

Global reach

China's impact on the semiconductor industry 2010 update

November 2010



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Welcome

While not immune to the 2008-09 global recession, China's semiconductor industry was less impacted and is recovering more quickly than the worldwide semiconductor industry. Domestic consumption, fueled by an expanding middle class and a rising demand for mobile devices, is driving much of this growth.

This, our fifth update to the original 2004 study, *China's impact on the semiconductor industry*, uses a variety of industry statistics as well as in-depth executive interviews to assess the current status of the semiconductor industry in China. It contains an analysis of both geographical and product category demand and examines changes in the semiconductor value chain. We wrap up by looking at a number of growth scenarios developed in our original report and summarize the probability of those realities.

Now a powerful player in the semiconductor industry, China is poised to assume a dominant position in the global marketplace. Four of China's top five semiconductor manufacturers are multinational companies. In the past year, Chinese companies have accounted for more than half of semiconductor IPOs completed worldwide and the Chinese financial markets have provided more than 80% of all the semiconductor IPO funding raised. China's share of worldwide semiconductor patents has been increasing steadily and a growing number are being first-issued in China.

Whether your company is focused on hardware, software or networking, there's no doubt that semiconductors play a central role in your advancements and performance. We hope this series of reports helps you to respond effectively to market changes and to plan your business strategies accordingly.

If you would like to discuss any of the findings in our report and how they might impact your business, please reach out to me or any member of our global technology team listed in the back of this document. To learn more about PwC's commitment to the technology industry, visit pwc.com/technology.

About this report

This 2010 update assesses the current status of the semiconductor industry in China and how it has changed since last year's report. As with our previous reports on this issue, we conducted a second-order analysis for the 2010 update. To accomplish this, first we reconciled data from different, incomplete and often contradictory reports from various sources. These sources included industry associations and third-party research firms located in Asia and the West. Then we 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 parts of the value chain.

This year we found reasonable consistency between various sources about the direction and relative magnitude of the changes in China's semiconductor market and industry. However, there was still a large variation between sources about absolute size of the market. The two principal Chinese sources, CCID Consulting (CCID) and China Semiconductor Industry Association (CSIA) report that China's 2009 semiconductor market measured in Renminbi (RMB) decreased by 4.1% or 4.8% respectively, which, when converted into US dollars, represents a 2009 market decline of 2.5% or 3.2% respectively. IC Insights reports the Chinese integrated circuit (IC) market experienced zero growth in 2009, while Gartner Dataquest (GDQ) reports the 2009 Chinese semiconductor market measured in US dollars decreased by

4.3%. Next, iSuppli reported that China's semiconductor market decreased by 6.7% in 2009. Between the various sources, the reported size of China's 2009 semiconductor market varied by as much as 33% with, when converted to US dollars, 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. They provide the most comprehensive detail about China's market and industry available and their reports are the principal source of information for Chinese policymakers. However, for the past two years, the global recession seems to have caused several of China's local industry participants to withhold their reporting to industry associations and analysts of what they considered to be singularly disappointing results. Also, the classification and reporting of China's optoelectronics production continues to differ from industry convention and may be incomplete. As a result, getting a definitive size and composition for the 2009 Chinese semiconductor industry has proven elusive.

For some of our detailed analysis we have utilized alternate sources that provide information not available elsewhere and have, wherever possible, tried to base each such analysis on a homogeneous data source. For example, for our analysis of both (a) China compared with the worldwide semiconductor market by application and by device and (b) of semiconductor consumption versus purchases, China versus worldwide by region, we have continued to utilize the values reported by GDQ. Our motivation: they provide database information for each of those markets that is reconciled on a worldwide basis.

Consequently, the value of some metrics may vary slightly between different figures and tables. In addition, some charts may not add to 100% due to rounding. We acknowledge these differences and trust that they will not divert our readers' attention from the value and significance of the overall findings of the report.

Our intent with this method remains 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 of those findings for multinational semiconductor industry companies. Then, finally, based on this newly developed information, we formulated a current set of recommendations for the 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 changes in the industry.

