181	1615	37	4	iSuppli
2	4	ST Microelectronics	1304	1489	14	4	iSuppli
6	5	Samsung Electronics	1013	1375	36	3	iSuppli
9	6	Hynix	690	1365	98	3	iSuppli
3	7	Toshiba	1282	1343	5	3	iSuppli
8	8	Infineon Technologies	755	1134	50	3	iSuppli
7	9	Freescale Semiconductor	767	1094	43	3	iSuppli
17	10	Micron Technology	299	673	125	2	iSuppli
Subtotals for top 10			13202	17705	34	42	
10	11	Renesas Technology	511	630	23	2	GDQ
25	12	ATI Technologies	217	617	184	1	GDQ
11	13	Rohm	481	568	18	1	GDQ
19	14	Agilent Technologies	266	558	110	1	GDQ
18	15	Broadcom	293	502	71	1	GDQ
Subtotals for next 5			1768	2875	63	7	
Totals for top 15			14970	20625	38	49	

Domestic and Export Consumption

The Chinese semiconductor market has two distinct parts: the domestic market and the much larger export market. More than 60 percent of the semiconductors consumed in China during 2004 were used in components of finished products assembled in China and exported for sale in other countries. The table here shows a breakdown by segment. Although China's total semiconductor consumption grew by $12.2 billion to total $41.8 billion in 2004, and semiconductors consumed in exported products increased from about $19.6 billion in 2003 to more than $25 billion in 2004, China's semiconductor export market share actually declined. It went from 66.3 percent in 2003 to 60.3 percent in 2004. This decline in export share is due to an increase in the domestic consumption of semiconductors incorporated in electronic products sold in China. This consumption increased by about 66 percent, to total $16.6 billion in 2004, and increased the domestic consumption to almost 40 percent of the total consumption.

The most significant increase in domestic consumption occurred in the data processing electronics sector.

Exports decreased from 60.3 percent to 48.5 percent, while domestic consumption increased by 133 percent, resulting in a sector increase from $12.2 billion in 2003 to $22.9 billion in 2004. This also means that for at least the last two years China's domestic consumption of semiconductors has again exceeded its semiconductor industry revenues. This growth provides another reason for the Chinese government to increase domestic semiconductor production.

Table 3: Semiconductor Export Percentages by Segment, 2004

Market segment	Total sales*	Export sales	
		Percentage	Value*
Data-processing	22.9	49	11.1
Communications	11.8	66	7.8
Consumer	9.7	79	7.7
Automotive	0.9	75	0.7
Totals	45.4	60	27.4

Source: Gartner Dataquest, PricewaterhouseCoopers, 2005
**In billions of dollars*

The Semiconductor Industry in China

Table 4: Largest Chinese Semiconductor Manufacturers, 2003–2004

Rank				Revenue in 100 million RMB		
2003	2004	Company	Sector	2003	2004	Change (%)
1	1	Freescale (China) Electronics Co. Ltd.	Packaging & Testing	79.85	81.20	1.7%
2	2	SMIC	Foundry	29.05	80.71	177.8%
4	3	Shanghai Huahong NEC Electronics Co. Ltd.	Foundry	15.61	26.79	71.6%
	4	RFMD Semiconductor (Beijing) Co. (RF Micro Devices)	Packaging & Testing		25.80	
3	5	RSSB IC (Beijing) Co., Ltd. (Renesas Stone)	Packaging & Testing/ Discrete	16.16	20.44	26.5%
	6	HJTC (Suzhou) Co., Ltd. (He Jian Technology Corp,)	Foundry		20.00	
7	7	Intel Products (Shanghai) Co. Ltd.	Packaging & Testing	9.08	16.00	76.2%
10	8	Nantong Fujitsu Microelectronics Co. Ltd.	Packaging & Testing	7.64	14.49	89.7%
5	9	Leshan Radio Co. Ltd. (ON Semiconductor)	Discrete	12.34	13.36	8.3%
11	10	Jiangsu Changdian Electronics Technology Co. Ltd.	Discrete	6.96	11.90	71.0%
6	11	Shenzhen STS Microelectronics Co. Ltd.	Packaging & Testing/Discrete	10.35	11.48	10.9%
9	12	ASMC	Foundry	7.84	11.47	46.3%
	13	Shanghai Grace Semiconductor Manufacturing Co., Ltd.	Foundry		9.68	
14	14	SG-NEC Electronics Co. Ltd. (Shougan NEC)	IDM	5.62	9.01	60.3%
16	15	Shanghai Matsushita Semiconductor Co. Ltd.	Packaging & Testing	5.01	8.58	71.3%
13	16	STATS ChipPAC (Shanghai) Co. Ltd.	Packaging & Testing (SATS)	6.05	7.80	28.9%
23	17	Wuxi CRMH Microelectronics Co. Ltd.	IDM/Foundry	3.28	7.67	133.8%
12	18	Datang Microelectronics Technology Co. Ltd.	Design	6.23	7.50	20.4%
	19	Jiangyin New Tide Science & Technology Group Co. Ltd.	Packaging & Testing		7.36	
20	20	CSMC Sci-Tech Co. Ltd.	Foundry	3.5	6.43	83.7%
21	21	Amkor Technology	Packaging & Testing (SATS)	3.4	5.19	52.6%
15	22	Hanzhou Silan Microelectronics Co. Ltd.	Design (Fabless)	5.35	5.09	-4.9%
	23	Zuhai Actions Semiconductor Co. Ltd.	Design (Fabless)		4.60	
	24	China Huada IC Design Center	Design (Fabless)		4.54	
	25	GAPT (Global Advanced Packaging Technology)	Packaging & Testing (SATS)		4.26	
	26	Beijing Vimicro Semiconductor Co. Ltd.	Design (Fabless)		4.20	
19	27	Jilin Huaxing Electronics Group Co. Ltd.	Discrete	3.64	4.12	
	28	Shanghai BCD Semiconductor Manufacturing Co. Ltd.	Foundry		3.94	
	29	Infineon Technology (Wuxi) Co., Ltd.	Packaging & Testing		3.91	
22	30	GOOD-ARK (Suzhou) Electronics Co., Ltd.	Discrete	3.29	3.75	14.0%
	31	Inferno (Wuxi) Electronics Co. Ltd.	Discrete		3.54	
24	32	Wuxi China Resources Microelectronics, Co. Ltd.	Discrete	2.93	3.42	16.7%
26	33	FASL Semiconductor (Suzhou) Co. Ltd. (Spansion)	Packaging & Testing	2.69	3.01	11.9%
27	34	Tianjin Zhonghuan Semiconductor Co. Ltd.	Discrete	2.63	3.03	15.2%
	35	Toshiba Semiconductor (Wuxi) Co. Ltd.	Packaging & Testing		2.91	
25	36	Shanghai Belling	IDM/Foundry	2.84	2.90	2.1%
28	37	Shanghai Simconix Electronics Co. Ltd.	Discrete	2.51	2.89	15.1%
	38	Xiamen Hualian Electronics Co. Ltd.	Discrete	0.52	2.86	450.0%
	39	Tian-shu-hua-tian Microelectronics Co. Ltd	Packaging & Testing		2.70	
	40	Xian Air Electronics Co. Ltd.	Discrete		2.62	
	41	Shaoxing Silicore Co. Ltd.	Design (Fabless)		2.53	
	42	Hangzhou Youwang Electronics Co, Ltd.	Design (Fabless)		2.47	
	43	Shenzen Shenai Semiconductor Co. Ltd.	Discrete		2.45	
	44	Renesas Semiconductor (Suzhou) Co. Ltd.	Packaging & Testing		2.38	
	45	Wuxi China Resources Semico, Co. Ltd.	Design (Fabless)		2.28	
30	46	Millennium Microtech (Shanghai) Co. Ltd.	Packaging & Testing (SATS)	1.63	2.16	

