Technology industry

China's impact on the semiconductor industry: 2009 update

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Welcome

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Global Technology Leader
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Despite phenomenal growth over the last five years, China's semiconductor industry did not prove immune to the downturn of 2008. In fact, this past year marked the first time in China's semiconductor history that it noticeably experienced the impact of a worldwide industry downturn, demonstrating that as China's share of the worldwide semiconductor market has increased so has its dependence on the export market. While the consumption of semiconductors for export products has increased by almost US$50 billion in the past five years, representing 68% of the overall growth of China's semiconductor market, the consumption of semiconductors for domestic products has increased by only US$23 billion.

Because semiconductors play a central role in advancements across the technology industry, PricewaterhouseCoopers developed this series of thought leadership reports, *China's impact on the semiconductor industry*. This is our fourth and most comprehensive update to our original study released in 2004. The 2009 update evaluates the current status of the semiconductor industry in China, assesses geographical and product category demand, reviews shifts in the semiconductor value chain and analyzes three different IC production growth scenarios.

The growth of China's semiconductor market continues to be a major catalyst for change in the industry. Even with the semiconductor downturn, electronic systems manufacturers in China continued to increase their consumption of semiconductors at a rate three to five times the worldwide rate. As a result, China's semiconductor consumption market grew by nearly 17% in 2008 to reach US$104 billion, accounting for more than one third of the worldwide market. China's consumption of semiconductors now exceeds the markets in Japan, North America, Europe and the rest of the world for the fourth consecutive year, making it a key player in the global semiconductor market.

Because of the significance of the China market on both the entire semiconductor sector and the technology industry overall, PwC continues this series of thought leadership reports to help our technology clients respond to market changes and plan their business strategies accordingly. To learn more about PwC's commitment to the industry, visit pwc.com/technology.

If you would like further information, or to discuss any of the findings in our report and how they might impact your business, please do not hesitate to contact me (raman.chitkara@us.pwc.com) or any member of our technology team around the world, listed in the back of this document.

About this report

The 2009 update assesses the current status of the semiconductor industry in China and how it has changed since our previous update. As with our previous reports on this issue, we conducted a second-order analysis for the 2009 update. To accomplish this, first we reconciled data from different, incomplete, and often contradictory reports from various sources. These sources included industry associations as well as third-party research firms located in Asia and the West. We then analyzed the reconciled data with an eye towards filling in gaps and revealing information that was not apparent in the original source material. We also interviewed industry executives to obtain current views from various links of the value chain.

This year we encountered greater differences between various sources in much of the basic data about the semiconductor market and industry in China than in any prior year. Much of this is probably a side effect of the economic crisis of 2008. The impact on China's semiconductor industry was sudden, unexpected, late in the year and significant. It disrupted many of the normal metrics and relationships used to evaluate market and industry performance at a time when year-end performance was being tabulated. In addition, it caused several local industry participants to withhold their reporting to industry associations and analysts of what they considered to be singularly disappointing results. As a result, determining a definitive direction and value for the 2008 China semiconductor market has proven challenging.

Depending on the source, CCID Consulting or CSIA, (the two principal Chinese sources), China's 2008 semiconductor market measured in RMB grew by either 6.7% or 3.8% respectively. In US dollar terms, that's either 16.8% or 13.6% respectively. IC Insights reports the 2008 Chinese IC market measured in dollars grew by 4.7%; while Gartner Dataquest first reported China's semiconductor market measured in dollars grew by 0.8% and later revised that to report China's semiconductor market decreased by 2.9%. Meanwhile, iSupply reported that China's semiconductor market decreased by 5.9% in 2008. Between the various sources the reported size of China's 2008 semiconductor market in US dollar terms varied by as much as 35%, with CCID reporting the largest value and IC Insights the smallest.

For our top level reporting of China's semiconductor consumption market and production industry, we have continued to utilize the values reported by CCID Consulting. Our reasons include (a) they provide the most comprehensive detail about China's market and industry available (b) their reports are the principal source of information for Chinese policymakers and (c) most industry executives we interviewed in China did indeed feel that semiconductor consumption increased in 2008.

For some of our detailed analysis we have utilized alternate sources able to provide information not available elsewhere. Wherever possible, we tried to base each such analysis on a homogeneous data source. For example, for our (1) analysis of China compared with the worldwide semiconductor market by application and by device and (2) of semiconductor consumption versus purchases China versus worldwide by region: we rely on Gartner Dataquest (GDQ), as they provide database information for each of these markets that is reconciled on a worldwide basis. As a

consequence, the value of some metrics may vary slightly between different figures and tables. We acknowledge these differences and trust that they will not divert our readers' attention from the value and significance of the findings of the report.

Our intent with this method remained to construct a more comprehensive, meaningful, and yet quantitatively based picture of the industry than is otherwise available. Using this method, we surfaced additional findings and considered the ramifications for multinational semiconductor industry companies. Then finally, based on this newly developed information, we formulated a current set of recommendations for industry companies.

The growth of China's semiconductor market—which consists primarily of electronics manufacturing services (EMS) companies, original design manufacturers (ODMs) and original equipment manufacturers (OEMs) that consume chips in China—continues to be a major catalyst for change in the industry. For this reason, we assessed the status of the market in depth and considered its effects on semiconductor production: wafer fabs; packaging, assembly and test facilities; and integrated design manufacturers (IDMs) of the industry. We also reviewed the status of the fabless and design companies in China.

Our report also examines the composition of the semiconductor value chain in China, comparing it with the worldwide value chain. As part of that analysis, the report reviews both the demand for semiconductor equipment in the country and the primary equipment suppliers to the market. We then reviewed three production forecast scenarios against actual production and consumption growth realized during the period.

A couple of further points we should note on the data sources. The metrics we used or developed had to be sufficiently comprehensive and consistent to be useful for the type of report we wanted to publish. For that reason we elected to use the World Semiconductor Trade Statistics (WSTS) values for the worldwide semiconductor market wherever possible even though several other market research firms have reported greater values. The WSTS values are the only official values recognized by the various industry associations, including the China Semiconductor Industry Association (CSIA), that are members of the World Semiconductor Council. We also elected to convert the Renminbi (RMB) currency values from various Chinese data sources to US dollar values at the average foreign exchange rate for the year reported on rather than at the year-end rate. Most of the semiconductor transactions in China are originally priced in dollars or other foreign currencies and converted to RMB on a contemporaneous basis for local reporting purposes.

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 remains valid and readers who would like to gain a better understanding of these fundamentals should refer to the original as well as subsequent reports available at www.pwc.com/techcenter.

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Executive summary

PricewaterhouseCoopers began the study series, *China's impact on the semiconductor industry*, in 2004 in response to our clients' interest in the rapid growth of the semiconductor industry in China. Specifically, clients wanted to find out whether China's production volumes would contribute to worldwide overcapacity and a subsequent downturn. Since then it has become clear that market growth in China is far more significant to the worldwide semiconductor industry than the nation's production volumes.

The past year marks the first time in China's semiconductor history that it noticeably experienced the impact of a worldwide industry downturn—an unexpected shock. China had been relatively untouched by the 2001 downturn, as its semiconductor market grew by 18% even as the worldwide market decreased a record 32%. Similarly, its markets grew by about 25% in both 1996 and 1998 in contrast to worldwide market decreases of 9% and 8%.

Probably as a result of this past immunity, most in China's semiconductor industry seemed to be slow to appreciate the significance of the 2008/09 semiconductor downturn. Following a 3% drop in 2008, the worldwide semiconductor industry was expected to decline in the double digits in 2009. Still, China expected positive single-digit growth in 2009 followed by low double-digit growth in 2010 and 2011. Such forecasts seem highly unlikely given that China represented 38% of the worldwide market in 2008 (up from less than 2% prior to 1996). Since then China has reported two quarters of double-digit negative year-on-year market and industry growth. Most in China's semiconductor industry have since recalibrated and now expect an 11% decrease in their 2009 semiconductor market relative to 2008.

Even with the semiconductor downturn, electronic systems manufacturers in China continued to increase their consumption of semiconductors at a rate three to five times the worldwide rate. As a result, China's semiconductor consumption market grew by nearly 17% in 2008 to reach US$104 billion, accounting for more than one third of the worldwide market. China's consumption of semiconductors now exceeds the markets in Japan, North America, Europe and the rest of the world for the fourth consecutive year. After the recovery, China's semiconductor consumption market will continue to grow somewhat faster than the worldwide market and should gain at least a couple of percentage points of market share over the next five years.

The 2008/09 semiconductor downturn demonstrates that as China's share of the worldwide semiconductor market has increased so has its dependence on the export market. During the past five years, since 2003, the consumption of semiconductors for export products has increased by almost US$50 billion, representing 68% of the overall growth of China's semiconductor market. Meanwhile, the consumption of semiconductors for domestic products has increased by US$23 billion.

That may gradually change after the recovery. Suppose that over the next five years, the relative share of domestic versus export consumption increases at the expected GDP growth rates of China versus those of the rest of the world. In that case, China's share of

the semiconductor consumption market used in the production of electronic products for domestic use will increase by seven percentage points to almost 40%. This should further increase the importance of semiconductor companies developing products that meet the unique requirements of China's domestic market. It should also increase the government's focus and efforts to encourage the development of China's IC design (fabless) industry sector and to reduce the use of foreign-owned intellectual property.

The largest suppliers to the Chinese market continue to be the same multinational semiconductor companies. There were no Chinese companies (or brands) among the top 50 suppliers to the Chinese semiconductor market in 2008. Even if the largest Chinese semiconductor companies sold all their 2008 output within China, no Chinese semiconductor company would be among the top 45 suppliers to the Chinese semiconductor market.

At the same time, China's leading OEMs are purchasing a significant and increasing number of semiconductor devices. They could be important customers for many of the international semiconductor companies intending to participate in the continuing growth of the Chinese semiconductor market. Assuming the semiconductor content of their products was 24.7% (the average for all of China's electronic systems production in 2008), these 12 Chinese OEMs could be responsible for semiconductor consumption of US$18.5 billion—equal to 17.8% of China's total semiconductor market.

On the production side, China's semiconductor industry growth was noticeably impacted by the 2008/09 semiconductor downturn, suffering a double-digit decline in the fourth quarter. Still, China's semiconductor industry's share of the worldwide industry continued to grow, accounting for 11% of worldwide production in 2008 (becoming both noticeable and significant). As was the case for the prior two years, much of this increase came from multinational rather than local domestic semiconductor companies. China's semiconductor industry remains much more heavily concentrated in OSD (optoelectronics, sensors, discretes) and IC packaging and testing than IC wafer manufacturing and IC design.

When and as the recovery from the 2008/09 semiconductor downturn is realized, it is expected that China's electronic systems production will continue to grow at a greater rate than worldwide production. The transfer of electronic systems production to China is forecast to continue through the next business cycle, although probably at a slower rate. It will continue as a result of: (a) further worldwide industry cost and market driven restructuring; (b) China's very competitive support infrastructure; (c) China's longer term economic stimulus programs and (d) China's growing domestic market demand. As a result, China's semiconductor consumption market will continue to grow somewhat faster than the worldwide market and should gain at least a couple of percentage points of market share over the next five years. An increasing share of this market will come from domestic consumption.

The post-downturn recovery of China's semiconductor industry will be diverse, varying by sector as each reacts differently to market and economic forces. During the next five years, China's IC design (fabless) sector will be strongly driven by China's semiconductor consumption market and especially China's domestic consumption. There will be sector consolidation as well as continued government incentive support for new entrants and successful survivors. Therefore we expect this sector to continue to grow faster than the other sectors of China's semiconductor industry and faster than China's consumption market.

China's OSD sector has a much larger share of both the China and the worldwide OSD market and industry than any other sector. Therefore its growth will be driven by the growth of both markets as well as by the continuation of the trend for multinational semiconductor companies to transfer OSD manufacture to Chinese subsidiaries or manufacturers on a rebranding basis. Over the next five years, we expect that China's OSD industry will grow somewhat faster than the worldwide OSD industry—but slightly slower than China's OSD consumption market.

China's IC packaging and testing sector will continue to be more affected by the worldwide semiconductor market than the local market. Most of the sector's capacity is owned and controlled by multinational semiconductor or SATS companies with similar facilities in several regions. If the Chinese government continues to provide competitive incentives, there is a logical reason to expect China's IC packaging and testing industry to grow faster than China's IC consumption market and to increase by at least 60% over the next five years.

More than anything else, the post-downturn growth of China's IC manufacturing sector will be determined by the availability and relative cost of investment capital. Almost all of the sector revenue is produced by foundry and IDM wafer fabrication facilities. Increasing wafer fabrication capacity is very capital intensive. The Chinese government has provided some very innovative investment funding (through separate provincial agencies) for China's largest foundries, but those foundries have yet to earn an attractive return to support further expansion.

The multinational IDMs have the appropriate technology and two have made significant investments in China's IC manufacturing sector. The first had a significant impact on that sector's revenue growth during the past two years; the other will start production next year and is expected to have a similar impact during the following two years.

However, there is a finite and decreasing number of such IDMs, along with intense competition between different locations to attract their next wafer fab capacity investment. Whether another IDM is attracted to invest in a major wafer fabrication plant in China will be determined by relative success of the first IDMs and the availability of attractive investment incentives. While that is a reasonable possibility, it may be several years before it has an impact on China's IC manufacturing sector. Therefore we expect that over the next five years China's IC manufacturing sector will grow along the lines of our moderate scenario, increasing by about 60%.

Findings

The following is a summary of our findings for this 2009 update. These conclusions reflect secondary research, interviews with industry executives and our own analysis.

The impact of the 2008/09 semiconductor downturn on China's semiconductor consumption measured in year-over-year percent change has been later and less severe than on the worldwide market. This is especially noticeable when measured in US dollars. The impact on China's semiconductor industry, which was somewhat later and less severe during the last two quarters of 2008, has since become as severe as that of the rest on the worldwide industry.

China continued to outperform the global semiconductor market in 2008. China's semiconductor consumption market grew from US$89 billion in 2007 to US $104 billion in 2008, an increase of nearly 17%, while the worldwide market decreased by 2.8%. Since 2001, the bottom of the last semiconductor business cycle, China's semiconductor consumption has grown at a 29.5% compounded annual growth rate (CAGR), while total worldwide consumption has grown at only an 8.6% CAGR.

China's semiconductor industry production revenues grew from US$27 billion in 2007 to US$31 billion in 2008, an increase of over 14%. As reported in US dollars, these account for about 11% of the worldwide industry. However when reported in RMB, China's semiconductor industry production revenues grew by less than 5%. Although still positive, this was China's lowest reported semiconductor industry growth rate since 2001. China's industry growth peaked in 2004, with a growth rate of 45% and has gradually declined since—with 2008 being the first year with a single-digit growth rate.

China's semiconductor performance has been noticeably impacted by currency exchange rate changes. Almost 10 percentage points of the 2008 increases were due to China's further revaluation of its currency. As reported in local currency, China's semiconductor market grew slightly less than 7%. Meanwhile, China's semiconductor industry grew slightly less than 5% in 2008. Of note, the OSD industry sector grew at 12%, offsetting a slight decrease (under 1%) in the IC industry sector.

The growth rate of China's semiconductor consumption market has been decelerating for the last four years. The immediate cause of this decline is attributed to the worldwide economic crisis and the decline in transfer of electronic equipment production to China. In the longer term, China's semiconductor market has passed through its high-speed development period. Its future growth is likely to be closer to the worldwide growth rate as it represents an increasingly larger share of the worldwide market.

Two of China's stimulus programs are being credited with having an immediate and noticeable impact on recovery from the 2008/09 semiconductor downturn. The countryside home appliance policy or "Electronics Go to Farmers Subsidy Program" was started on a trial basis in three provinces in 2007 and extended to a nationwide program on February 1, 2009. The program will last four years, until 2012, and is expected to drive the sale of 600

million home appliances. This translates into 1.6 trillion RMB (US$230 billion) in sales revenue and US$50 billion in semiconductor consumption.

A second initiative, the "Home Appliance Replacement Subsidy Program", was announced in May 2009. This was officially launched in five trial cities (Beijing, Shanghai, Tianjin, Fuzhou and Changsha) and four provinces (Jiangsu, Zhejiang, Shandong and Guangdong) in July 2009. This program could result in an additional US$600 million in semiconductor consumption in 2009.

On a longer term basis, the Chinese government's four trillion RMB (US$586 billion) stimulus programs also target railroad and air transportation, telecom networks, rural improvements and healthcare reform. These have the potential for an even greater impact on the recovery from the 2008/09 semiconductor downturn. They will, meanwhile, need huge investments in advanced technology and should stimulate demand for semiconductor-enabled products such as computers, servers and mobile devices for the world's largest population. There appears to be a strategic opportunity for major multinational semiconductor companies to team with appropriate government agencies in addressing these needs.

Integrated circuit (IC) design was the only segment of the China's IC industry to achieve positive growth in 2008. Its dollar revenues grew by 14.1% in 2008 despite a 2.8% decline in the worldwide semiconductor market. As such, IC design remained the fastest growing segment of China's semiconductor industry for this decade. IC design revenues grew from US$178 million in 2001 to US$3.4 billion in 2008, a CAGR of just over 52%. Most of the revenue in this sector can be attributed to China's fabless semiconductor companies, which in 2008 constituted about 6% of the US$55 billion worldwide fabless semiconductor industry. Much of the relative resilience of China's IC design sector during the 2008 semiconductor industry downturn has been contributed by those fabless firms that have concentrated on designing for China's growing domestic market.

One consequence of the 2008 semiconductor industry downturn was the second largest annual increase in China's IC consumption/production gap—the difference between IC consumption and IC industry revenues. The downturn had a greater negative impact on China's IC industry revenue in the third and fourth quarter of 2008 than it did on China's IC market. China's annual IC consumption increased 16%, or US$12 billion, while IC production increased only 9%, or US$1.4 billion. Consequently, China's IC consumption/production gap increased by US$10.5 billion to reach US$68 billion for 2008. This gap continues to increase despite all of the Chinese government's plans and efforts to contain it. This annual gap has now grown from US$5.7 billion in 2004 to a record US$68 billion in 2008 and the Chinese authorities expect that it will continue to increase through at least 2011.

It now appears that not all wafer fabs under construction in China will be completed. Moreover, not all of those starting production will be fully equipped and ramped to full production—at least not in a timely manner. The investment requirements for large, leading-edge plants have increased significantly. Meanwhile, investment sources have dried up. So physical plants are being

initially built as lower cost shells with individual modules completed only on an as-needed or as-financed basis. The fact is that equipment investment requirements are three to four times those of plant investment requirements. So investments are being limited to advancing technology capabilities rather than increasing capacity. Note: China continues to lag in wafer fabrication technology by more than two years.

Though the Greater China (China, Hong Kong and Taiwan) semiconductor market grew 8% in 2008, Taiwan's fell by 16%. The combined market reached US$113 billion, constituting almost 44% of the worldwide market. And while China, Hong Kong and Taiwan exhibit a high level of interdependence and interaction, Taiwan's semiconductor consumption market declined by 16% in 2008 to US$9.3 billion. Meanwhile, China's market grew by 17% to US$104 billion. The difference between the two markets reflects the continued and sustained transfer (or off-shoring) of worldwide electronics equipment production to China from other locations including Taiwan. As a result, China's consumption of semiconductors has grown to more than ten times that of Taiwan in 2008.

The semiconductor downturn altered or suspended the capacity expansion of many semiconductor companies in Greater China rather abruptly during the later half of 2008. Based upon all the wafer fabs in production by Q4 2008, Greater China could have 28% of total worldwide fab capacity if and when these fabs are all fully-equipped and ramped-up to full production. This is an increase from Greater China's potential of 25% of worldwide capacity at the end of 2007 and would represent 71% of worldwide pure-play foundry capacity, 31% of 300mm capacity, 30% of </= 0.12µm capacity and 30% of advanced </= 80nm capacity.

Recommendations

The following recommendations are intended to provide general guidance based upon our current findings. Issues addressed by this series include investment, intellectual property protection, risk assessment and contingency planning. Several recommendations are unchanged from prior reports while others are new or updated.

Participate in consumer stimulus programs. In particular, look for ways to benefit from China's "Electronics Go to the Farmers" and "Home Appliance Replacement Subsidy" programs. Work with qualified OEM suppliers and design or modify products to provide features that best serve these markets. Doing so will not only provide near-term revenue opportunities but will also provide valuable experience and relationships for participating in China's long-term growing domestic consumer electronics market.

Participate in China's infrastructure stimulus programs. China is spending over 4 trillion RMB (US$586 billion) in economic stimulus programs that cover railroad and air transportation, telecom networks, rural improvements and healthcare reform. These programs will need huge investments in advanced technology. Semiconductor companies should team with Chinese government agencies to address how to plan, develop and provide the required advanced technology support.

Reassess company presence. China's semiconductor consumption market is weathering the 2008/09 semiconductor downturn better than any other regional market. It is doing so at the expense of semiconductor consumption in other countries. This favorable preferential difference is expected to continue through the next semiconductor business cycle driven in part by China's rapid urbanization, increasing consumer consumption and green energy initiatives. In addition, many new opportunities for serving the worldwide market are emerging from inside China. Consequently, companies whose benchmarking reveals their China presence is less than that of their peers need to ramp up their business development efforts.

Design for the marketplace. China has become the largest site for low-cost consumer electronic system production and therefore is the largest user of low-ASP analog and standard logic devices. This includes a large number of white label products. Companies should design products that meet the specific requirements of this market.

Adapt to China's unique standards. China continues to propose alternate and unique standards which, if successful, may provide more desirable and effective solutions for specific developing-country environments that have large potential markets. Consequently, companies should monitor evolving Chinese standards keeping an eye out for emerging opportunities.

Explore acquisition or partnering opportunities. The majority of domestic design companies are small, with many under severe strain from the downturn. Moreover, many are focused on domestic opportunities that foreign companies tend to overlook. Multinational design companies can bring considerable local market intelligence and relationships to bear on Chinese market initiatives. In general, multinational companies should consider acquisition or partnership opportunities with Chinese design companies as a strategy to address the local market.

Move mature products to China. Companies should consider transferring mature product lines to China. This can extend the competitiveness of those lines as well as free up scarce capacity and resources. First movers are using this strategy successfully.

Re-brand for mature markets. Companies may find they can expand a product line by re-branding products for the Chinese and other markets. A local enterprise can even be used to manage the development effort. First movers are also using this strategy successfully.

Keep an eye on local competition. Continuously monitor the efforts of local EMS and ODM enterprises to gain control over their BOM (bill-of-material) sourcing. Their success could lead to the OEM qualification of local competitors and displacement of multinational suppliers.

Preempt discrete competition. Chinese companies continue to compete most effectively in the discrete area. As such, they could be gaining the scale, qualifications and recognition necessary to grow into potential worldwide competitors or to extend into the commodity analog area. So, leading discrete device companies should consider preempting these market share losses by participating actively in the Chinese market.

Adapt to China's "dislocated" buying structure. More than 40% of the semiconductors consumed in China in 2008 continued to be purchased outside of China. Suppliers need a team effort with design-in, qualification and purchasing focus at the OEM location *outside* China coordinated with application and supply chain focus at the manufacturing locations *in* China to ensure success.

Use Chinese foundries to gain pricing leverage while assuring future capacity. It is likely that the next semiconductor cycle will bring a foundry capacity shortage as a result of current downturn-driven reductions in capital spending and accelerating IDM shift to the fab-lite business model. With their preponderance of 150mm and 200mm wafer fabrication facilities, local foundries may provide an immediate lower cost alternative and assured future supply source for some product categories.

Adapt to the new Corporate Income Tax and other business laws. Companies with operations in China should carefully examine and monitor their business strategy, model and structure in light of China's new Corporate Income Tax and other business laws and related incentive programs. Recent entrants, for example, have seen reductions in expected incentives, while many current companies have been able to qualify for incentives that seemed to favor R&D, design and foundry operations.

Promote participation in global and local industry forums. Encourage the China Semiconductor Industry Association (CSIA) and its member companies to participate in the World Semiconductor Trade Statistics (WSTS) and Semiconductor International Capacity Statistics (SICAS) programs. Encourage local subsidiaries of all multinational semiconductor companies to participate in CSIA and CCID statistics programs. Their participation in these industry-wide statistic programs would contribute to a better and more accurate understanding of China's

semiconductor market and industry and their capabilities and contributions to the worldwide industry totals, which would benefit the entire industry as well as themselves.

Keep an eye on Greater China. It is almost certain that Taiwan will further loosen its restrictions on semiconductor investments in China and Chinese investments in Taiwan. Taiwan-based companies have already increased their presence in China, and the supply chain has started to follow suit. So companies should monitor the status of Taiwan and the Taiwan/China relationship with an eye toward new market opportunities and risks in Greater China.

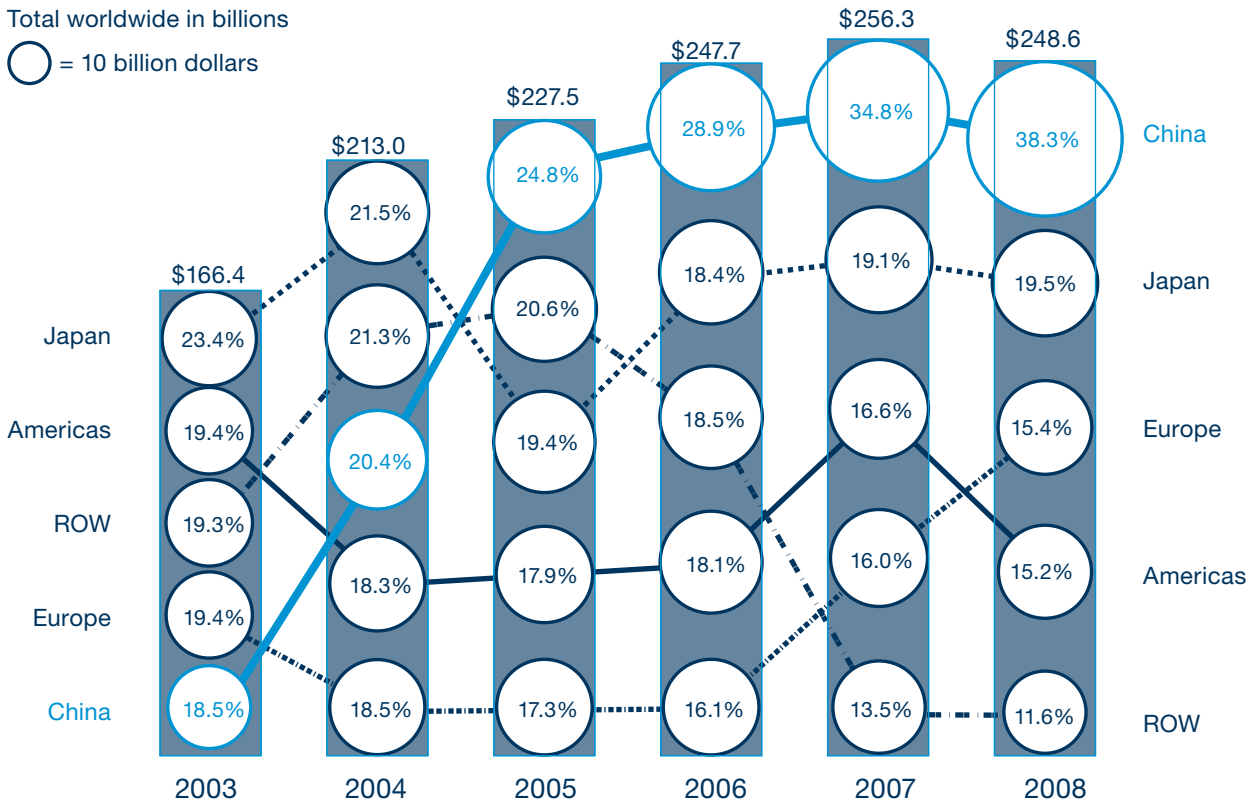
Diversify—globally. Companies should at all times keep tabs on global production and consumption trends. For example, there is always a need to diversify manufacturing by location to reduce risk. Trends to watch: greater China had 22% of all new fabs, but 62% of all fab capacity under construction in 2008.