For this reason, we assessed the status of the market in depth, considering its effects on semiconductor production (wafer fabs; packaging, assembly and test facilities) and integrated design manufacturers (IDMs). 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 and compares 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 on the data sources should be noted. For example, 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 although 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 CSIA, that are members of the World Semiconductor Council.

We also elected to convert the 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 US 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 the various issues that make China's role in that industry different or even unique. The fundamental analysis of the 2004 report remains valid. Readers who would like to gain a better understanding of these fundamentals should refer to the original report, which is available at www.pwc.com/technology.

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***Looking at the
bigger picture***
Executive summary

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 changes in the industry.

Responding to our clients' interest in the rapid growth of the semiconductor industry in China, PwC began the study series, "China's impact on the semiconductor industry", in 2004. 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.

China and the above-average semiconductor content of that equipment. The worldwide technology trend towards mobility is also contributing to China's increasing share of worldwide electronic systems production. China's share of global electronic equipment production has increased from 17% in 2004 to 33% in 2009, while the semiconductor content of that production averaged 25%. Regarding the latter, this compares to a worldwide average of only slightly more than 19%.

The consumption of semiconductors for export, i.e., semiconductors used in China as components of finished products exported for sale in other countries, has been the major contributor to the growth of China's semicon-

China has become a dominating consumer of semiconductors. Through the last eight years of ups and downs of the semiconductor business cycle, China's consumption growth has continuously outrun the rest of the world. Since 2001, the bottom of the last semiconductor business cycle, China's semiconductor consumption has grown at a 25.0% compounded annual growth rate (CAGR). This compares to a CAGR for total worldwide consumption of only 6.2%.

China has become a dominating consumer of semiconductors. Through the last eight years of ups and downs of the semiconductor business cycle, China's consumption growth has continuously outrun the rest of the world. Since 2001, the bottom of the last semiconductor business cycle, China's semiconductor consumption has grown at a 25.0% compounded annual growth rate (CAGR). This compares to a CAGR for total worldwide consumption of only 6.2%.

China's semiconductor consumption has grown many times faster than the worldwide market. This is the result, primarily, of two driving factors: the continuing transfer of worldwide electronic equipment production to

semiconductor consumption market. However, as a result of the global recession, such export market consumption became the principal drain. China's export market consumption decreased by more than US\$3 billion in 2009.

Meanwhile, China's consumption of semiconductors for domestic products increased by almost US\$1 billion. China's domestic market—semiconductors consumed in China and used in components of finished products assembled and sold in China—has become of increasing significance to the global semiconductor industry. Fueled by an expanding middle class and rising demand for mobile devices, China's domestic consumption market has made up almost 41% of the total world-



During the past five years, China has emerged as a significant source of new semiconductor companies and, more recently, of financial funding for semiconductor start-ups.

wide semiconductor market growth since 2003. China has been credited with initiating or leading the industry's recovery from the depths of its decline in the first quarter of 2009.

Although noticeably impacted by the global recession in 2009, China's semiconductor production has also been growing for the past decade. Much of that growth has been led by multinational integrated device manufacturers (IDMs) that make up four of the five largest semiconductor manufacturing enterprises in China. The top two are now completing evolutionary extensions, becoming truly vertically integrated IC manufacturers within China, which could result in a paradigm shift in the semiconductor industry. China's semiconductor production accounted for at least 7.5%—and possibly 11%—of the worldwide semiconductor industry in 2009, up from just 2% in 2000.

Thanks to booming domestic demand driven by China's economic stimulus policies, China's IC design (fabless) industry sector grew against all odds. China's fabless sector revenues increased by almost 17% to reach a record US\$4 billion in 2009. As a result, four new start-up companies with 2009 revenue increases of over 100% were added to our listing of China's Top 50 Semiconductor Manufacturers.