Revenue in millions of dollars		
2003	2004	Reference
964	981	CSIA 05 & CCID 04-05
351	975	PwC
189	324	CSIA 05 & CCID 04-05
0	312	CSIA 05 & CCID 04-05
195	247	CSIA 05 + CCID 04-05
0	242	CSIA 05 & CCID 04-05
110	193	CSIA 05 & CCID 04-05
92	175	CSIA 05 & CCID 04-05
149	161	CSIA 05 & CCID 04-05
84	144	CSIA 05
125	139	CSIA 05 + CCID 04-05
95	139	CSIA 05 & CCID 04-05
0	117	CSIA 05 & CCID 04-05
68	109	CSIA 05 & CCID 04-05
61	104	CSIA 05
73	94	CSIA 05 & CCID 04-05
40	93	CSIA 05 & CCID 04-05
75	91	CSIA 05
0	89	CCID 04-05
42	78	CSIA 05 & CCID 04-05
41	63	PwC
65	61	CSIA 05
0	56	CSIA 05
0	55	CSIA 05
0	51	CCID 04-05
0	51	CSIA 05
44	50	CSIA 05
0	48	CSIA 05 & CCID 04-05
0	47	CCID 04-05
40	45	CCID 04-05
0	43	CCID 04-05
35	41	CCID 04-05
32	36	CCID 04-05
32	37	CCID 04-05
0	35	CCID 04-05
34	35	CCID 04-05
30	35	CCID 04-05
6	35	CCID 04-05
0	33	CCID 04-05
0	32	CCID 04-05
	31	CSIA 05
	30	CSIA 05
0	30	CCID 04-05
	29	CCID 04-05
	28	CSIA 05
20	26	CCID 04-05

Major Chinese Semiconductor Manufacturers

This listing contains all the manufacturers in China that could be identified with 2004 revenues greater than $25 million. The list now totals 46 companies, which is an increase from the 30 companies that were identified in our previous report as having 2003 revenues higher than $20 million.

The combined reported 2004 revenues of these companies were $5.9 billion, which represents 49 percent of China's total industry revenues of $12 billion. This data suggests that there could be at least 250 other semiconductor manufacturing companies in China with average 2004 revenues of $25 million. A more likely possibility is that there are more than 600 additional semiconductor manufacturing companies in China with average 2004 revenues of less than $10 million.

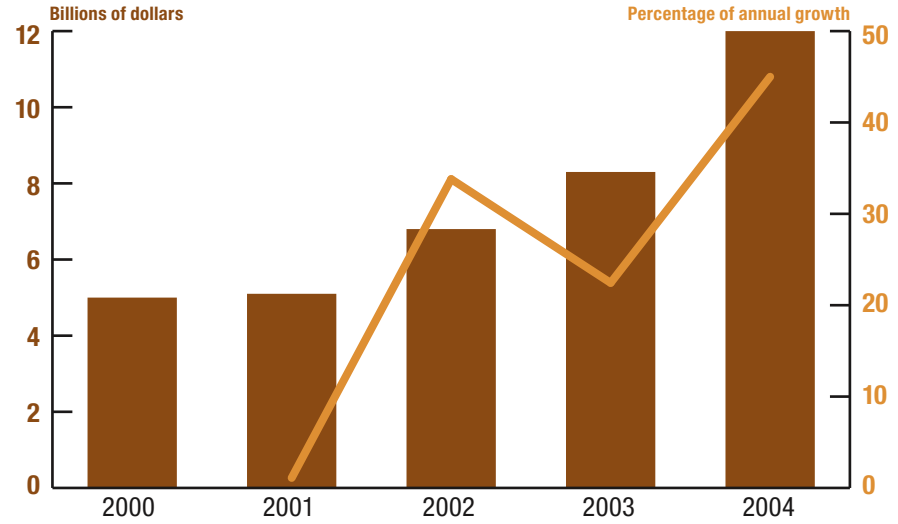
Of the 27 companies with reported revenues for both 2003 and 2004, their combined revenues increased by slightly more than 45 percent. The large foundry manufacturers achieved the largest increases, led by SMIC with an increase of over $600 million, or 175 percent.

Production Growth

China's reported semiconductor production revenues grew by a considerable 45 percent in 2004 to $12.0 billion. This increase is notably greater than the worldwide increase of 28 percent for the same period. China's semiconductor industry revenues, as reported, represent slightly more than 5 percent of the worldwide semiconductor industry revenues for 2004.

China's semiconductor industry remained more concentrated in discretes than is generally recognized. For 2004, discretes accounted for 45 percent of China's semiconductor industry revenues.

Figure 6: Chinese Semiconductor Production Revenues and Growth, 2000–2004

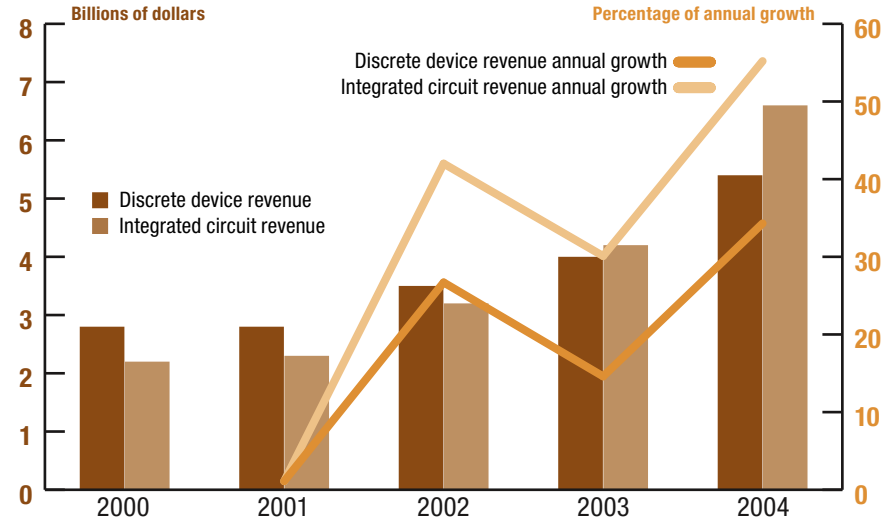


Source: CCID, CSIA, PricewaterhouseCoopers, 2005

Because of the possibility for overstatement or double counting, a comparison between China's semiconductor industry revenues and the sum of worldwide semiconductor device sales, plus foundry and SATS revenues, may provide a more representative measurement of China's impact on the semiconductor industry. For 2004, that comparison indicates that China's semiconductor industry accounted for slightly more than 4.9 percent of the worldwide industry, up from 4.2 percent in 2003 and 2.3 percent in 2000. However, it is important to note that domestic production levels could be overstated due to some IDM's using the sale/buyback or die-included price model for their SPA&T transfer pricing. For an explanation of how this double-counting, could occur, see "Probable Double Counting—A Hypothetical Example," on page 56.

Integrated Circuit and Discrete Growth

Figure 7: Chinese IC and Discrete Production Growth, 2000–2004



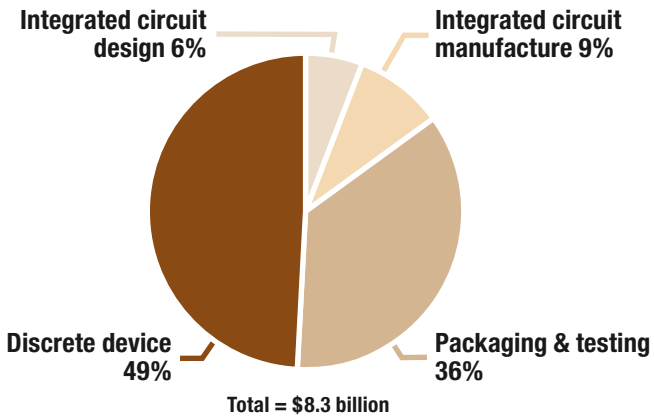
Source: CCID, CSIA, PricewaterhouseCoopers, 2005

China's discrete device industry revenues grew by 34 percent in 2004 to $5.4 billion, which represents almost 16 percent of worldwide discrete device revenues. Although China's IC industry revenues grew by 55 percent in 2004 to reach $6.6 billion, that amount represented less than 4 percent of worldwide IC revenues.