The semiconductor market in China

Overall consumption

China continued to outperform the global semiconductor market in 2008. In fact, in spite of an overall global economic downturn, China's semiconductor consumption market grew from US$88.1 billion in 2007 to US$104 billion in 2008. This is an increase of nearly 17%, taking place even as worldwide consumption decreased by 2.8%.

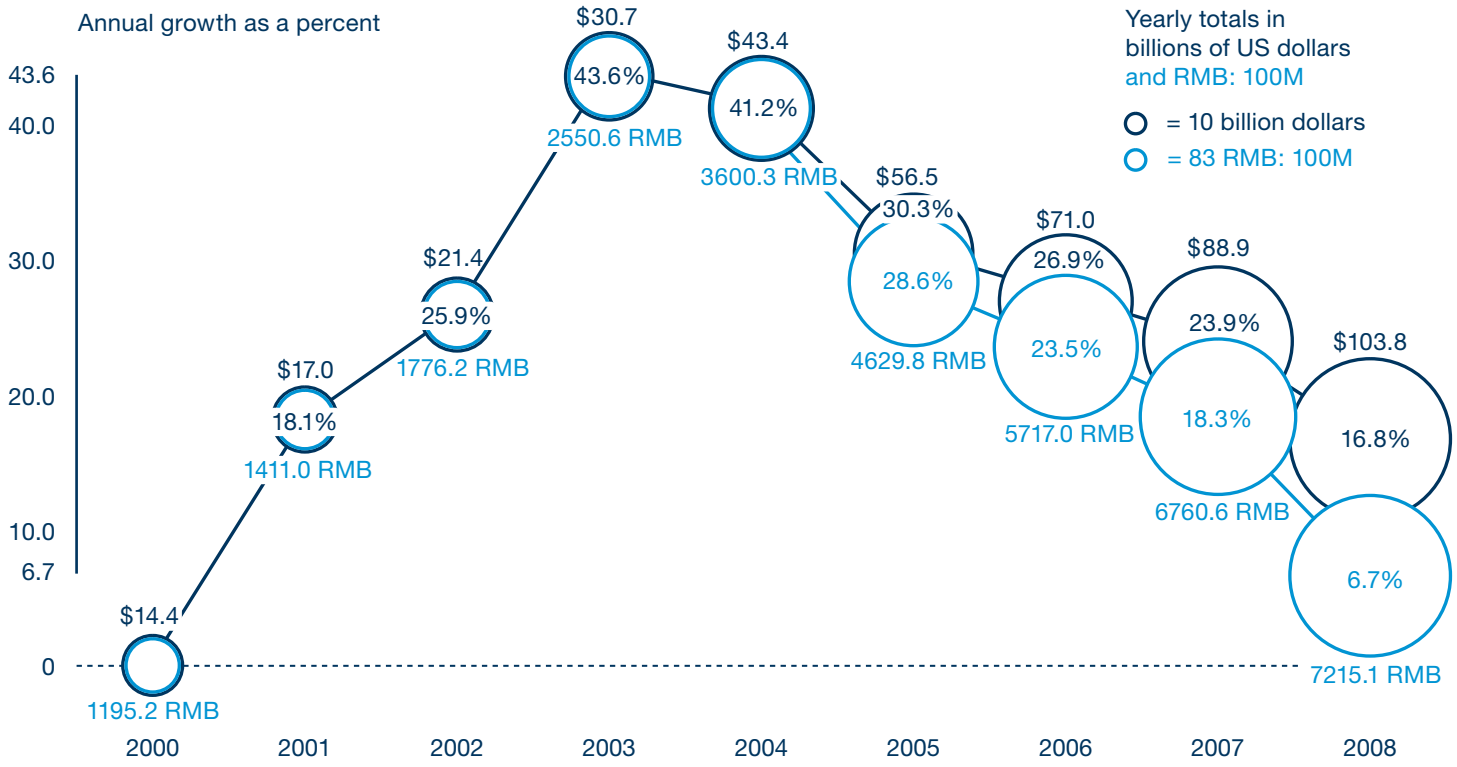
Figure 1: Worldwide semiconductor market by region, 2003–2008



Source: SIA, CCID

This growth occurred at the expense of decreases in market share by all other regions with the exception of Japan. As a result, China now represents 38% of the total 2008 worldwide semiconductor consumption market.

Figure 2: China's semiconductor market growth, 2000–2008



Source: CCID, CSIA

Measured in US dollars, China's semiconductor market and industry growth in 2008 was noticeably better than that of the total worldwide semiconductor industry. However, almost 10% of the increases in both instances were due to China's further revaluation of its currency. Reported in Renminbi (RMB), China's domestic currency, in 2008 China's semiconductor consumption market grew slightly less than 7%, while its overall semiconductor industry expanded slightly less than 5%. And while the integrated circuit (IC) industry sector declined by 1%, this was more than offset by a 12% increase in the OSD industry sector.

Throughout the seven years of this semiconductor business cycle, China's consumption growth has continuously outpaced the rest of the world. Since 2001, the bottom of the last semiconductor business cycle, China's semiconductor consumption has grown at a 29.5% CAGR compared to total worldwide consumption growth of only 8.6%.

Two factors drive this growth differential:

1. Growth in electronic equipment production. The rest of the world is transferring its electronic equipment production to China. During 2008 China's electronic equipment production value grew by 5.6% while worldwide production decreased by 0.3% and, as a result, China's share of worldwide electronic equipment production increased from 27.1% in 2007 to 28.7% in 2008.
2. Growth in semiconductor content. Another driver is that electronic equipment produced in China tends to have an above-average semiconductor content. In fact, semiconductor content of the electronic equipment produced in China averaged 25% in 2008. This compares to a worldwide average of 19%, a decrease from 20% in 2007.

A slowing growth rate

Though still growing fast, the pace of growth of China's semiconductor consumption market has been decelerating for the last four years. Measured in US dollars, growth reached a peak of 41.2% in 2004. Growth then slowed to 30.3%, 26.9% and 23.3% in the following three years and now, for 2008, is registering a still-healthy 16.8%.

But measured in local Chinese currency (RMB), the decline in growth is more severe, decreasing from a peak of 41.2% in 2004 through 28.6%, 23.5% and 18.3% in the following three years to only 6.7% in 2008. In fact, as the Chinese record events, 2008 is the first year their semiconductor consumption market declined to single-digit growth since the early 1990s.

The immediate cause of this decline is attributed to the worldwide economic crisis and the decline in the pace of the transfer of electronic equipment production to China. For the longer term, the realization is that China's semiconductor market is maturing. The nation has moved beyond its high-speed development period. As such, future growth for China will likely be closer to the worldwide growth rate.

As for the global semiconductor market, forecasts see double-digit declines in 2009. But while the Chinese at the start of 2009 forecasted a further decline in their semiconductor market growth, they expected it to achieve low but still single-digit growth in 2009—to be followed by low double-digit growth in 2010 and 2011.

Apparently, they expected a repeat of the semiconductor market performance of 2001, when China's market grew 18% while the global market decreased by a record 32%. But such a scenario is very unlikely now that China represents more than 38% of the global semiconductor market compared to only 7% of the market in 2000. Further, the Asia-Pacific market, of which China is the majority participant, has reported additional declines of 26.5% and 15.7% for the first two quarters of 2009 relative to the same quarters in 2008. As a result, the Chinese have since recalibrated and are expecting an 11% year-on-year decrease in their 2009 Chinese semiconductor market.

The global semiconductor downturn

Although interrelated, it is important to distinguish between the current global recession and the 2008/09 semiconductor downturn. The global recession was a sudden and relatively unexpected financial crises brought about by the collapse of the housing market and the worldwide banking industry.

Meanwhile, the 2008/09 semiconductor downturn was an inevitable result of the semiconductor industry's aggressive capital spending and significant capacity additions during the 2004–2006 time period. While the global recession impacted the timing, sharpness and magnitude of the 2008/09 semiconductor downturn, it was by no means the sole or even primary cause of the downturn.

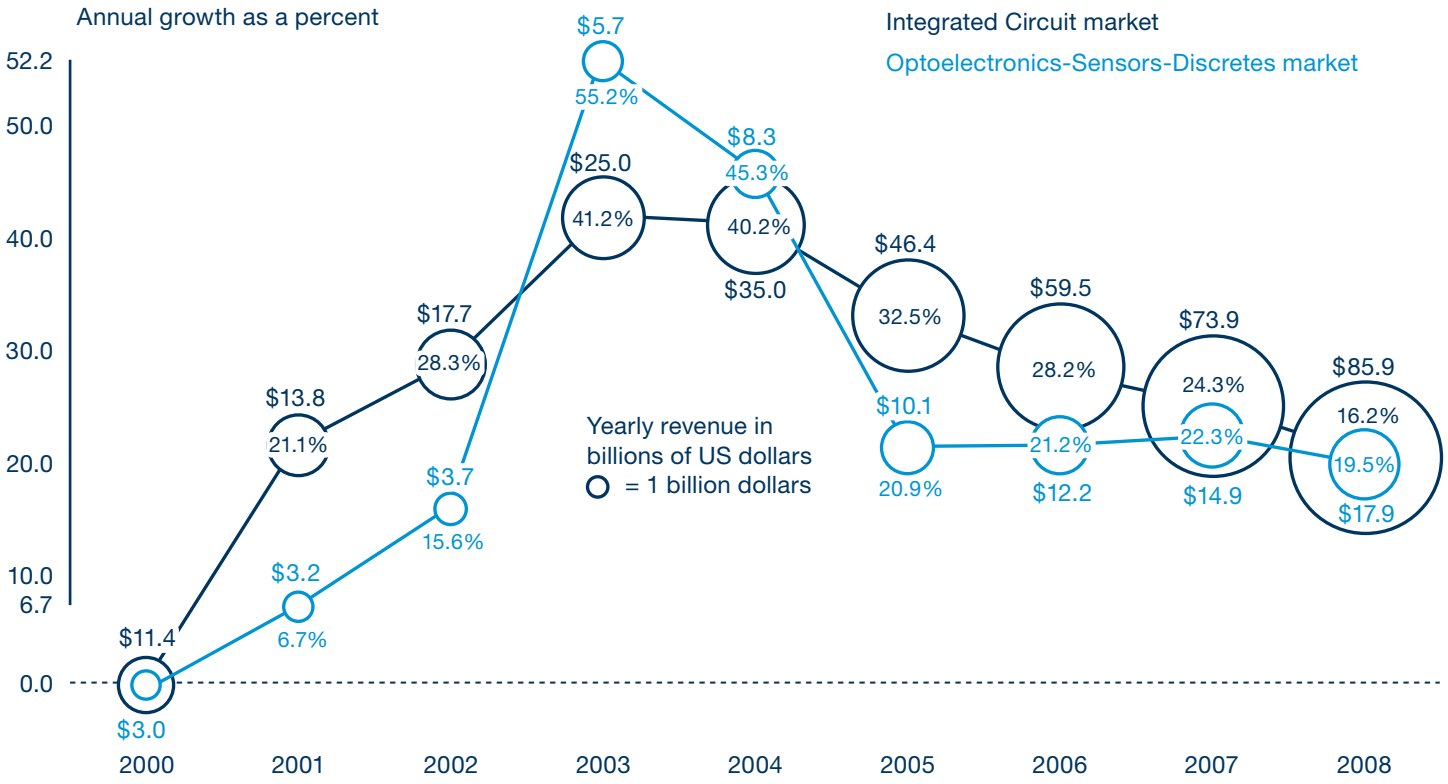
History is being repeated in yet another replay of the industry's eight stage, five- to seven-year business cycle. Supply is again exceeding demand, leading to price softening and weak markets. Although the severity is much greater than expected, driven by the broader economic downturn, this semiconductor slide had been forecast at least a year and a half in advance.

Now the emerging concern is that because of the extreme cut back in industry capital investment and the retirement of less efficient industry capacity, there is a growing possibility that recovery—when it comes—will lead to a time of capacity-constrained supply.

The market for OSD and IC

China's OSD consumption market grew 19.5% in 2008 to reach a new peak of US$17.9 billion, representing 40% of the worldwide market. While sensors are the smallest segment of this market at US$1.8 billion, they are also the fastest growing at 29%. Optoelectronics are the middle segment, at US$6.0 billion, with a growth rate of 18% in 2008. Discrete is the largest segment at US$10.1 billion—and growing at a healthy 19% rate.

Figure 3: China's IC and OSD market growth, 2000–2008



Source: CCID, CSIA

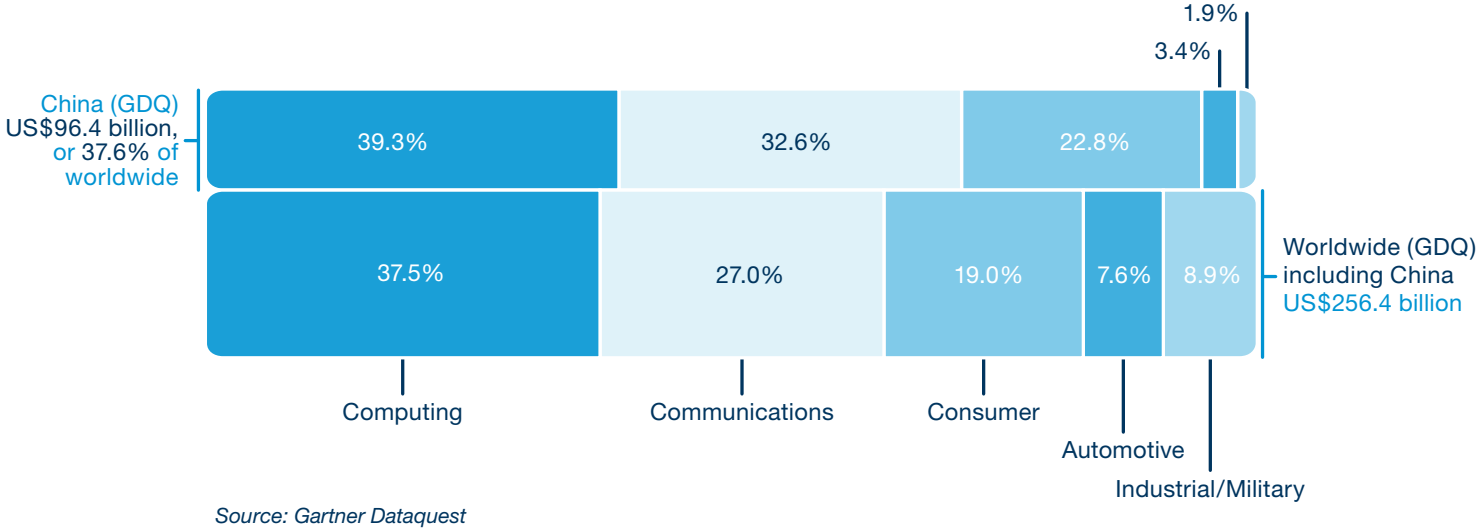
At 17.2%, China's OSD market represents a slightly larger share of its total semiconductor market than the worldwide average of about 16%. This relative difference is expected to increase further, with China's OSD market forecast to grow to represent 19.5% of its total semiconductor market by 2011 versus a worldwide average of about 17%.

China's IC consumption market grew 16.2% in 2008 to reach a new peak of US$85.9 billion, 38% of the worldwide market. In nominal terms, China's IC consumption, measured in US dollars, grew by about US$12 billion compared to a worldwide IC market decrease of at least US$7 billion. This infers that, in absolute value, China's IC consumption market grew during 2008 by displacing almost 9% of worldwide IC consumption from other regions. This is the second consecutive year that China's IC consumption has grown at the expense of displacing IC markets in other regions and represents a noticeable impact on the industry. Similarly, this is the third time China's OSD consumption market growth has displaced consumption in other regions, first in 2005 and then again in 2007 and 2008.

Market by application

Compared with the worldwide semiconductor market, the distribution of China's 2008 semiconductor consumption continued to be somewhat more concentrated in the communications and consumer sectors, slightly more concentrated in the computing sector and relatively less concentrated in the automotive and industrial/military sectors.

Figure 4: China compared with worldwide semiconductor market by application, 2008



Source: Gartner Dataquest

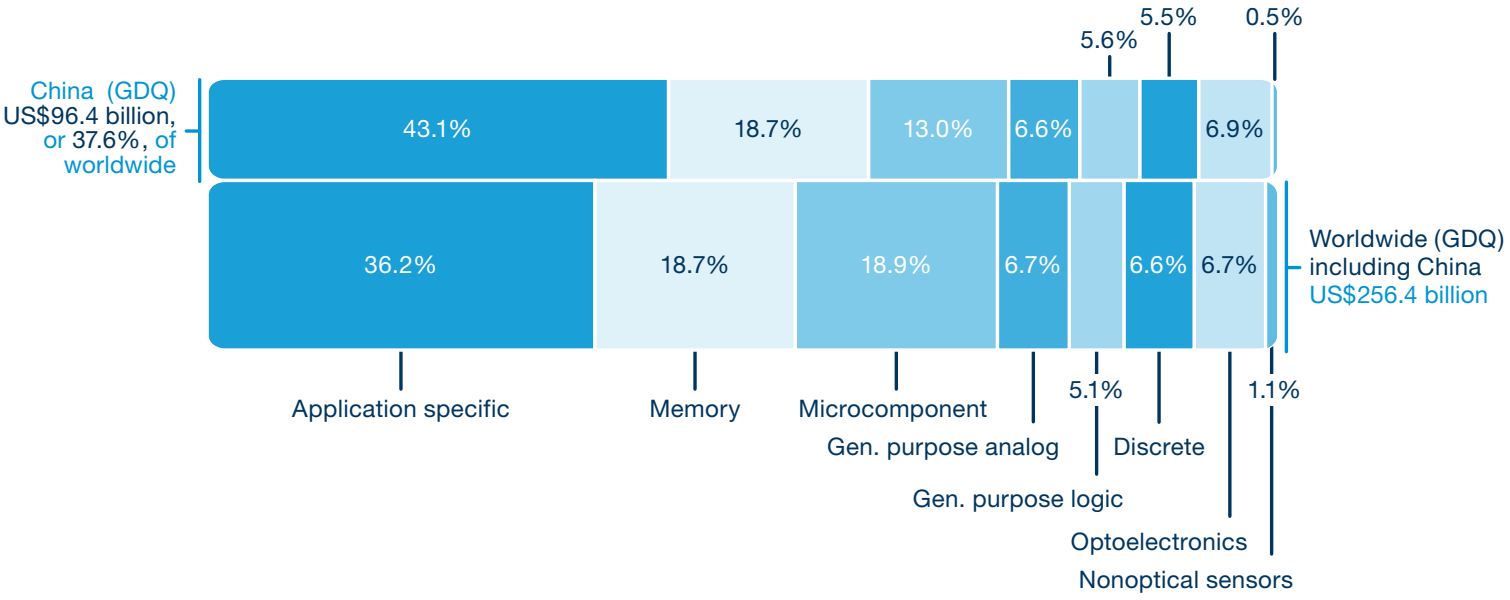
The share of China's semiconductor market consumed by the communications sector in 2008 increased by almost 6%. Meanwhile, the shares consumed by the consumer and computing sectors decreased by about 3% each.

During the last five years, since 2003, China's consumption of semiconductors for communications applications has grown at a 30% CAGR, while consumption for computing and consumer applications has grown at 24% and 25% respectively. China's consumption of semiconductors for industrial/ military applications is smaller, but has grown at the fastest rate of 36%, followed by automotive applications at 32% CAGR.

Market by device type

China's semiconductor consumption market in 2008 became even more concentrated in the application-specific integrated circuit sector than the worldwide market. At the same time, it was noticeably less concentrated in the microcomponent and slightly less concentrated in the discrete sectors.

Figure 5: China compared with worldwide semiconductor market by device, 2008



Source: Gartner Dataquest

The share of China's semiconductor market filled by application-specific devices in 2008 increased by 3%, while the share filled by memory decreased by 3%. Meanwhile, there were fractional share decreases in general purpose analog, logic and discrete devices offset by a modest 1% share increase in optoelectronic devices.

During the last five years, since 2003, nonoptical sensors, the smallest device sector of China's semiconductor market, was the fastest growing, increasing at a 66% CAGR. Application-specific was the next fastest growing sector at 29%, followed by optoelectronic at 28% CAGR. General purpose logic and discrete sectors experienced slower growth at about 20% CAGR, while all remaining sectors grew at about 27%.

Suppliers to the Chinese market

Major global semiconductor companies continue to dominate the Chinese market. Table 1 lists the suppliers with the largest sales revenue from the Chinese market in 2008.

This year, China's consumption of semiconductor products from these largest suppliers increased by 15.6% measured in dollars and by 5.7% measured in RMB. While this is about 1% less than the growth of the overall market in China, the impact for these top 10 suppliers is still positive, particularly in a year when total worldwide consumption of their products in dollar terms fell 9.6%. Together these 10 largest suppliers had more than a 42% share of the Chinese market in 2008, down fractionally from the almost 43% share they had maintained for the four preceding years.

The Chinese semiconductor market continues to be slightly less concentrated than the worldwide market. The top 10 suppliers to the worldwide market have had a very gradually declining share, ranging from 50% in 2004 to 47% in 2007 and 46% in 2008. It still appears that the shift of worldwide semiconductor consumption to China may be contributing to a gradual decrease in worldwide supplier concentration.

Although Gartner Dataquest stopped reporting market share data by country in 2008, it still appears that there is no Chinese company within the top 50 suppliers to the Chinese semiconductor market. Even if the largest Chinese semiconductor company sold all of their output within China, no Chinese semiconductor company would be among the top 45 suppliers to the Chinese semiconductor market in 2008.

Table 1: Semiconductor suppliers to the Chinese market 2007–2008

Rank			Revenue in millions of US dollars			Market share
2007	2008	Company	2007	2008	% change	%
1	1	Intel	12,737	15,585	22.4	15.0
2	2	Samsung	4,730	5,239	10.8	5.0
3	3	Hynix	3,479	3,461	-0.5	3.3
4	4	TI	2,978	3,363	12.9	3.2
6	5	Toshiba	2,958	3,305	11.7	3.2
5	6	AMD	2,731	3,230	18.3	3.1
7	7	ST	2,365	2,908	22.9	2.8
8	8	NXP	2,445	2,602	6.4	2.5
9	9	Freescale	1,998	2,305	15.3	2.2
10	10	Micron (MTK)	1,549	1,912	23.5	1.8
Total top 10			37,971	43,909	15.6	
Total top 10 share of:						
Chineses integrated circuit market			51.4%	51.1%		
Chinese semiconductor market			42.7%	42.3%		

Source: CCID Review and Forecast of China Semiconductor Market, 2009

Since China represents more than a third of the worldwide semiconductor market, it should not be surprising that many of the same companies are the largest suppliers to both the Chinese and worldwide markets. Six of ten companies were the largest suppliers to both markets in 2008, down from eight of ten in 2007. Meanwhile, Advanced Micro Devices (AMD), Freescale Semiconductor, Micron Technology (MTK) and NSP, though making the top 10 in China, are not among the top 10 largest suppliers worldwide. Conversely, Infineon Technologies (incl. Qimonda), Renesas Technology, Qualcomm and NEC Electronics, though among the top 10 suppliers worldwide, are not among the 10 largest suppliers to the Chinese.

Domestic consumption and the Chinese export market

The Chinese semiconductor consumption market is comprised of two distinct segments: the domestic market and the much larger export market. The share of semiconductors consumed in China that were used in components of finished products assembled in China and exported for sale in other countries declined slightly to 68% in 2008. That share had risen for the prior three years from 64% in 2005, to 66% in 2006 and 69% in 2007.

Table 2: Chinese semiconductor exports by segment, 2007–2008 (in billions of US dollars)

	Total sales		Export sales			
Market segment	2007	2008	2007	% of total	2008	% of total
Data processing	36.4	37.9	22.2	61	23.9	63
Communications	23.5	31.4	16.9	72	22	70
Consumer	22.8	22.0	18.9	83	17.8	81
Automotive	2.7	3.3	0.7	25	0.9	28
Industrial		1.6			0.6	37
Mil/Aero		0.2				15
Totals	85.4	96.4	58.7	68.8	65.2	67.7

Source: Gartner Dataquest, PricewaterhouseCoopers, 2009

The export market consumption of semiconductors has been the major contributor to the growth of China's semiconductor market. During the past five years, since 2003, the consumption of semiconductors for export products has increased by almost US$50 billion, constituting 68% of the overall growth of China's semiconductor market. By comparison, the consumption of semiconductor for domestic products has increased by US$23 billion.

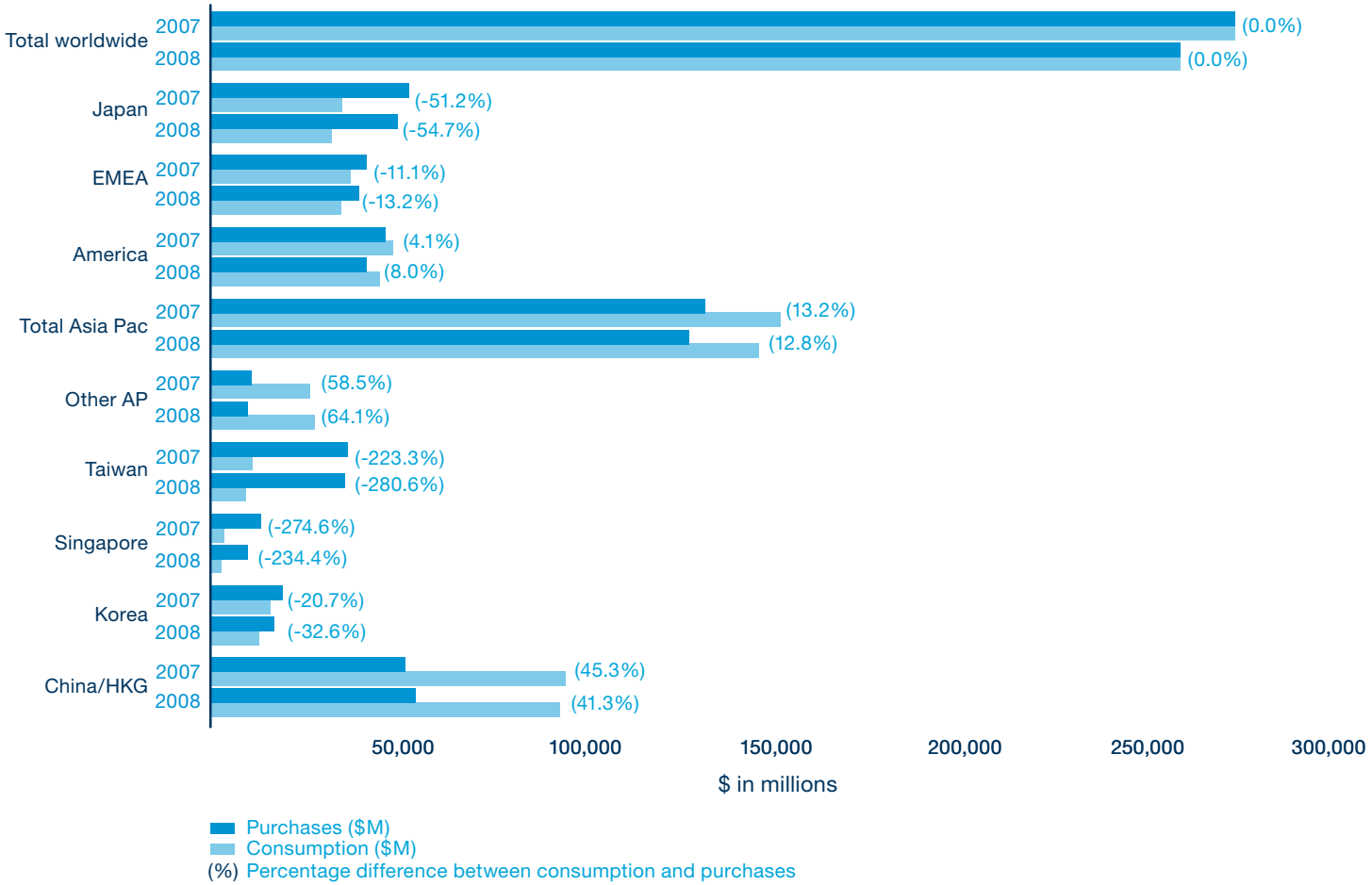
Still, China's domestic market is becoming of increasing significance to the global semiconductor industry. Since 2003, China's domestic market—the value of semiconductors consumed in China that are used in components of finished products assembled and sold in China—has grown at a 26.2% CAGR. This market has grown from US$10 billion in 2003 to US$34 billion in 2008. By itself, China's domestic consumption market has made up almost 28% of total worldwide semiconductor market growth since 2003.

