A decade of unprecedented growth
China's impact on the semiconductor industry 2014 update

Technology Institute

Section 1: *Market & Industry Overview*

August 2014

pwc

Introduction

In 2004 when we published our first report on China's impact on the semiconductor industry, we were responding to our clients' concerns that China's growing semiconductor production would cause over-capacity in the global market. Today, a decade later, it is not China's semiconductor production that's the story, but rather its semiconductor consumption. In fact, in 2013, China's semiconductor consumption market grew by 10.1% (more than double the worldwide market growth of 4.8%) to reach a new record of 55.6% of the global market. Ongoing global demand for smartphones and tablets—the lion's share of which are produced in China—is the main reason for this continued strong growth in semiconductor consumption and will continue to be a factor in the coming years.

Now a mature, global leader, we recognize that an annual in-depth look at the Chinese semiconductor market may not be as necessary or even as useful as it was ten years ago, and so this will be our final report in this format. Going forward, we will look at more targeted, specific issues and elements based on developments in the industry.

As we did in 2012, for this year's Update we have elected to release our report in three sections in order to provide the information to you as early in the year as possible. Our regular readers should note that all of the considerations described in the 2012 Update appendix, "Interpreting Chinese semiconductor statistics" and the "About this report" section remain relevant to this update and should be referred to as needed. The appendix, as well as all of our previously issued reports, are available at our website www.pwc.com/chinasemicon.

This first release contains the following sections:

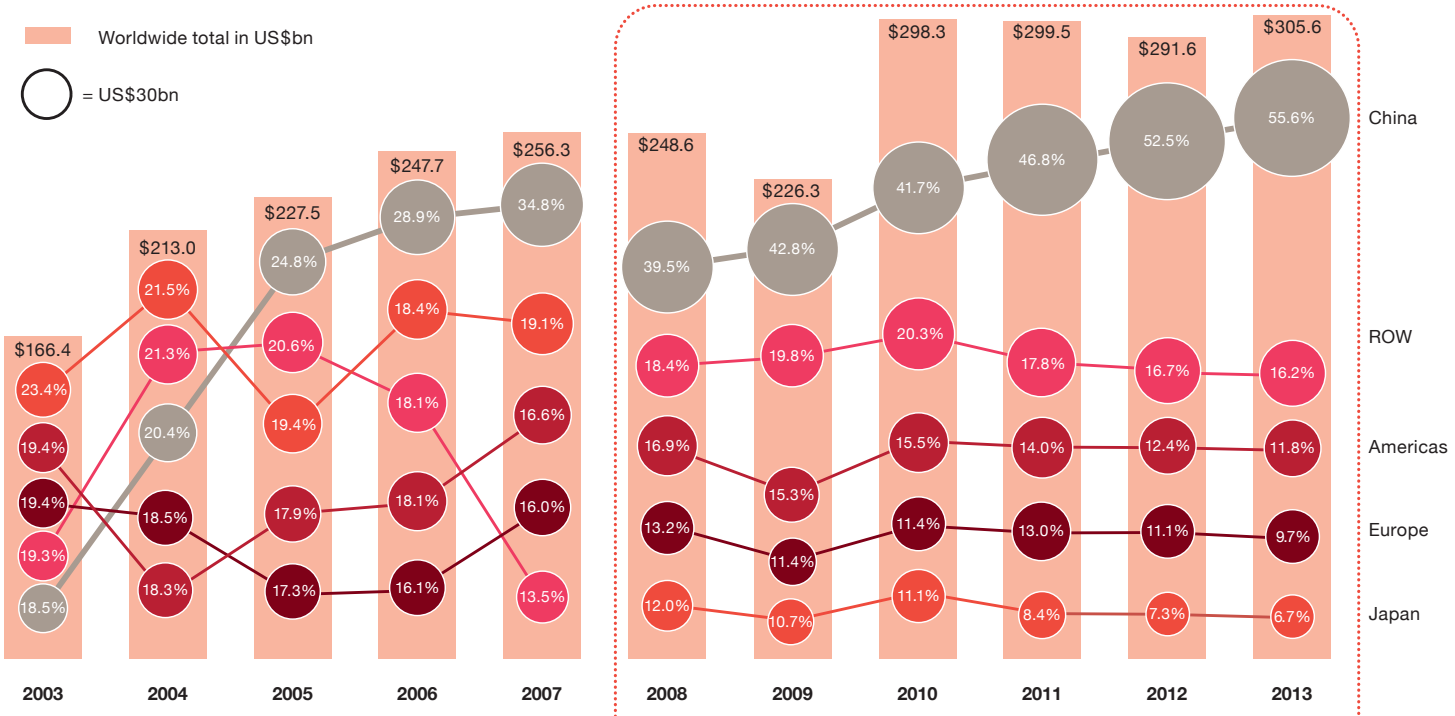
Our second release will cover semiconductor manufacturing, followed by the final section on the greater China market and current government incentives. A final report, featuring an executive summary, updated statistics (if any of the data has changed over the months) and a conclusion will be available toward the end of the year. Any revisions to text or data that become necessary will be reflected in the pdf files our website and in the final report.

All releases and the final report will be available on our website at www.pwc.com/chinasemicon.

China's semiconductor market

China's consumption growth continued to far exceed worldwide semiconductor market growth for a third consecutive year in 2013. While the worldwide semiconductor market increased 4.8% in 2013, China's semiconductor consumption market grew by 10.1% in 2013 to reach a new record of 55.6% of the global market. Although much of this exceptional growth continued to be the result of China's dominant position in the production of smartphones and media tablets, almost three percentage points of this increase was the result of China's continuing revaluation of the renminbi (RMB). Measured in local (RMB) currency, China's semiconductor consumption market grew by 7.3% in 2013. That 7.3% local currency growth, which was very close

Figure 1: Worldwide semiconductor consumption market by region, 2003–2013
(Total worldwide in US$bn)



Source: *Semiconductor Industry Association (SIA), McClean Report 2014 (MCR 14), Gartner Dataquest (GDQ), CCID Consulting (CCID)*

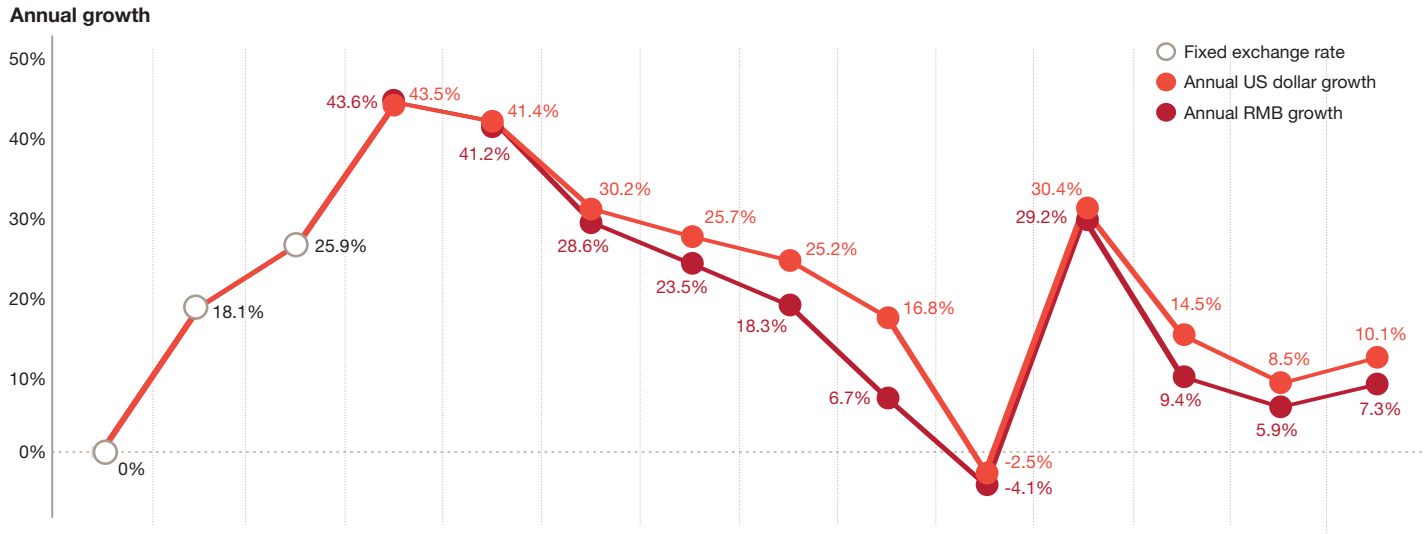
China's 2008–2013 share of consumption market based upon McClean Report 2014 (MCR 14) market history.

Regional share of worldwide consumption market is based upon Gartner "Semiconductor Forecast Database, Worldwide, 2012–2018 1Q14" and prior with adjustments for dislocated purchases.

to what Chinese officials had forecast at the start of the year, far exceeded all other regions and may be understated since most of the semiconductors consumed in China were sourced from multinational suppliers and priced in dollars, euros or yen.