Industry by Sector

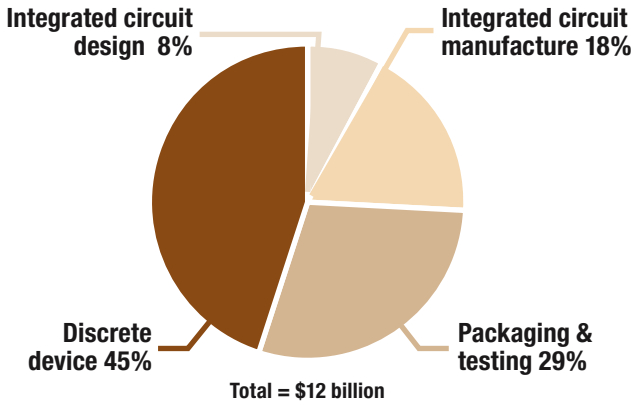
Figure 8: Semiconductor Production Revenue by Sector, 2003–2004

2003



Source: CSIA, CCID, 2005

2004



Source: CSIA, CCID, 2005

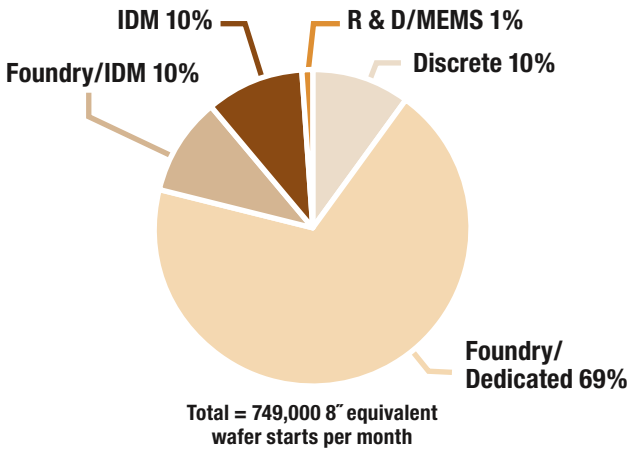
The distribution of China's semiconductor industry is changing as a result of the rapid growth of IC foundry production. Revenues for IC manufacturing grew by almost 200 percent in 2004 to $2.2 billion. As a result, the IC manufacturing sector increased its share of China's semiconductor industry revenues from 9 percent in 2003 to 18 percent in 2004.

During the remainder of this decade, China's IC manufacturing and IC design sectors are forecasted to grow faster than its overall semiconductor industry. By 2009, China's IC industry revenues will be more than twice its discrete device industry revenues.

Wafer Fab Capacity

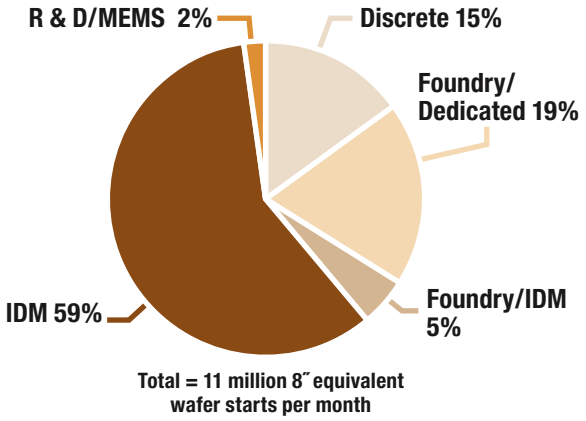
Figure 9: Comparison of China and Worldwide Current Wafer Fab Capacity, 2004

China



Source: World Fab Watch, 2005 *Note: WFW probability ≥ 1.0*

Worldwide



Source: World Fab Watch, 2005 *Note: WFW probability ≥ 1.0*

A comparison of China's current wafer capacity and worldwide capacity is shown here. Based upon its current capabilities—rather than its stated intentions— China can increase its share of total worldwide semiconductor wafer production from the ≤ 2 percent realized in 2003 to ≥ 6.8 percent by 2007. It can accomplish this increase by fully equipping and ramping to full capacity at mature yields all of its existing wafer fabrication modules. This action would triple China's share of worldwide wafer production and have a noteworthy impact. However, this represents only a further modest increase in China's relative total semiconductor capacity.

During the past year, China has put into production a net of five additional wafer fabrication modules. This addition represents an increase in potential capacity of 21 percent compared to the worldwide increase of potential capacity of only 7 percent. In absolute terms, China added 19 percent of potential worldwide wafer fab capacity added during 2004.

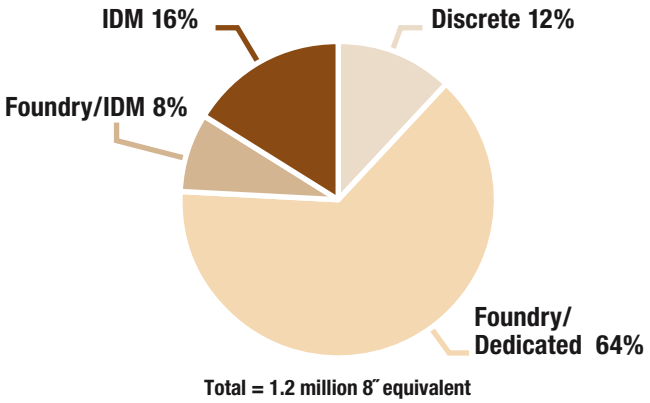
When fully equipped and ramped, more than 79 percent of China's current wafer fabrication capabilities will be dedicated to foundry production, compared to just under 25 percent worldwide.

Based upon these capabilities, China will be able to increase its share of worldwide foundry production to less than 22 percent by 2007. This increase could have a significant impact on the semiconductor industry. As of July 2005, China's 10 percent share of wafer fab capacity dedicated to IC IDMs and its 10 percent share dedicated to discretes remain significantly less than worldwide shares of 59 percent and 15 percent, respectively. This disparity likely results from several factors: the timing of when China opened the semiconductor sector to foreign investments, an election to mimic the Taiwanese semiconductor business model, and the very weak market position of China's state-owned semiconductor companies.

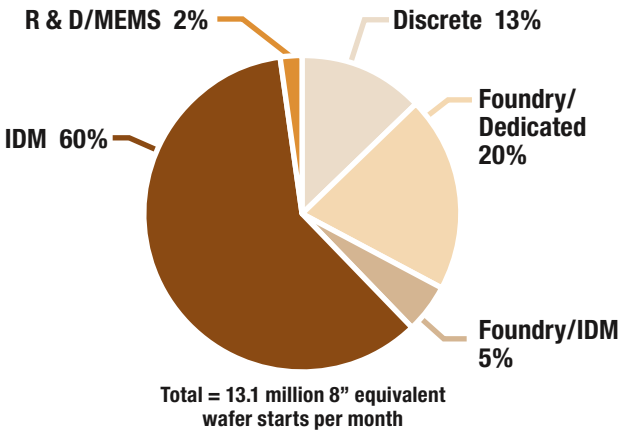
Share of Worldwide Fab Capacity

Figure 10: Comparison of Current and Committed China and Worldwide Wafer Fab Capacity, 2004

China



Worldwide



Source: World Fab Watch, 2005

Note: WFW probability ≥ 0.8

From a business model standpoint, China's current wafer fabrication capabilities are noticeably different from worldwide capabilities. As of July 2005, foundry capacity dominated China's capabilities.

As of October 2005, there were only four foreign IDMs with wafer fabrication capacity in China: NEC, ON, Philips (through its joint ventures with ASMC and JSMC), and Rohm. At this time, there is only one additional foreign IDM committed to establishing wafer fab capacity in China, the Hynix/ST joint venture.

During 2005, the number of wafer fabrication modules committed and under construction in China increased by 25 percent. These 20 modules under construction comprise 10 plants dedicated to foundry production, 5 for IDM production, 3 for discrete production, and 2 for foundry/IDM production. Together, these have the potential to further increase China's wafer fabrication capacity by 61 percent and represent 21 percent of the capacity of all wafer fabrication modules currently committed and under construction worldwide. (Note: Current and committed capacity refers to plants in production plus plants under construction.) These new plants would further increase China's significant share of worldwide foundry production to more than 27 percent, but still leave its share of wafer fab capacity dedicated to IC IDM production at 16 percent—significantly less that the 60 percent worldwide average.