During the past five years, China has emerged as a significant source of new semiconductor companies and, more recently, of financial funding for semiconductor start-ups. Chinese domiciled companies represented the third largest group of semiconductor initial public offerings (IPOs) completed worldwide between 2005 and 2009. Although less than half of these Chinese IPOs were completed in China's financial markets, that trend shifted significantly with the opening of two exchanges: the Shenzhen Stock Exchange Small and Medium Enterprise (SME) Board and the ChiNEXt Board. Both entities facilitate fund-raising for small and medium-sized enterprises and growing venture enterprises.

As a result, during the last four quarters (3Q/09–2Q/10), as the semiconductor industry recovered from the global recession, Chinese companies have accounted for more than half of all semiconductor IPOs completed worldwide. Moreover, Chinese financial markets have provided more than 80% of all the semiconductor IPO funding.

While it is likely that some these new Chinese public semiconductor companies will achieve larger scale either organically or through mergers, the emergence of a major indigenous Chinese semiconductor company seems less probable now than it did when PwC first began this series. While the Chinese government has provided some very innovative investment funding for China's largest foundries, those foundries have yet to earn a return that would support further expansion.

For now, these seem to be limited by high depreciation expenses and low selling prices, owing to dated technologies. In fact, the enterprises remain two or more years behind their leading competitors in implementing the most advanced technologies. So, while China will continue to grow in semiconductor manufacturing, it appears the nation still lacks the indigenous ability to fully innovate and develop all the technologies needed to address their unique mobile standards.

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What's new

Findings

The following is a summary of our findings for this 2010 update. These conclusions reflect secondary research, interviews with industry executives and our own analysis.

China and Greater China led the semiconductor recovery from the global recession in 2009.

China's semiconductor market was less impacted by the global recession during 2009 than the worldwide market. It only declined 2.5%, while the worldwide market decreased by 9.0%. This is due to the continuing transfer of electronic systems manufacture to China and the immediate benefits of China's economic stimulus policies.

China's semiconductor industry had a mixed impact from the global recession during 2009. China's IC packaging and testing and chip manufacturing sectors were more severely impacted than the worldwide industry due to their heavy dependence on multinational and export manufacturing. China's IC design did much better than worldwide due to its high dependence on the local market. China's optoelectronics, sensors and discrete (O-S-D) sector did somewhat better than worldwide due to strong light emitting diode (LED) performance.

China's domestic market is becoming increasingly more significant to the global semiconductor industry. Since 2003, China's domestic market has grown at a 23% CAGR from US\$10 billion in 2003 to more than US\$34 billion in 2009. China's domestic market grew to represent almost 18% of the worldwide semiconductor market in 2009, up from 14% in 2008 and 11% in 2007.

Owing to the global recession, three multinational semiconductor companies (Qimonda, NSC and Spansion) discontinued operations in China during 2009. Meanwhile, at least two others (ST and Intel) were driven by this same recession to significantly expand operations in China.

Intel Products (Chengdu) has moved up to the number one position among China's semiconductor manufacturers based on 2009 reported revenue, overtaking Hynix-Numonyx. As a result, in 2009, China's top two — and four out of their top five — semiconductor manufacturers are multinational companies.

During 2010, China's top two multinational semiconductor manufacturers established true vertical manufacturing capabilities (from wafer start through to finished device shipment). Hynix began captive IC packaging and testing operations in July 2010 and Intel began wafer manufacturing at Fab 68 in Dalian in October 2010.

Most of China's multinational semiconductor companies are being affected by much higher labor turnover in China than they experience in other worldwide locations. The semiconductor companies we interviewed for this update reported employee turnover rates ranging from 10% to 80% per year with a median around 29%.

Many multinational semiconductor companies observe that China is not the lowest cost location or site, but has become their best performing location. Minimum wage increases of an average of 20% have been put into effect in at least 18 provinces since February 2010, which is a noticeable change from the past several years when the average annual growth in real wages has increased from 3.3% in 1992 to 9.7% in 2008. Also, as a result of the past four and a half year gradual increase in RMB exchange rates (since July 2005), companies with sales transacted in US dollars have seen the RMB value of their sales revenue decrease by 17.5%. Companies with costs incurred in RMB have seen the US dollar value of those expenses increase by 21% with most of both changes experienced prior to 2009.