It has been ten years since our first report on China's impact on the semiconductor industry. During the first of those years China moved rapidly from being the smallest of the regional semiconductor consumption markets in 2003, with 18.5% share, to the largest by 2005, with 24.8% share. Since then, China has expanded its semiconductor consumption market leadership position and increased its market share every year but one (2010). During four of those years (2004, 2005, 2006 and 2010) China's semiconductor consumption grew by commanding the majority of worldwide market growth. During the other six years, including the past three, China's semiconductor consumption has grown at the expense of decreases in other regions. During the past ten years China's semiconductor consumption has grown at a 19.2% compounded annual growth rate (CAGR), while total worldwide consumption has only grown at a 6.3% CAGR. The net result is that while the worldwide semiconductor market as reported by WSTS has grown by US$139.2bn from 2003 to 2013, China's semiconductor consumption as reported by the China Semiconductor Industry Association (CSIA) has grown by US$150bn and 2013 was the second year that China consumed more than half of all the worldwide semiconductor market.

Figure 2: China's semiconductor market growth, 2000–2013



Market value

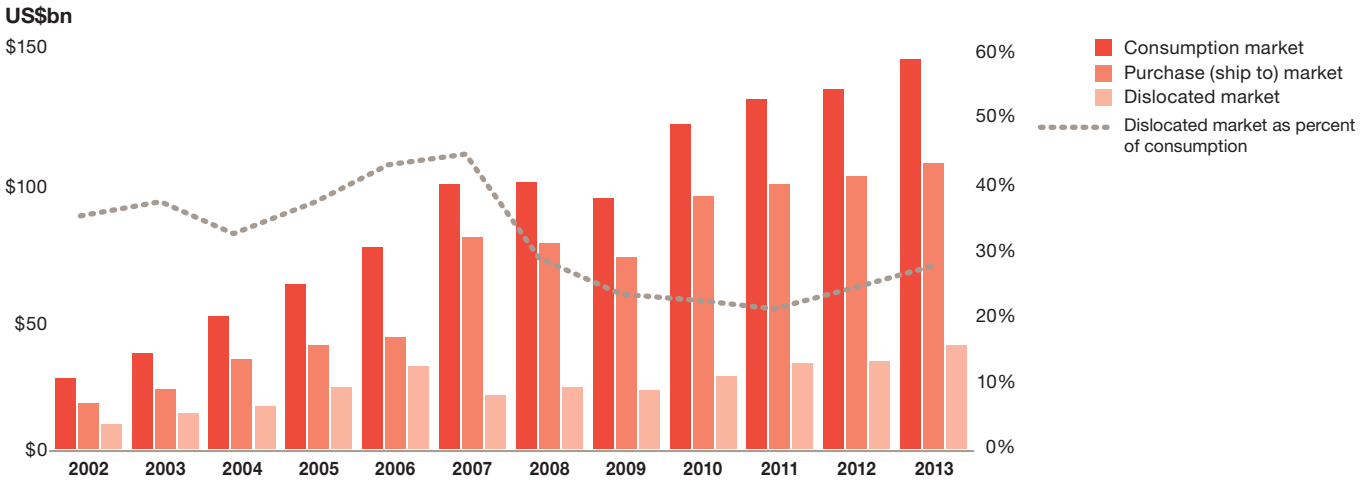
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
US$bn	14.4	17.0	21.4	30.7	43.4	56.5	71.0	88.9	103.8	101.2	132.0	151.2	164.1	180.8
RMBbn	119.5	141.1	177.6	255.1	360.0	463.0	571.7	676.1	721.5	691.6	893.4	977.5	1,035.6	1,111.7

Note: Market reporting has changed since 2003 with sensors and optical semiconductors included as part of the optoelectronics-sensors-discrete (O-S-D) segment which along with integrated curcuits make up the total semiconductor market.

Source: *CCID, CSIA*

China's reported semiconductor consumption market is greater than most market analysts' Chinese market share reports because a significant portion of the semiconductor devices consumed in China continue to be purchased outside of China. This "dislocated purchasing" occurs because some customers—due to supply chain considerations such as control of key inventory items, intellectual property protection and/or toll processing business models—will buy semiconductor devices outside of China and transship them to China for use and consumption. Since 2008 we have been identifying this "dislocated purchasing" for the Chinese consumption market by a comparison of consumption to purchasing TAM (total available market). Using the most recently revised measure of purchasing TAM, we have found that this "dislocated purchasing" declined noticeably during 2008 and 2009, remained relatively constant at just over 24% of consumption for the following three years before increasing to 28% in 2013. In 2013 the largest share of this "dislocated purchasing" occurred in Taiwan, Korea, the Americas and Singapore. Japan's share of this "dislocated purchasing" has declined significantly since 2011.

Figure 3: Analysis of China/Hong Kong consumption versus purchasing TAM semiconductor market history



Source: CSIA, Ministry of Industry and Information Technology (MIIT), Gartner

Table 1: China's production and worldwide share of main electronic products, 2008–2013

	Production in 1000s						% CAGR	Worldwide market share %					
	2008	2009	2010	2011	2012	2013		2008	2009	2010	2011	2012	2013
Main products													
Mobile phone	559,640	619,520	998,000	1,133,000	1,181,540	1,456,610	20.1%	44.7%	49.9%	62.7%	63.8%	67.7%	80.6%
Computer/PC	136,666	182,150	246,000	320,000	354,110	336,610	19.8%	47.0%	60.9%	73.4%	74.0%	70.8%	62.8%
Color TV	90,331	98,990	118,000	122,000	128,230	127,760	7.2%	43.9%	48.3%	47.8%	48.6%	53.8%	56.7%
Digital camera	81,883	80,260	90,000	82,900					62.3%	64.9%			
SPB exchange					28,280	31,160	10.2%						

Source: CSIA, Ministry of Industry and Information Technology (MIIT), Gartner

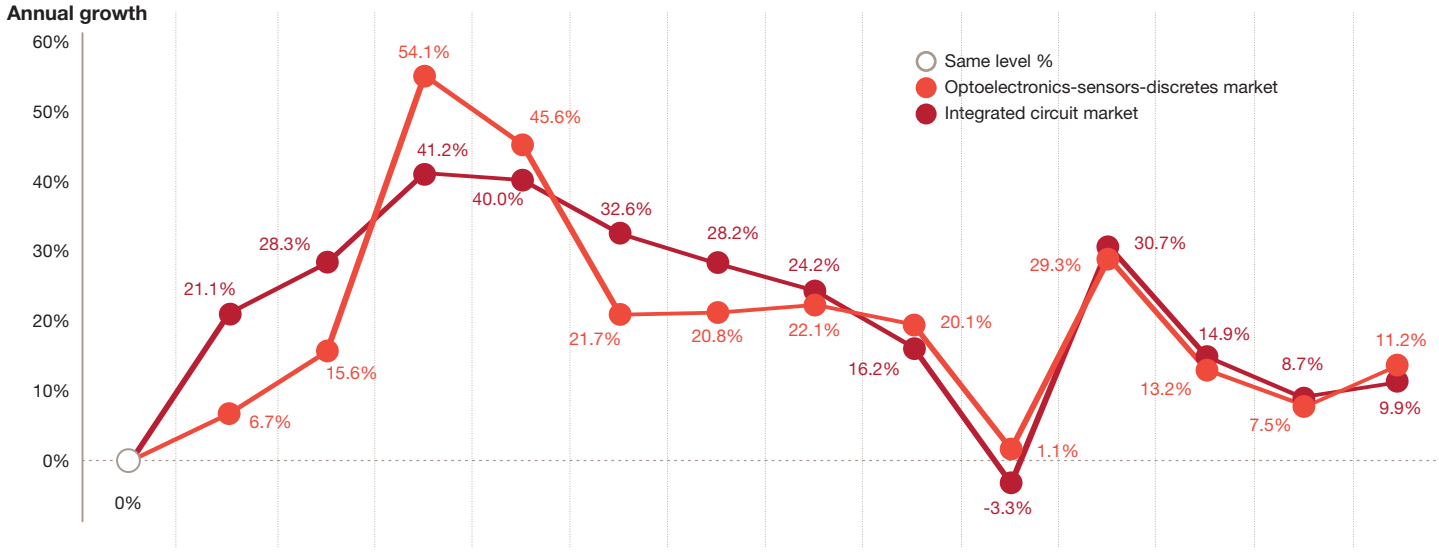
China's share of worldwide electronic equipment production increased by more than two percentage points to 35.1% in 2013.

China's semiconductor consumption market continues to grow many times faster than the worldwide market as a result of two driving factors—the continuing transfer of worldwide electronic equipment production to China and the above-average semiconductor content of that equipment. During 2013 electronic equipment production in China increased by US$45bn while it decreased by US$15bn, 1.5%, in the rest of the world. As a result, China's share of worldwide electronic equipment production increased by more than two percentage points to 35.1% in 2013. At the same time, the semiconductor content of China's electronic equipment production remained well above the 20% worldwide average at 34% in 2013.