Based upon China's current and committed plants as of July 2005, it can further increase its share of total worldwide semiconductor wafer production from the ≤ 2 percent realized in 2003 to ≥ 9.3 percent by 2009. To achieve this increase, financing is required to complete the 20 new plants currently under construction. These new plants, as well as existing wafer fabrication modules, must then be fully equipped and ramped to full capacity at mature yields. If this occurs, China would more than quadruple its share of worldwide wafer production and it would have a significant impact on the semiconductor industry.

Wafer Fab Capacity by Process Node

Table 5: Comparison of Current Wafer Fab Capacity, 2004

	China Capacity	%	World Capacity	%
Total	748.8		10,962.8	
By geometry				
≥ 0.7µm	148.2	20	2,232.0	20
< 0.7 to ≥ 0.4µm	46.2	6	1,202.2	11
< 0.4 to ≥ 0.3µm	69.7	9	881.6	8
< 0.3 to ≥ 0.2µm	18.0	3	992.5	9
< 0.2 to ≥ 0.16µm	30.0	4	497.1	5
< 0.16 to ≥ 0.12µm	293.0	39	2,097.6	19
< 0.12 µm	120.0	16	3,009.7	28
N/A	23.8	3	50.1	
By wafer size				
≥ 4”	73.4	10	634.7	6
5”	47.1	6	832.9	7
6”	185.3	25	2,712.9	25
8”	398.0	53	5,237.3	48
12”	45.0	6	1,545.0	14

Capacity = 8” equivalent wafer starts per month in thousands
World Fab Watch probability ≥ 1.0
Source: World Fab Watch, 2005

From a geometry/technology-node distribution standpoint, China’s current wafer fabrication capabilities are somewhat bimodal, but remain reasonably comparable with worldwide capabilities. China has 26 percent to 29 percent of capacity at the mature ≥ 0.4µm nodes compared with worldwide shares of 31 percent to 32 percent. At the mid range of < 0.4 to ≥ 0.16µm it has a 16 percent share compared with 22 percent worldwide.

When fully equipped and ramped, China will have a notable 39 percent share at the more attractive < 0.16µm to ≥ 0.12µm nodes compared with a 19 percent worldwide share. China will have a less notable 16 percent share at the leading edge < 0.12µm nodes, compared with 28 percent worldwide.

From a wafer-size standpoint, China’s current capabilities are also reasonably comparable to worldwide

Table 6: Comparison of Current and Committed Wafer Fab Capacity, 2004

	China Capacity	%	World Capacity	%
Total	1,218.2		13,019.8	
By geometry				
≥ 0.7µm	184.1	15	2,269.3	17
< 0.7 to ≥ 0.4µm	91.1	8	1,247.2	11
< 0.4 to ≥ 0.3µm	69.7	6	881.9	7
< 0.3 to ≥ 0.2µm	185.1	15	1,210.5	9
< 0.2 to ≥ 0.16µm	30.0	2	570.8	4
< 0.16 to ≥ 0.12µm	348.0	29	2,227.6	17
< 0.12 µm	286.3	23	4,634.7	36
N/A	23.8	2	50.1	
By wafer size				
≥ 4”	73.4	6	636.3	5
5”	51.0	4	836.8	6
6”	267.5	22	2,795.9	21
8”	662.0	54	5,734.3	44
12”	164.0	14	3,088.0	24

Capacity = 8” equivalent wafer starts per month in thousands
World Fab Watch probability ≥ 0.8
Source: World Fab Watch, 2005

capabilities with one still significant exception. China currently has only one 12-inch (300mm) wafer fabrication modules in production; there are 35 such modules currently in production worldwide. There have been a variety of geopolitical reasons why China is not adding more 300mm capacity at this point. The implication, however, is that for at least the next three years, wafer fab plants in other locations have the capabilities for retaining manufacturing cost leadership in the low-mix/ high-volume advanced technology segment.

After that time period, the three additional 12-inch (300mm) wafer fabs that have been committed in China will be completed, and can be equipped and fully ramped to full capacity at mature yields. This addition will constitute 14 percent of China’s wafer fab capacity, and more than 5 percent of worldwide 12-inch (300mm) capacity.

China and the Semiconductor Value Chain

Semiconductor Value Chain Revenues

Worldwide semiconductor value chain revenues for 2000 compared with 2010 are shown in Table 7. This table is updated from our original report to include 2004 actual value chain revenues. The 2000 revenues, 2010 forecast value chain revenues, and compound annual growth rates (CAGR) remain unchanged.

Table 7: Worldwide Value Chain Revenues, 2000, 2004, 2010

Value chain activity	2000	2004	2010	CAGR 2000–2010
Electronic design automation	3.8	4	7.8	7
Semiconductor intellectual property	0.7	1.2	2.3	13
Equipment	52.5	37.1	43.3	-2
Materials	26.6	26.7	35.7	3
IDMs	184.0	180.0	291.7	5
Fabless device companies	20.4	33	44.6	9
Foundries	7.4	17	49.6	21
SATS	10.9	13.7	26.0	9

In billions of dollars
Source: SEMI, EDAC, FSA, IC Insights, Gartner Dataquest, PricewaterhouseCoopers, 2001–2005

2004 was the first year in which worldwide semiconductor revenues ($213 billion) exceeded those of 2000 ($204 billion). During this time, it is noteworthy that distribution between IDM and fabless revenues also changed. IDM revenues in 2004 were slightly (2 percent) less than 2000, while fabless revenues in 2004 were significantly (62 percent) greater. Foundry revenues in 2004 increased by 130 percent over 2000 revenues, as a result of the industry's further shift to the fabless and fab-lite business models. SATS revenues in 2004 increased by 26 percent over 2000, less than the foundry increase because IDMs had been outsourcing significant volume to SATS prior to 2000.

Based upon their 2004 revenues, only two of the eight activities in the worldwide semiconductor value chain have maintained or exceeded the forecasted CAGR appearing in the 2004 report: fabless device companies and semiconductor intellectual property.

Table 8: China Versus Worldwide Semiconductor and Value Chain Revenue in Billions of Dollars, 2004

Value chain activity	Worldwide	China Production	China Consumption	China's role
Electronic design automation	4.00	N/A	0.10	Software user, not producer
Semiconductor intellectual property	1.20	N/A	0.03	Licensee, not licensor
Equipment	37.10	*0.05	2.73	First-tier and wafer fab buyer; used equipment favored; manufacturer of some SPA&T equipment
Materials	26.70	*0.25	1.17	First-tier buyer, second- or third-tier producer
IDMs	180.00	5.70	35.30	Plant location for large IDMs, domestic source of smaller IDMs
Fabless device companies	33.00	1.00	6.50	Small domestic presence; good supply chain opportunities for other fabless companies
Foundries	17.00	2.30	3.30	Substantial; More than 14% worldwide capacity by 2006
SATS	13.70	1.00	2.60	Substantial; More than 18% worldwide SATS manufacturing space already in China

Source: SEMI, EDAC, FSA, IC Insights, Gartner Dataquest, PricewaterhouseCoopers, 2005

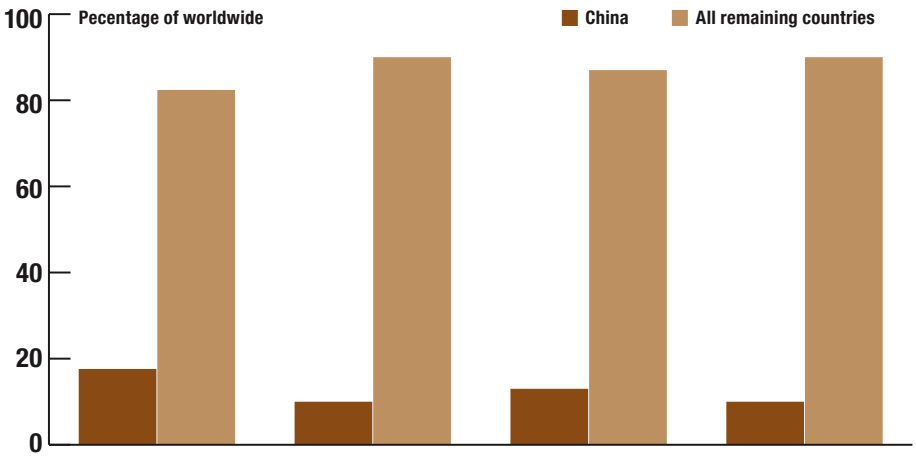
**Chinese domestic companies only; excludes local subsidiaries of foreign companies*

In Table 8 above we present our initial analysis of China's estimated contributions to the semiconductor value chain revenue for 2004. Because of the significance and difference between China's consumption and production activities we have shown both data when they are available. China's role on the supply side of the current value chain continues to be most significant in foundry, SATS operations, and IDM assembly and test facilities. We estimate that the aggregated sum of China's 2004 supply-side activities' revenue was less than 4 percent of the worldwide aggregated activity revenues.