China's semiconductor industry total employee count has grown by about a 10% CAGR during the last five years to about 300,000. This represents more than 25% of equivalent worldwide semiconductor employees. By comparison, US semiconductor employee count has decreased by an approximate 4% annual rate.

China has emerged as a significant source of new companies and more recently of financial funding for semiconductor start-ups. During the last four quarters (3Q/09–2Q/10), as the semiconductor industry recovered from the global recession, Chinese companies have accounted for more than half of semiconductor IPOs completed worldwide. Moreover, the Chinese financial markets have provided more than 80% of all the semiconductor IPO funding raised.

China's share of worldwide semiconductor patents has been increasing over the last five years and an increasing number are being first issued in China. China's share of worldwide semiconductor technology-focused patents published by year increased from 13.4% in 2005 to 21.6% in 2009 — and is forecast to reach 33% in 2010. More significant, China's share of first issued semiconductor patents has grown from zero in 2005 and 2006 to 24.1% in 2009.

China's semiconductor market recovery from the global recession has been faster than the worldwide market recovery. China's first half 2010 market consumption has grown more compared to first half 2008 than worldwide (14.1% vs. 13.4%). As for the IC industry, growth is only 7.5% vs. 13.4% worldwide.

Action Semiconductor Co. Ltd., once an emerging star and early NASDAQ IPO, has dropped off the China Top 50 Semiconductor Manufacturers list for 2009.

China's domestic IC manufacturing industry is experiencing slow and/or disappointing growth. As a result, the emergence of a Chinese Tier 1 global semiconductor company seems less likely in the next decade than previously thought.

Within Greater China (China, Hong Kong and Taiwan) the global recession had a more noticeable impact in Taiwan than in China. Taiwan's semiconductor market declined a further 16% in 2009, while China's market only suffered a 3% drop. However, Greater China fared better during the recession than the total industry. Over the last two years, Greater China's consumption market increased 2%, while the worldwide market dropped 12%. This is because China's consumption increased 6%, while Taiwan's decreased 30%. The differences between the two markets reflect the continued and sustained transfer (or off-shoring) of worldwide electronics production to China from other locations, including Taiwan. In 2009, China's consumption of semiconductors had grown to thirteen times that of Taiwan.

China's annual IC consumption/production gap (value of consumption less production) had been growing since 2000 to reach over US\$68 billion in 2008 before decreasing slightly to US\$67 billion in 2009. By comparison, Taiwan's annual production/consumption surplus, which reached over US\$33 billion for the second consecutive year in 2008, decreased to US\$30 billion in 2009. Therefore, Greater China had a semiconductor consumption/production gap of US\$37 billion in 2009, a further increase from US\$35 billion in 2008 and US\$24 billion in 2007. While it is still significantly less than that of China (PRC) alone, this gap has now grown to be about 17% of the total worldwide semiconductor market.

The global recession altered or suspended the capacity expansion of many semiconductor companies in Greater China during the latter half of 2008. Many of those projects have since been resumed and some expanded. Since the end of 2008, 11 new wafer fabs began production in Greater China and 20 additional wafer fab facilities are under construction. If and when all are completed, put into production, fully equipped and ramped to full capacity, Greater China will have 29% of total worldwide wafer fab capacity. This will include 71% of pure-play foundry capacity, 32% of 300mm capacity, and 31% of advanced \leq 80nm capacity.

Things you should consider

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.

Team with Chinese government agencies. Companies should be addressing how to plan, develop and provide the advanced technology needed to support China's 4 trillion RMB economic stimulus programs. These include initiatives in railroad and air transportation, telecom networks, rural improvements and healthcare reforms. These programs will need huge investments in advanced technology and should promote the use of semiconductor enhanced products.

Reassess company presence. China's semiconductor consumption market is weathering the global recession better than any other regional market. It is doing so at the expense of semiconductor consumption in other countries. This differential 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 of low-cost consumer electronic system production, including a significant white label market and, therefore, the largest user of low-ASP analog and standard logic devices. 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. The global recession has put a severe strain on many of them. 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.