In 2008, China's domestic market represented almost 13.5% of the worldwide semiconductor market, up from 11% in 2007. Understandably, this is having a noticeable impact on the semiconductor industry. Moreover, China's attractiveness to the industry is likely to increase further in the next year or so as a result of the nation's economic stimulus package—which includes a focus on increased consumption of electronic consumer products.

Dislocated purchasing

More than 40% of the semiconductor devices consumed in China are purchased outside of China. This is 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.

Figure 6: Analysis of 2007 and 2008 semiconductor consumption vs. purchases; China vs. worldwide by regions



Source: 1. Consumption regional data is taken from:
Semiconductor Forecast Worldwide: Forecast Database ID Number: SEQS-WW-DB-DATA 29 May 2008
2. Purchases are taken from Gartner Dataquest Semiconductor Industry Worldwide Annual Market Share:
Database ID Number: G00120719 <<Worldwide Semi market share database.zip

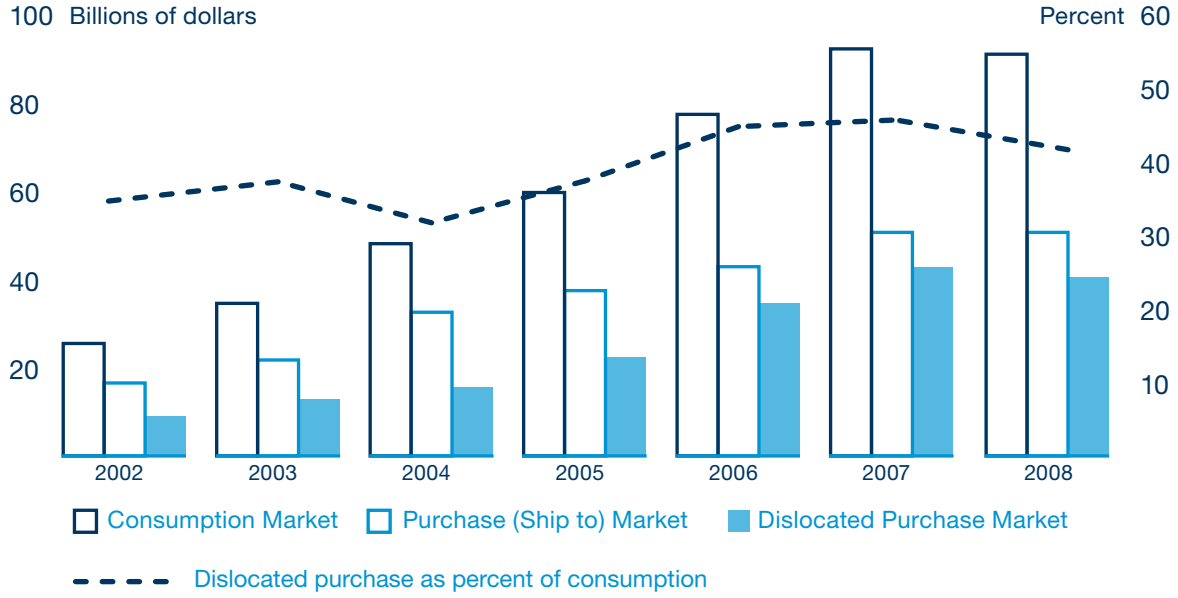
Such “dislocated” purchasing of semiconductors for the Chinese consumption market had increased noticeably, from about a third in 2004 to more than 45% in 2007. However, for 2008, the share of such purchasing decreased slightly, to 41%.

Still, this relatively high figure indicates that a significant portion of buying decisions—and therefore selling opportunities—for customer-specified devices consumed in China continue to made outside of China. During the past three years, the largest share of this dislocated purchasing of semiconductors for consumption in China took place in Taiwan and Japan, which corresponds to the ongoing transfer of electronic equipment production from these regions to China. The other regions, with a smaller share of this dislocated purchasing, include Singapore, Europe and Korea.

Dislocation purchasing as a share of the total China consumption market will likely decrease gradually over the coming years as:

- ODM and EMS plants in China achieve greater control over their Bills of Materials (BOM);
- Multinational electronic equipment OEM and semiconductor companies offshore more design and purchasing activities to China;
- Chinese fabless semiconductor companies gain market share in the China market;
- China’s domestic market consumption increases its share of China’s total semiconductor market; and
- China’s government implements effective intellectual property protection.

Figure 7: Dislocated purchases vs. China/Hong Kong consumption market, 2002–2008



Source: Consumption Market is based upon Gartner Dataquest Semiconductor Forecast Database
Purchase (Ship To) Market is based upon Gartner Dataquest Market Share Database

Chinese semiconductor companies

Table 3 on the following page lists the Chinese semiconductor companies that had the largest revenues in 2008. By definition, the companies on the list are the largest indigenous Chinese companies that design, manufacture (or have manufactured, the legal term for outsourcing), market and sell semiconductor devices. Therefore neither foundries nor packaging and testing companies are included on the list. Instead, they, along with foreign semiconductor companies manufacturing in China, are included in Table 5 (on pages 40 and 41).

The threshold for inclusion in this 2008 listing remained at US$30 million, the same as used for the 2007 listing. Meanwhile, the number of qualifying companies increased from 29 to 33. Three companies from the 2007 list—one IC design and two discrete companies—failed to qualify for the 2008 list due to revenue declines ranging from 17–44%. Seven new Chinese companies were added to this year's list—four IC design, two discrete and one IDM (integrated device manufacturer) companies.

The most notable addition was RDA Microelectronics, Inc. This is an IC design (fabless) company founded in 2004 with funding from a world premier private equity fund. RDA is focusing on the development and marketing of RF ICs (radio frequency integrated circuits). With several CMOS-based transceiver and GaAs-based power amplifiers successfully launched since 2005, RDA has now shipped millions of units. Its revenue grew by more than 200% in 2008 and RDA is now the leader in sales among all China-based RF IC producers.

The largest of the Chinese semiconductor companies, HiSilicon Technology Co. Ltd., had the second highest growth rate, almost 140% in RMB (or 160% in US$) and the largest absolute increase in revenues. HiSilicon is the former chip R&D center of the Huawei Company, but was spun out in 2005. HiSilicon has considerable experience in telecom ASIC device R&D. Its technical level ranks among the top tier of China's IC design companies with capabilities of designing at the 0.11μm technology node. With double-digit revenue growth in 2006 and 2007 and triple-digit growth in 2008, the company is demonstrating strong competitiveness.

Ningbo KangQuiang Electronics Co., Ltd., a discrete device manufacturer, also experienced triple-digit revenue growth in 2008—at least 100%. Of the remaining 30 on the list, nine had double-digit, five had single-digit and one had zero revenue growth. Finally, fifteen of these companies had negative revenue growth in 2008.

Table 3: Chinese semiconductor companies by revenue, 2008

Rank		Sales revenue (RMB:100M)				Sales revenue (US$M)		
2008	Company	2007	2008	Change (%)	Sector	2007	2008	Change (%)
1	HiSilicon Technologies Co., Ltd.	13.05	30.94	137.1%	Design (Fabless)	172	445	159.5%
2	Jilin Sino Microelectronics Co., Ltd.	11.30	10.48	-7.3%	Discrete	149	151	1.5%
3	Wuxi China Resources Huajian Microelectronics Co., Ltd.	10.10	9.32	-7.7%	IDM & Discrete	133	134	1.0%
4	Tianjin ZhongHuan Semiconductor Co., Ltd.	7.00	8.90	27.1%	Discrete	92	128	39.1%
5	Datang Microelectronics Technology Co., Ltd.	10.79	8.36	-22.5%	Design (Fabless)	142	120	-15.2%
6	Hangzhou Silan Microelectronics Co., Ltd.	8.20	8.12	-1.0%	Design (Fabless)	108	117	8.4%
7	Spreadtrum Communications Inc.	11.06	7.48	-32.4%	Design (Fabless)	145	108	-26.0%
8	No. 50 Research Institute of China Electronics Technology Group Corporation	5.52	7.07	28.1%	IDM	73	102	40.2%
9	Shenzhen ZTE Microelectronics Technology Co., Ltd.	5.66	7.02	24.0%	Design (Fabless)	74	101	35.7%
10	Ningbo KangQuiang Electronics Co., Ltd.	3.50	7.00	100.0%	Discrete	46	101	118.9%
11	Actions Semiconductor Co., Ltd.	8.78	6.78	-22.8%	Design (Fabless)	115	98	-15.5%
12	BCD Semiconductor Manufacturing Ltd.	7.57	6.30	-16.8%	IDM	100	91	-8.9%
13	Changzhou Galaxy Electrical Co., Ltd.	5.80	6.30	8.6%	Discrete	76	91	18.9%
14	Wuxi China Resources Semico Co., Ltd.	8.50	6.24	-26.6%	Design (Fabless)	112	90	-19.7%
15	Beijing Vimicro Co., Ltd.	7.06	6.22	-11.9%	Design (Fabless)	93	89	-3.6%
16	Shanghai Huahong IC Co., Ltd.	6.83	6.14	-10.1%	Design (Fabless)	90	88	-1.6%
17	CEC Huada Electronics Design Co., Ltd. (HED)	5.63	5.81	3.2%	Design (Fabless)	74	84	12.9%
18	ShenZhen Si Semiconductor Co. Ltd.	5.90	5.20	-11.9%	Discrete	78	75	-3.5%
19	Suzhou Good-Ark Electronics Co., Ltd.	3.80	5.00	31.6%	Discrete	50	72	44.0%
20	NingBo Hualong Electronics Co., Ltd.	4.50	4.80	6.7%	Discrete	59	69	16.7%
21	Shanghai Belling	3.98	4.43	11.3%	IDM & Foundry	52	64	21.8%
22	Tongfang Microelectronics Company	4.57	3.97	-13.1%	Design (Fabless)	60	57	-4.9%
23	RDA Microelectronics, Inc.	1.03	3.47	236.9%	Design (Fabless)	14	50	268.7%
24	Fosham Blue Rocket Electronics Co., Ltd.	3.40	3.40	0.0%	Discrete	45	49	9.4%
25	Shanghai Fudan Microelectronics Co., Ltd.	3.27	2.81	-14.1%	Design (Fabless)	43	40	-6.0%
26	Shantou Huashan Electronic Device Co., Ltd.	3.10	2.73	-11.9%	Discrete	41	39	-3.6%
27	Forward Semiconductor Company	1.95	2.46	26.2%	Discrete	26	35	38.1%
28	Yangzhou JingLai Semiconductor (Group) Co., Ltd.	2.30	2.40	4.3%	Discrete	30	35	14.2%
29	China Electronics Technology Group Corporation No. 58 Institute	1.60	2.32	45.0%	Discrete	21	33	58.7%
30	Chendu Sino Microelectronics Systems Co., Ltd.	1.54	2.29	48.7%	Design (Fabless)	20	33	62.7%
31	Beijing Huadazhibao Electronic Systems Co., Ltd.	1.79	2.24	25.1%	Design (Fabless)	24	32	37.0%
32	Huaya Microelectronics Company	2.13	2.20	3.3%	Design (Fabless)	28	32	13.0%
33	Hangzhou Youwang Electronics Co., Ltd.	2.62	2.15	-17.9%	Design (Fabless)	34	31	-10.2%

Source: CCID, CSIA, GSA, PwC 2008-2009

The combined revenue of the 33 companies on the list was US$2.9 billion—a figure which has grown to represent slightly more than 1% of the worldwide industry. These top 33 companies together constitute 48% of China's IC design sector and 7% of China's discrete sector. Overall these 33 companies reported an average 19% increase in revenues measured in US dollars (or 9% measured in RMB). This is more than the 15% increase measured in US dollars (or 5% measured in RMB) reported for China's semiconductor industry and notably more than the 2.7% decrease reported for the worldwide semiconductor industry for 2008.

Industry awareness of Chinese semiconductor companies has been slowly increasing. By definition, all of these largest Chinese semiconductor companies should be included in the semiconductor market share reports compiled by industry analysts. However only 14 of these 33 companies were included in work from third-party research firm Gartner Dataquest.

Their database, "Top Companies (ALL) Revenue from Shipments of Total Semiconductors—Worldwide (Millions of $US)," ranked 287 companies by their 2008 revenues. Six of the top 10 were included. The Chinese company with the largest 2008 revenue, HiSilicon, was ranked 108, up from 156 a year ago. The majority of the largest Chinese semiconductor companies missing from the Gartner Dataquest database continue to be discrete companies, which is an indication of the industry's general lack of awareness of the significance of this sector within China.

The Gartner Dataquest database did include five additional Chinese semiconductor companies with 2008 revenues less than US$30 million, for a total of 19 Chinese companies. This is the same number as included in their 2007 database of 277 worldwide companies, but an increase from the 15 out of 227 in their 2005 database.

Domestic OEM buying power

Table 4 on the following page is a listing of the 12 largest Chinese OEMs that we identified with 2008 revenues greater than US $1 billion. These OEMs had a 23% increase in their combined revenues during 2008 to reach a record total of US$75 billion. Their combined revenue increase is comparable with that of China's electronic and information industry which also increased 23% measured in US dollars (or 12.5% reported in RMB). Assuming the semiconductor content of their products was 24.7% (the average for all of China's electronic systems production in 2008) these 12 Chinese OEMs could be responsible for semiconductor consumption of US$18.5 billion—or 17.8% of China's total semiconductor market.

Eight of the largest of China's OEMs were listed among the Top 100 Semiconductor-consuming Companies 2008 by Gartner Dataquest. Their 2008 semiconductor consumption was reported to be US$11.5 billion, a decrease of almost 13% from 2007. Meanwhile, this total represents only 11% of China's total semiconductor market, down from almost 16% in 2007.

The calculated semiconductor content of the combined revenues of these eight OEMs declined from an above-average 30.7% in 2007 to a below-average 20.8% in 2008. Some of this decrease is believed to be a reflection of the intense competitive price concessions these large OEMs were able to obtain from their semiconductor suppliers during the business downturn.

Table 4: Chinese OEMs by electrical equipment revenue and semiconductor consumption 2007–2008 (in billions of US dollars)

	Electronic revenue			Semiconductor consumption		
Name of company	**2007**	**2008**	**Change %**	**2007**	**2008**	**Change %**
Huawei	12.8	18.3	42.7	1.9	2.5	31.6
Lenovo	14.5	16.4	12.7	7.0	4.9	-30.0
Midea	4.6	6.6	45.8			
ZTE	4.8	6.5	36.4	1.0	1.2	20.0
Gree	5.2	6.2	18.8			
TCL	5.3	5.6	5.3	0.8	0.6	-25.0
Haier	4.0	4.5	10.5	1.1	0.8	-27.3
Changhong	3.2	4.1	29.7	0.6	0.7	16.7
Hisense	2.0	2.0	-3.3	0.4	0.4	0.0
Skyworth	1.6	1.8	11.4			
Konka Group	1.7	1.8	7.3	0.4	n/a	
Founder	1.2	1.1	-7.5	n/a	0.4	
Total	60.9	74.8	23.0	13.2	11.5	-12.9

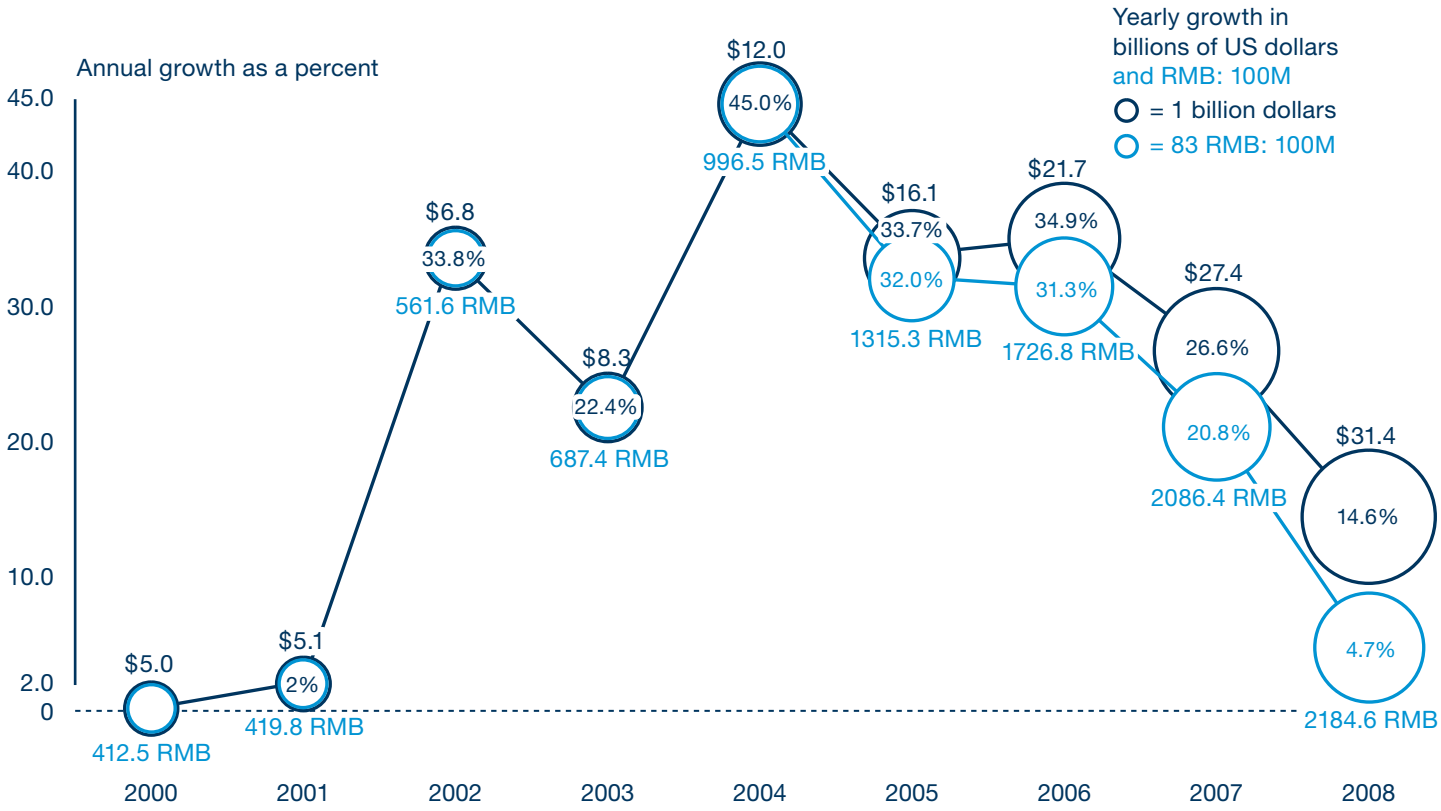
Source: Company reports, Thomson Financial, Gartner Dataquest, 2008 & 2009

These leading Chinese OEMs purchase a significant and increasing number of semiconductor devices. They could be important customers for many of the international semiconductor companies intending to participate in China's economic stimulus projects and the continuing growth of the Chinese semiconductor market. As a result, the strategies of these OEMs will likely have an increasing impact on the design and sales operations of a growing number of international semiconductor companies.

Production growth

Measured in US dollars, China's semiconductor industry production revenues grew from US$27 billion in 2007 to US$31 billion in 2008, an increase of more than 14%. However, when reported in RMB, China's semiconductor industry production revenues grew by less than 5%. Although still positive, this was China's lowest reported semiconductor industry growth rate since 2001. China's industry growth peaked in 2004, with a growth rate of 45%, and has gradually declined ever since. This year, 2008, is the first year with a single-digit growth rate.

Figure 8: China's semiconductor industry revenue and growth, 2000–2008

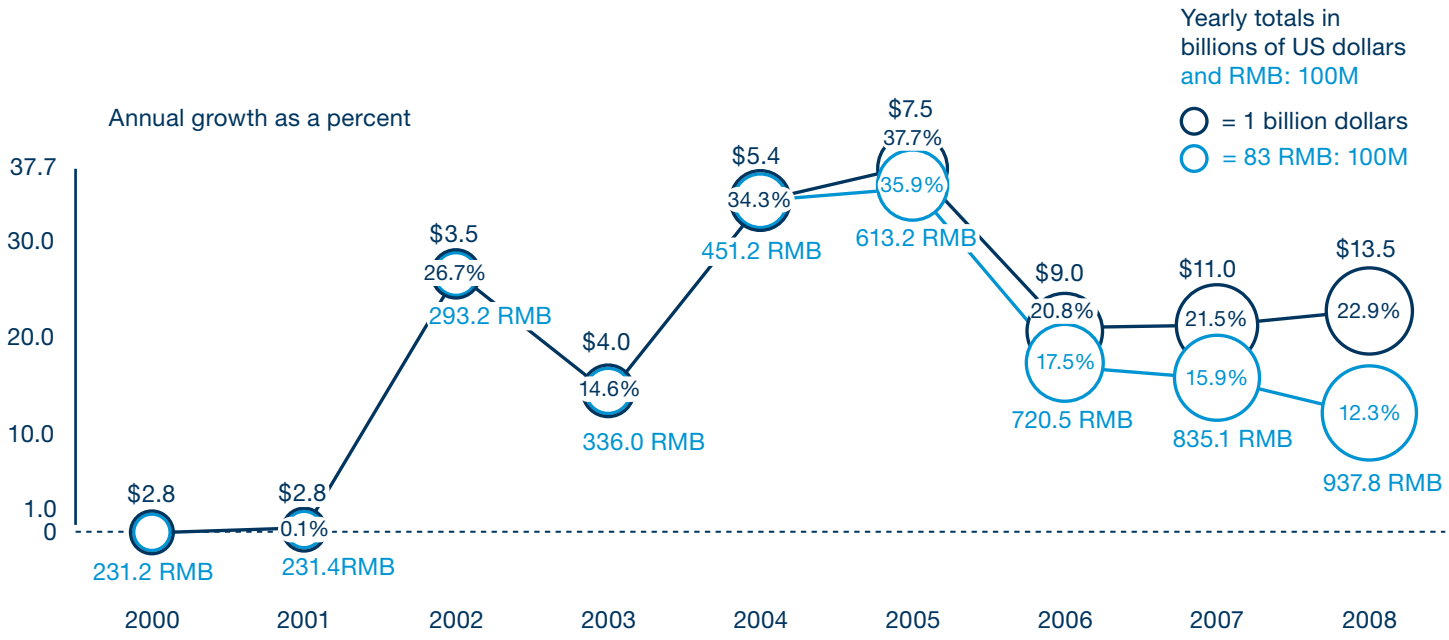


Source: CCID, CSIA

Because of the possibility of overstatement or double counting, a comparison between China's reported semiconductor industry revenue and the sum of worldwide semiconductor device sales, plus foundry and semiconductor assembly and test services (SATS) revenue, may provide a more representative measurement of China's impact on the semiconductor industry. On that basis, China's semiconductor industry accounted for 10.7% of the worldwide semiconductor industry in 2008, up from 9.1% in 2007. Although this measurement is probably overstated, the trend continues to be very clear. China's share of the worldwide semiconductor industry is growing, becoming noticeable and significant. (It was a mere 2% in 2000.)

Reported in RMB, the OSD sector grew by just over 12% in 2008, with revenues of 938 RMB: 100M. Output reached almost 250 billion units, driven by significant developments in the nation's LED segment. China's OSD sector comprises more than 300 enterprises including packaging, testing, design, as well as manufacturing.

Figure 9: China's OSD industry revenue and growth, 2000–2008

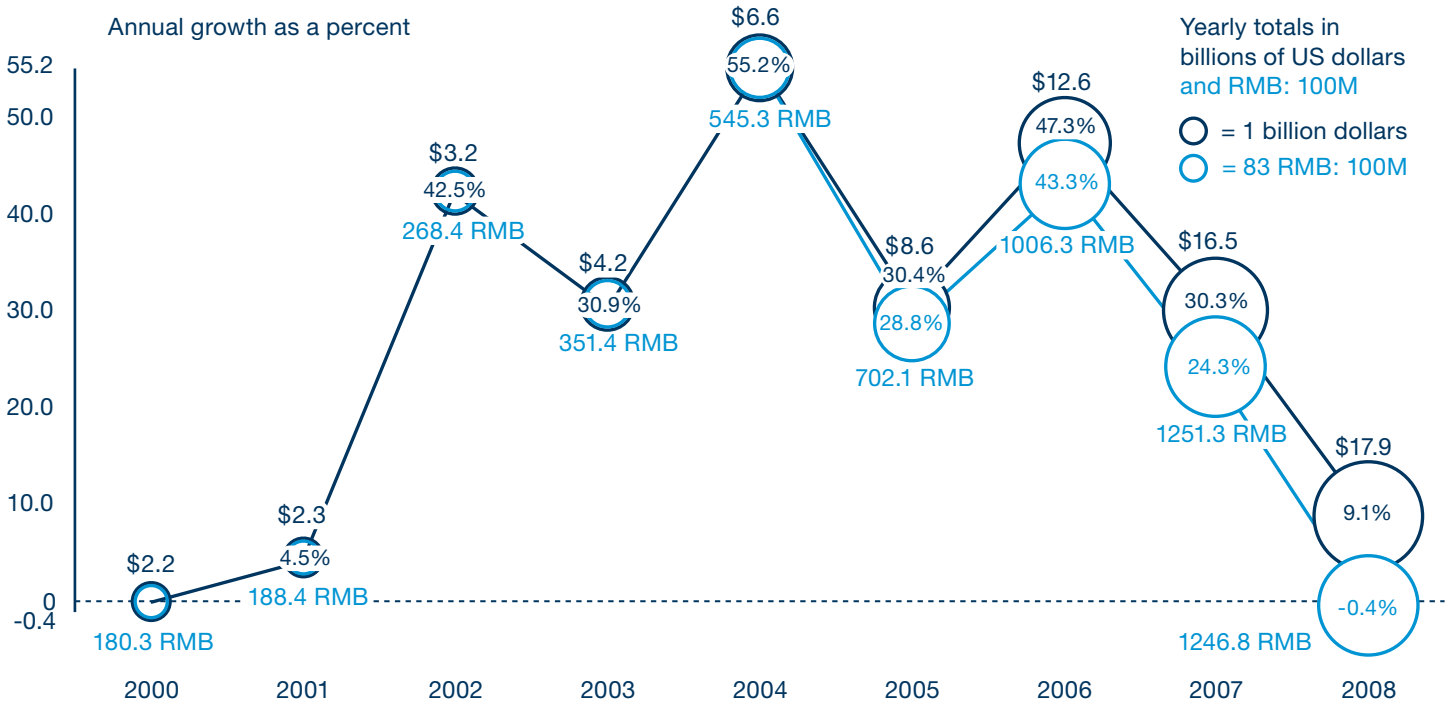


Source: CCID, CSIA

China's IC industry (the sum of design, wafer manufacturing and packaging and testing) reported negative RMB sales growth for the first time ever in 2008. While China's IC industry revenues measured in US dollars increased by 9%, to almost US$18 million, reported in RMB, they decreased by 0.4% to 1247 RMB:100M.

While all three sectors of China's IC industry were impacted by the global semiconductor market downturn, the two sectors with greater multinational company involvement were affected the most. IC manufacturing, which includes China's wafer foundries, was affected earlier with reduced orders, causing lower capacity utilization and year-over-year revenue declines of 4% and 14% in the third and fourth quarters, resulting in an overall 1.3% sector revenue decline in 2008 (measured in RMB). IC assembly and test, which includes both multinational SATS and captive facilities, felt the ill effects later, but much more severely. Reduced or cancelled orders causing capacity under-loads and a 39% year-over-year revenue decline in the fourth quarter resulted in an overall 1.4% sector decline for 2008 (again, in RMB).