On the demand side, China's role has been first and foremost as a consumer of semiconductor devices, just over 60 percent of which were built into products for export during 2004. China continues to be a growing user of equipment, buyer of materials, and modest licensor of design intellectual property and electronic design automation tools. We estimate that the aggregated sum of China's 2004 demand-side activities' revenue was less than 17 percent of the worldwide aggregated activity revenue.

Packaging, Assembly, and Test Production

Figure 11: Comparison of China and Other Countries' SPA&T Resources, 2004



Source: Gartner Dataquest, 2005

As shown in Figure 11, in 2004 China had 79 SPA&T facilities, which represent 17.6 percent of the total number of worldwide SPA&T facilities. This represents 13 percent of the total worldwide SPA&T manufacturing floor space but only a reported 10 percent of the total number of worldwide employees. China's relatively low reported share of employees and its decline from 12 percent a year ago is believed to be an artifact of the reporting system. Several of the SPA&T facilities in

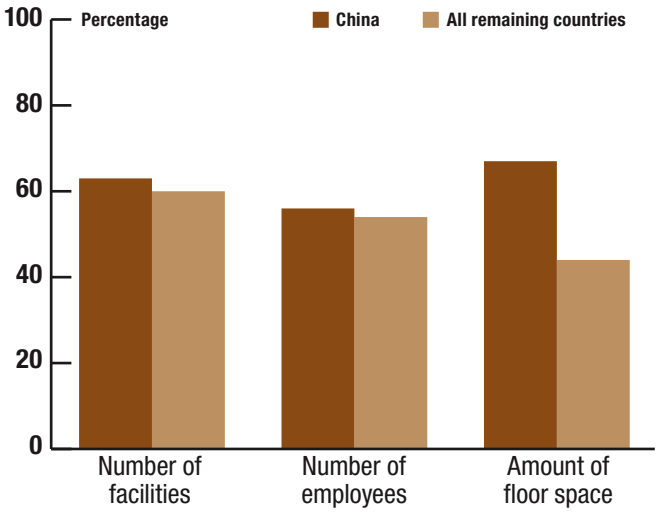
China do not report their employee count. Additionally, IDMs may not be adequately represented. For example, Lenovo, which was included in the reported Chinese SPA&T statistics at the end of 2003 and had an employee count of 10,920, was not included in the statistics for 2004.

Of the total SPA&T facilities in China, about 20 percent belong to Chinese companies, which is a reduction from 2003 figures. These Chinese facilities had only 15 percent of worldwide SPA&T employees and 12 percent of SPA&T manufacturing floor space in China. We believe this is because a number of foreign companies have invested recently in new, large SPA&T facilities. These new facilities have greater automation, enabling higher productivity and more unused floor space for future expansion than their Chinese competitors.

The value of China's IC SPA&T production in 2004 represented slightly more than 9 percent of the value of worldwide production, which is on par with 2002 and 2003 levels. During 2004, China's IC SPA&T production units represented 17 percent of worldwide units, which constitutes a significant increase from our 2003 estimate of ≥ 11 percent. The value of China's discrete SPA&T production in 2004 was estimated to be about 16 percent of the value of worldwide production. In terms of production units, China's share represented about 24 percent of worldwide discrete units in 2004. The composite weighted average value of China's SPA&T production in 2004 was estimated to be 10 percent of worldwide SPA&T production, the same as it was in 2003.

SATS and Other SPA&T Trends

Figure 12: China Versus All Remaining Countries,
SATS Share of Packaging, Assembly and Test Capacity, 2004



Source: Gartner Dataquest, 2005

As shown in Figure 12, China's SPA&T capacity was slightly more concentrated in SATS suppliers, than the worldwide share. China had 50 SATS facilities, which represented 63 percent of its SPA&T facilities, compared with 60 percent worldwide. SATS manufacturing floor space represented 67 percent of its SPA&T manufacturing space, compared with 44 percent for all others worldwide. Its SATS employees represented 56 percent of its SPA&T employees, compared with 54 percent

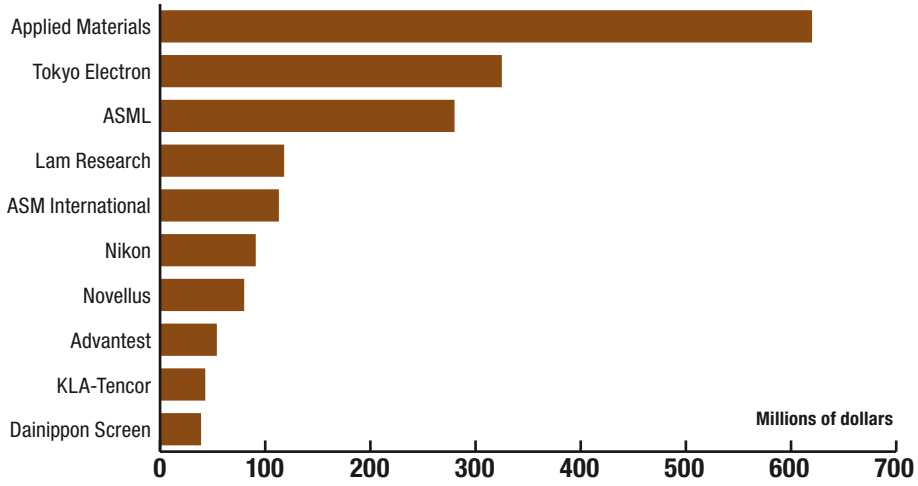
for all others worldwide. Of the 50 SATS facilities in China, 16 belonged to Chinese companies and 34 to foreign companies. However, all of the 29 IDM SPA&T facilities in China were owned by foreign companies.

A significant portion of new SPA&T facilities that started production during 2004 were located in China. A total of 15 facilities started production during 2004, of which 11 were located in China. These new Chinese SPA&T facilities represented 56 percent of the new SPA&T facility manufacturing space and 77 percent of the new SPA&T facility employees added during 2004.

Based upon the Chinese Semiconductor Industry Association (CSIA) data, China's IC SPA&T production for 2004 was estimated to be 18 billion units, representing about 17 percent of total worldwide SPA&T production. CSIA forecasted China's IC SPA&T production to increase to about 53 billion units in 2009. This forecasted increase in production of about 35 billion units over the five-year period between 2004 and 2009 would represent 90 percent of the total forecasted worldwide increase in IC SPA&T production. If realized, it would represent an increase in China's share of worldwide IC SPA&T production from 17 percent in 2004 to 37 percent in 2009 and would require China to increase its IC SPA&T production at a 24 percent CAGR during those five years. While this is not a conservative forecast, it is reasonably possible because of the high portion of new SPA&T facilities that have started production in China, and we would consider it to be compatible with a moderate growth scenario.