Whether the Chinese semiconductor consumption market will continue to gain global market share will be primarily determined by the future transfer of electronic equipment production. Most industry analysts predict that the trend of an increasing share of electronic equipment production in China will moderate but continue over the next several years. According to Gartner, China's share of electronic equipment production is forecast to increase to more than 38% by 2017; the semiconductor content of that production to gradually increase to over 35%, while the worldwide average content increases to 25%; and China's share of worldwide semiconductor consumption to increase by a further 4%.

The integrated circuit (IC) consumption market in China increased 9.9% to US$149bn in 2013. This increase was realized while the worldwide IC only market increased 4.7%. As a consequence, China's IC consumption grew to represent almost 56% of worldwide consumption in 2013. During 2013 China's IC consumption increased by more than US$13bn while the worldwide market increased by US$12bn. This is the sixth time in the past seven years that

Figure 4: China's IC and O-S-D market growth, 2000–2013



Market value	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
US$bn	3.0	3.2	3.7	5.7	8.3	10.1	12.2	14.9	17.9	18.1	23.4	26.5	28.5	31.7
US$bn	11.4	13.8	17.7	25.0	35.0	46.4	59.5	73.9	85.9	83.1	108.6	124.8	135.6	149.0

Note: *Market reporting has changed since 2003 and the definition O-S-D (Optoelectronics-Sensors-Discretes) market now includes sensors and optical semiconductors*

Source: *CCID, CSIA*

China's IC consumption grew faster than the rest of the world's IC market and China's IC consumption grew at the expense of displacing IC markets in other regions. This confirms the resumption in the dynamics of China's impact on the industry, although China's rate of IC consumption market growth is gradually moving closer to the worldwide rate.

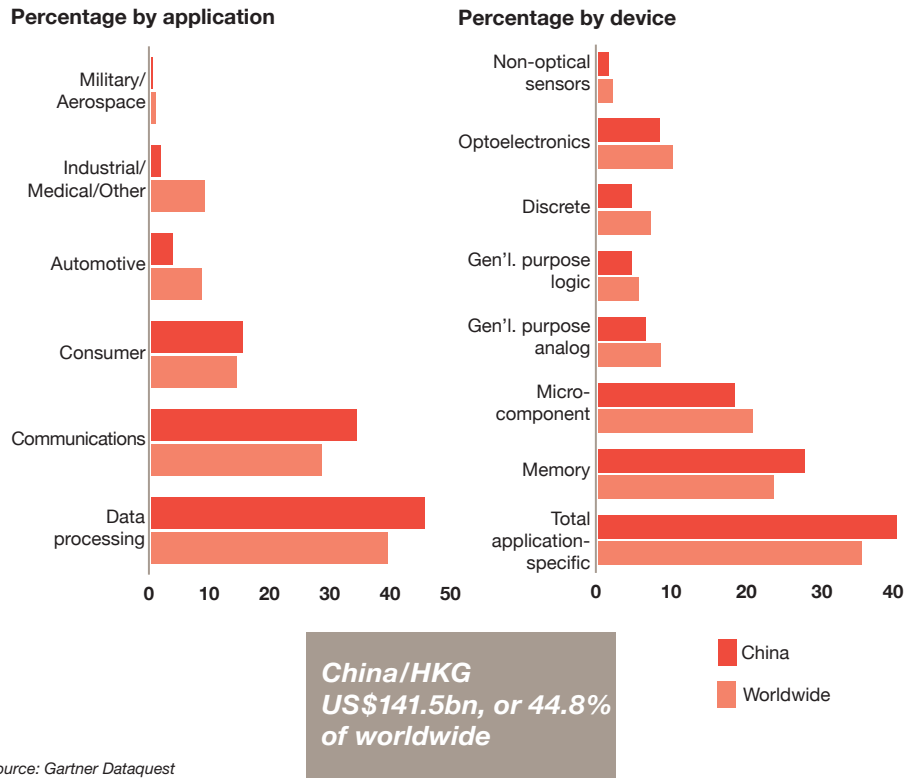
In 2013 China's O-S-D (optoelectronics-sensor-discrete) consumption market grew 11.2% to reach a new peak of US$31.7bn. For the second consecutive year this increase was much greater than the worldwide O-S-D market increase of 1%. As a result, China's share of that market grew to 54% in 2013 (from 49% in 2012). China's O-S-D market share is noticeably more concentrated in discrete devices than the worldwide market, with China's consumption representing almost 80% of the worldwide discrete market; 48% of the worldwide sensor market and only 38% of the worldwide optoelectronics market. Discrete devices continued to be the largest segment of China's O-S-D market (at US$14.6bn) and for the first year since 2004 was the fastest growing in 2013 at 13%. While sensors remained the smallest segment of China's O-S-D market (at US$4.2bn), it was the second fastest growing in 2013 at 12%. Optoelectronics continued as the middle segment at US$11.1bn while growing 9% in 2013.

During 2013 China's semiconductor consumption continued to be more concentrated in the communications and data processing (computing) applications sectors than the worldwide market, while becoming slightly less concentrated in the consumer, remaining less concentrated in the automotive and noticeably less concentrated in the industrial/medical/other and military/aerospace sectors. China's share of 2013 worldwide semiconductor consumption was largest for the communications (computing) sector, where it increased along with China's share of the 2013 worldwide data processing and automotive sectors. China's share of the worldwide consumer, industrial/medical/other and mil/aero sectors decreased during 2013.

During the ten years since our initial report there has been a noticeable shift in the distribution of China's semiconductor consumption by application. The share of China's consumption of semiconductors for the communications and data processing sectors has increased by eight and three percentage points, respectively, while the consumer share has decreased by almost 12 percentage points. Since 2003 China's consumption of semiconductors for communications and data processing (computing) applications has grown at a 20% and 18% CAGR, while consumption for consumer applications has only grown at a 10% CAGR. China's consumption for automotive applications is smaller, but has grown at a faster rate of slightly more than 20% while China's consumption for industrial applications, which decreased in 2013, has only grown at a 11% CAGR.

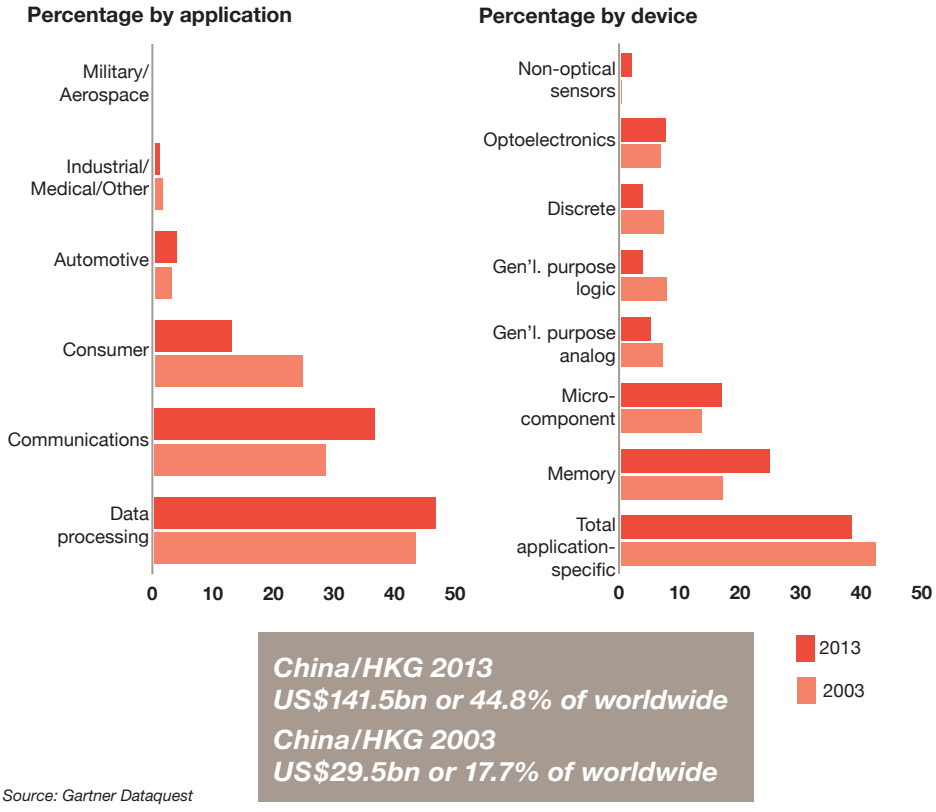
In 2013 China's O-S-D (optoelectronics-sensor-discrete) consumption market grew 11.2% to reach a new peak of US$31.7bn.

Figure 5: China compared with worldwide semiconductor market by application and device, 2013



Source: Gartner Dataquest

Figure 6: China Semiconductor market by application and device 2013 vs 2003



Source: Gartner Dataquest

Compared to 2012 China's semiconductor consumption became even more concentrated during 2013 in the application-specific and memory device sectors than the worldwide market. China's share of 2013 worldwide semiconductor consumption decreased by about two percentage points each for the general purpose analog, discrete and optoelectonics sectors, while it increased for all the other device sectors. The application-specific and memory device sectors continue to be the largest and increased their worldwide share by three and two percentage points each. Although it remained the smallest, non-optical sensors continued to be the fastest growing device sector of China's semiconductor consumption, increasing at a 50% CAGR from 2003. During the same ten-year period the microcomponent and memory sectors have grown at a 20% CAGR and optoelectronics at a 19% CAGR.