Figure 10: China's IC industry revenue and growth, 2000–2008



Source: CCID, CSIA

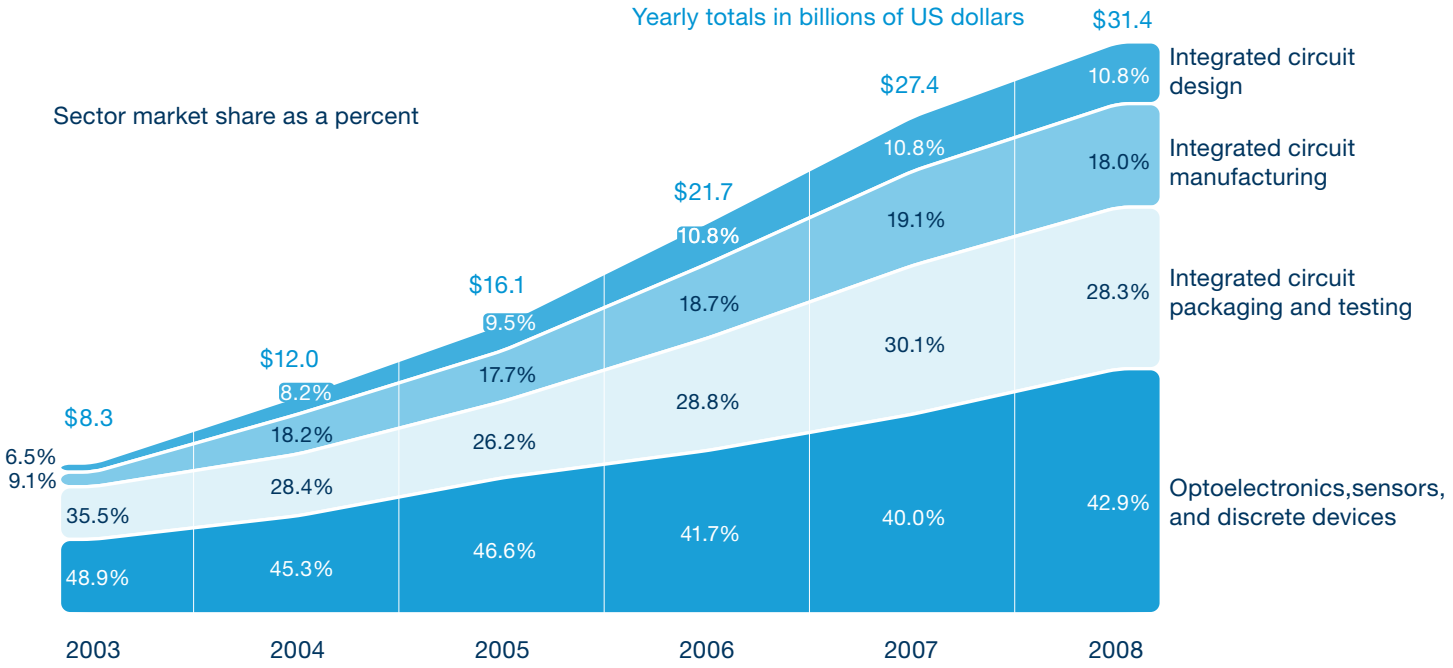
The IC design sector faired a bit better, with key vendors' new designs and innovations somewhat offsetting the overall slowdown in China's domestic demand growth. This group experienced a 4% year-over-year revenue decline in the fourth quarter, resulting in a noticeably reduced but still positive 4.2% annual increase, again calculated in RMB.

The distribution of China's semiconductor industry continued to change in 2008 as a result of above-average growth of the OSD sector. OSD, which had previously been described as the Discrete or Discrete Device sector, contributed greater than 100% of the 2008 revenue growth of China's semiconductor industry. This growth was more than enough to offset revenue declines in the IC manufacturing, packaging and testing sectors. Measured in US dollars, OSD grew by almost 23% in 2008 to US$13 billion, representing more than 31% of worldwide OSD revenues.

Industry by sector

As a result, the OSD sector remains the largest sector of China's semiconductor industry, but last year was able to gain almost three percentage points to reach a 43% overall share. (See Figure 11) Although the least celebrated or promoted—and usually the slowest growing—the OSD sector has remained the largest sector for at least the last seven years. During this period, the OSD sector grew from US$2.8 billion in 2001 to US$13.5 billion in 2008 for a CAGR of just over 25%. Measured in US dollars, the OSD sector achieved a relatively consistent 23% growth in 2008, making it the fastest growing sector for the year.

Figure 11: China's semiconductor industry by sector, 2003–2008



Source: CCID, CSIA, PwC 2004-2009

The IC design (fabless) sector has been the fastest growing sector over the past seven years, with a dollar revenue CAGR of just over 52%. This segment has grown from less than US$200 million in 2001 to more than US$3 billion in 2008. Although its growth has slowed from 54% in 2006 to 27% in 2007 and 14% in 2008, for all three years IC design still accounts for approximately 11% of the industry overall.

IC manufacturing, which includes IC wafer foundries, has been the second fastest growing and most variable sector over the past seven years. During the past seven years it has experienced annual dollar revenue growth ranging from a 2004 peak of 190% down to a 2008 low of 8% for a CAGR of more than 47%. In US dollar terms, the IC manufacturing sector has grown from less than US$400 million in 2001 to US$5.6 billion in 2008, representing 18% of China's 2008 semiconductor industry revenue (albeit down from 19% in 2007).

IC packaging and testing, which includes multinational and Chinese semiconductor assembly and test services (SATS) as well as multinational captive facilities, is the second largest sector of China's semiconductor industry. Over the past seven years its US dollar revenue has grown at a 26.5% CAGR, from less than US$2 million in 2001 to almost US$9 billion in 2008. However, because of a very large drop in fourth quarter 2008 production, this sector had the lowest US dollar revenue growth, at slightly less than 8%. As a result, this sector's share based on US dollar revenues of the total China semiconductor industry fell to 28%, down from 30% in 2007.

The top Chinese semiconductor manufacturers

Table 5 on pages 40 and 41 lists the 50 largest semiconductor manufacturers in China—those reporting 2008 revenues of US$72 million or more. This revenue threshold is up from the US$54 million threshold of the top 50 in our 2008 report.

This table includes five groups that each own one or more companies in the various sectors of China's semiconductor industry. Such groups are combined and listed in place of listing their individual companies in order to better reflect their increasing significance in the growth and concentration of China's semiconductor industry. This approach also corresponds to the CSIA's (China Semiconductor Industry Association's) current reporting practice, which reports group totals (by industry sector).

The five groups with their most significant companies are:

	Revenue (US$M)	
	2007	2008
China Resources Microelectronics (Holding) Ltd.	613	654
Wuxi China Resources Microelectronics Co., Ltd. (CR Micro) (former CSMC)—Foundry	143	154
Wuxi China Resources Huajing Microelectronics Co., Ltd. —Discrete	110	134
Wuxi China resources Semico Microelectronics Co., Ltd. —IC Design	112	90
XINCHAO Group	497	574
JECT (Jiangsu Changjiang Electronics Technology Co., Ltd.) —Pkg & Test	304	342
Shanghai Huahong (Group) Co., Ltd.	461	431
HHNEC (Shanghai Huahong NEC Electronics Co., Ltd.) —Foundry	319	279
Shanghai Huahong IC Co., Ltd.—Design	90	88
Shanghai Beiling Stock Co., Ltd.—IDM/Foundry	52	64
China Huada Integrated Circuits Design (Group) Co., Ltd. (CIDC Group)	192	208
CEC Huada Electronics Design Co., Ltd.—IC Design	74	84
Beijing Huada Zhaibao Electronic Systems Co., Ltd. —IC Design	23	32
Hangzhou Silan Microelectronics Co., Ltd.	128	136
Hangzhou Silan Microelectronics Co., Ltd.—Design	108	117
Hangzhou Silan Integrated Circuit Co., Ltd —IDM/Foundry/OSD	43	55

In addition to these five groups, Table 5 also lists a single entry for each of several multinational semiconductor companies that have more than one manufacturing facility in China—although each facility may be legally organized as a separate company in China. These companies include Freescale, Renesas, Intel and EEMS. Each listing reflects the combined revenues of all the companies' manufacturing facilities in China.

The combined 2008 revenues reported for these top 50 enterprises is US$16.5 billion, representing more than 52% of China's total 2008 semiconductor industry revenue of US$31.4 billion. China's industry remains significantly less concentrated than the worldwide industry in which the top 50 companies represent slightly more than 82% and the top 14 companies more than 53% of the total market. While the combined reported RMB revenues of these top 50 manufacturers dropped by about 1% in 2008, their US dollar revenues increased by more than 8%.

There are five companies that were new to the top 50 Chinese semiconductor manufacturers list for 2008 (listed by 2008 ranking):

- ASAT Semiconductor (Dongguan) Ltd. which had been previously overlooked when it moved the majority of its manufacturing operations from Hong Kong to China in 2006.
- Fairchild Semiconductor (Suzhou) Co., Ltd. which reported a 150% increase in dollar revenues for 2008 to qualify.
- Shenzhen ZTE Microelectronics Technology Co., Ltd. which had previously been unreported when it was spun out of its parent company.
- NingBo KangQiang Electronics Co., Ltd. which reported a 121% increase in dollar revenues for 2008 to qualify.
- SanDisk Semiconductor (Shanghai) Co., Ltd. which ramped up its new facility into full volume production during 2008.

Table 5: Major Chinese semiconductor manufacturers (including groups) in 2008

Rank				Sales revenue (RMB:100M)			Sales revenue (US$M)		
2007	2008	Company	Sector	2007	2008	Change (%)	2007	2008	Change (%)
4	1	Hynix - Numonyx Semiconductor	IDM	93.59	122.07	30.4%	1,230	1,756	42.7%
1	2	Freescale Semiconductor (China) & (Suzhou) Co., Ltd.	Packaging & Testing & Design	134.63	116.08	-13.8%	1,770	1,670	-5.6%
2	3	SMIC (Semiconductor Manufacturing International Corp.)	Foundry	111.43	93.03	-16.5%	1,465	1,339	-8.6%
3	4	Quimonda	Packaging & Testing	100.33	85.95	-14.3%	1,319	1,237	-6.2%
9	5	Renesas Semiconductor (Beijing & Suzhou) Co., Ltd.	Packaging & Testing	34.72	45.50	31.0%	456	655	43.4%
6	6	China Resources Microelectronics (Holdings) Ltd.	IDM, Discrete, Design	46.63	45.45	-2.5%	613	654	6.7%
5	7	RFMD (RF Micro Devices (Beijing) Co., Ltd.	Packaging & Testing	54.15	45.01	-16.9%	712	648	-9.0%
7	8	XINCHAO Group	Packaging & Testing	37.80	39.88	5.5%	497	574	15.5%
10	9	Shanghai Panasonic Semiconductor Co., Ltd.	Packaging & Testing	32.67	39.07	19.6%	430	562	30.9%
11	10	ST Microelectronics	Packaging & Testing	30.61	35.50	16.0%	402	511	26.9%
24	11	HiSilicon Technologies Co., Ltd.	Design (Fabless)	12.90	30.94	139.8%	170	445	162.5%
8	12	Shanghai Huahong (Group) Company Ltd.	Design & Foundry	35.09	29.95	-14.6%	461	431	-6.6%
12	13	Natong Fujitsu Microelectronics Co., Ltd.	Packaging & Testing	22.86	26.60	16.4%	301	383	27.3%
16	14	Infineon Technologies (Wuxi) Co., Ltd.	Packaging & Testing	19.02	23.19	21.9%	250	334	33.4%
18	15	Samsung Electronics (Suzhou) Semiconductor Co.,Ltd.	Packaging & Testing	18.53	21.90	18.2%	244	315	29.3%
15	16	Leshan Radio Co., Ltd. (incl ON Semiconductor JV)	Discrete	19.34	21.25	9.9%	254	306	20.3%
17	17	Intel Products (Shanghai) Co., Ltd.	Packaging & Testing	18.83	18.57	-1.4%	248	267	7.9%
20	18	ASE Assembly & Test (Shanghai) Ltd.	Packaging & Testing	14.77	17.45	18.1%	194	251	29.3%
13	19	STATS ChipPAC	Packaging & Testing	20.59	14.66	-28.8%	271	211	-22.1%
19	20	Shanghai Grace Semiconductor Manufacturing Co., Ltd	Foundry	15.34	14.56	-5.1%	202	210	3.9%
21	21	China Huada Integrated Circuits Design (Group) Co., Ltd.	Design (Fabless)	14.61	14.43	-1.2%	192	208	8.1%
22	22	Shougang NEC Electronics	Foundry	14.04	14.35	2.2%	185	206	11.9%
14	23	HeJian Technology (Suzhou) Co., Ltd.	Foundry	19.70	13.40	-32.0%	259	193	-25.6%
29	24	Chipmore Technology Corporation Ltd.	Packaging & Testing	11.02	11.60	5.3%	145	167	15.2%
37	25	EEMS Co., Ltd.	Packaging & Testing	16.27	11.24	-30.9%	214	162	-24.4%
23	26	TSMC (Shanghai) Co., Ltd.	Foundry	13.40	11.00	-17.9%	176	158	-10.2%

Source: CSIA, CCID, PwC, 2008–2009

Rank				Sales revenue (RMB:100M)			Sales revenue (US$M)		
2007	2008	Company	Sector	2007	2008	Change (%)	2007	2008	Change (%)
26	27	Jilin Sino Microelectronics Co., Ltd.	Discrete	11.30	10.48	-7.3%	149	151	1.5%
31	28	SIPIN Technology (Suzhou) Co., Ltd.	Packaging & Testing	9.77	10.37	6.1%	128	149	16.2%
	29	ASAT Semiconductor (Dongguan) Limited	Packaging & Testing	10.88	9.46	-13.1%	143	136	-4.8%
32	30	Hangzhou Silan Microelectronics Co., Ltd.	Design, Discrete, Foundry	9.70	9.33	-3.8%	128	134	5.3%
25	31	ASMC (Advanced Semiconductor Manufacturing Co., Ltd.)	Foundry	11.83	9.33	-21.1%	156	134	-13.7%
36	32	Tianshui Huatian Microelectronics Co., Ltd.	Packaging & Testing	8.44	9.27	9.8%	111	133	20.2%
42	33	TianJIn ZhongHuan Semiconductor Co., Ltd.	Discrete	7.00	8.90	27.1%	92	128	39.1%
30	34	Datang Microelectronics Technology Co., Ltd.	Design (Fabless)	10.79	8.36	-22.5%	142	120	-15.2%
38	35	Amkor Technology China Ltd.	Packaging & Testing	7.90	7.79	-1.4%	104	112	7.9%
81	36	Fairchild Semiconductor (Suzhou) Co., Ltd.	Packaging & Testing	3.38	7.73	128.7%	44	111	150.3%
27	37	Spreadtrum Communications Inc.	Design (Fabless)	11.06	7.48	-32.4%	145	108	-26.0%
33	38	GEM Electronics (Shanghai) Co., Ltd.	Packaging & Testing	9.31	7.43	-20.2%	122	107	-12.7%
40	39	Shangahi Kai Hong Electronics Co., Ltd.	Packaging & Testing	7.49	7.39	-1.3%	98	106	8.0%
46	40	No. 50 Research Institute of China Electronics Technology Group Corporation	IDM	5.52	7.07	28.1%	73	102	40.2%
	41	Shenzhen ZTE Microelectronics Technology Co., Ltd.	Design (Fabless)	5.66	7.02	24.0%	74	101	
83	42	NingBo KangQiang Electronics Co., Ltd.	Discrete	3.47	7.00	101.7%	46	101	120.8%
34	43	Actions Semiconductor Co., Ltd	Design (Fabless)	8.78	6.78	-22.8%	115	98	-15.5%
28	44	China Wafer Level CSP Ltd. (Suzhou)	Packaging & Testing	11.02	6.63	-39.8%	145	95	-34.2%
	45	SanDisk Semiconductor (Shanghai) Co., Ltd.	Packaging & Testing		6.34			91	
39	46	BCD Semiconductor Manufacturing Ltd.	IDM	7.57	6.30	-16.8%	100	91	-8.9%
45	47	Changzhou Galaxy Electrical Co., Ltd.	Discrete	5.80	6.30	8.6%	76	91	18.9%
41	48	Beijing Vimicro Co., Ltd.	Design (Fabless)	7.06	6.22	-11.9%	93	89	-3.6%
44	49	ShenZhen Si Semiconductor Co., Ltd.	Discrete	5.90	5.20	-11.9%	78	75	-3.5%
43	50	Suzhou Zhenkun Technology Co., Ltd.	Packaging & Testing	6.74	5.19	-23.0%	89	75	-15.7%

Source: CSIA, CCID, PwC, 2008–2009

Correspondingly there were five manufacturers from 2007 that did not qualify for the to 50 list in 2008. These include:

- Phoenix Semiconductor Telecommunications (Suzhou) Co., Ltd. which was reclassified to be a memory module manufacturer (EMS) rather than a semiconductor manufacturer.
- Tongfang Microelectronics Co. which reported a 12% decline in RMB revenues in 2008 and dropped below the dollar qualifying threshold.
- Suzhou Good-Ark Electronics Co., Ltd. which, although it reported a 5.9% increase in RMB revenue, failed to meet the 2008 qualifying threshold which had increased 22% in RMB and 33% in US dollars.
- NingBo Hualong Electronics Co., Ltd. which, although it reported a 7% increase in RMB revenue, also failed to meet the 2008 qualifying threshold.
- AMD Technologies (China) Co., Ltd. which reported an 8% decline in RMB revenues for 2008 and dropped below the dollar qualifying threshold.

Measured in US dollars, China's reported semiconductor industry revenues increased by 14.6% or US$4.0 billion during 2008. As was the case for the prior two years, much of this increase came from multinational rather than local domestic semiconductor companies. Four of the top five contributors to that increase in reported revenues were multinational companies:

- Hynix-Numonyx (contributing 13.1% of the total increase)
- Renesas Semiconductor (5.0%)
- Panasonic Semiconductor (3.3%)
- ST Microelectronics (2.7%)

Performance from Hynix-Numonyx continues to be noteworthy as this firm had also been the largest contributor to the growth of China's semiconductor industry revenues in 2006 and 2007. This demonstrates the significant impact of a large advanced wafer fab, which since start-up in 2005, has continued to expand and grow.

The one Chinese company among the top five contributors to the 2008 semiconductor industry revenue increase is HiSilicon Technologies (contributing 6.9% of the total increase).

Meanwhile, four of the five companies with the largest decreases in 2008 semiconductor industry revenue were also multinational companies:

- Freescale (-2.5%)
- Quimonda (-2.0%)
- HeJian Technologies (-1.6%)
- RFMD (-1.6%)

The one Chinese company leading the five companies with the largest decrease in 2008 was SMIC (offsetting -3.1% of the total increase).

Wafer fab capacity

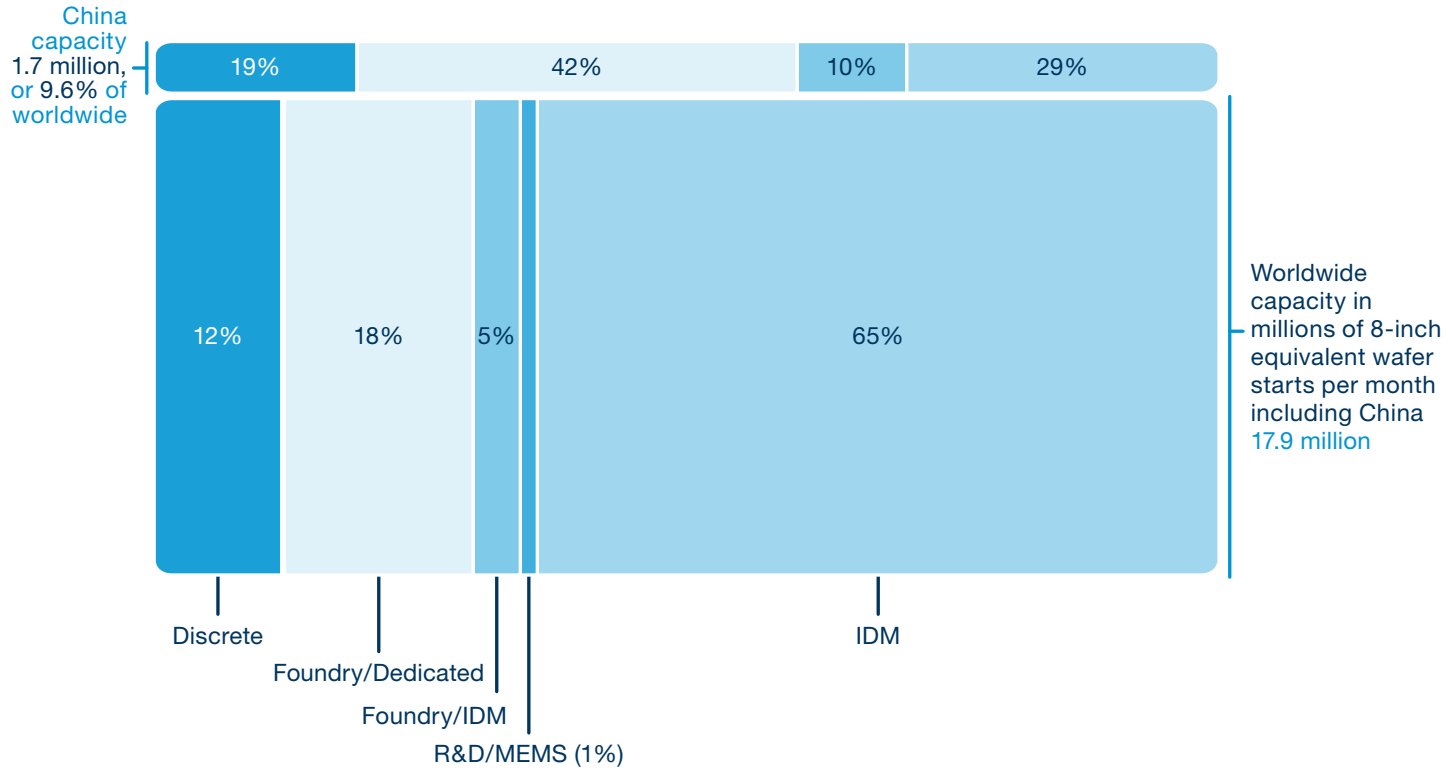
China continued to increase wafer fab capacity faster than other regions during 2008. Based upon current capabilities and not stated intentions—i.e., World Fab Watch (WFW) Probability ≥1.0—China could now increase their share of total worldwide semiconductor wafer production simply by fully equipping and ramping to full capacity all of their existing wafer fabrication modules. Total share could rise from around 2% realized in 2003 to approximately 9.6% by 2011. While this would almost quintuple their share of worldwide wafer production compared to 2003, it also represents a 10% increase in China's relative capacity during the past year from 8.7% to 9.6% of worldwide capacity.

Recognition of the significance and impact of China's local discrete sector is growing. For example, WFW added 13 Chinese wafer fabs to its database in 2008. These were mostly small, discrete wafer fabs that began production between 1998 and 2007 and yet had previously been unrecorded. As a result, China's 2007 wafer fab capacity was revised to 1,497.9K Wafer Starts per Month (WSpM)—an 8% correction, at the time—representing 8.7% of worldwide capacity.

China further increased its current wafer fab capacity during 2008 by starting production at eight new sites while discontinuing production at two others, including the relatively new and large Hynix-Numonyx 200mm DRAM facility. China thereby increased the net number of fabs in production by six (7%), increasing production capacity by 15%. Meanwhile, worldwide capacity increased by only 4%.

The closure of the Hynix-Numonyx facility “due to worsening memory market” is a noteworthy casualty of the current business cycle. The site had been the second largest (in terms of WSpM capacity) fab in China, with relatively advanced technology and had been in production since only 2006.

Figure 12: China compared with worldwide current wafer fab capacity (WFW probability ≥ 1.0)



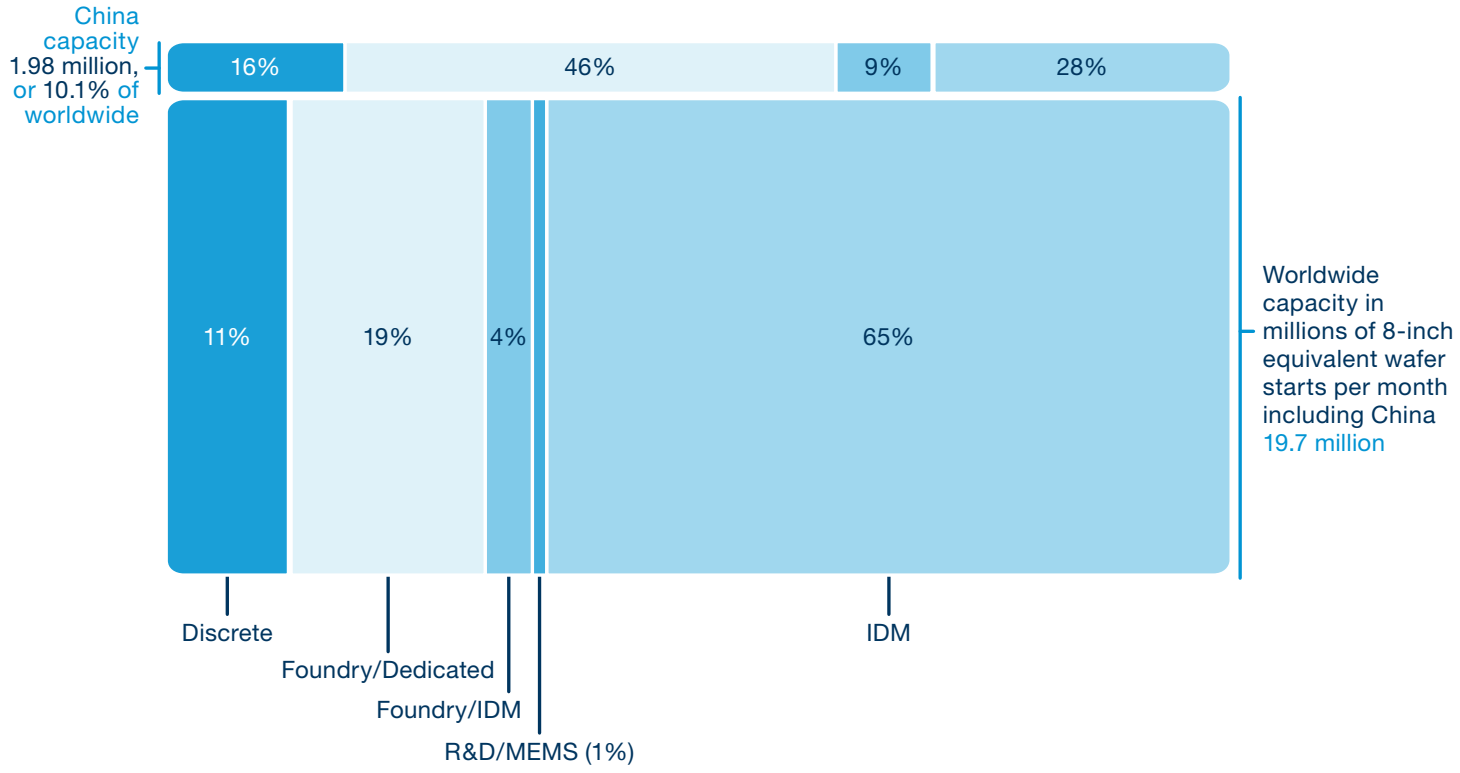
Source: SEMI Wafer Fab Watch May 2009

Currently China has eight additional wafer fabs that are committed and under construction. This is almost a quarter in number of the total of 33 additional committed fabs under construction worldwide—but represents only slightly more than 15% of their capacity. China is getting less capacity per new wafer fab plant because they are adding a greater proportion of smaller 4-inch (100mm) and 8-inch (200mm) plants than other regions and less than a fifth the proportion of 12-inch (300mm) plants. During the past three years, the number

of wafer fabrication modules committed and under construction in China has decreased from 20 to eight. These eight modules have the potential to further increase China's wafer fabrication capacity by 16%. Moreover, they represent 15% of the capacity of all wafer fabrication modules currently committed and under construction worldwide.

Based upon their current plus committed capabilities, i.e., plants in production plus plants under construction (i.e., WFW Probability =/>0.8), China could increase their share of total worldwide semiconductor wafer production to over 10% by 2013. However, achieving this would require obtaining needed financing, completing the eight wafer fabrication plants currently under construction and then fully equipping and ramping to full capacity at mature yields those new plants plus all of the existing wafer fabrication modules. If all this were to come to pass, China's share of worldwide wafer production will have increased by fivefold since 2003, exacting a moderate impact on the global semiconductor industry.