Equipment Market Shares

Figure 13: Equipment Sales to China, Top Ten Vendors, 2004



Source: Gartner Dataquest, 2005

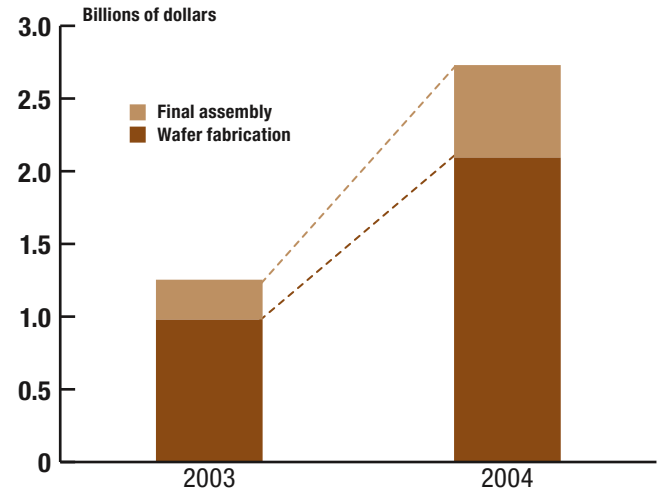
Note: Total Market = 2.6 billion dollars

The sales of the top ten semiconductor equipment suppliers in 2004 to the Chinese market increased by 100 percent and represented a 70 percent share of that market. The Chinese market for new semiconductor equipment had been reasonably concentrated with the top 15 suppliers having a 70 percent share, down from 77 percent in 2003. Also, of these 15 leading suppliers, 11 were manufacturers of wafer fabrication equipment, with the remaining 4 suppliers being divided evenly between test and assembly equipment. At least three of these suppliers (ASM International, Kulicke & Soffa, and Teradyne) have manufacturing operations in China that serve their international customers on a global basis.

Semiconductor Equipment and Materials International (SEMI) estimated that sales of used equipment in China represented 7 percent to 9 percent of the Chinese semiconductor equipment market in 2004, down from 14 percent in 2003. In addition to the top 15 suppliers, which are well recognized international companies, there are a large number of other suppliers, including many regional and several indigenous Chinese suppliers that are trying to establish a presence in the market.

Equipment Sales

Figure 14: China's Semiconductor Market by Sector, 2003–2004



Source: SEMI, Wafer News, 2005

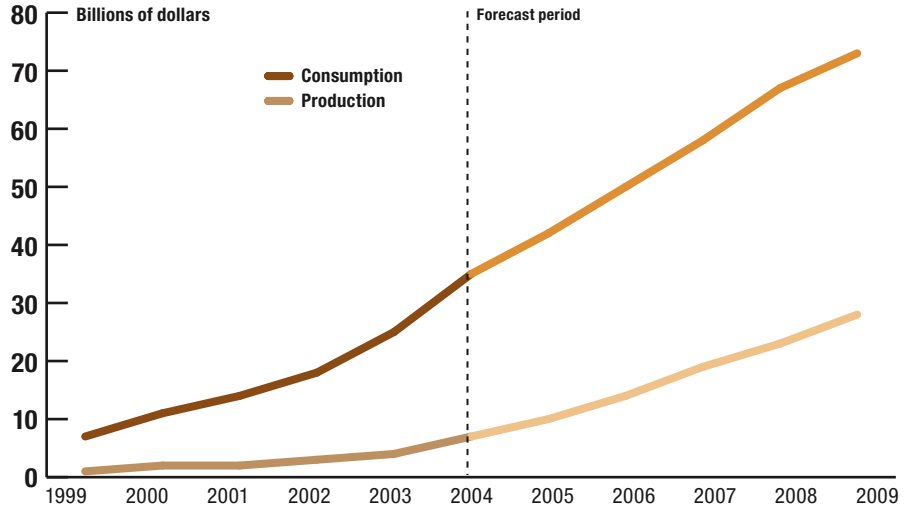
As is typical of historical semiconductor business cycles, semiconductor equipment sales growth in China exceeded that of semiconductor device sales in 2004, the peak year of the current cycle. According to SEMI, semiconductor equipment sales to China increased by almost 120 percent in 2004 to reach $2.73 billion, which represented just over 7 percent of the worldwide market.

Wafer fabrication equipment sales in China increased 114 percent in 2004 to $2.09 billion, 77 percent of total equipment sales. Most of this equipment was used by the new foundry fabrication plants that were ramping production during the year and contributed to the almost 200 percent increase in China's IC manufacturing revenues in 2004.

Packaging, assembly, and test equipment sales in China increased 131 percent in 2004 to $0.64 billion, or 23 percent of total equipment sales. This equipment was used by the broad base of SPA&T and discrete plants in China, contributing to an average 26 percent increase in the revenues of those sectors.

IC Consumption/Production Gap

Figure 15: China's Integrated Circuit Consumption Versus Production, 1999–2009



Source: CCID, CSIA, PwC, 2005

China's increasing IC consumption/production gap, the increasing difference between IC consumption and IC industry revenues, is illustrated in Figure 15. During 2004, China's IC consumption increased by $10 billion to $35 billion, while China's IC industry revenues increased only by $2.4 billion to $6.6 billion.

As a result, even though China's IC industry grew at a faster rate (57 percent) than its IC market (40 percent), China's IC consumption/production gap increased by $7.7 billion to $28.5 billion for the year. This gap has grown from $5.7 billion in 1999 to $28.5 billion in 2004, and the Chinese authorities now expect that it will continue to increase through at least 2009.

According to the CSIA 2005 report, China's IC market was forecasted to grow to $73.4 billion by 2009, while its IC production was forecasted to grow to $27.8 billion. This forecasted growth would result in a further increase in China's IC consumption/production gap to $45.6 billion. This gap also contributes to the Chinese government's initiatives to increase indigenous production.

Production Growth Scenarios

Assessing Production Growth

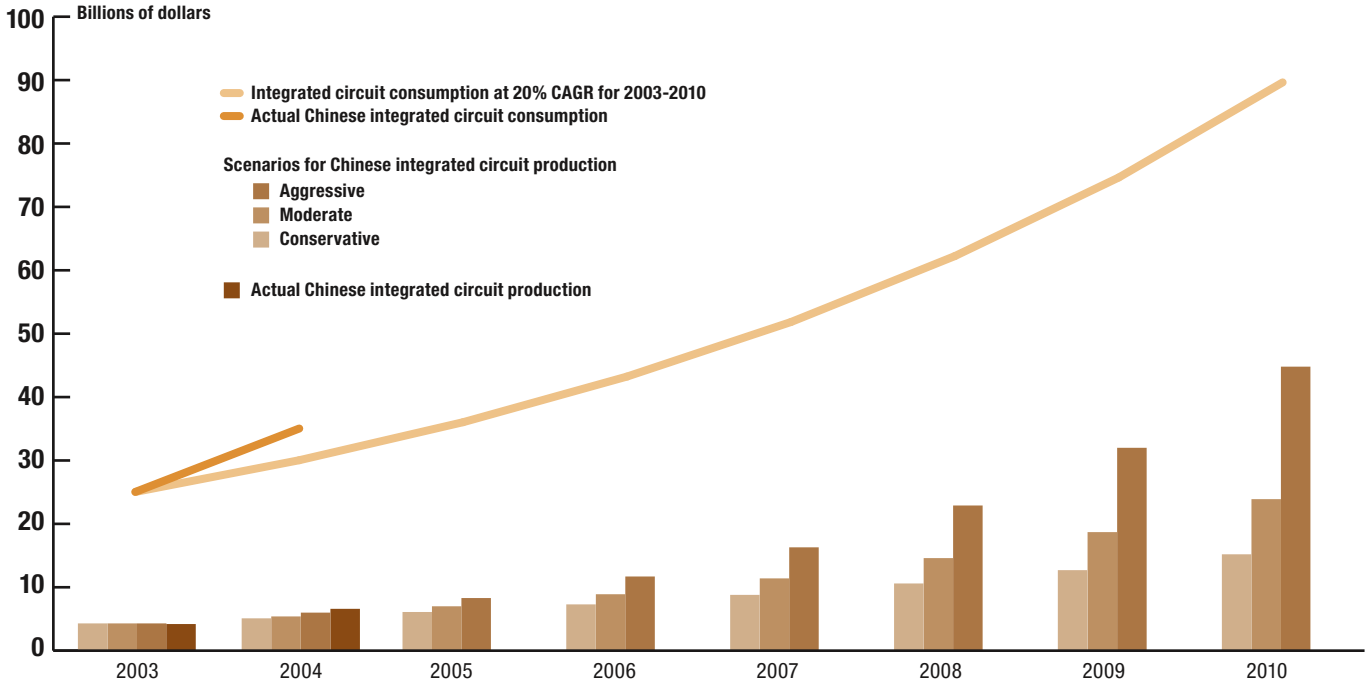
As in our 2004 report, this section provides an assessment of conservative, moderate, and aggressive IC production growth scenarios and Chinese predictions on IC consumption (both export and domestic) in the country. The production scenarios and consumption forecast themselves are unchanged from 2004, but this year we have added actual consumption and production through 2004 to be able to compare with the forecasts.