The past ten years have seen a very modest shift in the overall distribution of China's semiconductor consumption, with ICs increasing and O-S-D devices decreasing by slightly more than one percentage point. However, there has been a more noticeable shift within the distribution of the ICs. The memory device share of China's total semiconductor consumption has increased by almost eight percentage points and the microcomponent share by more than three percentage points. At same time, the application-specific and general purpose logic share of China's semiconductor consumption decreased by four percentage points each and the general purpose analog share by two percentage points. Among the O-S-D devices, the discrete device share of China's total semiconductor consumption decreased by almost four percentage points; the optoelectonic share increased by almost one percentage point, while the smaller non-optical sensors share increased by almost two percentage points.

The major global semiconductor companies continue to dominate the Chinese market. Table 2 lists the top ten suppliers with the largest value of semiconductors consumed in China during 2013. There have only been fourteen different companies among these top ten suppliers over the past ten years (since our initial report). Seven companies have been among the top ten suppliers to China every year from 2003 through 2013: Intel, Samsung, TI, Toshiba, SK Hynix, ST and Freescale. AMD joined the list in 2004 and has been among the top ten suppliers to China for the last ten years. Qualcomm, which joined this list for the first time in 2012 at number 10 displacing NXP, moved up to number six in 2013. NXP had been among the top ten suppliers to China for every year from 2003 through 2011, while MediaTek had been among the top ten for the three years 2007 to 2009 and Qimonda for only one year, 2006. During 2013 China's consumption of semiconductor products from these ten largest suppliers increased by 9.7%, slightly less than the growth of the overall semiconductor market in China,. The Chinese semiconductor consumption market continued its trend of becoming less concentrated than the worldwide market. The top ten suppliers' share of China's consumption declined to 42.9% in 2013, down from 43% in 2012 and 45% in 2011 and less than the 53% share the top ten suppliers to the 2013 worldwide market held. For the first

Table 2: Semiconductor suppliers to the Chinese market 2012–2013

	Rank		Revenue in US$M						Market share %
Company	2012	2013	2012 IC	2013 IC	% change	2012 Semi	2013 Semi	% change	
Intel	1	1	25,076	24,941	-0.5%	25,076	24,941	-0.5%	13.8%
Samsung	2	2	10,759	12,981	20.7%	11,450	13,723	19.9%	7.6%
SK Hynix	5	3	5,108	7,230	41.5%	5,108	7,230	41.5%	4.0%
Toshiba	4	4	4,235	4,876	15.1%	5,152	5,886	14.2%	3.3%
TI	3	5	5,062	5,273	4.2%	5,398	5,605	3.8%	3.1%
Qualcomm	10	6	3,171	4,658	46.9%	3,171	4,658	46.9%	2.6%
ST	6	7	3,351	3,450	3.0%	4,359	4,546	4.3%	2.5%
AMD	7	8	4,219	4,050	-4.0%	4,219	4,050	-4.0%	2.2%
Freescale	8	9	3,043	3,325	9.3%	3,561	3,958	11.1%	2.2%
Renesas	9	10	2,646	2,437	-7.9%	3,260	3,008	-7.7%	1.7%
Total Top 10			**66,670**	**73,221**	**9.8%**	**70,754**	**77,605**	**9.7%**	**42.9%**
Total Top 10 share of									
Chinese integrated circuit market			49.1%	49.1%	0.1%				
Chinese semiconductor market						43.0%	42.9%	-0.2%	

Note: Semi equals IC + Discrete (including LED) market.

Source: CCID IC Market China 2013 & 2014 Conferences – March 2013 & March 2014

For the first time in our ten years of reporting it appears that it is possible that there were one or two Chinese companies within the top 30 suppliers to the Chinese semiconductor market in 2013.

time in our ten years of reporting it appears that it is possible that there were one or two Chinese companies within the top 30 suppliers to the Chinese semiconductor market in 2013. If either or both of the two largest Chinese semiconductor companies had all of their 2013 output consumed within China they would have been within the top 30 suppliers to that market. That is a notable change from 2012 and 2011 when they would not have been within the top 30 or 35 suppliers. Moreover, it is quite likely that with the recent industry consolidations at least one of the largest Chinese semiconductor companies will be among the top 20 suppliers to the Chinese semiconductor market in 2014.

Table 3: Top ten suppliers to the Chinese semiconductor market 2003–2013

	Rank										
Name of company	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Intel	1	1	1	1	1	1	1	1	1	1	1
Samsung	6	5	2	2	2	2	2	2	2	2	2
SK Hynix	9	6	7	3	3	3	4	3	5	5	3
Toshiba	3	7	6	6	5	5	3	4	3	4	4
TI	4	2	3	4	4	4	7	5	4	3	5
Qualcom								15	13	10	6
ST	2	4	5	8	8	7	5	6	6	6	7
AMD		10	10	5	6	6	6	7	7	7	8
Freescale	7	9	9	9	9	9	10	10	9	8	9
Renesas	10	11						9	8	9	10
NXP	5	3	4	7	7	8	8	8	10		
Infineon	8	8	8					11	11		
MediaTek					10	10	9	13	15		
Qimonda				10							
ON Semiconductor								14	12		

Supplied consumption value (US$M)											
Total top 10 ICs ($M)	13,414	18,669	24,399	30,672	37,971	43,909	44,019	56,848	63,443	66,670	73,221
Total top 10 semiconductors (US$M)							46,876	60,821	68,037	70,754	77,605
Total China IC market	24,989	35,037	46,423	59,493	73,937	85,949	83,091	108,585	124,789	135,623	149,036
Top 10 % China IC market	53.7%	53.3%	52.6%	51.6%	51.4%	51.1%	56.4%	56.0%	54.5%	52.2%	52.1%
Total China Semiconductor market							101,240	131,991	151,241	164,106	180,748
Top 10 % China Semiconductor market							46.3%	46.1%	45.0%	43.1%	42.9%

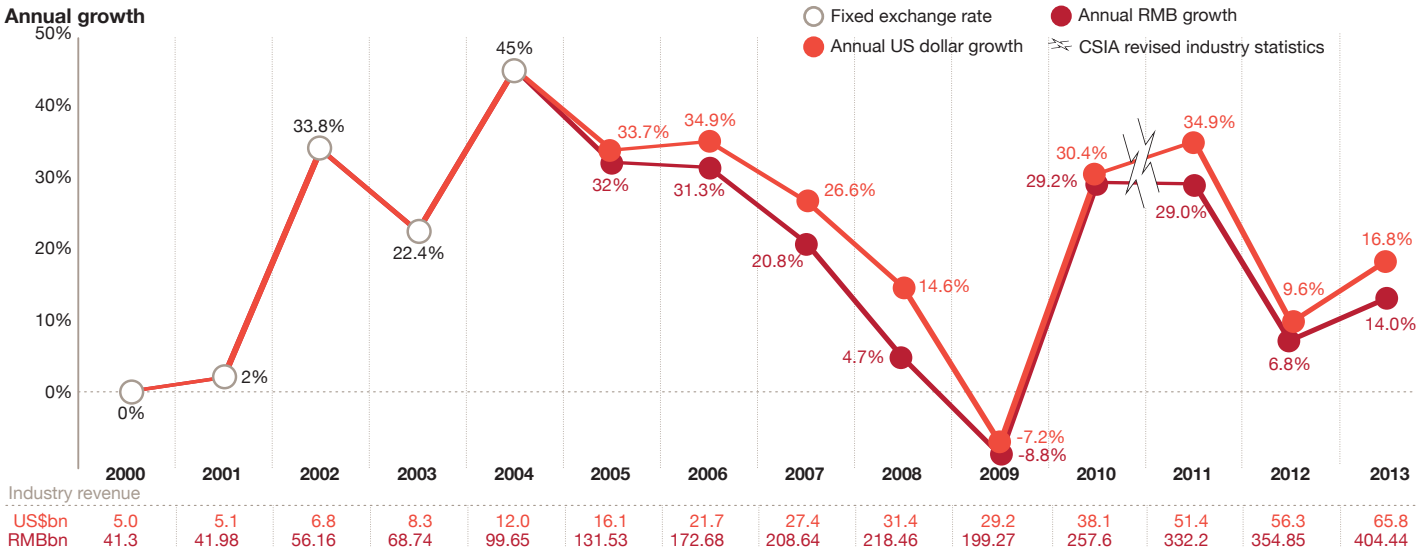
Source: *CCID, CSIA, Changed from reporting IC to semiconductors (IC + O-S-D) in 2009.*
Top 10 totals are based on each year's top 10 suppliers.