Figure 13: China compared with worldwide current and committed wafer fab capacity (WFW probability ≥ 0.8)



Source: SEMI Wafer Fab Watch May 2009

Capacity by process node and wafer size

From a geometry/technology node distribution standpoint, China's current wafer fabrication capabilities have not kept up with the worldwide industry. When fully equipped and ramped, China will only have 27% of its capacity at the leading edge <0.08µm node compared to a worldwide industry distribution of 45%. By contrast, China will have 26% at the less advanced <0.16 to =/>0.08µm nodes versus 17% worldwide and 21% at the mid-range <0.4 to =/>0.16µm nodes versus 17% worldwide. Probably because of its heavier focus on discrete production China will also have 27% of its capacity at the mature >0.4µm nodes versus worldwide 18%.

Table 6: Comparison of current wafer fab capacity, 2008

	China			Worldwide	
	Capacity	%	CN%WW	Capacity	%
Geometry					
≥ 0.7 µm	345.4	20	14.9	2,311.1	13
< 0.7 to ≥ 0.4 µm	114.1	7	12.0	953.1	5
< 0.4 to ≥ 0.3 µm	160.4	9	13.7	1,173.7	7
< 0.3 to ≥ 0.2 µm	64.3	4	5.6	1,152.3	6
< 0.2 to ≥ 0.16 µm	145.0	8	22.0	658.9	4
< 0.16 to ≥ 0.12 µm	215.0	13	13.6	1,581.0	9
< 0.12 to ≥ 0.08 µm	215.0	13	15.3	1,406.1	8
< 0.08 µm	456.8	27	5.6	8,114.7	45
n/a		0	0.0	582.0	3
Total	1,716.0	100	9.6	17,932.7	100
Wafer size					
≥ 4-inch	151.0	9	22.7	665.0	4
5-inch	138.1	8	16.5	836.4	5
6-inch	345.1	20	13.4	2,581.2	14
8-inch	580.0	34	9.5	6,111.9	34
12-inch	501.8	29	6.5	7,738.3	43
Total	1,716.0	100	9.6	17,932.8	100

Capacity = 1000s 8-inch Equivalent Wafer Starts per Month (KWSpM)
Current capacity = World Fab Watch Probability ≥ 1.0

Source: SEMI World Fab Watch, 2009

In terms of wafer size, China's current capabilities continue to be more concentrated in the smaller size ranges. To illustrate, China has:

- 37% of its capacity in 6-inch or smaller wafers versus the worldwide mix of 23%;
- 34% of its capacity in 8-inch wafers equal to the worldwide mix of 34%; and
- 29% of its capacity in 12-inch wafers compared to the worldwide mix of 43%.

Of the 84 12-inch (300mm) wafer fabrication plants currently in production worldwide, only five are in China, constituting 6.5% of worldwide 300mm capacity. As a result, for at least the next three years, wafer fab plants in other nations will maintain cost leadership in low mix/high volume advanced technology (e.g., DRAM and NAND Flash) wafer manufacturing.

China does have three additional 12-inch (300mm) wafer fab plants committed and under construction. But they are only three out of 13 committed worldwide. When completed and if fully equipped and ramped to full capacity—which could be three years from now—these could increase China's 300mm capabilities to constitute 35% of its total wafer fab capacity. Still, these would increase China's share of worldwide 300mm capacity to only 7.4% when all 13 of the world's committed 12-inch fabs are brought into production.

Offsetting this relative lack of 12-inch (300mm) wafer fab capacity, China continues to maintain a greater than average concentration of 6-inch and smaller fab capacity. China currently has 66 6-inch or smaller wafer fabs in production, constituting 37% of total capacity compared to a worldwide average of 23%.

Overall it seems China has newer wafer fabrication plants with older technology. The majority of China's current wafer fab capacity has been brought into production within the last five years. Forty-six of China's current 88 wafer fab plants started production after 2003 and represent 64% of China's current capacity. By contrast, worldwide wafer fab plants starting production after 2003 only represent 37% of total current capacity. At the same time, China lags the worldwide average in technology node and wafer size. This apparent anomaly is the result of many of China's wafer fab plants being established with used equipment and technology.

From a business model standpoint, China's wafer fabrication capabilities remain noticeably different from worldwide capabilities. Foundry capacity dominates both China's current and committed capabilities. For example, when fully equipped and ramped, foundry production will account for almost 52% of China's current capacity compared to just over 22% worldwide. In the future, if all the committed wafer fab plants under construction are fully equipped and ramped to volume worldwide, foundry production will account for 55% of China's capacity versus 23% worldwide.

China's wafer foundries accounted for about 12% of worldwide wafer foundry revenues in 2008, which was a decrease from 13% in 2007. Based upon its current capabilities, China should be able to increase its share of worldwide foundry production to almost 23% by 2011 by fully equipping and ramping to full capacity at mature yields all of their existing wafer fabrication modules. This could have a significant impact on the semiconductor industry. China could further increase it share of worldwide foundry production to 25% by 2013 if all of the committed wafer fabs under construction are completed and ramped to full production.

Table 7: Comparison of committed future wafer fab capacity, 2008

	China				Worldwide		
	# Fabs	Capacity	%	CN%WW	# Fabs	Capacity	%
Geometry							
≥ 0.7 µm	1	3.5	1	15.5	4	22.6	1
< 0.7 to ≥ 0.4 µm			0	0.0	2	14.0	1
< 0.4 to ≥ 0.3 µm			0	0.0	4	21.8	1
< 0.3 to ≥ 0.2 µm	1		0	0.0	2	30.0	2
< 0.2 to ≥ 0.16 µm	1	10.0	4	28.6	2	35.0	2
< 0.16 to ≥ 0.12 µm			0	0.0	2	45.0	3
< 0.12 to ≥ 0.08 µm	2	70.0	26	79.5	3	88.0	5
< 0.08 µm	3	189.0	69	12.3	14	1,539.8	86
n/a			0	0.0			0
Total	8	272.5	100	15.2	33	1,796.2	100
Wafer size							
≥ 4 inch	1	3.5	1	41.2	3	8.5	0
5 inch			0				0
6 inch	1		0	0.0	5	15.8	1
8 inch	3	80.0	29	34.5	12	232.2	13
12 inch	3	189.0	69	12.3	13	1,539.6	86
Total	8	272.5	100	15.2	33	1,796.1	100

Capacity = 1000s 8-inch Equivalent Wafer Starts per Month (KWSpM)
Committed future capacity = Wafer Fab Watch WFW Probability ≥ 0.8 to < 1.0.

Source: SEMI World Fab Watch, 2009

China's share of current wafer fab capacity allocated to IC integrated device manufacturers (IDM) has diverged further from the worldwide average. IC IDM capacity now represents only 29% of China's current wafer fab capabilities versus the 65% average worldwide. This is primarily a result of the closure of the Hynix-Numonyx 200mm facility, but it is also impacted by the addition of the 13 facilities to the WFW database during 2008. The figure could drop still further, to 28% by 2013, if all of the committed wafer fabs under construction are completed and ramped to full production.

Under any scenario, China represents only slightly more than 4% of worldwide IC IDM capacity. This divergence probably had been the result of the timing of China's opening the semiconductor sector to foreign investments, an election to mimic the Taiwan foundry model and the very weak market position of China's state-owned semiconductor companies. It is now being exacerbated by China's focus on developing the IC Design (fabless) sector. Currently there are only seven foreign IDMs with some form of invested wafer fabrication capacity in China: Hynix, Intel, NEC (Hua Hong and SG JVs), Numonyx, NXP (ASMC and JiLin JVs), ON and ProMOS.

At the same time, China's share of wafer fab capacity allocated to the OSD sector has increased. OSD capacity now represents 19% of China's current wafer fab capabilities versus 12% of worldwide. It could decrease to 16% for China versus 11% worldwide by 2013 if all of the committed wafer fabs under construction are completed and ramped to full production. However, in either case, China represents more than 15% of worldwide OSD capacity.

As of May 2009, WFW shows there were eight additional new wafer fabs announced and/or planned (i.e., WFW probability of =/>0.45 <0.80) for China that had not been committed by the start of construction. This is one less than a year ago and represents 20% of the 40 new fabs announced and/or planned worldwide, but only 11% of their equivalent capacity. The number of such announced and/or planned but not committed new fabs worldwide has decreased noticeably from 54 to 40 in the last year. If all of these additional new fabs were completed and ramped into full production at mature yields, China's share of total worldwide semiconductor wafer production would increase from the approximate 2% realized in 2003 to 10.3% by 2015. This is somewhat lower than the plans of three or four years ago and could have an only moderate impact on the semiconductor industry.

While it remains unlikely that all of these announced and/or planned wafer fab plants will be realized, they do provide a measure of the evolving prospects for China's semiconductor industry. Five of the eight will be 12-inch (300mm) fabs, which would account for 78% of the potential additional capacity. The other three are 8-inch (200mm) fabs. Six of the eight are planned for foundry and two for IC IDM production. There are no new announced and/or planned OSD, MEMS or R&D fabs in China at this time. Elpida, (Japan), Siltera (Malaysia), UMC (Taiwan) and Ultimate (Malaysia) are involved with four of these eight possible additional wafer fabs, including the smallest (Ultimate) and the largest (Elpida). All told, these represent 59% of possible additional capacity.

Design in China

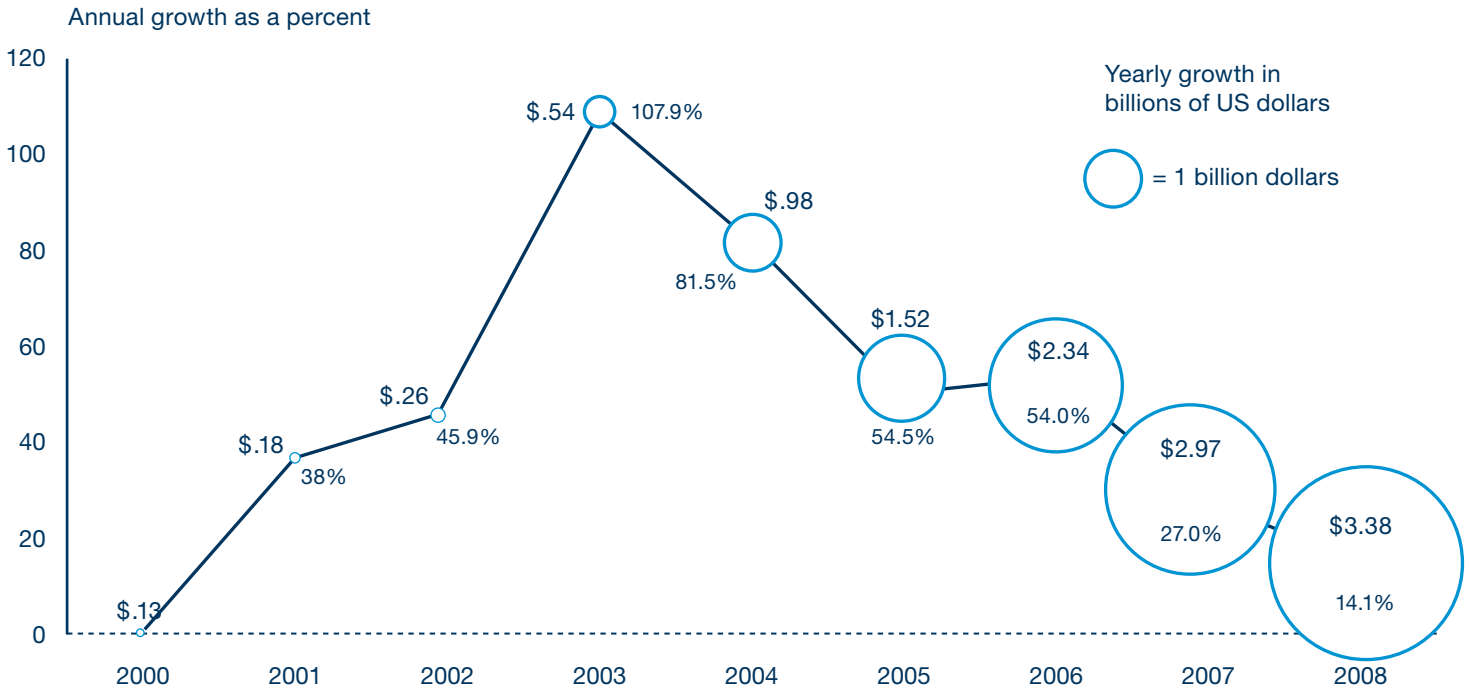
Integrated circuit design

IC design was the only segment of the China's IC industry that achieved positive year-over-year growth in 2008. It remains the fastest growing segment of China's semiconductor industry for this decade.

IC design revenues grew from US$178 million in 2001 to US$3.4 billion in 2008, a CAGR of just over 52%. As this sector has grown, its growth rate has decreased from a peak of 108% in 2003 to a plateau of about 55% in 2004 and 2005. The growth rate continued to fall in 2007 (to 27%) and 2008 (to 14%). Of note, China's IC design sector dollar revenues grew by 14.1% in 2008 despite a 2.8% decline in the worldwide semiconductor market.

While China's IC design revenue growth for 2008 (14%) exceeded that of China's IC manufacturing and IC packaging and testing industry sectors (8%), it was slightly less than that of the much larger OSD sector (23%). In fact, the sector's growth rate was below the overall average growth of China's semiconductor industry for the first time since 2004.

Figure 14: China's IC design industry revenue and growth



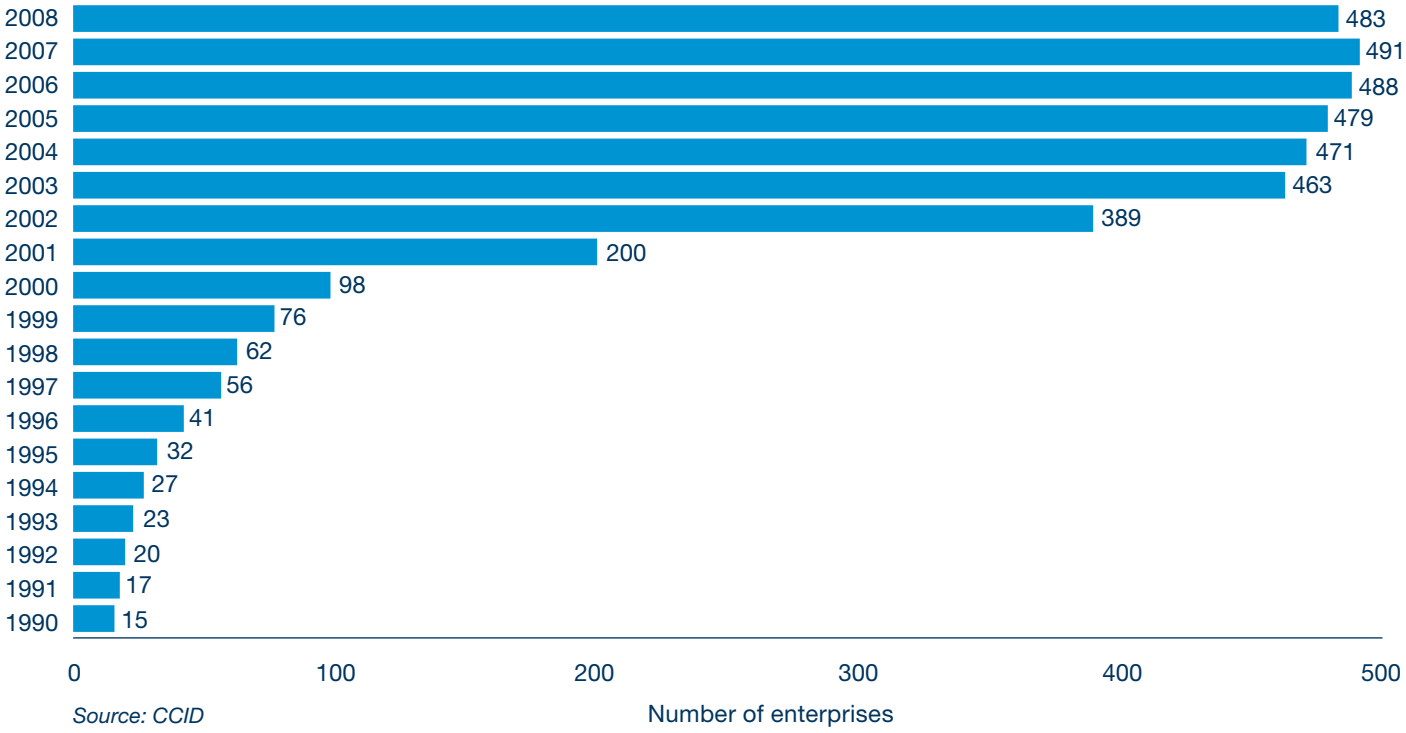
Source: CCID, CSIA

Overall, the IC design sector's share of China's semiconductor industry remained at 10.8% in 2008 for a third consecutive year. Most of the revenue in this sector can be attributed to China's fabless semiconductor companies, which in 2008 constituted about 6% of the US$55 billion worldwide fabless semiconductor industry. This is up from a 1% share in 2001 and a 4% share in 2004. Much of the relative resilience of China's IC design sector during the 2008 downturn can be attributed to fabless firms who concentrated on designing for China's growing domestic market.

Design enterprises

China had 483 IC design enterprises at the close of 2008, according to China Center of Information Industry Development (CCID) Consulting. This is a decrease from 491 reported at the close of 2007 and is believed to be the start of a consolidation and survival of the fittest phase.

Figure 15: Number of Chinese IC design enterprises



Source: CCID

With significant slowdowns in the Chinese and worldwide semiconductor markets, competition between Chinese IC design enterprises intensified. Many of these enterprises' products had concentrated on low-end consumer applications and the differentiation between enterprises and products became blurred as the applications became more homogeneous.

Price wars became the common mode of competition and the slow down in new markets further restricted the operations of some IC design enterprises focusing on those markets. This environment places a severe strain on many of China's IC design enterprises and several have had difficulty surviving. Some IC design enterprises went bankrupt in 2008 and more are predicted to do so or go through reorganization in 2009. It is estimated that there are currently no more than 100, possibly less than 50, local indigenous IC design enterprises that are truly viable.

Of the 483 IC design enterprises reported at the end of 2008, approximately 100 were the design units or activities of foreign-invested or subsidiary multinational companies. Of this group, PricewaterhouseCoopers analysis has identified over 90 participants. This group remains concentrated among the largest of the more than 275 multinational semiconductor companies and the 100 largest semiconductor-consuming OEMs identified in the Gartner Dataquest market share databases. It includes the Chinese design activities of 18 of the top 25 multinational semiconductor companies and 24 of the top 100 semiconductor-consuming OEMs. The drivers behind these multinational design activities in China include:

- Protecting their long-term access to local markets by demonstrating participation in the country's technology growth initiatives;
- Servicing large Chinese OEMs who are addressing the worldwide market;
- Developing products for the unique and specific standards and requirements of the Chinese market;
- Developing and utilizing China's large pool of lower cost talent;
- Participating in the government's economic stimulus and other long-term infrastructure development initiatives; and
- Qualifying for NHTE (New and High Tech Enterprise) status tax incentives.

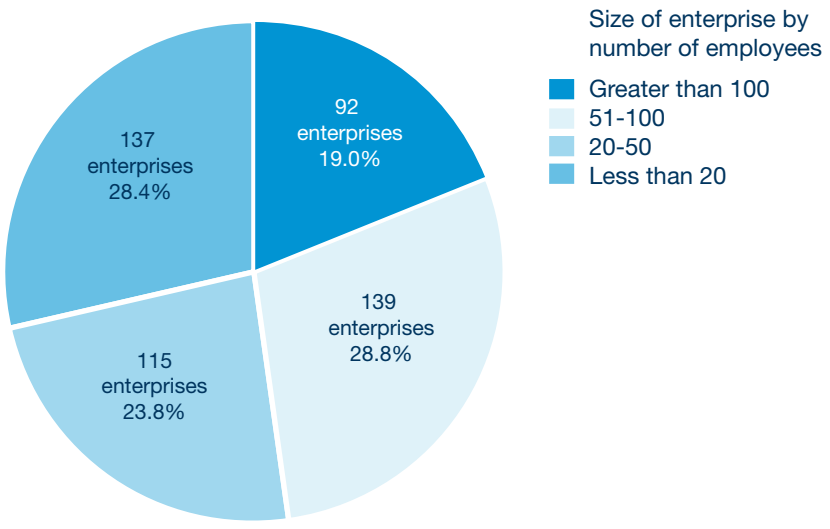
Design employees

There has been a reported increase in the employee density among the IC design enterprises. Although the number of reported IC design enterprises in China decreased by about 2% to 483 in 2008, the number of employees has increased by at least 18%. Compared to 2007, the number of enterprises with more than 100 employees has increased by 39% (26 enterprises), while the number with less than 50 employees has decreased by 19% (60 enterprises). Similarly, by the end of 2008, more than a quarter of China's IC design enterprises had less than 20 employees and more than half had less than 50 employees. This is a reduction from more than one third with less than 20 employees and almost two thirds with less than 50 employees reported at the end of 2007.

However, this increase in employee density has resulted in reduced productivity for several of China's better recognized public IC design companies. Five Chinese IC design companies were reported in the latest Global Semiconductor Alliance (GSA) Global Financials Report. Based on 180 fabless companies worldwide, GSA reports an average of US$343,000 sales per employee in 2008. As for Chinese companies, only one, Actions Semiconductor (568 employees), had a sales per employee productivity level that was more than one third that of the GSA average.

Specifically, Actions Semiconductor achieved sales per employee of only US$167,000 in 2008, down from US$454,000 in 2007. The other four were even lower: Vimicro (US$141,000/568 employees), Spreadtrum Communications (US$141,000/768 employees), Shanghai Fudan Microelectronics (US$99,000/416 employees) and Beijing Baida Jade-Bird (US$38,000/600 employees).

Figure 16: China's IC design enterprises by employee count, 2008



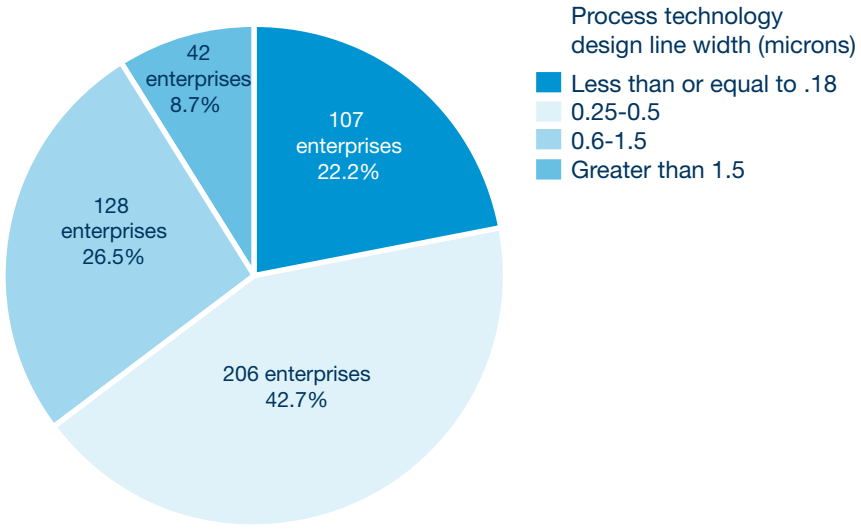
Source: CCID

Design focus

China's IC design industry continued to achieve moderate qualitative improvements in 2008. For example, there was a further migration of design capabilities to finer design line widths. According to CCID, the number and percentage of design enterprises with design capabilities of equal to or less than 0.18 micron has increased by six enterprises or almost 6% in the last year. At the same time, the number of design enterprises with capabilities of over 0.18 microns decreased by 14 (just over 4%), including eight enterprises that are no longer reported.

This was also the third year for a now-annual "China Semiconductor Products and Technology Innovation Award". Of the 12 winning chip designs for 2008, three were System on Chip (SoC), two applied 32-bit core technology and several others relied on 0.13, 0.18, 0.25, or 0.35 micron technology. This awards program is presented jointly by the China Semiconductor Industry Association, China Electronic Materials Industry Association, China Electronic Special Equipment Association and China Electronics News. Winners are determined based upon a range of criteria, including innovation, practical applications and industry conditions.

Figure 17: China's IC design industry by process technology, 2008



Source: CCID

Design industry outlook

Of the various sectors in China's semiconductor industry, the IC design segment has the best prospects for a rapid recovery from the 2008/2009 semiconductor downturn. This segment has demonstrated year-on-year growth during all but one of the most difficult quarters of the recession from Q1 08 through Q2 09.

In response to the global financial crisis, the Chinese government has introduced various measures to increase China's domestic demand. These include releasing three 3G licenses—TD-SCDMA, WCDMA and CDMA300—and extending its "Home Appliances Going to the Countryside" program to cover the entire country. TD-SCMA, middle- and low-end home appliances and local brand TVs and mobile phones are major markets for China's domestic chip manufacturers. It has also been reported that China is stepping up its initiatives to seed as many 30 fabless semiconductor start-ups that could grow to US$200 million or more in annual revenue.

It is further reported that a portion of an estimated US$586 billion Chinese economic stimulus package has been earmarked as a source for grants, loans and equipment for fabless start-ups. China's 11th Five Year Plan, covering 2006 through 2010, calls for the development of five IC design companies each worth three to five billion RMB (revenues of US$432 million to US$719 million). In addition, the plan calls for 10 companies each worth one to three billion RMB (revenues of US$144 to US$432 million). If these goals could be realized, these 15 companies alone would contribute IC design industry revenue of US$3.6 billion to US$7.9 billion by 2010.

However, the current 2008/09 semiconductor downturn places these goals beyond practical reach. The top 15 Chinese IC design companies had total combined revenues of US$1.6 billion in 2008, up 21% from US$1.3 billion in 2007. If these top 15 companies were to achieve even the lower range of the 11th Five Year Plan revenue goals they would need to achieve a CAGR of 54% over the next two years—which in the current environment seems unlikely.

In general, the 2008/09 semiconductor downturn injects a degree of greater realism to local expectations. CCID's current forecast is that China's IC design sector industry will grow slightly more than 8% in 2009 and almost 16% in 2010 to US$4.24 billion. Still, this is a reduction of almost 44% from the forecast of only a year ago. If this more recent forecast is realized, China's IC design industry will represent more than 8% of worldwide fabless semiconductor revenues and about 2% of the worldwide IC market.

The primary factors that could facilitate such industry growth include:

- Growth in the domestic consumption of electronic products;
- Continuation of China's better-than-worldwide IC market performance;
- Resumption of China's IC market growth;
- Growth of China's major indigenous OEMs;
- Support from favorable government policies and programs;
- Continuing availability of low-cost engineers and technicians;
- Increasing presence of foreign design enterprises; and
- Progress in local product design innovation.

Factors that could hinder China's IC design industry growth include:

- Lagging technology;
- Increasing global competition;
- Low research and development (R&D) spending;
- The small IC industry scale;
- Increasing investment requirements and limited investment funding;
- Low value-added IC industry services; and
- A continuing shortage of high-level design and design management talent.

China and the semiconductor value chain

Value chain revenue

In aggregate, semiconductor value chain revenues decreased 5.6% as a result of the 2008/09 semiconductor downturn. Still, the semiconductor intellectual property, fabless, foundry and materials sectors all had modest increases in revenue in 2008—driven by shifts to the outsourced or fabless business model and more advanced and expensive materials. However, increased revenues in these sectors totaled only US$3.2 billion and were more than offset by the significant US$10.1 and US$13.3 billion decreases experienced by the IDM and semiconductor equipment sectors.

Table 8 lists worldwide semiconductor value chain revenues for 2000, 2006, 2007 and 2008 compared with forecasts for 2010. For comparison purposes, the 2010 forecast and the CAGR for the ten-year period remain unchanged from our original 2004 report.

The 2008/09 semiconductor downturn has significantly changed industry expectations. The current consensus is that 2009 will result in a further decline of almost 16% in aggregate semiconductor value chain revenues and that the following recovery will only restore 2010 revenues to about the 2008 level. This means that the semiconductor value chain will have realized a compounded annual growth rate in revenues of only 1.8% for the decade instead of the 5% originally forecast in 2004. Such will be the combined impact of the 2000/01 and 2008/09 semiconductor industry downturns.