Our conservative growth scenario was based upon the assumption that China would equip and ramp to full capacity at mature yields all current and committed wafer fabrication plants. Under those original assumptions, China's semiconductor industry revenues were forecasted to reach $16 billion by 2010.

Our moderate growth scenario was based upon China achieving the specific objectives articulated by the CSIA in 2002, with semiconductor production revenues forecasted to reach $24.1 billion by 2010.

Our aggressive growth scenario was based upon the assumption that the Chinese semiconductor market would grow at 20 percent, twice the worldwide rate. It also called for China achieving its goal of having its semiconductor industry revenues equal at least half of its market demand by 2010, amounting to $44.8 billion in that year. Under those original assumptions, China's IC market was forecasted to reach $89.5 billion by 2010.

Figure 16: IC Production and Consumption Under Our Production Scenarios



Source: CSIA, World Fab Watch, PricewaterhouseCoopers, 2005

How Our 2004 Forecasts Compared to Actual Performance

Figure 16 now includes China's actual performance for 2003 and 2004. Comparing actual performance to our forecasts, we see that both China's IC production and consumption for 2004 exceeded our aggressive growth scenario. This outcome was most likely the result of 2004 being the peak growth year of the current semiconductor business cycle.

The government IC consumption forecast developed in 2004 was based upon the assumption that China's IC market would grow at a CAGR of 20 percent—twice the forecasted worldwide CAGR of 10 percent. The 2005 industry forecasts now call for a worldwide IC market CAGR of 11.9 percent from the period 2003 to 2009, while the 2005 CSIA forecast calls for a Chinese IC market CAGR of 19.8 percent over the same period.

Our Forecast Scenarios

As of November 2005, we have not identified any fundamental changes that will cause our original growth scenarios to be revised or the findings to be significantly altered.

Our analysis also presents the actions and investments required to realize each scenario and the likelihood of each occurring during the five-year forecast period.

Conservative Growth Scenario

The potential capacity of all current and committed wafer fabrication plants in China as of mid-2005 has increased by about 22 percent over capacity levels in early 2004 when we made our original forecast. This capacity increase can be attributed to the addition of seven new plants in production and five more under construction. To now realize the conservative growth scenario will require a larger equipment investment than previously forecasted.

Moderate Growth Scenario

The moderate growth scenario was based upon China achieving the specific objectives articulated by the CSIA in 2002. These objectives call for meeting 50 percent of domestic demand by 2010 with IC production of 20 billion pieces and revenue of 60 to 80 billion yuan ($7.2 to $9.6 billion) by 2005; and 50 billion pieces and revenue of 200 billion yuan ($24.1 billion) by 2010. This forecast represented a CAGR of 25 percent from 2004 to 2010.

According to the CSIA's 2005 report, China's IC production in 2004 was 21.2 billion pieces and revenue of 54.5 billion yuan and was forecasted to be 29.6 billion pieces and revenue of 84.6 billion yuan in 2005, rising to 83.1 billion pieces and revenue of 280 billion yuan in 2010. This forecast puts China's IC production at meeting 36 percent of domestic demand in 2010. However, even if all the current fabs and those now under construction are put into full production at standard 85 percent capacity, China would

be 273,000 wafer starts per month (WSpM) units short of its goal.

To realize the moderate growth scenario requires the construction of six additional fabs of 45,000 WSpM capacity, at a total cost of $15 billion. This goal can only be accomplished if construction on 80 percent of the fabs currently planned (or rumored but not yet committed) is started within the next two years. Because this scenario continues to rely on the construction of fabs that are not fully committed and requires considerable further capital investments, this projection is still considered to be somewhat optimistic.

Aggressive Growth Scenario

According to the CSIA 2005 report China's IC market was now forecasted to reach $92.3 billion by 2010. Under the aggressive growth scenario, China's IC industry will reach revenues of $44.8 billion by 2010, which now represents a 38 percent CAGR from 2004 to 2010 and still seems distinctly unlikely. Even under the most favorable business model, this scenario would require China to increase its wafer fab capacity to 1,830,000 WSpM, which would require the construction and ramping to full production of 14 additional fabs not currently under construction. This new construction represents an additional investment of about $35 billion, which also still seems distinctly unlikely.

Conclusion and Recommendations

Conclusion

The high cost of new fab capacity is a definite factor limiting China's semiconductor production growth. Government subsidies can address land, construction, and tax costs, but these only go so far. Used 200mm equipment being replaced outside of China would continue to be useful inside the country.

Additionally, experienced labor is in short supply, and it is evident that a proportion of the existing labor force is relatively unskilled and continues to face a steep learning curve. Foundries in the country have had mixed success, which opens the possibility of consolidation among foundries and the repurposing of current plant assets to other industry segments. The next round of investment in China might involve placing bets on fewer companies. Over time, the formation of a large IDM continues to be a possibility, one which could draw additional investor interest.

Foreign companies who have decided to add a large amount of 300mm capacity in China will have to assume the attendant risk involving the exposure of their intellectual property. If investment levels in 300mm capacity turn out to be lower than expected, the obvious beneficiaries of a wafer production shortfall in China would be foundries in Taiwan and Singapore. All of these factors support the expectation that Chinese foundries will still be driven to compete heavily on cost.

The outlook for other semiconductor industry sectors is positive. SPA&T activity is diverse and strong. A number of fabless companies are finding success, particularly in high-volume handheld applications, such as MP3 players or mobile phones. These companies include some headquartered in China, such as Actions Semiconductor and Vimicro, as well as a large number of foreign-headquartered firms. Design capability in the country continues to grow rapidly, with one source indicating that the number of active Chinese designs by October 2005 exceeded 500. Overall, both the Chinese and those who seek to supply Chinese demand from outside the country should find a market that continues to offer substantial growth potential.

Recommendations

China's growing influence on the semiconductor industry is having broad-ranging effects. The following recommendations, unchanged from our 2004 report, provide some preliminary guidance to companies seeking to take advantage of new business opportunities in China. They are also applicable to those companies anticipating opportunities and challenges that will result from the country's new role as a major semiconductor producer.

- Protect intellectual property (IP).
- Avoid exposing any information that could jeopardize competitive advantage.
- Conduct a risk assessment before any venture in China.
- Design and implement physical and IT security systems that are appropriate for the risk.
- Make appropriate legal arrangements and develop strong documentation.
- Establish close relationships with employees and educate them on the best IP protection methods.
- Establish alliances with companies and government entities that can benefit from protecting (IP).
- Proactively monitor IP and pursue violators.
- Avoid underestimating Chinese R&D capabilities.
- Prepare for increased volatility with contingency planning.
- Use periods of overcapacity to negotiate favorable deals.
- Identify and focus on specific, strong customers and their requirements.
- Evaluate new partners and suppliers thoroughly.
- Market leaders: outflank the external competition.
- Low volume and high-volume producers: join the indigenous competition.
- Introduce new products selectively.
- Provide developer support to the local market.
- Establish and protect brand identity in China.
- Promote and adhere to best health, safety, and other practices.
- Invest early in Asian standards development.
- Leverage other successful ventures in China.
- Anticipate logistics problems and plan for effective product delivery.
- Adopt a localized procurement strategy early.
- Work closely with local governments.

Appendix

Interpreting Chinese Semiconductor Statistics

This report is based in part on Chinese sources of statistics. This is because the Chinese statistics are those relied on by the Chinese policy makers, and also because western statistical sources on the subject are incomplete and widely divergent. Despite increasing international interest and press coverage, market reports and statistics of the Chinese semiconductor industry are difficult to obtain and often subject to misunderstanding and skepticism. Because the Chinese government agencies themselves rely upon these reports and statistics to establish industry policy, companies should be aware of how these statistics differ from conventional semiconductor statistics.