Capitalize on opportunities. The global recession has also put a severe strain on at least two local, relatively new, government-funded foundry wafer fabrication facilities. This could provide the right technically capable multinational IDMs with added capacity at advantageous terms.

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.

Pre-empt O-S-D competition. Chinese companies continue to compete most effectively in the discrete and LED areas. As such, they could be gaining the scale, qualifications and recognition necessary to grow into potential worldwide competitors or to extend into the commodity IC area. So, leading O-S-D companies should consider pre-empting these market share losses by participating actively in the Chinese market.

Adapt to China's "dislocated" buying structure. Almost 40% of the semiconductors consumed in China in 2009 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 current semiconductor cycle will bring a foundry capacity shortage as a result of recent global recession-driven reductions in capital spending and an 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 assure a 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 a reduction in expected incentives while many current companies have been able to qualify for incentives that seemed to favor R&D, design and foundry operations.

Invest in effective human relations. When establishing an enterprise in China, apply the effort and resources from the start to develop a human relations program that is both effective and sensitive to local demographics and environment. The impact on employee retention and operating costs can be quite significant.

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. Taiwan has started to 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 is beginning 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 50% of all new wafer fabrication facilities and 48% of all new wafer start capacity under construction in 2009.



Increasing market share

The semiconductor market in China

China continued to outperform the global semiconductor market in 2009. China's semiconductor (consumption) market declined only 2.5% from US\$104 billion in 2008 to US\$101 billion in 2009, while the worldwide market decreased by 9.0%. China's share of the total 2009 worldwide semiconductor consumption market increased to 41%, up from 38% in 2008.

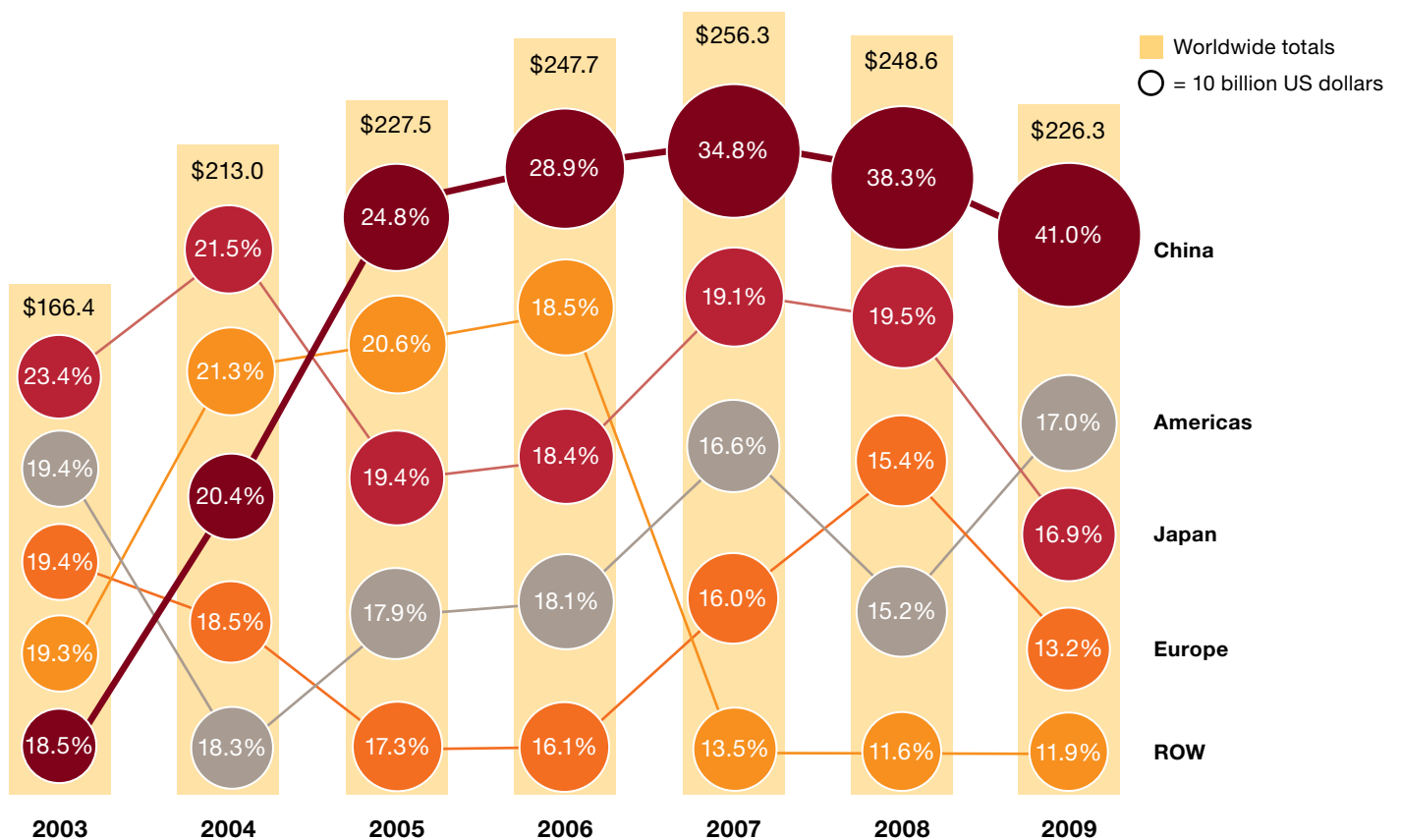
market increased to 41%, up from 38% in 2008. During 2009, China's consumption market share increased at the expense of decreases in market share by Japan and Europe.