Table 8: Worldwide semiconductor value chain revenue and original forecast, 2000–2010 (in billions of US dollars)

	Actual				Original report	
	2000	2006	2007	2008	2010	CAGR 2000–2010
Electronic design automation	3.8	4.3	4.8	4.2	7.8	7
Semiconductor intellectual property	0.7	1.0	1.9	2.1	2.3	13
Equipment	52.5	40.6	42.8	29.5	43.3	-2
Materials	26.6	36.1	42.5	42.7	35.7	3
IDMs	184.0	199.8	203.3	193.2	291.7	5
Fabless	20.4	49.7	53.0	55.4	44.6	9
Foundries	7.4	23.3	23.9	24.4	49.6	21
SATS	10.9	19.1	20.6	20.1	26.0	9
Totals	306.3	373.9	392.8	371.6	501.0	5

Source: EDAC, Gartner Dataquest, GSA. SEMI, SIA, PwC 2001–2008

Table 9 presents our current analysis of China's estimated contributions to worldwide semiconductor value chain revenues for 2008. China's role within each value chain segment is characterized on the basis of its relative revenue for production and consumption (where data is available).

China's role on the production side continues to be most significant in discrete device manufacturing, SATS and foundry operations. The nation's role is only somewhat significant in IDM assembly and test operations. In 2008 China contributed more than 30% of worldwide discrete device revenues, almost 25% of worldwide SATS revenues and almost 15% of worldwide wafer foundry revenues. China has grown to become the dominant supplier of several lines of low-cost commodity discrete devices. Examples are small signal diodes and transistors for major IDMs who either have their discrete manufacturing operations in China or have entered into rebranding programs with indigenous Chinese suppliers. China's noticeable presence in the SATS and foundry segments has increased market competitiveness, placing downward pressure on prices as well as providing alternative sources of capacity for small and start-up fabless companies.

In the last three years China's fabless revenues have increased by almost 125%, but still represent only slightly more than 6% of worldwide fabless revenues. During that same time period, China's IDM (including OSD) revenues increased by more than 105% to represent almost 8.5% of worldwide IDM

Table 9: China's contribution to worldwide semiconductor value chain revenue, 2008 (in billions of US dollars)

	Worldwide	China		
	Revenue	Sales	Consumption	China's role
Electronic design automation	4.2	n/a	0.15	Software user, not EDA producer
Semiconductor intellectual property	2.1	n/a	0.20	Licensees by IC design and foundries; not licensor
Equipment	29.5	0.09†	1.89	First-tier and wafer-fab buyer; used equipment favored; solar and second- or third-tier producer
Materials	42.7	0.34†	3.43	First-tier buyer, solar and second- or third-tier producer
IDM	193.2	16.4	81.0	Plant location for MNC IDMs' SPA&T and 2 fabs; local source of OSD and smaller IC IDMs
Fabless	55.4	3.4	22.8	Small but continually growing local capabilities
Foundries	24.4	3.6	10.8	Substantial; 23% worldwide foundry capacity by 2011
SATS	20.1	5.2	8.4	Substantial: almost 20% worldwide SATA capacity
Totals	371.6		128.67	

† Chinese domestic equipment and materials companies only, without local subsidiaries of foreign companies.

Source: CSIA, EDAC, Gartner Dataquest, GSA, SEMI, PwC

revenues. In aggregate, China's semiconductor value chain production revenues have increased to represent almost 8% of the 2008 worldwide semiconductor value chain.

On the consumption side, more than 67% of the semiconductor devices China consumed in 2008 were used in the manufacture of electronic products for export. By corollary, almost one third were used in electronic products for domestic consumption within China. This share of semiconductors used for electronic products for domestic consumption is expected to increase as a result of China's economic stimulus package and other government initiatives.

China also continues to be a growing buyer of materials, a cyclical user of equipment and a modest licensor of semiconductor property and electronic design automation tools. Due to China's relatively large and growing share of semiconductor packaging, assembly and test production, its materials use continues to be somewhat more concentrated in back-end materials rather than in wafer fab materials. In the last three years China's semiconductor value chain aggregate consumption has increased by 90%. Based on 2008 results, the country now consumes 35% of the worldwide semiconductor value chain, compared to only 21% in 2005.

Packaging, assembly and test production

On net, China reported eight additional semiconductor packaging, assembly and test (SPA&T) facilities in 2008, bringing the total to 107. Though the country reported the addition of 12 new facilities—and that others were expanded—four more were closed. These 107 facilities represent:

- 20% of the total number of worldwide SPA&T facilities;
- 17% of worldwide SPA&T manufacturing floor space (ranking third behind Taiwan with 20% and Japan with 19%); and
- 18% of reported worldwide SPA&T employees.

China's eight net new facilities represent an 8% nominal increase. Meanwhile, the number of worldwide SPA&T facilities increased by a net 66 to a total of 548 (a 14% increase). Overall, China's share of net new reported facilities in 2008 was 12%.

Most of the increase in both China and worldwide SPA&T facilities results from under-reporting in prior years. For example, reported SPA&T manufacturing space in China increased by a net of 3.3 million square feet (31%) during 2008, while SPA&T manufacturing space reported worldwide increased by 10.2 million square feet (14%) to a total of almost 82 million square feet. Here, China accounts for 33% of newly reported worldwide SPA&T manufacturing space. However, this relatively large share was about equally the result of (1) better reporting of prior listed but not space measured facilities and (2) actual expansions plus newly listed facilities.

Figure 18: Comparison of China and all remaining countries' SPA&T resources, 2008

Source: Gartner Dataquest 2009

Only two SPA&T facilities in China out of a total of seven worldwide actually started production in 2008.

China continues to have the largest share of planned future SPA&T facilities. Of 16 planned worldwide at the end of 2008, five were located in China. This compares to two each in Taiwan, Vietnam and Philippines and one in each of five additional countries. These five Chinese sites represent 31% of planned facilities worldwide and more than 45% of planned manufacturing space.

In terms of ownership of SPA&T facilities, very little has changed in 2008. Of the total 107 SPA&T facilities in China, about one third belong to Chinese companies. A further 13% of China's SPA&T facilities belong to companies from Taiwan (10%) and Hong Kong (3%). The largest foreign ownership is that of companies from the US who own almost 22% of China's SPA&T facilities.

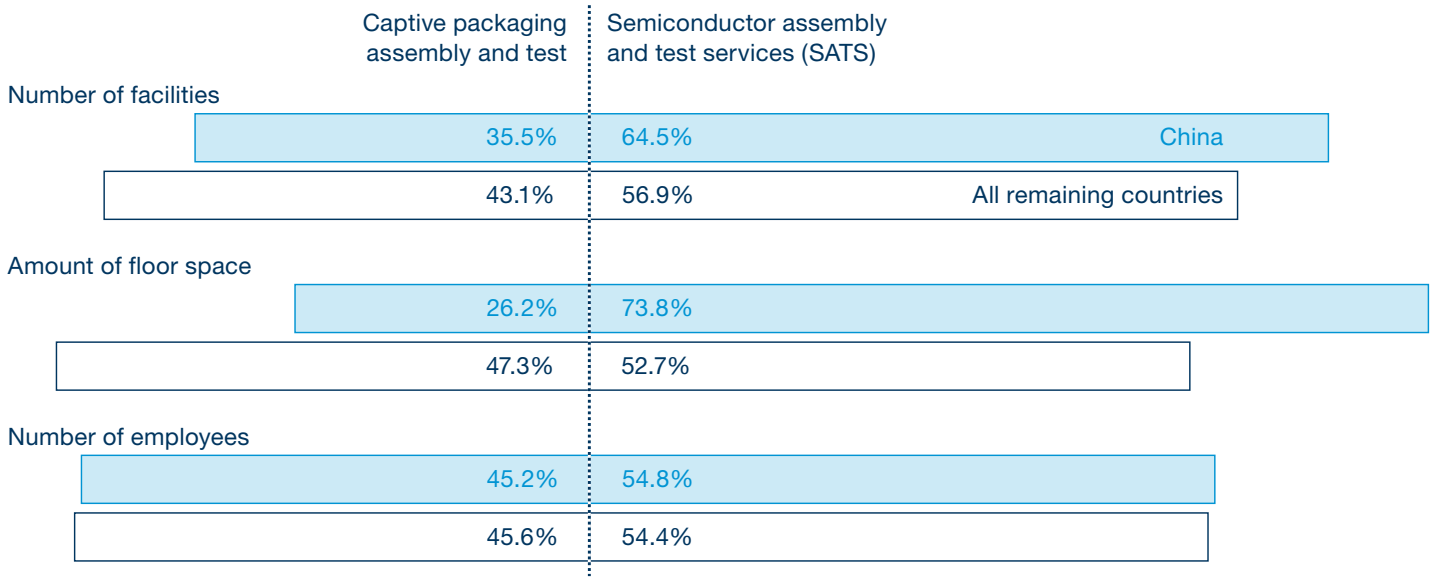
China continued to gain share of worldwide SPA&T production value during 2008. The value of China's IC SPA&T production increased in 2008 to represent just over 15% of the value of worldwide production in 2008, up from 13% in 2007. Similarly, the value of China's OSD production reached an estimated 32% of worldwide production in 2008, an increase from 26% in 2007. The composite weighted average of China's 2008 SPA&T production is estimated to be slightly less than 18% of worldwide, up from 15% in 2007.

China's increased share of worldwide SPA&T value during 2008 was more the result of a changing mix and increasing ASP (average selling price) than of increases in volume. At the same time, China's SPA&T production continues to be more heavily utilized for higher volume and lower cost packages and products. Specifically, China's IC SPA&T accounts for about 25% of worldwide unit volume, while China's OSD SPA&T accounts for about 54% of worldwide unit volume in 2008—about the same proportions as in 2006 and 2007.

Semiconductor assembly and test services (SATS)

Figure 19 shows the share of China's SPA&T capacity that is dedicated to SATS suppliers compared with all other regions. China's share remains somewhat more concentrated than that of other regions. SATS resources represent 74% of China's SPA&T manufacturing floor space and 65% of China's SPA&T facilities versus 53% and 57% for all other countries.

Figure 19: Comparison of China and all remaining countries' SATS share of SPA&T capacity, 2008



Source: Gartner Dataquest 2009

At the end of 2008, 69 SATS facilities were in production in China. Of these, 34 were owned by Chinese companies and 35 by foreign companies. Each of the five largest and eight of the ten largest multinational SATS companies had one or more facility in China. By comparison, 37 of the 38 IDM SPA&T in production in China by the end of 2008 were owned by foreign companies and only one, Jingsu Chiangjiang, was owned by a Chinese company.

Two of the Chinese SATS companies have grown to rank among the 15 largest SATS suppliers on a worldwide basis. They are Xinchao Group (including JCET and JCAP) and Natong Fujitsu with almost 3% and 2% worldwide 2008 market share respectively. These have grown to achieve sizeable scale in the leadframe segment of the SATS sector, giving them greater ability to influence pricing.

Equipment sales and market share

The 2008/09 semiconductor downturn had a very direct impact on equipment sales. Semiconductor equipment sales to China decreased by 35% in 2008, to US$1.89 billion, the lowest level since 2005. This correlates with worldwide equipment sales which fell by 31% in 2008 to US$29.5 billion, the lowest value since 2003. Topping the list, the Taiwan equipment market recorded a 53% decline.

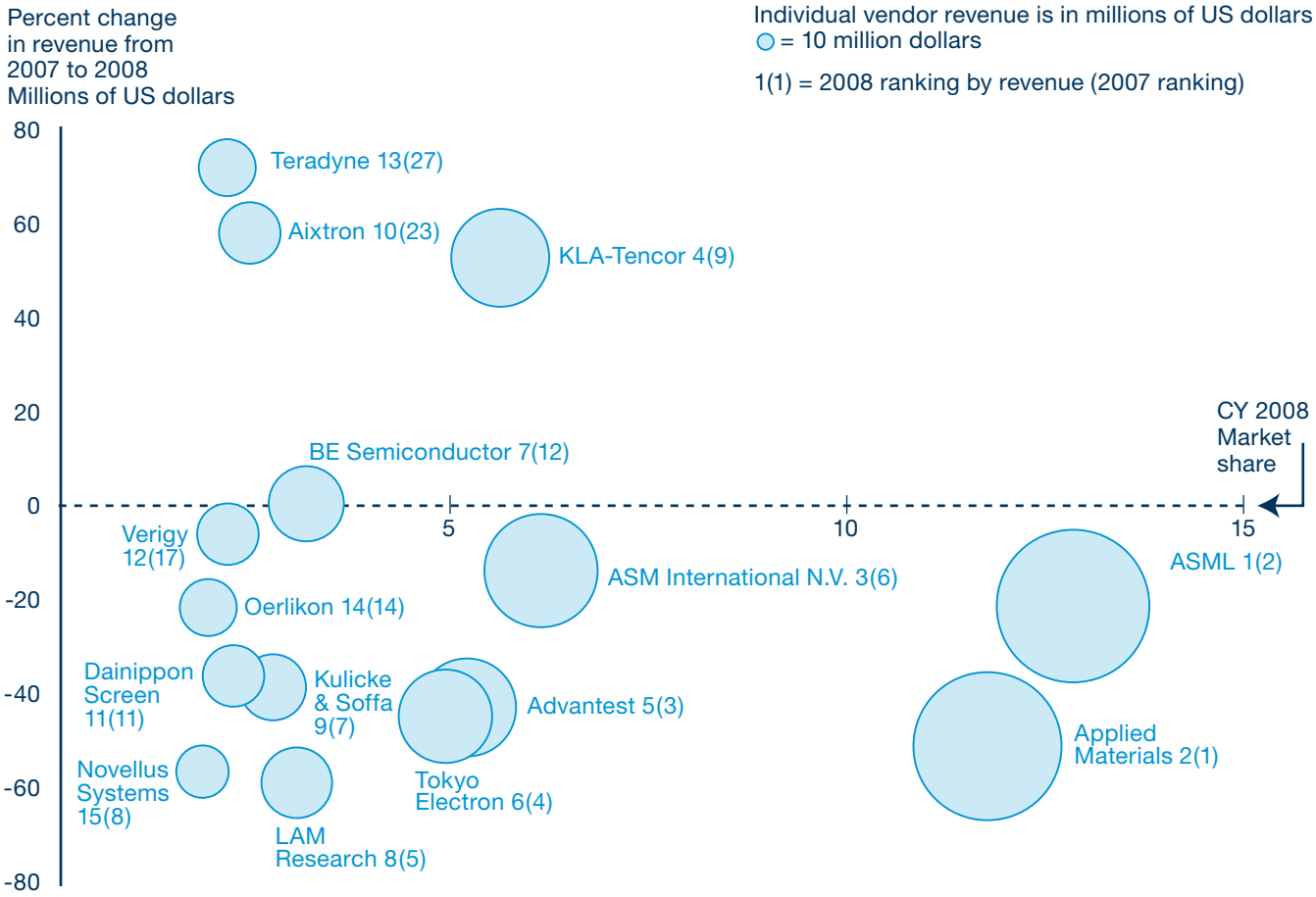
China's semiconductor equipment market remains a relatively small share of the worldwide market. From 5.7% of worldwide equipment sales in 2003, its share rose to 7.0% in 2007 before declining to 6.4% in 2008. Current estimates are that it will decline to an even smaller 5.5% share of a much reduced worldwide market in 2009 before recovering to a 7.7% share of a still depressed 2010 worldwide market.

More than anything else these swings in semiconductor equipment sales in China reflect the equipping and ramping to full production of several very large 300mm wafer fab installations. Specifically, this means the Hynix-Numonyx and SMIC Wuhan fabs in 2007 and 2008 and the Intel Dalian fab in 2009 and 2010. During 2008 the distribution of China's equipment market shifted slightly from 63% wafer fab equipment in 2007 to 58% in 2008 with the remainder split between packaging and assembly equipment (32%) and testing equipment (10%).

At the end of 2008 China had eight wafer fab plants both committed and under construction. These represent 24% of the 33 new plants under construction worldwide, but only slightly more than 15% of their capacity. China continues

to add less capacity and spend less on equipment per new wafer fab plant because they are adding a greater proportion of smaller 4-inch (100mm) and 8-inch (200mm) plants than other regions. This includes less than a fifth of the proportion of 12-inch (300mm) plants.

Figure 20: Equipment sales to China by vendor revenue

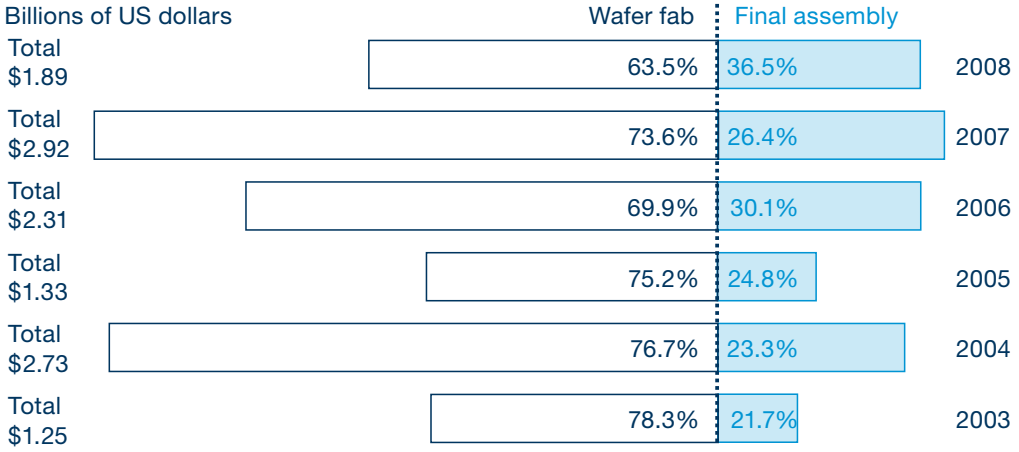


Source: Gartner Dataquest 2009

Gartner Dataquest indicates that the sales of the 15 largest semiconductor equipment suppliers to China decreased 32% in 2008, to US$1.56 billion, representing almost two thirds of the market. This is slightly less concentrated than the worldwide market, where the top 15 suppliers represented just over 70% of the market. The concentration and ranking of the top 15 suppliers with the largest market share in China (shown in Figure 20 on previous page) changed somewhat in 2008, with Sokudo, Disco and Varian being displaced by Teradyne, Aixtron and Verigy. Eight of these top 15 are suppliers of wafer fab equipment, four of packaging and assembly equipment and three of testing equipment.

In addition to the recognized international suppliers to the Chinese semiconductor equipment market, a large and growing number of companies are trying to establish a viable presence in the market. These include many regional as well as some 80 indigenous businesses. As a group, these other suppliers were also impacted by the 2008 downturn as their sales in China decreased by 33% during the past year.

Figure 21: China's semiconductor equipment market and growth



Source: SEMI, Solid State Technology 2006 -2009

However, the China Electronic Specialized Equipment Industry Association (CESEIA) reports that the indigenous Chinese semiconductor equipment industry increased its sales of semiconductor equipment by 37% in 2008, to about US$90 million. The CESEIA also reports that the Chinese semiconductor equipment industry total sales grew 57% in 2008, to US$344 million—with 74% of this revenue coming from the sales of solar cell equipment (which grew by 71% during the year).

Of note, the solar sector appears to present the best opportunity for China's semiconductor equipment industry and materials suppliers to achieve significant growth after the recovery from the 2008/09 semiconductor downturn. As a result of downturn-induced plant consolidations and closures, the worldwide semiconductor equipment market will likely be saturated with competitively priced used equipment for established technologies.

Therefore the only market for new semiconductor equipment will focus on advanced technologies, with the number of potential customers being dramatically reduced to a limited number of major IDMs and foundries. Very few, if any, of the indigenous semiconductor equipment companies have the capabilities to succeed in this market environment. By comparison, China has a dynamically growing solar industry, with a developing technology that seems much more suited to the capabilities of the indigenous semiconductor equipment companies.

Integrated circuit consumption/production gap

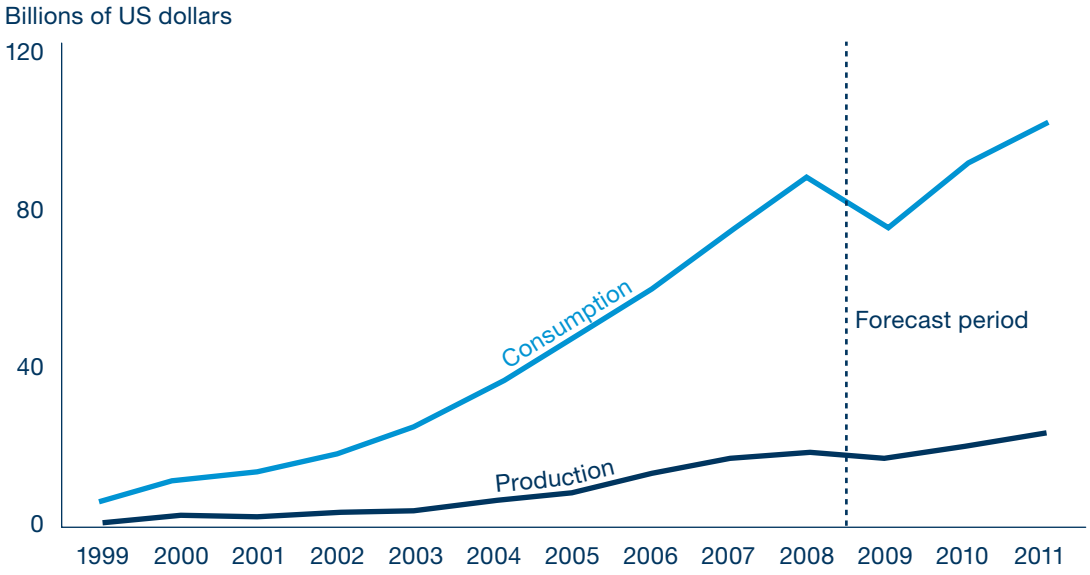
Another impact of the 2008/09 downturn is the second largest annual increase in China's IC consumption/production gap. This gap is the difference between IC consumption and IC industry revenues. The downturn had a greater negative impact on China's IC industry revenue in the third and fourth quarters of 2008 than it did on China's IC market. Reported in RMB, China's IC industry revenue (production) decreased 2.7% and 20.8% in the third and fourth quarters, while China's IC market grew 6.4% in the third quarter, but then decreased 13.7% in the fourth quarter. As a result, while China's annual IC consumption reported in RMB increased 6.2% in 2008, IC production decreased by 0.4%.

Measured in US dollars, China's annual IC consumption increased 16%, or US$12 billion, while IC production increased 9%, or US$1.5 billion. Consequently, China's IC consumption/production gap increased by US$10.5 billion to reach US$68 billion for 2008. This gap continues to grow despite all of the Chinese government's plans and efforts to contain it. This annual gap has now grown from US$5.7 billion in 2004 to a record US$68 billion in 2008—and Chinese authorities expect this trend to continue through at least 2011.

According to the China Semiconductor Industry Association (CSIA) 2009 report, China's IC market is forecast to grow to US$102 billion by 2011, with IC industry revenues expected to reach US$23 billion. This forecast implies a further widening of China's IC consumption/production gap to US$79 billion.

While recovery from the 2008/09 semiconductor downturn may change the timing and absolute value of China's IC market consumption and IC industry revenue in the near term, we do not believe it will change their relative relationship over the longer term. The gap will decrease in 2009 due to decreases in both China's IC market and industry revenues. However, we expect that China's IC market consumption will recover sooner and grow faster than China's IC industry revenue. Therefore, China's IC consumption/ production gap will continue to increase thereafter through 2011 and probably through the remainder of this next semiconductor industry cycle. It is our belief that this gap continues to contribute to the Chinese government's continuing initiatives to increase indigenous production.

Figure 22: Comparison of China's integrated circuit consumption and production, 1999–2011



Source: CCID, CISA, PwC 2004-2009

Greater China

Preface

The global economic downturn had a noticeable impact on the semiconductor industry in the Greater China region which includes China, Hong Kong and Taiwan. While the three areas feature a high level of interdependence, the semiconductor downturn was especially harsh in Taiwan. Here, exports of high-tech electronic goods, including semiconductors sent to China, dropped off the proverbial cliff toward the end of 2008. Overall, Taiwanese semiconductor companies' product revenues fell by 11.5% in 2008, to US$18.4 billion, a much steeper drop than the worldwide semiconductor market average decline of 2.8%.

In response to the severity of the downturn, several of Taiwan's semiconductor companies temporarily shut down or slowed their production lines, slashed their capital expenditures and disposed of assets. Oversupply and falling demand hit Taiwan's DRAM sector particularly hard, resulting in liquidity problems at several manufacturers who subsequently petitioned the government for a bail out. While industry consolidation in Taiwan is very likely, the direction it will take remains in question.

Taiwan's DRAM industry rescue plan

The global recession worsened an already severe downturn in Taiwan's DRAM industry, which makes nearly a quarter of all the world's memory chips that are widely used in personal computers. The Taiwan government has repeatedly stated its intention to ensure the long-term survival of the industry. Still, it has been reluctant to bail out the island's six DRAM manufacturers, which lost a combined US$12.5 billion from 2007 through 2008, accumulating US$11 billion in debt.

Taiwan's DRAM makers include:

- Nanya Technology Corp.
- Inotera Memories Inc. (a joint venture between Nanya and America's Micron Technology Inc.)
- Powerchip Semiconductor Corp.
- Rexchip Electronics Corp. (a joint venture between Powerchip and Japan's Elpida Memory Inc.)
- ProMOS Technologies Inc.
- Winbond Electronics Corp.

All have been hard hit by the global recession due to slumping demand for their memory chips. Also, over-investment in new factories a few years ago created a chip glut, leading to falling DRAM prices and mounting losses for producers.

The government's rescue efforts have primarily focused on establishing a self-sufficient technology capability, as Taiwan's DRAM makers have long manufactured chips using technology from foreign companies. In March 2009, the government announced plans for the establishment of a new state-backed company, Taiwan Memory Company (TMC), which will partner with Elpida to develop more customized, higher-margin memory chips. TMC will reportedly have no production capabilities of its own, but will instead contract local firms to produce products using its newly developed technology. TMC would then in turn sell these products to its customers. In other words, TMC will be a fabless design house that outsources manufacturing to DRAM makers.

Lawmakers have threatened to derail the government's attempts to shore up Taiwan's troubled DRAM industry, arguing that TMC will become a competitor to existing companies. Indeed, several chipmakers ruled out participating in TMC, and opted to come up with their own rescue plans by either securing new funds, extending bank loans or strengthening cooperation with foreign partners. In response to TMC's inability to gain traction from local chip makers, the government put forward a new plan in mid-July to extend up to US$915 million to new and existing players as an investment, not a loan. However, they have to present plans to develop technology with foreign partners and propose restructuring options, such as mergers or acquisitions, that would benefit the wider industry.

China stimulus revives Taiwanese chipmakers

Despite much bad news for the DRAM sector, China's 4 trillion RMB (US$586 billion) spending plan, which was launched in December 2008 to boost domestic demand in the face of a slumping export market, provided a much-needed fillip to Taiwan's semiconductor companies. China's rural economic-stimulus program, which includes subsidies for a variety of consumer electronic products, as well as the build out of China's 3G cellular infrastructure, helped boost demand for the semiconductor chips used in PCs, flat-screen TVs, cell phones and other electronic gadgets.

Though reeling from falling orders from the US and Europe in the first half of 2009, Taiwanese chipmakers nonetheless benefited from robust Chinese demand, prompting several to upwardly revise their outlook. In fact in June 2009, Taiwan Semiconductor Manufacturing Co. (TSMC), the world's largest

contract chipmaker, bet on recovery by restoring investment plans curtailed only two months previously and expanding its R&D team. TSMC is playing a growing role in the global chip industry as IDMs are increasingly outsourcing production, largely because of poor market conditions and the rising cost and complexity of making advanced chips. For instance, in March 2009, Intel turned to TSMC for help in making its microprocessors, the first time the US company has outsourced production. Two months later, Fujitsu Microelectronics announced that TSMC would make some of its chips.