The two principal indigenous sources for most Chinese semiconductor industry and market reports, data, and statistics are China Center for Information Industry Development (CCID) Consulting and the Chinese Semiconductor Industry Association (CSIA), both of which are associated with the Ministry of Information Industries (MII) and share common data sources and industry analysts.

Definitional Issues

Because both sources compile their data and write their reports in Chinese and then translate them into English, their English language reports contain a number of translation anomalies, especially related to units of measure. Both sources compile and analyze their data based upon an industry structure that is somewhat different from that employed by Western analysts. This industry structure is not clearly defined in their English language reports, but may be best described by the following statement contained in the CSIA seminal, *An Investigation Report of China's Semiconductor Industry 2002*. "The term 'the semiconductor industry' in this Report covers IC design, IC manufacture, packaging and test, semiconductor discrete device and semiconductor supporting sector, etc. In view that the investigation on supporting sector is not comprehensive, the term 'China semiconductor industry' in 'General Introduction' and in its relevant statistic data excludes this sector."

Therefore we have come to understand that according to MII, CCID, and CSIA usage, their reports on the Chinese semiconductor industry are based upon an industry structure organized into the following sectors.

IC Design

This sector includes integrated circuit (IC) design companies, institutes, and laboratories as well as all fabless IC semiconductor companies in China regardless of ownership structure. Most of the revenue and all of the unit production reported for this sector come from product sales of the fabless semiconductor companies.

IC Manufacture

Sometimes identified as wafer manufacturing, this category includes wafer foundries, wafer fabrication plants of foreign IC semiconductor companies, and Chinese IC integrated device manufacturers (IDM). As a result, the revenue and unit production reported for this sector is a nonhomogeneous mix of wafer and finished-product unit sales.

Packaging and Testing

This sector includes the IC semiconductor packaging, assembly and test (SPA&T) plants of foreign semiconductor companies as well as all IC semiconductor assembly and test services (SATS) plants and companies in China. This sector does not include the discrete SPA&T plants of foreign semiconductor companies or the IC SPA&T activities of Chinese IDMs. Because some SPA&T plants of foreign semiconductor companies utilize a wafer/die sale/buyback business model and others a consigned wafer/die business model, the revenue production reported for this sector is not homogeneous and is potentially misleading. However, the unit production reported is relatively homogeneous.

Discrete Device

This sector includes all Chinese discrete IDMs as well as all discrete wafer fabrication and SPA&T plants of foreign semiconductor companies in China. Because many of the SPA&T plants of foreign semiconductor companies utilize a consigned wafer/die business model rather than the fully costed IDM business model, the revenue production reported for this sector in not homogeneous and is potentially misleading. However, the unit production reported is relatively homogeneous.

Data Compilation Methods

Both CCID and CSIA compile their data from reports filed by the various entities in each industry sector. These entities typically report their activities as separate standalone companies, and CCID and CSIA consolidate the reports from each company in an industry sector without any eliminations or offsets. The results are often industry sector totals that are aggregates of nonhomogeneous inputs (for example, foundry wafer revenues and wafer shipments combined with IDM finished unit product sales revenues and unit shipments) and therefore misleading. One of the most confusing terms used in their reports is “pieces” or “pcs” (sometimes mistranslated “wafers”). As used in their reports, the definition of this term varies with the type of company, so that it includes finished devices from a fabless semiconductor company, wafers from a wafer foundry, finished devices from an IDM, and assembled and possibly tested units from a SPA&T plant or SATS company. It is very difficult to relate one to the other and therefore almost impossible to determine average selling prices (ASP) from their industry sector data.

Because at least one of the largest SPA&T plants of a foreign semiconductor company uses a wafer/die sale/buyback business model, its reported revenues are approximately four times as large as they would be if reported using the conventional consigned wafer/die (cost less die) basis. This reporting difference is very significant and could account for a potential overstatement of 25 percent in the 2003 revenues for the packaging and testing sector, 17 percent in the 2003 revenues of the Chinese IC industry and 8 percent in the 2003 revenues of the Chinese semiconductor industry.

Probable Double Counting—A Hypothetical Example

Because CCID and CSIA consolidate the reports from each plant or company in an industry sector without any eliminations or offsets, double counting between sectors is very probable. For example, here is a hypothetical manufacturing flow for a Chinese fabless semiconductor company that uses a Chinese wafer foundry and SATS company to manufacture its products:

- Datang is a fabless semiconductor company in the IC design sector.
- ASMC is a wafer foundry in the IC manufacturing sector.
- GAPT is a SATS company in the packaging and testing sector.
- Solectron is an electronics manufacturing services (EMS) customer.
- Datang Microelectronics buys 1,000 wafers (200mm) from ASMC for $1,200 per wafer for a total of $1,200,000.
- Datang consigns the 1,000 wafers to GAPT for assembly and testing in plastic ball grid array (PBGA) packages with 600 net die per wafer and a die free package cost of $1 per package, for a total of $600,000.
- Datang sells the 600,000 finished units to Solectron for an ASP of $4 per device for a total of $2,400,000.

Using CCID and CSIA reporting practices, these transactions would be classified and recorded as in the table below.

As a result of CCID and CSIA reporting practices, the total Chinese semiconductor industry revenue in the hypothetical example just described is overstated by 75 percent and unit shipments by 100 percent when compared to conventional Western reporting standards.

Despite the evident disparities, we use the aggregate statistics as reported, while carefully noting that they represent China's semiconductor industry as reported in China, that is, the sales revenue of all semiconductor companies in China as reported to the Chinese authorities. We do so because we have no way to determine which business model is being used by every company, and because Chinese policy makers do rely upon these results. As the tendency has been for these sources to overstate the size of the industry, there is some assurance that understatement is not a possibility, and we want to be careful not to understate the impact of China on the industry as a whole. In cases where the Chinese have identified individual company revenues, we have been able to augment that information from other sources.

	Pieces	Revenue
IC manufacturing section	1,000	1,200,000.00
Packaging and testing section	600,00	600.00
IC design section	600.00	2,400,000.00
Total	1,201,000	4,200.000.00

Implications of Statistical Disparities

Compared to the more conventional practices and standards of the World Semiconductor Trade Statistics (WSTS) and related industry associations and analysts, these differences in CCID and CSIA reporting practices and standards could lead to noticeable variability in reported Chinese semiconductor industry results, depending upon the mix of business models employed. Furthermore, these differences could have a significant impact on China's apparent ability to meet the CSIA's objective of increasing the output of nationwide IC to meet 50 percent of the domestic market by 2010.

An example of an identical IC device that is wafer fabricated, packaged, assembled and tested in China can illustrate that impact. Based upon the current CCID/CSIA reporting practices, an average reported semiconductor industry revenue could be 100 yuan if the device were manufactured and sold by a Chinese IDM, but only 66 yuan if the device were manufactured by a wafer foundry and SATS supplier for a foreign fabless semiconductor company, or a more significant 166 yuan if the device were manufactured by a wafer foundry and SATS supplier for a Chinese fabless semiconductor company.

Increasing international interest and visibility during the next few years may encourage CCID and CSIA to discontinue their current Chinese semiconductor industry reporting practices and standards. If China elects to change to more conventional semiconductor industry reporting practices and standards, the country may find it desirable to revise the CSIA objectives accordingly.

Identifying Chinese Semiconductor Companies

The English names of many of the Chinese semiconductor companies are often the source of confusion for a variety of translation and structural reasons. Many have English names that are different from the literal translation of their Chinese names and often incorporate location prefixes on an inconsistent basis. As a result, the same company may be identified by a number of different English names in various reports and articles.

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TECHNOLOGY CENTER

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Editor
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Analyst
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Raman Chitkara

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KEY CONTACTS

Raman Chitkara
Partner, Global Leader, Semiconductor Practice
US: +1 408 817-3746
raman.chitkara@us.pwc.com

www.pwc.com

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