China's semiconductor industry

China's reported 2013 semiconductor industry growth continued to exceed both China's semiconductor consumption growth and the worldwide semiconductor market growth. During 2013 China's semiconductor industry grew by 16.7% to reach a record US$65.8bn. China's semiconductor industry has grown at an equal or greater rate than its semiconductor market consumption for eight of the past ten years. During 2013, US$9.4bn of additional fixed-asset investments were made in China's IC industry, up almost 71% from the nearly US$5.5bn in investments made in 2012. This US$9.4bn investment represented 16.1% of the 2013 total worldwide semiconductor capital expenditures. From 2003 through 2013, China's semiconductor industry has achieved a ten-year CAGR of 23.0% measured in US dollars (or 19.4% measured in local RMB currency). During this same ten-year period, China's semiconductor consumption achieved a 19.4% CAGR and the worldwide semiconductor market a 6.3% CAGR both measured in dollars.

Our earlier reports made a comparison between China's reported semiconductor industry revenue and the sum of worldwide semiconductor device sales plus foundry and assembly and test services (SATS) revenues which would measure China as accounting for almost 17% of the worldwide industry in 2013. However, that value is most likely overstated since a significant share of China's industry production is contributed by captive IDM wafer fabrication, assembly and test facilities rather

Figure 7: China's semiconductor industry revenue and growth, 2000-2014



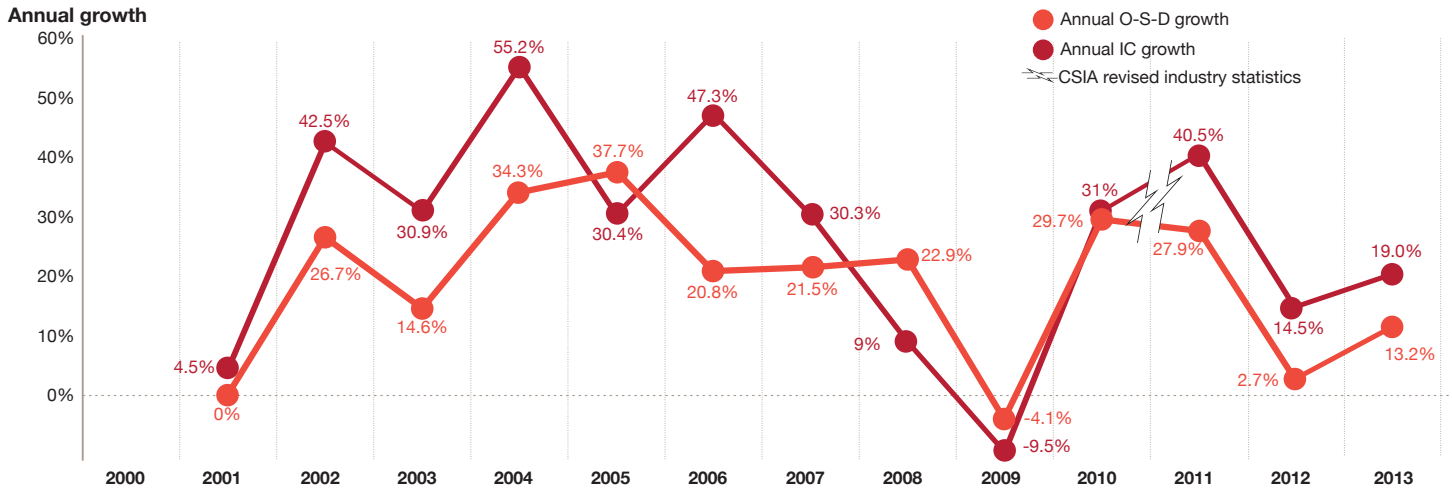
Source: CCID, CSIA

The overall performance of China's IC industry (the sum of IC design, IC wafer manufacturing and IC packaging and testing) continued to be the major contributor to China's overall semiconductor industry growth in 2013.

than just foundry and SATS facilities. Therefore, starting with the 2010 Update we added a more conservative alternate comparison against the sum of device sales revenue plus the value of all wafer fabrication and packaging, assembly and test production. That comparison indicates that China's semiconductor industry accounted for slightly more than 12% of the worldwide semiconductor industry in 2013, up from 11.6% in 2012. What is important is that both comparisons confirm that China's share of the worldwide semiconductor industry is continuing to grow, becoming both noticeable and significant. Looking forward, the Chinese authorities currently forecast that China's semiconductor industry revenues will grow to reach US$86bn by 2016. When compared to the sum of the SIA/WSTS forecast for worldwide device sales—plus all wafer fabrication and packaging, assembly and test values—that forecast projects that China's semiconductor industry will account for almost 15% of the worldwide semiconductor industry by 2016. This seems compatible with China's recent 16% share of worldwide semiconductor capital expenditures.

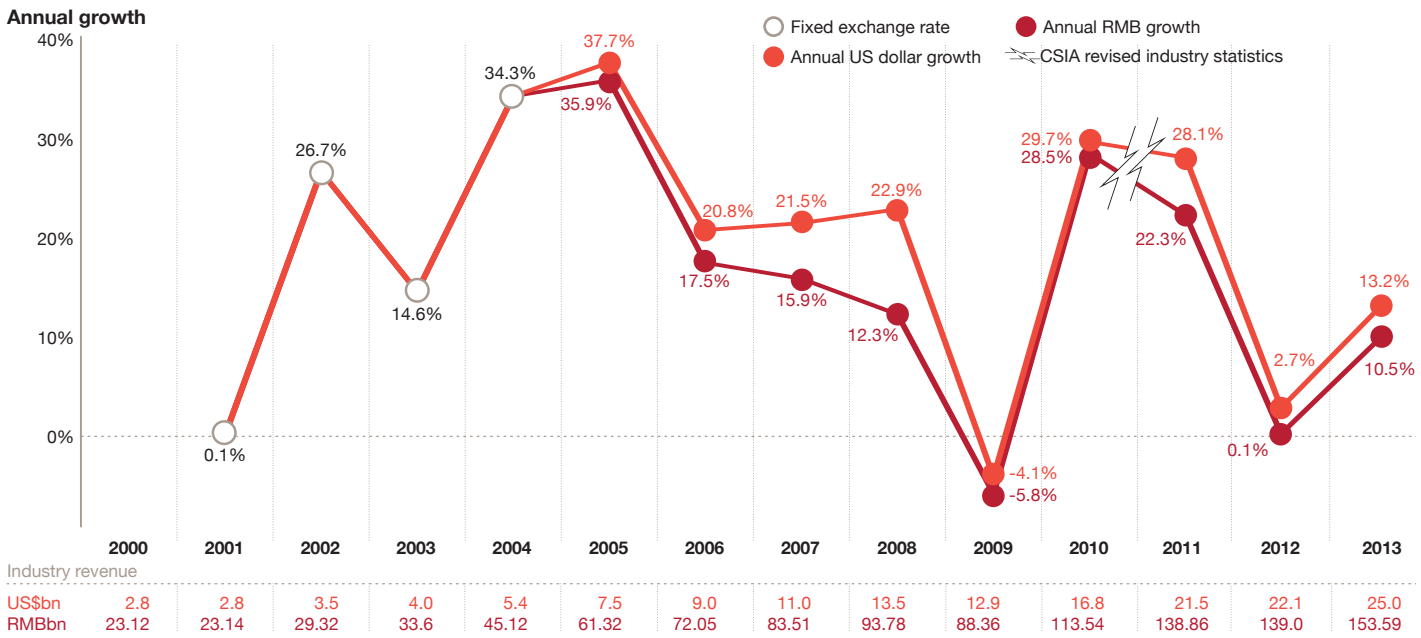
The overall performance of China's IC industry (the sum of IC design, IC wafer manufacturing and IC packaging and testing) continued to be the major contributor to China's overall semiconductor industry growth in 2013. IC industry revenues, measured in dollars, increased by 19%, to almost US$41bn in 2013. The same IC industry revenues measured in local RMB currency increased by 16.2% to 251bn RMB. Measured in dollars, two sectors of China's IC industry reported double-digit growth in 2013. As a prioritized sector and benefiting from the continuing growth of the smartphone and IC card markets, China's IC design sector grew by 33% in 2013 to a new record US$13.2bn. Thanks to an increase in both domestic and multinational demand, the IC packaging and testing sector grew by almost 19% in 2013 to a record US$18bn. Also, as measured in local currency, the IC packaging and testing sector topped the 100bn RMB mark for the first time in 2013. However, because of the fire at the SK Hynix Wuxi wafer fab facility and a slower than expected ramp up of Intel's Fab 68, the growth of China's IC wafer manufacturing sector slowed to just 4.3% in 2013 and did not reach US$10bn as had been expected.