China's growing impact on Taiwan's semiconductor industry can also be seen from moves by the island's largest IC design house, MediaTek Inc., to use the mainland as a stepping stone to become a global chip powerhouse. Mediatek, one of the few semiconductor companies to have thrived in the downturn, has grown rapidly in recent years on the back of China's expanding mobile phone market. It is the biggest supplier of chips used in low-priced mobile phones in China, and is aiming to challenge bigger US rivals Broadcom and Qualcomm by supplying chips to global handset makers such as Nokia. Impressed by MediaTek's prowess in China, Microsoft has teamed up with the company to develop smartphone chipsets for the emerging Chinese 3G market.

Taiwan opens door to Chinese investment

In another sign of the further strengthening of economic ties across the Taiwan Strait, in July 2009, the Taiwanese government lifted a long-standing ban on direct Chinese investment in the island's companies. Even so, the semiconductor industry remains off limits, for the time being at least.

The new rules will allow Chinese companies and investors to invest in 64 sectors of Taiwan's manufacturing industry, 25 sectors of the service industry and in 11 infrastructure projects. The liberalized investment rules significantly open up opportunities for Chinese firms, but they still give the Taiwanese government tight control over the approval process. For this reason, it may be some time before substantial mainland investments take form.

Taiwan will also continue to exclude Chinese investment in utility industries and business sectors that play a key role in domestic economic development, financial stability or national security. These include the semiconductor, flat panel display, solar panel making and telecommunications sectors. Government officials said these sectors may come up for consideration during an eventual second round of liberalization, but there is no timeframe on further opening up of Taiwan's industries to Chinese investment. For that reason, China-based electronics makers eager to obtain advanced technologies are likely to initially focus on sourcing Taiwan-made products to establish relations with Taiwanese manufacturers, thereby paving the way for investment opportunities in the future.

Taiwan still mulling loosening semiconductor restrictions

Taiwan's chipmakers are just as eager to further improve the symbiotic relationship with China by building their presence on the mainland through direct investment and mergers and acquisitions. However, the Taiwanese government has still yet to decide whether to allow its semiconductor makers to build 12-inch wafer fabs in China. Amid concerns over advanced technology transfers, Taiwan currently has permitted the set up of only three 8-inch chip plants by Taiwanese companies in China—including one each by TSMC and ProMos, while the third approved fab has not yet been built by Powerchip. The government said it will seek to comply with the Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies in dealing with the issue, but it may take some time to arrive at a final decision.

Notwithstanding Taiwan's pending policy for fab investment in China, United Microelectronics Corporation (UMC), the world's second-largest pure-play foundry after TSMC, has pushed ahead with its plans to make aggressive inroads into China's fast-growing chip market. In June 2009, UMC received shareholder approval to raise its investment stake in China-based Hejian Technology (Suzhou) Co. Ltd.—a semiconductor foundry set up by former employees of UMC—from 15% to 85%. However, the acquisition is still subject to the approval of Taiwan's Investment Commission.

Many of Taiwan's technology companies that set up in China were initially attracted by its cheap labor. And to get through the door they were prepared to shift some expertise to the mainland. But the most advanced work in critical areas, notably semiconductors, remains in Taiwan. Such technology is the most appealing to Chinese companies looking to invest in Taiwan. But it is also what Taiwan is most reluctant to give up, hence the government's foot dragging over the issue.

Greater China's impact on the semiconductor industry

Within Greater China, the 2008/09 semiconductor downturn had a much more noticeable impact in Taiwan than in China. Taiwan's semiconductor (consumption) market declined by 16% in 2008, to US$9.3 billion, while China's market grew by 17%, to US$104 billion. Reported in local currencies, Taiwan's market decreased almost 20% in new Taiwan dollars (NTD), while China's market increased almost 7% in RMB.

Either way, the difference between the two markets reflects the continued and sustained transfer (or off-shoring) of worldwide electronics equipment production to China from other locations including Taiwan. As a result, China's consumption of semiconductors has grown to be more than ten times that of Taiwan in 2008.

A conspicuous portion of that market consumption in China is being created by Taiwanese electronic manufacturing service (EMS) and original design manufacturer (ODM) companies. As a result, Greater China's semiconductor market grew 8% in 2008 to reach US$113 billion, constituting almost 44% of the worldwide market.

We gauge semiconductor market share by region including Greater China to be:

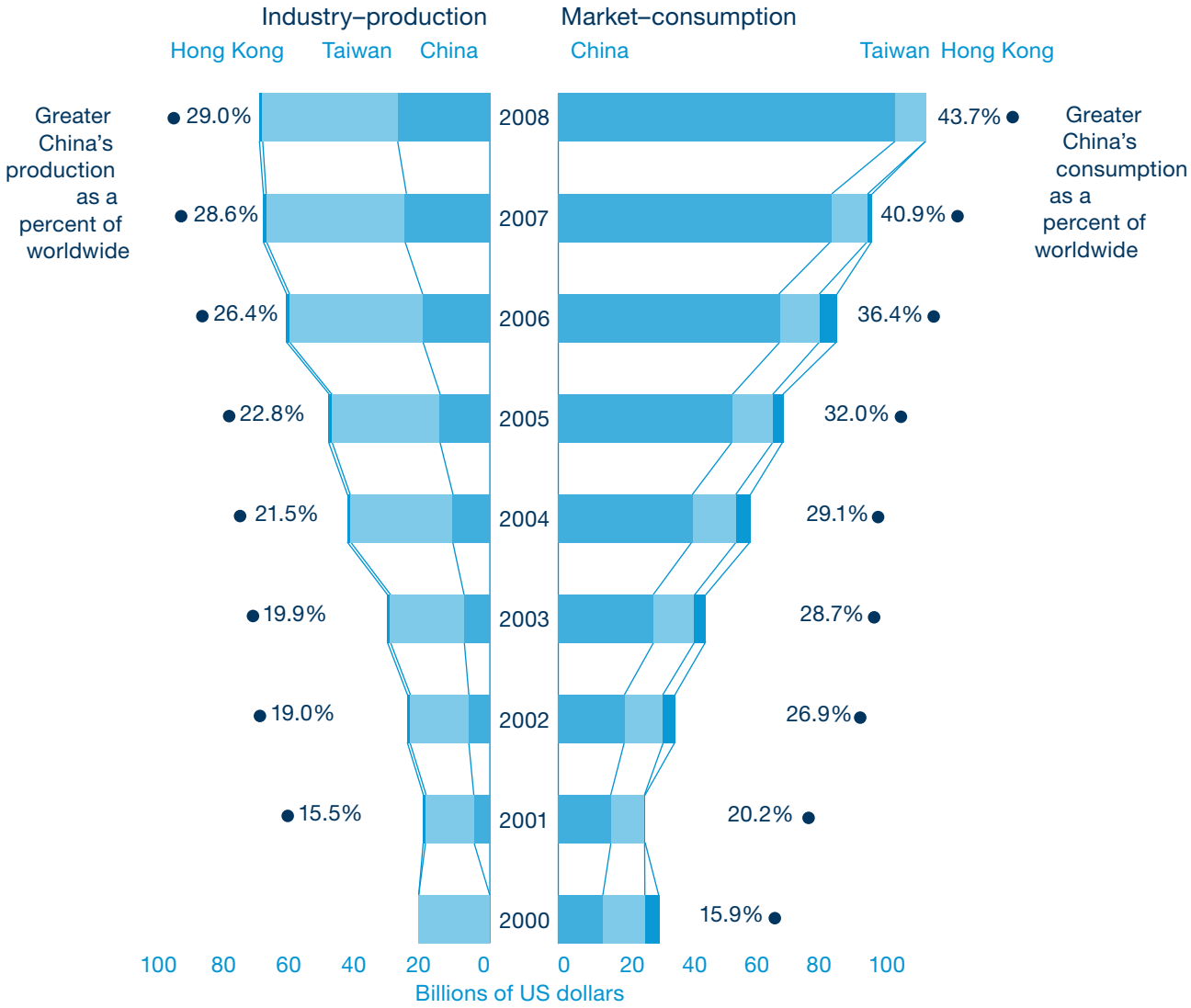
	2005	2007	2008	Change (05-08)
Greater China	32%	39%	44%	+12%
Japan	20%	19%	20%	+0%
Americas	18%	17%	15%	-3%
Europe	17%	16%	15%	-2%
Rest of world	13%	9%	6%	-7%

Taiwan's semiconductor industry continues to be much larger, uses more advanced technology and features more renowned companies than China's. Nonetheless, Taiwan was also more vulnerable to the downturn. Taiwan's IC industry revenues declined by 4% in 2008, to US$42.7 billion, even as China's IC industry grew by 9%, to US$17.0 billion. Reported in local currencies, Taiwan's IC industry decreased 8% in NTD, while China's decreased less than 1% in RMB.

The majority, 65%, of the decrease in Taiwan's IC industry revenues was reported by the IDM/IC manufacturing sector, reflecting the crash of the worldwide DRAM market. Another 21% of the decrease came from Taiwan's IC design (fabless) sector. The remainder of the decrease was relatively evenly split between the foundry, packaging and testing sectors. As a result, Taiwan's IC industry revenue fell to only two and a half times as large as China's in 2008.

China's IC consumption/production gap (value of consumption less production) has been growing since 2000 to reach over US$68 billion in 2008. By comparison, Taiwan continues to maintain a production/consumption surplus which, in 2008, reached over US$33 billion for the second consecutive year. Therefore, Greater China had a semiconductor consumption/production gap of US$35 billion in 2008. That is a further increase from US$26 billion in 2007. While this is still significantly less than that of China alone, this gap has grown to be about 14% of the total worldwide semiconductor market.

Figure 23: Greater China's share of the worldwide semiconductor industry



Source: CCID, Gartner Dataquest, ICI, TSIA, WSTS, PwC 2004 - 2008

The downturn has altered or suspended the capacity expansion of many semiconductor companies in Greater China rather abruptly—particularly during the latter half of 2008. Based upon all the wafer fabs in production by Q4 2008, Greater China could have 28% of total worldwide fab capacity if and when these fabs are all fully-equipped and ramped-up to full production. This is an increase from Greater China's potential of 25% of worldwide capacity at the end of 2007 and would represent:

- 71% of worldwide pure-play foundry capacity
- 31% of 300mm capacity
- 30% of </= 0.12µm capacity, and
- 30% of advanced </= 80nm capacity

Fifty-two percent (52%) of all the wafer fabs that were under construction as of the end of 2008, representing 62% of their total capacity, were located in Greater China. If and when all these fabs are completed, put into production, fully equipped and ramped to full capacity, Greater China will have 31% of total worldwide wafer fab capacity, including 75% of pure-play foundry capacity, 36% of 300mm capacity and 36% of advanced </= 80nm capacity.

Four of the eight new semiconductor package, assembly and test facilities that were added worldwide during 2008 were located in Greater China. As a result, Greater China now accounts for 37% of total worldwide semiconductor package, assembly and test capacity.

In summary, in 2008 Greater China represents:

- 44% of the worldwide semiconductor (consumption) market;
- 29% of the worldwide semiconductor industry (production) revenue;
- 22% of all new wafer fabs and 62% of all fab capacity under construction;
- 28% of current worldwide wafer fab capacity;
- 31% of committed worldwide wafer capacity;
- 75% of committed worldwide pure-play foundry capacity;
- 36% of worldwide 300mm fab capacity;
- 36% of worldwide advanced, </= 80nm fab capacity; and
- 37% of worldwide semiconductor package, assembly & test capacity.

Government

Revised laws

Two new laws affecting almost all high-tech companies with operations in China became effective January 1, 2008. They are the revised Corporate Income Tax (CIT) Law and the Labor Contract Law (LCL). As discussed in the 2008 update, we believe these new laws could have an impact on the semiconductor supply chain and industry in China.

The new CIT Law changed the tax and incentive environment for many semiconductor and semiconductor value chain companies operating in China. Many of the more recent participants saw some reductions in expected incentive benefits. The playing field has been leveled for domestic companies and future incentives seem to favor R&D, IC design and foundry companies.

There were some significant clarifications to the CIT Law released during 2008. Of particular interest was the final version of the "Implementation Measures of Special Tax Adjustments (Trial)" which laid out detailed rules on administering all the aspects covered by special tax adjustments, including the mandatory contemporaneous transfer pricing documentation (TPD) requirements. Enhancement and more standardized enforcement continue to mean that companies that put more effort into tax planning and preparation could benefit.

Under the new CIT Law, New/High Tech Enterprises (NHTE) that meet specific qualifying criteria are eligible for a reduced income tax rate of 15%. Criteria include core proprietary intellectual property (IP) rights, proportion of university graduates employed and engaged in R&D, percentage of revenue spent on R&D and percentage of income from high/new tech products or services. To qualify, companies must score more than 70 on a 100-point scale.

During 2008 over 15,000 enterprises passed the assessment and obtained NHTE certification based on public statistics released by local authorities. Around 10 to 25% of these NHTEs are Foreign Invested Enterprises (FIEs), while the rest are domestic enterprises. The number of approved NHTEs is higher than initial expectation, particularly on the number of approved FIEs. Several of the companies we interviewed for this report had qualified for NHTE certification while other similar companies had not. There are several key factors which could have helped enterprises in obtaining the qualification. These include:

- Friendly attitude of the local authority
- More FIEs are registering IP in China
- Reliability of third-party's reports

Despite these factors, there are relevant risk areas in that the assessment results publicized by local authorities will still be subject to review by the Ministry of Finance and State Administration of Taxation (MoST). Moreover, authorities will conduct on-going review of the NHTE qualification status of the approved NHTEs during the three-year period of validity. Therefore we suggest that company management prepare the NHTE application package with solid facts and documentation support. Then, once NHTE status is obtained, companies should put in place certain control mechanisms to ensure they continue meeting the requirements to qualify for the tax incentive.

During 2008 the government of China amended the Provisional Regulations for Value-added Tax (VAT), Business Tax and Consumption Tax and their respective Detailed Implementation Rules (DIR). The most important change in the VAT regime is the transformation from the "production-based" VAT system to the "consumption-based" VAT system effective January 1, 2009. Effectively, input VAT incurred on fixed assets is eligible for credit against output VAT starting from January 1, 2009.

One of the policy circulars implementing this change formally cancels the VAT refund policy on purchase of domestically-made equipment by FIEs and provides some grandfathering treatment for the affected FIEs. Another policy circular formally cancels the VAT exemption treatment for the importation of equipment for encouraged projects and provides some grandfathering treatment for the affected projects. It also clarifies that the customs duty exemption treatment still remains, even though the VAT exemption treatment for the importation of equipment is cancelled. As a consequence, companies may want to consider proper strategies to alleviate the adverse cash flow impact arising from the cancellation of the preferential VAT exemption on imported equipment.

The new LCL emphasizes the legal protection of employee rights and combats potential exploitation during China's rapid economic growth. While introducing more stringent regulations, the LCL offers better and more comprehensive guidance on the employment relationship which, in the past, had tended to be quite ambiguous and subject to local interpretation/jurisdiction. When implemented, it includes sections on probationary periods, redundancy, liquidated damages, severance pay, collective bargaining, noncompete and part-time employment.

There were also some significant clarifications to the LCL released during 2008. The most relevant was the "Regulations of Paid Annual Leave of Employees" which provides that all employees that have been working continuously for more than one year are entitled to paid annual leave. It further establishes the

length of entitled leave based upon years of service, leave payment at wages of a normal working day and 300% remuneration for those employees when annual leave cannot be arranged due to work requirements.

As a result of the semiconductor industry downturn, several of the companies we interviewed for this report had reductions in force and/or plant closures since the enactment of the new LCL. All reported that they were able to complete these difficult changes without incident by consulting in advance with the local labor authorities, communicating extensively with employees and meeting or exceeding the requirements of the LCL.

For most multinational companies these actions were all relatively comparable with their standard practices and expectations. However, we understand that there were a number of companies and plants in Southern China that were closed because of the LCL. The new LCL may have substantially increased labor costs and reduced flexibility for some employers relative to their prior practices. However for most multinational semiconductor companies, the new LCL more likely provided a more level playing field in that it requires local competitors to provide a comparable level of human resource management practices and costs.

During 2008 China introduced new antitrust laws, including a clause subjecting mergers and acquisitions of certain companies to review. These include (1) those which individually have annual revenue of more than 400 million RMB (US$58 million) in China plus more than 10 billion RMB (US$1.45 billion) worldwide and (2) those with more than 2 billion RMB (US$292 million) in China.

Through the first half of 2009, China's Ministry of Commerce Anti-monopoly Bureau had completed 46 merger reviews. While approving two global mergers, Mitsubishi Rayon Co's acquisition of UK-based Lucite International Group Ltd. and InBev NV's acquisition of Anheuser-Busch Co., it meanwhile set conditions on those deals. It also blocked Coca-Cola's bid for the Chinese company, Huiyuan Juice, on the grounds that Coke may take advantage of its dominant position in soft drinks to unfairly affect competition in the juice sector. While this new law has not yet been applied to any semiconductor company, it certainly may in the future. Based upon 2008 revenues, there are at least 50 semiconductor companies that meet the criteria to be subject to such review. For example, this law has recently caused a postponement in the completion of the Toshiba-Fujitsu HDD acquisition.

Economic stimulus programs

The government of China announced a RMB four trillion (US$586 billion) economic stimulus plan on November 9, 2008. Their statement said the State Council had approved a plan to invest four trillion RMB in infrastructure and social welfare by the end of 2010. In March 2009, China's National Development and Reform Committee (NDRC) announced a revision of the stimulus and published a breakdown of how the funds would be distributed. Total spending was not changed, but some of the funding for infrastructure was reduced in order to increase funding for technology, rural public works and social welfare projects. According to the NDRC breakdown the stimulus funding will be allocated as follows:

- Public (transportation) infrastructure development—1.5 trillion RMB (38%)
- Post-earthquake (Sichuan) reconstruction—1 trillion RMB (25%)
- Social welfare/low-income housing—400 billion RMB (10%)
- Rural infrastructure projects—370 billion RMB (9%)
- Technology and industry restructuring—370 billion RMB (9%)
- Sustainable environment—210 billion RMB (5%)
- Health and education—150 billion RMB (4%)

At the same time, the NDRC announced that about 70% of the four trillion RMB stimulus package will come from local governments and private companies. The central government will draw 1.2 trillion RMB from four budget areas to finance investment under the plan. The remaining 2.8 trillion RMB, 70.5% of the total plan, will come from local government policy loans, local government bonds issued by the central government, corporate bonds, medium-term notes and bank loans.

After the announcement of the four trillion RMB stimulus plan, the Promotional Adjustment Plan of 10 Large Industry of the Nation were introduced, one after another. The ten industries include steel, automotive, textile, equipment manufacture, ship building, electronic information, light industry, petrochemical, non-ferrous metal and logistics.

The objectives for the electronic information industry is to make the industry account for at least 0.7% of GDP increase and create 1.5 million jobs in three years. There are nine focus areas for the electronic information industry:

- Ensure the steady growth of 1) PC, 2) electronic component, and 3) audio & visual products;
- Improve the technology of 4) integrated circuits, 5) display devices, and 6) software; and
- Seek growth opportunity in 7) communications equipment, 8) information services and 9) information technology.

Two additional stimulus programs are being credited with having a more immediate and noticeable impact on recovery from the 2008/09 semiconductor downturn.

The first is the countryside home appliance policy or "Electronics Go to Farmers Subsidy Program." This was begun on a trial basis in three provinces in 2007 and extended to a nationwide program on February 1, 2009. Through this program the government provides an allowance to rural area residents to promote sales of nine home appliances which include color TVs, refrigerators, washing machines, mobile phones, personal computers, air-conditioning units, water heaters, microwave ovens and small appliances. The program targets rural residents only, provides allowances in the form of product-specific redeemable vouchers and limits the allowance to two items per household. In addition, the policy limits the allowance to 13% of sale price to a maximum price set by the government, encouraging a focus on basic product design and domestic brands.

The program will last four years until 2012. It is estimated that the program will result in the sale of 600 million home appliances and 1.6 trillion RMB (US$230 billion) in sales revenue. At the current worldwide average electronic systems semiconductor content of 21%, this program will have then resulted in US$50 billion in semiconductor consumption.

The second program, the "Home Appliance Replacement Subsidy Program," was announced in May 2009 and formally started in five trial cities (Beijing, Shanghai, Tianjin, Fuzhou and Changsha) and four provinces (Jiangsu, Zhejiang, Shandong and Guangdong) in July 2009. This program offers subsidies for consumers who trade in five kinds of used home electronic appliances—TVs, refrigerators, washing machines, air conditioning units and personal computers—to purchase new units with more efficient power consumption. The program provides a subsidy of 10% of sales price to a set

maximum for each type of appliance plus paying for the transportation expense of collecting the used appliance. There is some question about how effective this program will be as there is already a market for consumers to sell their used appliances to traders that may offset the net value of any subsidy. Still, the government has allocated 2 billion RMB (US$290 million) for this program in 2009. If this subsidy is fully utilized in 2009, it could result in US$600 million in semiconductor consumption.

On a longer term basis, the government's stimulus programs that cover railroad and air transportation, telecom networks, rural improvements and healthcare reform have the potential for an even greater impact on the recovery from the 2008/09 semiconductor downturn. These programs will need huge investments in advanced technology and should promote the use of semiconductor-enabled products such as computers, servers and mobile devices for the world's most populous nation. There appears to be an opportunity for major multinational semiconductor companies to team with appropriate government agencies in addressing these needs. The Chinese government's stimulus package will accelerate the use of computers and other emerging technology devices in the country and will help increase the market's recovery.

Currency exchange rates

Prior to 2005, China had maintained the value of its RMB at a relative fixed exchange rate to the US dollar of RMB 8.28 = US$1.00. From the third quarter of 2005 China has allowed the value of its RMB currency to gradually increase to the point that, by the fourth quarter of 2008, the quarter average exchange rate was RMB 6.84 = US$1.00 and the annual average rate for 2008 was RMB 6.9498 = US$1.00.

This three and a half year gradual increase in the RMB/US$ exchange rate has had some impact on the semiconductor industry, especially for those companies with operations in China. The magnitude of that impact varies depending upon each company's business model. Since July 2005, companies with sales transacted in US$ have seen the RMB value of their sales revenue decrease by 16%, while companies with costs incurred in RMB have seen the US$ value of those expenses increase by 19%.

Most multinational companies operating in China and local companies serving international markets earn most of their revenues in US$ or equivalent currencies while incurring some to most costs in RMB. Companies in the IC manufacturing sector, that is foundries and IDM wafer fabs, earn almost all revenue in US$. But meanwhile, they also have a relatively higher percentage

of US$ based costs as depreciation on US$ based imported equipment. In addition, most of their direct materials are US$ based and constitute a large portion of their expenses.

Companies in the IC design (fabless) sector could have a substantial portion of their sales and costs transacted in RMB if they primarily supply the Chinese consumption market and use local foundries and SATS suppliers. However, this may not always be the case because of customer and supplier preferences based upon their financial considerations.

Companies in the semiconductor packaging and testing sector, and especially those who are SATS suppliers, are probably the most impacted by these currency exchange changes. Most of this sector's sales are transacted in US$. Meanwhile, these firms have a relatively lower percentage of US dollar-based depreciation expenses, a higher percentage of RMB employee costs and many purchase their direct materials in RMB from local subsidiaries of multinational suppliers. Since their US dollar cost per lead equivalent unit pricing very rarely increases due to worldwide competition and their local expenses are increasing in equivalent US dollar costs, these firms are experiencing a noticeable cost/price squeeze. As one general manager we interviewed related, the consequence of a strengthening RMB is an intense motivation to drive efficiency improvements.

Production growth scenarios

Overview

PricewaterhouseCoopers' original 2004 report examined the effects that different levels of growth in the Chinese integrated circuit (IC) semiconductor industry would have on the greater industry. We used scenarios that spanned the time period of 2003 through 2010, and we also analyzed the developments, investments and milestones that would need to occur for China to achieve each level of growth during the forecast period. Finally we predicted the likelihood that China would achieve each level of growth—conservative, moderate or aggressive—based upon then current market conditions.

In subsequent updates, we re-examined these original production growth scenarios and revised our analysis. Prior to the 2008/09 semiconductor downturn we had not identified any fundamental changes that would cause the basic concepts of our original production growth scenarios to be changed. However, we did add revisions to each scenario for the 2008 update to reflect the application of then-current market conditions to those concepts. Those revisions, along with our original forecasts, are shown in Figure 24, on page 83, where we have also added actual consumption and production through 2008 for comparison.

The 2008/09 semiconductor downturn has significantly altered the relative likelihood of our revised scenarios. It remains very likely that our original market projection and conservative production scenario will be met or exceeded. However, the 2008 revised scenarios have become very unlikely and the 2008/09 semiconductor downturn has made further revisions based upon our conservative production concepts less likely than those based upon our moderate concepts. An examination of those scenarios and recent history may provide a better understanding of China's recent and potential impact on the semiconductor industry.

Our conservative growth scenario was based upon the assumption that China would be able to equip and ramp to full capacity at mature yields all current and committed wafer fabrication plants that existed as of mid-2004. Under those original assumptions, China's IC 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 Chinese Semiconductor Industry Association (CSIA) in 2002, with IC production revenues forecasted to reach US$24.1 billion by 2010.

Our aggressive growth scenario was based upon the assumption that the Chinese semiconductor market would grow from its 2003 level at a 20% CAGR, twice the worldwide rate. It also called for China to achieve its goal of having its IC industry revenues equal at least half of its market demand by 2010, amounting to US$44.8 billion in that year. Under those original assumptions, China's IC market was forecasted to reach US$89.5 billion by 2010.

China's performance compared with the scenarios

Figure 24 now includes China's actual performance for 2003 through 2008. Comparing actual performance to our original scenarios we see that China's IC consumption has continued to exceed our aggressive growth scenarios for every year since 2003. China's IC production also continued to exceed the original conservative and moderate scenarios for every year since 2003, while falling short of the aggressive scenario for the first time in 2008.

Several factors have contributed to this outcome. China's IC consumption market has grown faster than three times the worldwide rate and much faster than forecast. China's IC market has grown at a 29.5% CAGR from 2003 to 2008 compared to a worldwide 8.6%. The impact of the 2008/09 semiconductor downturn on China's IC consumption, measured in year-over-year percentage change, has been later to materialize and initially less severe than on the worldwide market. As a result, China now accounts for 90% of the total net increase in the worldwide IC market between 2003 and 2009. However, from here, China's IC market growth is now expected to slow. The CSIA forecasts that China's IC market growth in RMB will average less than 8% CAGR for the next three years through 2011.

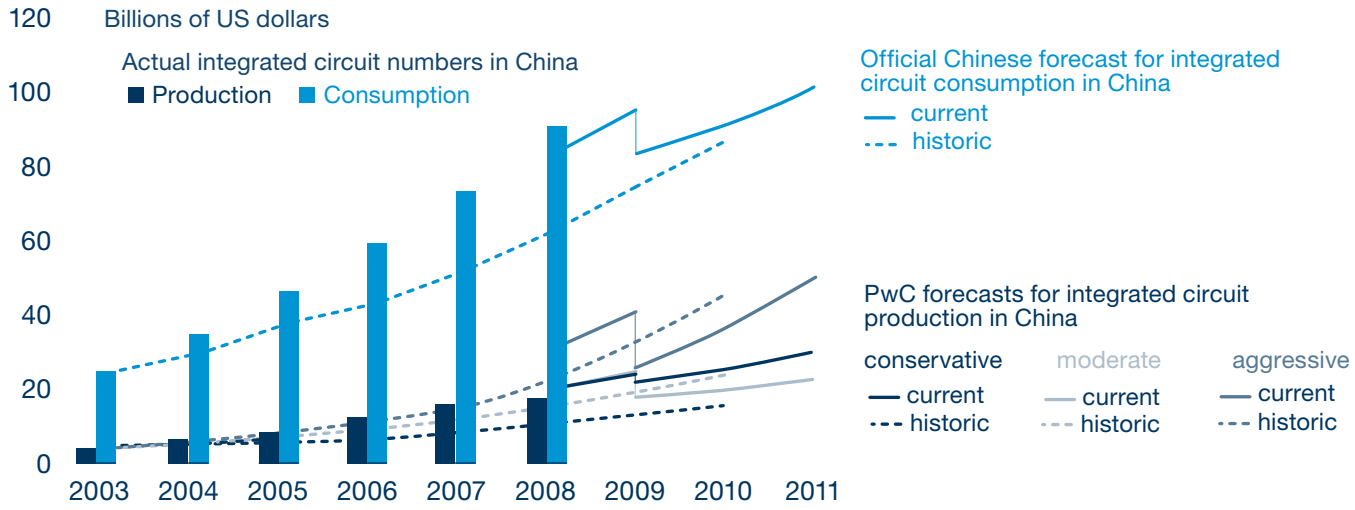
During the past five years, China's IC production has increased by an average 33% CAGR, down from 40% for the first four years and slightly less than our aggressive scenario. This very high rate of growth through 2007 was the result of (1) an extraordinary 190% increase in the IC manufacturing (primarily foundry) sector in 2004 (2) three years of greater than 50% per year growth in the IC design (fabless) sector between 2004 and 2006 and (3) a greater than 40% increase in the IC packaging and test sector in 2006.