Overall consumption

Although affected by the global recession, China continued to outperform the global semiconductor market in 2009. China's semiconductor (consumption) market declined only 2.5% from US\$104 billion in 2008 to US\$101 billion in 2009, while the worldwide market decreased by 9.0%. As a result, China's share of the total 2009 worldwide semiconductor consumption

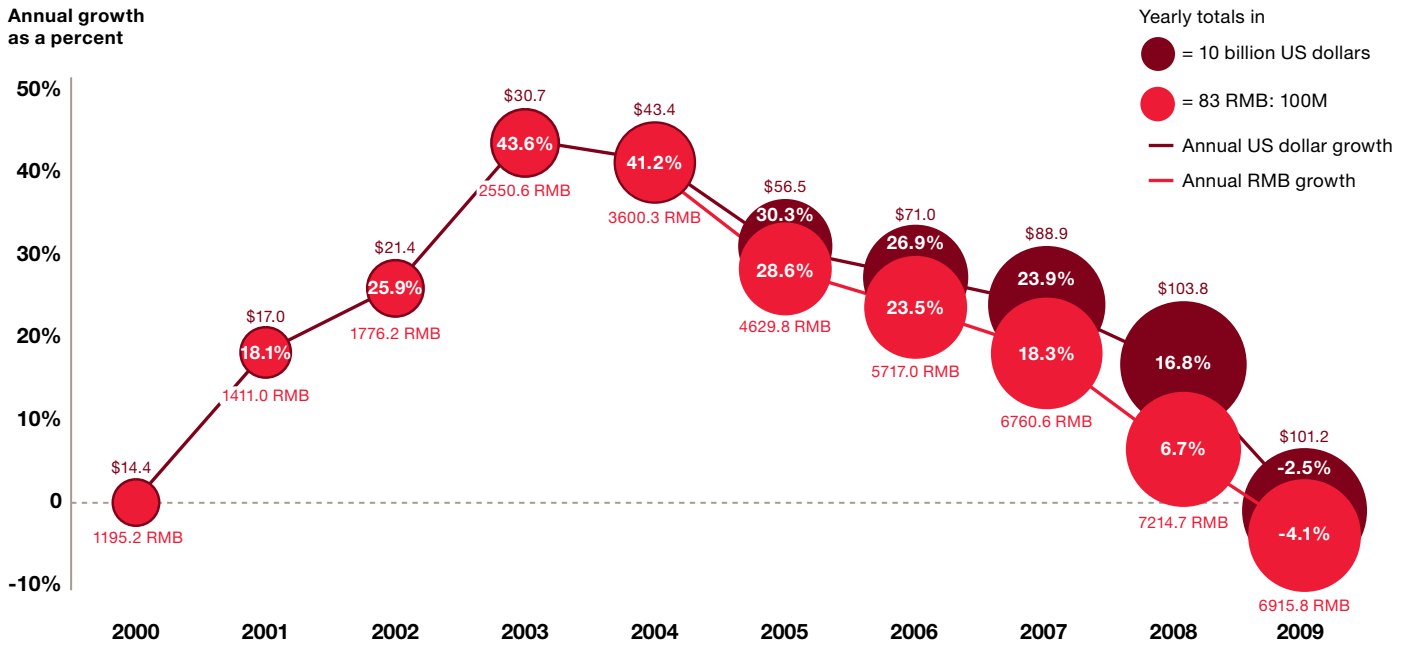
Measured in US dollars, China's semiconductor market decline in 2009 was noticeably less than that of the total worldwide semiconductor industry. Less than two percentage points of that difference was due to China's further revaluation of its currency. As reported in local currency, China's semiconductor market decreased slightly more than 4% with almost all of the decrease incurring in China's IC consumption which dropped 5%.