Figure 8: China's O-S-D and IC industry revenue and growth, 2000–2013



Source: CCID, CSIA

Figure 9: China's O-S-D industry revenue and growth, 2000–2013

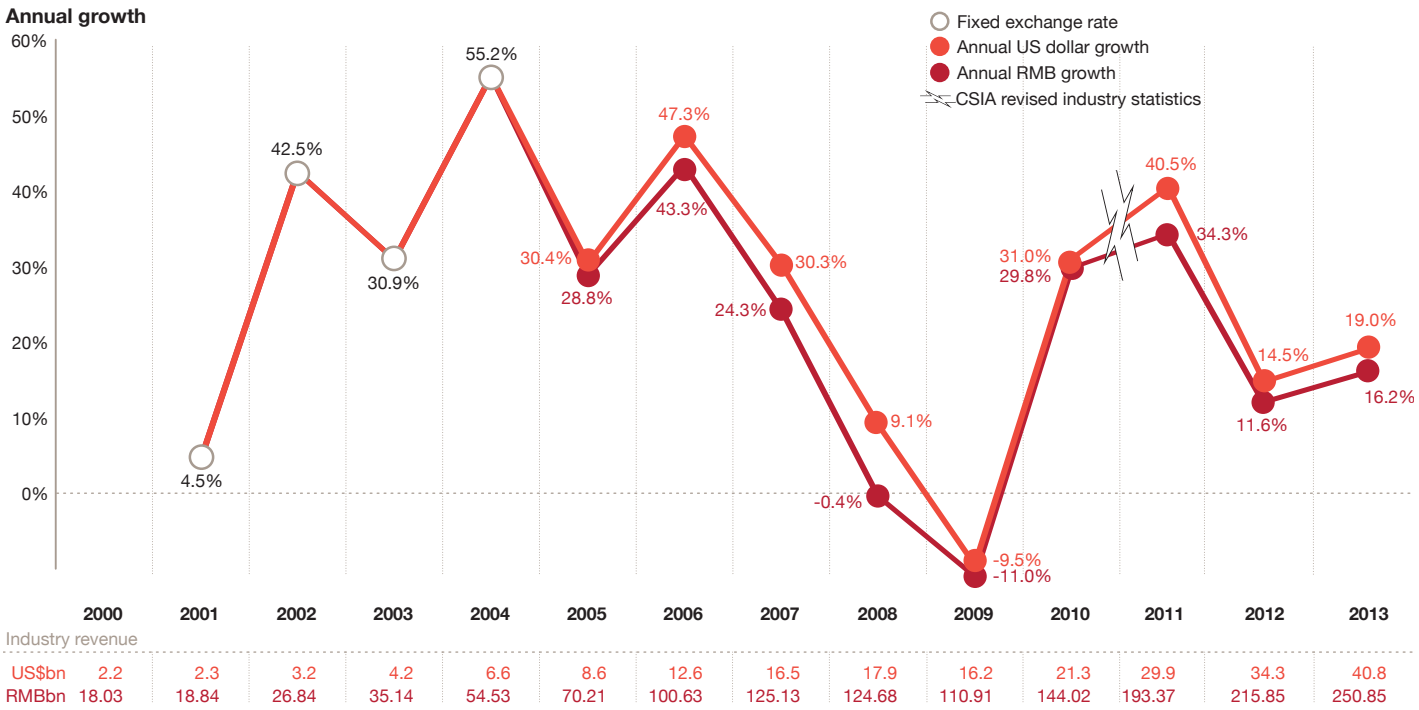


Source: CCID, CSIA

According to the China Semiconductor Industry Association (CSIA) China's IC industry unit production increased by 5% in 2013, and IC dollar unit average selling price (ASP) increased by 13%. Based upon the current reported revenue values, China's IC industry achieved an overall self-sufficiency ratio of about 27% (ratio of production versus consumption values) in 2013, which is a further increase from the 25% reported for 2012 and noticeably higher than the 20% average for the previous nine years since 2003. As noted in prior updates, based upon the CSIA's reported unit volumes, China's IC industry unit self-sufficiency ratio for 2013 might have been much greater if units were valued at worldwide market ASPs.

China's O-S-D industry sector reported significantly better performance in 2013 than worldwide O-S-D performance. Measured in dollars, China's O-S-D sector revenues increased 13.2% in 2013 to a record US$25bn. When measured in local RMB currency, China's O-S-D sector revenues increased by 10.5% and contributed more than 29% to China's total semiconductor industry growth in 2013. Within the sector, China's LED revenues grew by 36% to US$9.2bn, while discrete device revenues only grew by 3% to US$15.7bn. China's reported O-S-D production unit output increased by 11% and ASPs remained relatively unchanged during 2013. Measured in local RMB currency, China's O-S-D industry ASPs have been

Figure 10: China's IC industry revenue and growth, 2000-2013



Source: CCID, CSIA

relatively constant during the ten-year period from 2003 through 2013, decreasing just 0.1%. However, when measured in US dollars those same O-S-D ASPs have increased by almost 32% from 4.1 cents to 5.4 cents. Based upon revenue values, China's reported O-S-D industry achieved self-sufficiency for the fourth consecutive year in 2013, with an overall self-sufficiency ratio of about 110% (ratio of production versus consumption values).

Correspondingly, while the value of China's O-S-D exports exceeded the value of O-S-D imports for the fourth year in a row in 2013, the net export value, which had declined sharply in 2012, remained relatively modest for a second year.

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Interview

S. H. Hong

Vice President
System LSI Business
Samsung Electronics

Samsung is the second largest semiconductor manufacturer in the world and the second largest supplier to the China semiconductor consumption market.

How has China impacted your company over the past 10 years? What is different about your company regarding China?

In the 1990s, Samsung established a memory semiconductor back-end processing company in Suzhou in order to secure cost competitiveness. As the demand for semiconductors in China grew, Samsung further established a sales company and a manufacturing company to meet local demand.

Over the last decade, Samsung's growth has been mainly powered by LSI products (DDI, MCU, MOSFET, etc.). However, with the rapid growth of Chinese smartphone makers in the late 2000s, Samsung has been focusing on expanding the China business by means of developing products—such as Image, Mobile AP, etc.—unique to the needs of the China market.

Today, our main operations for the semiconductor business remain in Korea, while overseas production takes place in both the US and China. The growth rate in China, however, is very high compared to Korea and other countries, but operations of a foreign entitle are heavily regulated by government policies.

How has China impacted the semiconductor industry over the past 10 years? What is different about the industry regarding China?

There is no doubt that China has been the fuel for the growth of worldwide semiconductor market. In the past, China's contribution has mainly been from the supply perspective as the "world's factory". In recent years, however, it has been making a significant contribution as a consumer, with its vast domestic market size.

It can also be said that the most significant influence the China market has had on the semiconductor industry is driving down the average sales price (ASP). Recent market trends seem to indicate that price competitiveness between semiconductor vendors is among the highest in China.

How will China impact the semiconductor industry over the next five to ten years?

It is expected that China will continue to lead the growth of the worldwide semiconductor market for the next 5-10 years. Since the mobile market, represented by smartphones and tablets, will be leading the overall IT and electronics industry, local Chinese manufacturers threatening the Big 2 (Apple, Samsung) are expected to continuously increase their market share. It is also likely that Chinese

companies will again demonstrate strong market presence upon commodification of smartphones and tablets as it did with PC and feature phones.

In addition, there are a number of unique features specific to the Chinese market, design, standards and specifications. For the memory business, low-price smartphones and white label tablets constitute a high portion of the product mix. Consequently, solution products are in a greater demand than unit products are. It is currently in transition from LP2 to LP3. For the System LSI business, small- and medium-sized customers with their own communication standards prefer SoC solution chips to unit products. Turn-key solutions are in demand.

What factors influence, enhance and/or limit China's impact on the semiconductor industry and market?

The following two factors are expected to impact the China market from the consumption/manufacturing perspective:

- In terms of consumption, how quickly will China's domestic market be saturated?
- In terms of manufacturing, how quickly will the "world's factory" relocate to newly booming markets (such as Vietnam, India, etc.) from China?

What challenges and opportunities will China provide your company over the next five to ten years?

The target market for Samsung has been laid out clearly—it is China.

While the China market is a business opportunity for Samsung, competition is becoming more and more intense, with the vast majority of semiconductor companies competing in it. Succeeding in the China market will become less likely unless Samsung secures an absolute advantage and dominates the rapidly growing local Chinese semiconductor companies.

The future of our business hinges on whether we make a breakthrough in China for further growth.

Samsung is establishing what will be the most technically advanced and largest capital invested wafer fab in China (20nm NAND fab in Xi'an).

Why and how did Samsung decide to make this investment?

Requests from our customers were the main reason for our investment in China.

Global manufacturers in China frequently asked for a local supply of semiconductors, and Samsung itself raised concerns over the need to diversify its production base. Currently, electronic products are mostly produced in China, and Samsung is planning to actively support global IT companies in China and Chinese companies through the Xi'an fab.

Samsung chose Xi'an based on its proximity to key customers and the production/research bases of global IT companies. Samsung also expects it will be able to gain access to top level talent through the Xi'an fab. As a strategic location selected for the Western development program administered by the Chinese government, Xi'an has a relatively well-developed industrial infrastructure, including reliable electricity and water supplies, and is considered to have long-term development potential.