China now has more and much larger wafer fabs than was expected in 2004. By the end of 2008 China had more wafer fabs in production (88) than committed to (73) at the start of 2004, featuring significantly more capacity

(1,716,000 versus 998,000 8-inch equivalent Wafer Starts per Month). Also, China has almost doubled the amount of IC packaging and testing done with imported wafers since 2005.

As mentioned, the impact of the semiconductor downturn on China's IC industry was initially less severe than that for the world at large. However, the impact has since become equally severe. As a result, China's IC production is now also expected to slow. The CSIA forecasts that China's IC production in local currency will also average slightly less than 8% for the next three years through 2011.

Figure 24: China's integrated circuit production and consumption forecasts compared with actual



Source: CSIA, CCID, World Fab Watch, PricewaterhouseCoopers

Conservative growth scenario

The potential capacity of all current and committed wafer fabrication plants in China as of the end of 2008 is now double the capacity level in early 2004 when we made our original forecast. The capacity increase is the result of 18 additional plants, net of closures, being put into production plus eight additional new plants starting construction. It is our estimate that these current wafer fabrication plants are equipped to about 60% of their full capacity.

During 2008 less than 50% of their potential full revenue capacity was realized as some were in the process of ramping to nominal capacity during the early part of the year and almost all were impacted by the downturn during the latter part of the year.

In the 2008 update we refined our scenario model to incorporate a trend of continuing decreasing average wafer values to US$800 per 8-inch equivalent wafer with an average of 90% capacity utilization. We also assumed that the plants under construction would realize only 50% of their nominal capacity by 2010. At that time we found that scenario could result in an increase in 2010 IC production revenue to US$28.8 billion and would require an additional investment of at least US$20 billion for capital equipment and facilities. To better reflect the realities of the 2008/09 downturn, we further refined this scenario model to consider a three-year recovery cycle through 2011, a further decreasing average wafer price to US$700, and 40% additional equipment required to reach full capacity.

Under these refined assumptions and current conditions, our conservative scenario could result in an increase in 2011 IC production revenue to US$30 billion, requiring an additional investment of at least US$15 billion for capital equipment and facilities. This projection represents an IC production CAGR of almost 19% during the period from 2009 through 2011.

Although SEMI and others report that the Chinese government is likely to invest a total of over US$20 billion in semiconductors over the next five years, we believe that attainment of this scenario projection no longer appears reasonably probable. It is unlikely that anyone will make large investments in additional semiconductor capacity in 2009 or 2010 until a recovery from both the 2008/09 semiconductor downturn and the world economic crises is clearly underway.

Moderate growth scenario

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

According to the CCID 2008–2009 report, China's IC unit production increased 2.4% to 41.7 billion pieces, while IC production revenue decreased 0.4% to 124.7 billion RMB (US$17.9 billion) in 2008. As a result of the 2008/09 semiconductor downturn, CSIA now forecasts IC production revenue to increase to 137 billion RMB (US$19.7 billion at 2008 FX rates) by 2010 and to 156 billion RMB (US$22.4 billion) by 2011. This forecast represents a CAGR of 7.7% from 2008 to 2011.

While this forecast now falls short of the CSIA's original revenue objectives, it also falls noticeably short of their 50% of domestic demand objective as it will satisfy no more than 22% of China's consumption demand by 2010. However, in order to realize this revised moderate growth scenario, China will have to further equip and ramp into full production the equivalent of only seven of the larger wafer fabrication plants currently in production. This would only require a further capital investment of less than US$7 billion.

The investment requirements for this 2008/09 semiconductor downturn adjusted revision of the moderate scenario is now less than half that of the revised conservative scenario. Achievement of this revised moderate scenario now appears to be reasonably possible as well as more probable than achievement of the revised conservative scenario.

If China can recover from the downturn and achieve these latest CSIA goals their IC industry will have grown to reach revenues that will represent more than 9% of the worldwide market by 2011. Realization of this scenario now means that China's IC industry will have to maintain an average 8% CAGR over the next three years and, as a result, will have achieved an average 21% CAGR for the five-year period from 2005 through 2010. That would be a noteworthy achievement over a period during which the worldwide IC market achieved less than a 1% CAGR.

The 2008/09 semiconductor downturn has made the further scenario revisions based upon our conservative production concepts less likely than those based upon our moderate concepts. The basic premises underpinning our conservative scenario concepts were: a) that future achievements are more determined by capabilities than by intentions and b) that if you build it they will come, i.e., investments made in physical plants would ultimately get completed and utilized.

The resulting concepts were effective for the earlier years. But it now appears not all wafer fabs that have started construction will get completed, nor that all of those starting production will ever get fully equipped and ramped to full production—at least in a timely manner. The investment requirements for large, leading-edge plants have increased significantly—even as investment sources have dried up. Also, physical plants can be initially built as lower cost shells with individual modules completed on an as needed or financed basis. Equipment investment requirements are three to four times as much as plant investment requirements and investments are being limited to advancing technology capabilities rather than increasing capacity. Since China continues to lag in wafer fabrication technology by more than two years, it will remain less attractive for such investments.

Aggressive growth scenario

It continues to appear that the Chinese authorities have postponed their goal of growing their IC industry revenues to equal half of their IC consumption market from 2010 to some indefinite time in the future. Still, our aggressive growth scenario remains based upon that premise for comparative purposes.

According to the CSIA 2009 report, China's IC market is now forecast to reach US$91.7 billion by 2010 and US$101.6 billion by 2011. That represents a 16% reduction from their 2008 report and is an early reaction to the 2008/09 semiconductor industry downturn.

Under the aggressive growth scenario China's IC industry would now have to reach revenues of US$45.9 billion by 2010, which would represent a 60% CAGR or US$50.8 billion by 2011, which would represent a 42% CAGR from 2008 to 2011. Both scenarios remain very unlikely.

Under the most likely business model, this scenario would now require China to increase its wafer fab capacity to more than 3,200,000 8-inch equivalent WSpM (wafer starts per month) by 2011. This would require the construction and ramping to full production of at least 22 additional wafer fabrication plants not currently under construction. All of these plants would have to be of the largest size currently planned for China (e.g., Intel Dalian) and this new capacity would require an additional investment of about US$25 billion beyond that

required for the conservative growth scenario—all of which seems very unlikely. The size of the required investment and the uncertainties of being able to undertake such a plan probably explain why this goal, growing the IC industry to equal half of the IC market, has been indefinitely postponed.

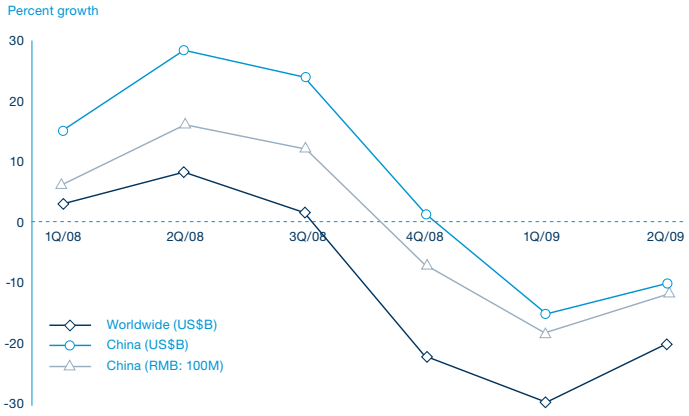
This scenario is most sensitive to China's IC industry business model and reporting practices. For example, assume that China could radically expand its design (fabless) sector and implement a business model in which all its wafer fabrication and packaging and testing production were used to support its design sector—all while continuing its current reporting practice of double counting. If this could be done, the aggressive scenario could be achieved by just completing and fully utilizing all the current and committed wafer fabrication plants. This would reduce the required additional capital investment to about US$2 billion, for a total investment of US$17.3 billion by 2011.

However it would require China's design (fabless) sector to grow by more than nine times during the next three years. While we consider that to be an impractical alternative, we believe it provides valuable insight into the impact of that business model and China's motivation for continuing to highly incentivize the development of their IC design sector.

Post-recovery scenarios

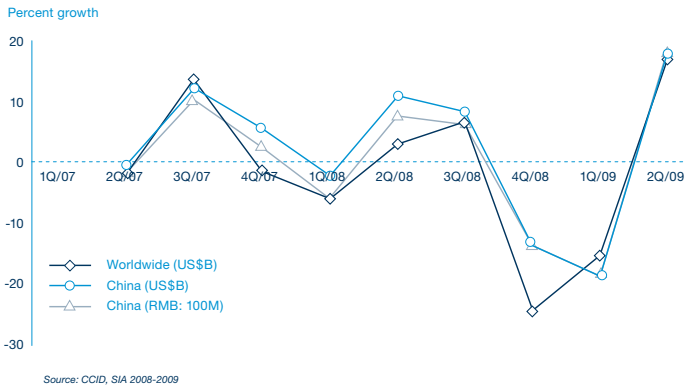
Figures 25 and 26 illustrate how the impact of the 2008/09 semiconductor downturn on China's IC consumption, measured in year-over-year percentage change, has been later and less severe than on the worldwide market. Changes in foreign exchange rates make this especially noticeable when China's consumption is measured in dollars.

Figure 25: China vs. WW Semicon year-over-year market growth by quarter 2008–2009



Source: CCID, SIA 2008-2009

Figure 26: China vs. WW Semicon quarter-over-quarter market growth by quarter 2007–2009



Source: CCID, SIA 2008-2009

Similarly, Figures 27 and 28 show the impact of the 2008/09 semiconductor downturn on China's IC industry. In this case, the impact on China's IC industry, measured in year-over-year percentage change, initially occurred somewhat later and with less severity than on the worldwide industry. However matters worsened during the last two quarters of 2008, making matters just as severe for China as for the worldwide industry. In fact, measured in local currency, the impact in the first quarter of 2009 was more severe for China than the rest of the world.

Figure 27: China vs. WW Semicon year-over-year industry growth by quarter 2008–2009

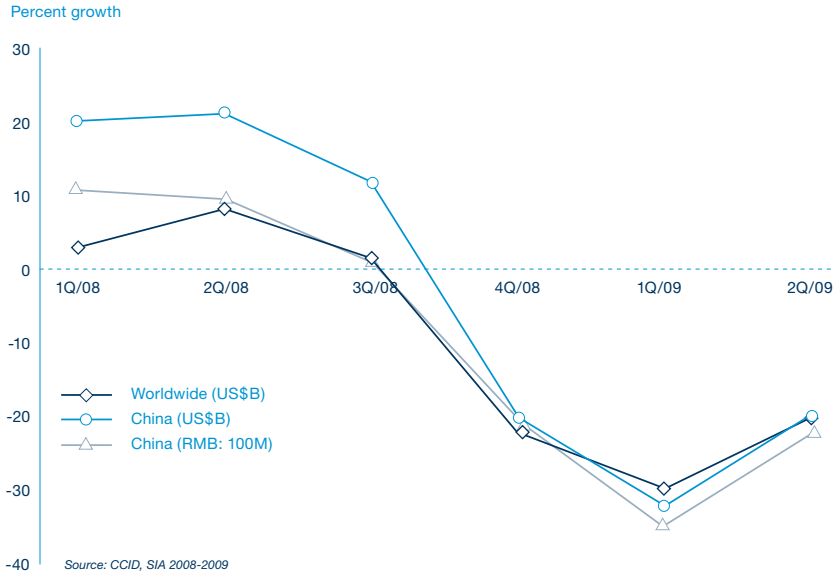


Figure 28: China vs. WW Semicon quarter-over-quarter industry growth by quarter 2007–2009

When and as the recovery is realized, it is expected that China's electronic systems production will continue to grow at a greater rate than worldwide production. The transfer of electronic systems production to China is forecast to continue through the next business cycle, although probably at a slower rate. This will be driven by worldwide industry cost and market-driven restructuring, China's very competitive support infrastructure, China's longer term economic stimulus programs and China's growing domestic market demand.

As a result, China's semiconductor consumption market will continue to grow somewhat faster than the worldwide market and should gain at least a couple of percentage points of market share over the next five years. An increasing share of this market will come from domestic consumption. If the relative share of domestic versus export consumption increases at merely the expected GDP growth rates of China versus the world, the share of China's semiconductor consumption market used in the production of electronic products for domestic use will increase by seven percentage points, to almost 40% in five years' time. This should further increase the importance of semiconductor companies developing products that meet the unique requirements of China's domestic market. This ranges from white-label handsets to transportation and medical infrastructure servers. It should also increase the government's efforts to encourage the development of China's IC design (fabless) industry sector and to reduce the use of foreign-owned intellectual property.

We expect that the post-downturn recovery of China's semiconductor industry will be diverse, varying by sector as each reacts differently to market and economic forces.

- IC design—During the next five years China's IC design (fabless) sector will be strongly driven by China's semiconductor consumption market and especially China's domestic consumption. Successful companies in this sector will continue to grow by exploiting a range of opportunities. These include: (a) China's white label handsets and other consumer electronic products; (b) cost reduced alternative products for volume electronic systems manufacturers; (c) unique Chinese standards and requirements for products such as smart cards and (d) designs for China's major OEMs. There will also be sector consolidation as well as continued government incentive support for new entrants and successful survivors. Therefore we expect this sector to continue to grow faster than the other sectors of China's semiconductor industry and faster than China's consumption market.
- OSD—China's OSD sector has a much larger share of both the Chinese and the worldwide OSD markets and industry than any other sector has of the IC market and industry. Therefore its growth will be driven by the growth of both markets as well as by the continuation of the trend for multinational semiconductor companies to transfer OSD manufacture

to Chinese subsidiaries or manufacturers on a rebranding basis. The investment requirements are modest compared to IC capacity and there is an adequate supply of used equipment available. Moreover, there are few, if any, restrictions on the transfer of relevant technology and most of the business is compatible with Chinese manufacturers' focus on high-volume, cost-driven, low-margin production. As a result, we expect that during the next five years, China's OSD industry will grow somewhat faster than the worldwide OSD industry, but slightly less than China's OSD consumption market.

- IC packaging and testing—This sector will continue to be more affected by the worldwide semiconductor market than the local market. Most of the sector's capacity is owned and controlled by multinational semiconductor or SATS companies with similar facilities in several regions. During business cycles they will allocate capacity loading between their different facilities based upon cost, capability, qualification, logistic and other considerations. During the past two cycles, this sector has grown faster than the worldwide market primarily because companies added capacity in China to meet their growth in worldwide demand in preference to other regions because of favorable cost considerations. However, China's cost advantage for IC packaging and testing may be waning as other countries such as Vietnam or Philippines offer relatively more competitive wage rates and other incentives. On the other hand, China has developed strong infrastructure support for IC packaging. There could also be supply chain and logistical advantages for locating IC packaging and testing in China to meet the needs of China's consumption market, provided customs and VAT issues are effectively resolved. If the Chinese government continues to provide competitive incentives, there is a logical reason to expect China's IC packaging and testing industry to grow faster than China's IC consumption market and to increase by at least 60% over the next five years.
- IC manufacturing—More than anything else, the post-downturn growth of this sector will be determined by the availability and relative cost of investment capital. Almost all of the sector revenue is produced by foundry and IDM wafer fabrication facilities. Increasing wafer fabrication capacity is very capital intensive. This is true even in China where, according to WFW, the historical average investment for the 28 200 and 300mm current and committed wafer fabs is over US$1 billion and for the later 300mm fabs is over US$2 billion.

  We expect these investment costs to increase as we expect almost all new capacity additions to feature leading edge technology. There seems to be more than enough mature and senior technology capacity available on a worldwide basis as such capacity is being taken off line as a result of the 2008/09 semiconductor downturn. There is a possibility that some of that excess mature technology capacity may be transferred and re-installed in China. Some of that mature capacity could be used by Chinese IDMs

to develop a low-cost, high-volume capability for commodity analog ICs similar to that established for OSD rebranded products. But we do not expect this to have a significant impact on China's IC manufacturing sector revenue growth during the next five years.

The Chinese government has provided some very innovative investment funding (through separate provincial agencies) for China's largest foundries, but those foundries have yet to earn an attractive return to support further expansion via internal growth or outside funding. These seem to be handicapped by high depreciation expenses and low, technology-limited, selling prices. They remain two or more years behind their leading competitors in implementing the most advanced technologies. Whether they can make the investments required to fully equip and ramp their facilities to further increase their capacity is most likely to be dependent upon continuing Chinese government assistance.

The multinational IDMs have the appropriate technology and two have made significant investments in China's IC manufacturing sector. The first had a significant impact on that sector's revenue growth during the past two years and the second, which will start production next year, is expected to have a similar impact during the following two years.

However there is a finite and decreasing number of such IDMs and there is intense competition between different locations to attract their next wafer fab capacity investment. While there are currently 70 companies fabricating ICs on 200mm wafers, there are only 31 using 300mm wafers and the latest projection is that there may be no more that 14 companies who will be able to move to 450mm wafers in the next decade. Whether another IDM is attracted to invest in a major wafer fabrication plant in China will be determined by the success of the first two IDMs and the availability of attractive investment incentives. While that is a reasonable possibility, it may be several years before it has an impact on China's IC manufacturing sector. Therefore we expect that over the next five years China's IC manufacturing sector will grow along the lines of our moderate scenario, increasing by about 60%.

If China really wants to leap-frog the technology barrier, and is willing to commit significant resources, there could be a window of opportunity resulting from the ongoing reluctance of most of the worldwide industry to invest in moving to 450mm wafer production. The three announced collaborators actively supporting the development of 450mm technology—Intel, Samsung and TSMC—have semiconductor facilities in China and two, Intel and TSMC, have wafer fab facilities in China. Could China fund the worldwide 450mm development effort in return for rights to participate in its development, rights to the technology and first pilot and production implementation in China? If so, and successfully pursued, that could have a very noticeable impact on the semiconductor industry.

Appendix 1—Interpreting Chinese semiconductor statistics

Despite increasing international interest and press coverage, market reports and statistics of the Chinese semiconductor industry remain difficult to obtain and are often subject to misinterpretation or skepticism. Nonetheless, this report is based, in part, on data derived from Chinese sources. We use this data for two reasons. First, Western sources on the subject are incomplete and somewhat divergent and second, this is the same data used by the Chinese policymakers.

The two principal indigenous sources for most Chinese semiconductor industry and market reports, data and statistics are the China Center for Information Industry Development (CCID) Consulting and the China Semiconductor Industry Association (CSIA). Both are associated with the Ministry of Industry and Information Technology (MIIT) and share common data sources and industry analysts. Below we delineate how these Chinese sources differ from conventional semiconductor industry statistics.

Definitional differences

Because both sources compile their data and write their reports in Chinese, their English-language translations of the reports contain a number of anomalies. For example, while traditional industry reports use three orders of magnitude such as thousands (kilo), millions (mega), and billions (giga), China's reports use two orders of magnitude such as ten-thousands and hundred-millions. So analysis requires a translation to a common standard.

CCID and CSIA measure and report on the China semiconductor market only. Their data is based upon a consumption model. They obtain data on the output of China's electronic systems production, calculate the consumption of semiconductors in every electronic product, value at current local average selling prices and add all the consumption to get the total of China's semiconductor market size. CCID collects output data on electronic system production from the MIIT, (Ministry of Industry and Information Technology), National Bureau of Statistics of China, General Administration of Customs of PRC, CCID's Electronic Products Research Database and other industry associations and organizations.

This is different from World Semiconductor Trade Statistics (WSTS) and most international market research firms which measure and report on the worldwide semiconductor market based upon a sales model. The WSTS and others compile their reports of semiconductor market size based upon sales revenue data collected from semiconductor companies. As a consequence, there can be significant differences and discrepancies resulting from the use of these two different models and from major inventory changes, dislocated purchasing, WSTS' lack of Chinese company participants and the difference between worldwide and Chinese local average selling prices.

Adjustments to databases

In addition, CCID has had to make some noticeable adjustments to their historical Product Structure of China Semiconductor Market database to bring it into complete and inclusive alignment with the international definitions

of the OSD (optoelectronics, sensors and discretes) market segments. It appears that prior to 2008 CCID included LEDs in their discrete market segment and reported only photo electrics rather than all optoelectronic devices. CCID's semiconductor monthly monitoring reports still include only the IC and discrete markets and not the optoelectronics and sensors markets.

Further, both the CCID and CSIA compile and analyze their industry or production data based upon a 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 CSIA's seminal report, *An Investigation Report of China's Semiconductor Industry 2002*:

> "The term 'the semiconductor industry' in this report covers IC [integrated circuit] 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, according to CCID, CSIA, and MIIT usage, their reports on the Chinese semiconductor industry are based upon an industry structure organized into the following sectors:

IC design—This sector includes 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 by fabless semiconductor companies.

IC manufacture—Sometimes identified as the chip manufacturing industry, this sector includes wafer foundries, wafer fabrication plants of foreign IC semiconductor companies and Chinese IC integrated device manufacturers (IDMs). As a result, the revenue and unit production reported for this sector is a heterogeneous mix of wafer and finished product unit sales.

IC packaging and testing—This sector, which is sometimes identified as the encapsulation and testing industry, 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. Nor does it include LED plants since the CSIA continues to include LEDs within the discrete industry. Because some SPA&T plants of foreign semiconductor companies use a wafer/die sale/buy-back or imported processing business model and others use a consigned wafer/die or another toll-processing business model, the revenue reported for this sector is not homogeneous and is potentially misleading. However, reported unit production is relatively homogeneous.

Discrete device—This sector includes all Chinese discrete IDMs and several Chinese SPA&T plants, as well as all discrete wafer fabrication and SPA&T plants of foreign semiconductor companies in China. It also includes LEDs, which CSIA continues to include within the discrete industry sector. Because many of the SPA&T plants of foreign semiconductor companies use a consigned wafer/die business model rather than the fully-costed IDM business model, the revenue reported for this sector is not homogeneous and can be misleading. However, reported unit production is relatively consistent and reliable.

Data compilation methods

Both the CCID and CSIA compile their industry data from reports or survey responses filed by the various entities in each industry sector. These entities usually report their activities as separate stand-alone companies. CCID and CSIA consolidate the reports from each company in an industry sector without any eliminations or offsets. So the results are often industry-sector totals that are aggregates of different inputs and therefore misleading. For example, the data might include foundry wafer revenues and wafer shipments combined with IDM finished-unit product sales revenues and unit shipments.

Because at least three of the largest SPA&T plants of foreign semiconductor companies use a wafer/die sale/buy-back business model, their 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 an overstatement of 29% in the 2008 revenues for the IC packaging and testing sector, 14% in the 2008 revenues of the Chinese IC industry and 8% in the 2008 revenues of the overall Chinese semiconductor industry.

Probable double-counting: A hypothetical example

Because of the way the CCID and CSIA compile their data without any eliminations or offsets, it is very probable that there will be instances of double-counting between sectors. The following example—a hypothetical manufacturing flow for a Chinese fabless semiconductor company using both a Chinese wafer foundry and a SATS company to manufacture its products—illustrates the impact of this approach.

In our example, Average Semiconductor is a fabless semiconductor company in the IC design sector; XMIC is a wafer foundry in the IC manufacturing sector; XSE is a SATS company in the packaging and testing sector and Solectron is an electronics manufacturing services (EMS) customer.

Table 10: Revenue comparison

	Pieces	Revenue	Revenue using industry standards
IC manufacturing sector	1,000	$850,000	Not reported
Packaging and testing sector	1,250,000	$337,500	Not reported
IC design sector	1,250,000	$1,875,000	$1,875,000
Total	2,501,000	$3,062,500	$1,875,000

(All revenues are in US$)

Further assume:

- Average buys 1,000 wafers (200mm) from XMIC for US$850 per wafer, for a total of US$850,000
- Average consigns the 1,000 wafers to XSE for assembly and testing in plastic ball grid array (PBGA) packages with 1,250 net die per wafer and a die-free package cost of US$0.27 per package, for a total of 1,250,000 finished units and a value of US$337,500
- Average sells the 1,250,000 finished units to Solectron for an average selling price of US$1.50 per device, for a total of US$1,875,000

Using CCID and CSIA reporting practices, these transactions would be classified and recorded as shown in Table 10.

Under CCID and CSIA reporting practices, the revenue at each stage is included in the total—a divergence from traditional industry standards. Consequently, in this example, the total Chinese semiconductor industry revenue is overstated by 63% and the unit shipments by 100% relative to conventional industry standards.

Implications of statistical disparities

Compared with 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. This variance would be greater or lower depending upon the mix of business models employed.

Furthermore, these differences could have a significant impact on China's ability to gauge the need for or to even manage the output of nationwide IC production (for example, to meet a greater share of its domestic consumption).

Consider the accounting impact as it relates to an IC device that is wafer fabricated, packaged, assembled and tested in China. Using the current CCID/CSIA reporting practices, the average reported semiconductor industry revenue could range from 63–163 RMB, depending on the scenario:

63 RMB The device is manufactured by a wafer foundry and SATS supplier for a foreign fabless semiconductor company.

100 RMB The device is manufactured and sold by a Chinese IDM.

163 RMB The device is manufactured by a Chinese wafer foundry and SATS supplier for a Chinese fabless semiconductor company and sold by that fabless company.

This variance is significant, creating an operational and planning challenge for both China and the global semiconductor industry.

For the future, increasing international interest and visibility may encourage the CCID and CSIA to replace their current Chinese semiconductor industry reporting practices and standards with more common international standards and practices. For example, the CSIA recently joined the World Semiconductor Council (WSC). They should be further encouraged to participate in the World Semiconductor Trade Statistics (WSTS) and Semiconductor International Capacity Statistics (SICAS) programs. 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.

Statistics used in our report

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 policymakers themselves rely upon these results.

As the tendency is for these sources to overstate the size of the industry, understatement is far less likely—and the fact is, we want to be careful not to understate the impact of China on the industry as a whole. Still, in cases where the Chinese have identified individual company revenues, we have been able to augment that data with information from other sources.

Identifying Chinese semiconductor companies

For a variety of translation and structural reasons, the English names of many of the Chinese semiconductor companies are often a source of confusion. Many companies have English names that are different from the literal translation of their Chinese names and often inconsistently incorporate location prefixes. 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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Industry Perspectives
During the preparation of this report, we benefited from interviews with the following executives:

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Kit Ho Chee: Senior Director China Strategy Office, Intel China Ltd.

Peter Chen: Managing Director, ReGen Assets Group

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Of further interest

PricewaterhouseCoopers began the study series *China's impact on the semiconductor industry* in 2004 in response to our clients' interest in the rapid growth of the semiconductor industry in China. Subsequent updates were published in 2005, 2006 and 2008. Visit ww.pwc.com/technology to access all these reports.

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In light of the current economic crisis and its characteristics, PricewaterhouseCoopers has prepared this article analyzing the origins of the global economic crisis and its impact on the global and Chinese economies. We review the response measures by the Chinese government, and most importantly provide our view points and recommendations on the actions that should be taken by the Chinese government. Visit www.pwccn.com to read or download the pdf file.

Eurasia Group global trends quarterly – Third Quarter 2009
This quarterly report, prepared by Eurasia Group on behalf of PricewaterhouseCoopers, summarizes the findings of five white papers examining the following topics: Prospects for BRIC Countries, Taxation, Infrastructure, Implications of Commodity Price Shock, and Offshoring. Visit www.pwcglobal.com and type Eurasia into the search box to read or download the latest pdf file.

Technology Forecast
PwC's quarterly journal exploring the latest technology trends and business drivers, the Summer 2009 issue explores the impact of cloud computing trends on IT infrastructure and its role in creating a foundation for business agility. Visit www.pwc.com/techforecast to browse through current and past issues.

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