Figure 1: Worldwide semiconductor market by region, 2003–2009
(Total worldwide in billions of US dollars)



Source: SIA, CCID

Figure 2: China's semiconductor market growth, 2000–2009



Source: CCID, CSIA

China's consumption growth has continuously outrun the rest of the world.

Throughout the eight years of ups and downs of this semiconductor business cycle, China's consumption growth has continuously outrun the rest of the world. Since 2001, the bottom of the last semiconductor business cycle, China's semiconductor consumption has grown at a 25.0% CAGR, while total worldwide consumption has grown at a CAGR of only 6.2%.

China's semiconductor consumption market has grown many times faster than the worldwide market as a result of two driving factors: the continuing transfer of worldwide electronic equipment production to China and the above-average semiconductor content of that equipment. The worldwide technology trend

towards mobility is also contributing to China's increasing share of worldwide electronic systems production.

So, in spite of a global recession, with worldwide production decreasing by 11%, China's electronic equipment production value actually grew in 2009—even if only slightly. As a result, China's share of worldwide electronic equipment production increased from 28.7% in 2008 to 32.8% in 2009. Table 1 shows China's production and worldwide share of main electronic products.

At the same time, the semiconductor content of the electronic equipment produced in China remained higher than the worldwide average. Though decreasing in China from 25% in 2008

to 23% in 2009, this is still greater than the worldwide average, which remained at 19% in 2009. During the past five years, from 2004 to 2009, China's share of electronic equipment production has increased from 17% in 2004 to 33% in 2009, while the semiconductor content of that production averaged 25% compared to the worldwide average of slightly more than 19%.

The growth rate of China's semiconductor consumption market has been decelerating for the last five years. Measured in US dollars that growth rate has decreased from a peak of 41.2% in 2004 through 30.3%, 26.9%, and 23.9% in the next three years to a still noteworthy 16.8% in 2008. The nation then experienced its first year of negative growth in 2009.

China's revisions to its currency exchange rate have amplified the apparent magnitude of this deceleration since 2004. When measured in local Chinese currency, the decline in growth rate is more severe, decreasing from a peak of 41.2% in 2004 through 28.6%, 23.5%, 18.3%, and 6.7% in the following four years before dropping negative to -4.1% in 2009. As the Chinese report industry performance, 2008 was the first year their semiconductor consumption market declined to single-digit growth since the early 1990s and 2009 was the first year of negative growth ever.

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.