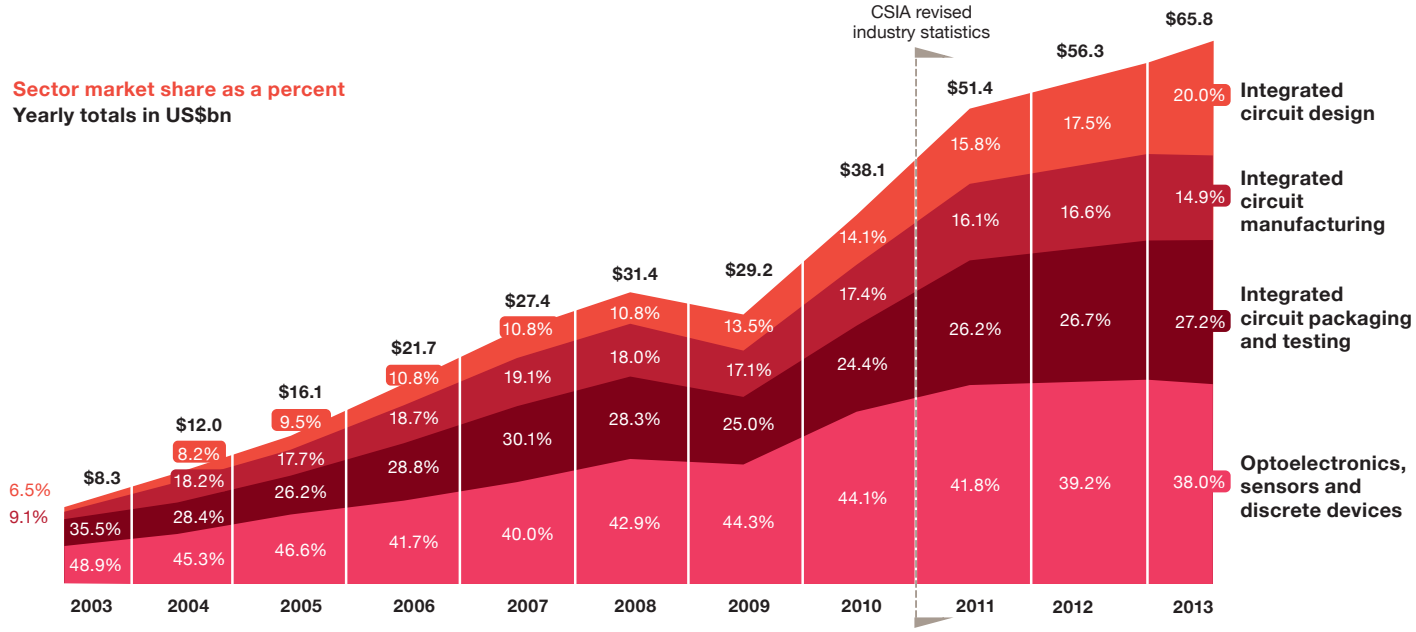
In terms of financing, while Samsung has been operating with capital investment without the use of local borrowing, some portion of the investment in the new fab in Xi'an is financed in China.

Where and how does Samsung plan to get the technologists needed to staff this fab?

One of the reasons Samsung chose Xi'an was its abundant source of labor and talent. Samsung expects that Xi'an will be able to fill the majority of its labor needs. To meet this objective, Samsung is already engaging with local colleges in Xi'an for operation of workforce development programs.

Today, our staff consists mainly of local hires. Secondees from headquarters are kept to the minimum level required to perform essential functions. Our manufacturing and foundry companies have reached over 99% of local hires while our sales companies have achieved an 80% rate for local hires.

Figure 11: China's semiconductor industry by sector 2003–2013



Source: CCID, CSIA

The distribution of China's industry has noticeably changed since our first report. Over the past ten years, from 2003 through 2013, the once very small IC design sector has grown at a 37.6% CAGR, the slightly larger IC manufacturing sector at a 29.2% CAGR, while the much larger O-S-D and IC packaging and testing sectors have only grown at a 20% CAGR. As a result, the IC design sector revenues have grown to exceed those of the IC manufacturing sector by an increasing amount since 2012, reorganizing the sector distribution from largest to smallest share of total industry revenue to the following in 2013:

1.	O-S-D devices	38.0%
2.	IC packaging and testing	27.1%
3.	IC design	20.0%
4.	IC manufacturing	14.9%

Source: PWC, CCID, CSIA

During the ten years for 2003 through 2013 China's three IC industry sectors have grown from 51.5% to 62% of China's total semiconductor industry.

As mentioned in our 2012 Update, we remain concerned that some of the industry and sector yearly and quarterly growth rates for the half decade before 2012 may be questionable because of the CSIA's inexplicable and significant October 2012 revision to the industry statistics for 2011 and 2012 year-to-date. However, we do believe the reported ten-year CAGR for China's semiconductor industry 2003 through 2013 remains reasonably representative.

Integrated circuit and O-S-D consumption production gap and surplus

China's IC consumption/production gap increased again in 2013 to a new record annual high despite all the various government plans and efforts to contain it. This gap is the yearly difference between IC consumption and IC industry revenues. Based upon the most recent CSIA industry statistics, this annual gap grew by a further US$6.6bn (6.5%) in 2013 to reach US$108.2bn. During the ten-year span of our reports on China's semiconductor industry, this gap has grown from US$20.8bn in 2003 to US$108.2bn in 2013 by increasing every year except 2009. Further, depending upon how it is utilized, this reported gap may be understated or misleading for a couple of reasons. As explained in our appendix (available at www.pwc.com/chinasemicon), China's reported industry revenue values include some double counting of the value added by indigenous wafer foundries and/or package and assembly suppliers to the IC design sector revenues. Also, the gap does not adequately represent the difference between IC devices consumed in China versus those produced in China or, more specifically, those produced by indigenous Chinese companies. However, despite those caveats there have been some incremental improvements in the balance between China's IC consumption and production. The ratio of China's IC production revenue to IC consumption has shown some improvement. It had grown with yearly variability from

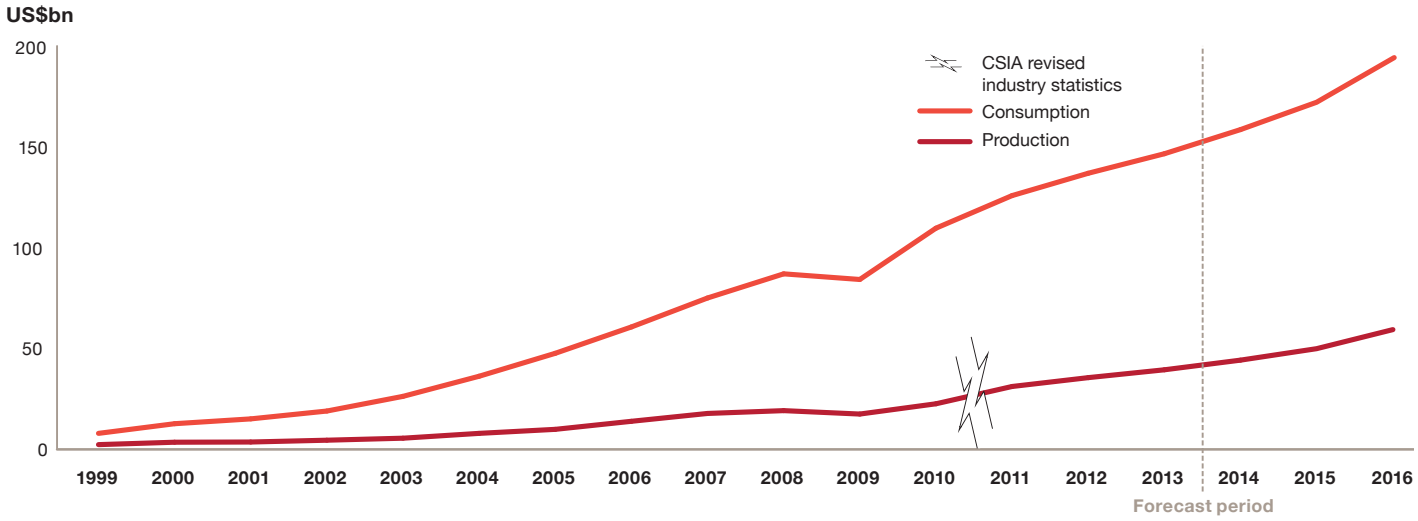
16% in 2001 to a peak of 22% in 2007 before declining slightly to 20% in 2008 and 2010. It is now reported to have grown to 24% in 2011, to 25% in 2012 and further to 27% in 2013. According to CSIA, this ratio is now expected to increase to 32% by 2016, which is up from the 28% they had forecast for 2015 a year ago. However, this will still result in a further increase in China's IC consumption/production gap. According to the CSIA 2014 report, China's IC market is forecast to grow to US$191bn by 2016, with IC industry revenue expected to reach US$61bn. This forecast implies a further widening of China's IC consumption/production gap to US$130bn despite all the Chinese government's plans and efforts to contain it. It is our belief that this gap continues to contribute to the Chinese government's ongoing initiatives to increase indigenous IC production.

According to the CSIA 2014 report, China's IC market is forecast to grow to US$191bn by 2016, with IC industry revenue expected to reach US$61bn.

Over the near term, China's IC consumption/production gap continues to represent an unparalleled market opportunity. But over the longer term, it represents a domestic industry void that will inevitability be filled. The question remains how will it be filled: will it be a combination of transfer and expansion of multinational companies or the emergence and growth of significant Chinese companies?

As discussed in our prior update, the only measure we have of China's O-S-D consumption versus production is an evaluation of what China's defines as their discrete sector which consists of discrete plus LED devices, but not other optoelectronic or sensor devices. This evaluation may be significant because it is so notably different from the IC consumption/production gap. Since 2005 there has not been a significant deficiency between China's reported discrete (including LED) production and consumption values. That difference has gone from a moderate US$374mn (5%) gap in 2005 to a modest surplus in 2008 and 2010 and now to significant surpluses of US$3.3bn (15%), US$ 1.9bn (9%) and US$2.2bn (10%) in 2011, 2012 and 2013. Although China's reported O-S-D sector revenues could be understated by as much as 7% since their reporting protocols do not include optoelectronics other than LEDs and sensors in the sector, that does not significantly change the relative sector growth measurements.

Figure 12: Comparison of China's integrated circuit consumption and production, 1999–2016



Actual annual average FX rates used for 1999-2013, & 2013 average FX rate used for forecast 2014 - 2016.
Source: *CCID, CISA, PwC 2004–2012.*

Interview

John Peng

Senior Vice President
and General Manager
SMIC China Business Unit,
SMIC

Semiconductor Manufacturing International Corporation (SMIC) is a semiconductor foundry headquartered in Shanghai, China. SMIC is currently the largest and most advanced semiconductor foundry in mainland China.

How has China impacted your company over the past 10 years? What is different about your company because of China?

The continuous growth of the Chinese economy has greatly benefited SMIC over the past decade. China has gradually transformed itself from being a labor-intensive manufacturing country to a capital-intensive and value-added one. The demand for new technologies as well as effective and efficient manufacturing processes has increased. Over the years, numerous foreign electronic system vendors and semiconductor IC designers came to China to expand their operations locally and, most importantly, to capture the growing markets in China. Being able to continue to develop and offer needed manufacturing processes enabled SMIC to grow its business with these overseas customers and as their strategic partners in China.

On the other hand, Chinese system and fabless companies have also emerged to compete in both domestic and global sectors. The Chinese government's support policies to nurture China's domestic IC design ecosystem have also greatly benefited SMIC as many local IC designers select SMIC as their preferred foundry partner.

SMIC is an international and independent pure-play foundry with established worldwide offices in China, the US, Europe, Japan and Taiwan. SMIC's main foundry operations are conveniently located in Shanghai, Beijing, Tianjin and Shenzhen in China. With its locations close to major cities and key electronics manufacturing and IC design sites, SMIC has the largest pure-play semiconductor foundry operations in China when compared to other leading foundries. This unique position of being in China enables SMIC to better service both overseas and domestic customers' needs to operate in China.

How has China impacted the semiconductor industry over the past 10 years? What is different about the industry because of China?

China has approximately 1.36 billion citizens, which is close to 19% of the world's population. This represents an enormous market and huge demands for electronics goods; however, not all Chinese consumers could afford high priced electronics in the past. The demand for affordable goods provided great opportunities for local Chinese system vendors and IC designers to develop products and services to satisfy cost sensitive markets. This becomes more significant as the market transitioned from the PC era to the mobile computing era over the past decade. The growth of China's domestic electronic system vendors and IC designers has greatly impacted China's semiconductor industry developments and its position in the global market.

Besides China's large population and the advantage of specific targeted market segments, China has also driven the semiconductor market in its own unique ways through governmental policies that increase the competitiveness of local ecosystems. For instance, governmental policies have driven the growth of IC designers in the Telecommunications and Wireless chipsets (e.g.,TD-SCDMA), smartcards, bank cards, smart metering, etc. Many of these segments were closely related to local policy making and were constructively designed to give Chinese IC designers opportunities or an equal footing to compete against foreign counterparts. On the other hand, governmental funding for electronics and white goods has also driven and helped many local system vendors to open up domestic markets and has indirectly helped local IC designers as well. A series of electronics and white goods replacement programs for metropolitan areas were also designed to drive economic growth and consumer purchases. Moreover, central government programs to fund and to support local IC designers have also stimulated the growth of the domestic semiconductor industry. In short, local and central governmental support has greatly influenced the growth of China's semiconductor industry over the past decade.

Aside from governmental policies, another perspective is that the scale of China's investment in the semiconductor industry has been growing for the past decade.

How will China impact the semiconductor industry over the next five to ten years?

Today in China, there are well over 600 fabless IC designers competing not only for the Chinese market, but also against foreign players in the global market. Right now, we are seeing more integration among Chinese IC designers to better prepare themselves to compete in the global market. Also, we are seeing increasing demands on mobile computing devices, IoT (Internet of Things), automotive electronics and medical devices. China's domestic IC supply is expected to still fall short of meeting its IC demands. Through government funds, various investment programs and loan programs, China is expected to grow its semiconductor industry even further.

What factors influence, enhance, and/or limit China's participation and impact on the semiconductor industry and market?

As system vendors and IC designers continue to be more demanding on technology availabilities and manufacturing capacities, upstream players such as foundry suppliers will need to catch up with the technology developments and offerings that are essential to support the downstream demands. Companies in China need to invest more in R&D capabilities to shorten or to close the technology gap against the industry leaders. Moreover, it is essential for China to have a strong and committed capital investment throughout a long period of time to cultivate the business environment as well as the technology development cycles. More collaboration across local industries and supply chains shall take place to enhance the competitiveness of the domestic ecosystem.

What challenges and opportunities will China represent for your company over the next five to ten years?

There are some anticipated challenges and opportunities for the upcoming decade:

- Developing well-planned roadmaps and matching technologies to capture customers' design window and market demands.
- Investing in talent and technologists in the foundry industry to advance research and development efforts; acquiring more talent and cultivating innovative ideas will be increasingly important.
- Collaborating with local material suppliers, equipment vendors, design and IP services, OSAT (outsourced semiconductor assembly and testing), etc. to strengthen local eco-systems and shorten customers' cycle times.
- With rising environmental challenges, SMIC must continue to tighten its EHS (Environmental, Health and Safety) policies to meet regulation standards and to keep our operations green for environmental protection.

SMIC has been one of China's larger and leading semiconductor manufacturers for several years. How has SMIC contributed to local technology; academic; and R&D development?

SMIC contributes to local technology in many aspects. As one of the leading foundries in the world, SMIC continues to develop advanced technology and offer specialized technology to meet growing customer demands. With SMIC's continuous efforts in technology offerings, domestic IC designers can enjoy the technology availabilities to design and manufacture in China and to compete in the worldwide market. Over the past 10 years, SMIC's revenue from Chinese customers has grown at nearly 34% CAGR from 2004, which is quadruple the pure-play foundry industry's average growth.

Besides our technology competencies and offerings, SMIC has also increased its alliances with domestic equipment and materials vendors to cultivate the local supply chain and ecosystems. Over the past five years, SMIC has greatly increased its equipment purchases with local suppliers, at nearly 56% CAGR in terms of domestic equipment quantities and close to 67% CAGR in terms of equipment dollar values. SMIC also has dedicated engineering teams to collaborate with local equipment vendors and material suppliers to improve the quality of their products and services as well as regularly hosting troubleshooting sessions and developing case studies to resolve actual engineering issues and work together for future solutions. This is part of SMIC's pledge and dedication to be part of the ecosystem and to support the local semiconductor industry.

Moreover, in the academic and research domains, SMIC has been actively establishing and participating in university programs and collaborating with local government programs to both nurture the next generation of talent as well as design future R&D developments and directions. In fact, SMIC actively participates to support China's national projects, to conduct research and development on advanced process technology platforms and modeling and to co-share the successful results and IP developments, and to increase the talent pool with master and PhD educational programs.

Has this status made SMIC a highly preferred employer for new university graduates?

Certainly, for many, SMIC is considered as a leading entity in today's Chinese semiconductor manufacturing ecosystem. We are not only attracting talent domestically, but also gaining more international talent.

Conclusion

This concludes the first section of this year's update. Our next section will cover semiconductor manufacturing in China and will include interviews with executives from NXP and JCET. This will be followed by a third section covering the Greater China market and government incentives and will feature an additional two interviews.

All sections of this year's update and the full report will be available at www.pwc.com/chinasemicon.

PwC can help

If your company is facing challenges doing business in China, or you just want to have a deeper discussion about what's happening in the market and how we can help, please reach out to one of the technology industry leaders listed here.

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The Technology Institute is PwC's global research network that studies the business of technology and the technology of business with the purpose of creating thought leadership that offers both fact-based analysis and experience-based perspectives. Technology Institute insights and viewpoints originate from active collaboration between our professionals across the globe and their first-hand experiences working in and with the technology industry. For more information please contact Raman Chitkara, Global Technology Industry Leader.

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