Both the global and Chinese semiconductor markets reached the bottom of the current downturn cycle in Q1/09 and have gradually improved in the following quarters. This improving trend continued in Q1 and Q2/10 and is expected to extend through all of 2010. Both the global and Chinese semiconductor markets are forecast to reach new record highs in 2010. Whether the Chinese semiconductor market will be able to continue to gain global share will be primarily determined by the future transfer of electronic equipment production.

Table 1: China's production and worldwide share of main electronic products, 2008–2009

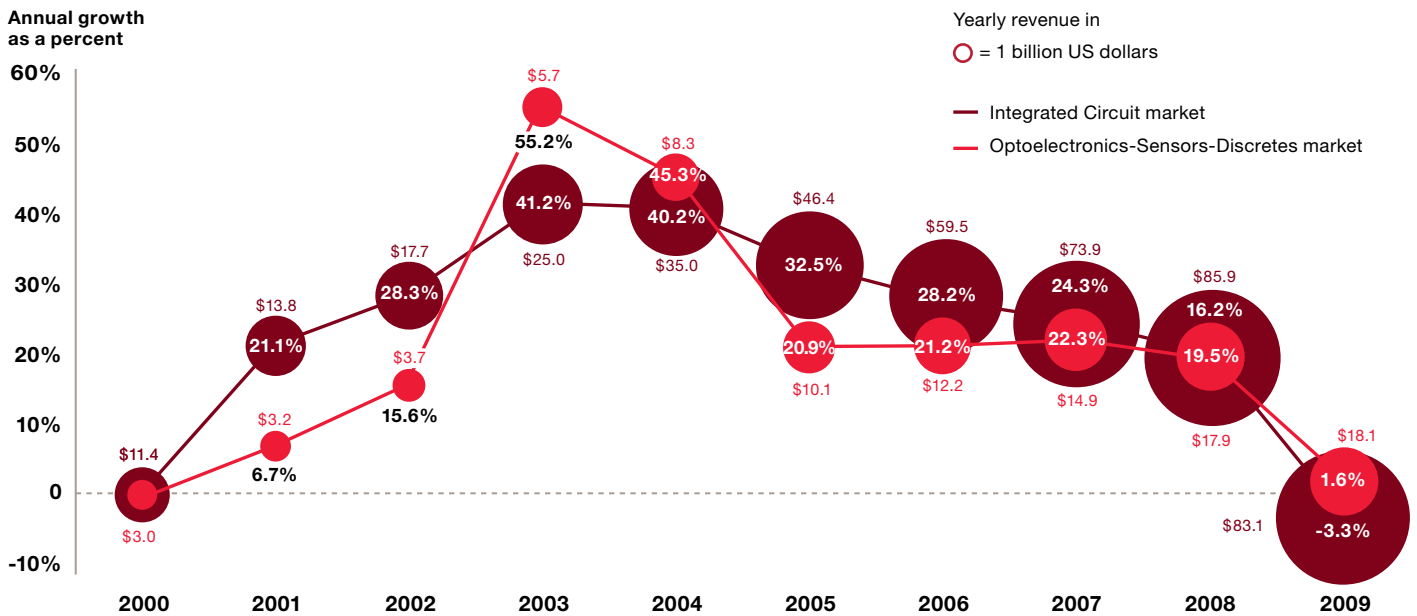
Main products	Production in 1000s		Growth	Worldwide market share	
	2008	2009		2008	2009
Mobile Phone	559,640	619,520	10.7%	44.7%	44.9%
Computer/PC	136,666	182,150	33.3%	47.0%	60.9%
Color TV	90,331	98,990	9.6%	43.9%	48.3%
Digital Camera	81,883	80,260	-2.0%		80.0%

Source: CSIA MIIT, 2010

The market for O-S-D and IC devices

China's O-S-D consumption provided a modest exception to the overall semiconductor market decline in 2009. During 2009 China's O-S-D market measured in US dollars grew 1.6% to reach a new peak of US\$18.1 billion, representing 48% of the worldwide O-S-D consumption. Optoelectronics was the middle segment of this market at US\$6.7 billion, but the fastest growing at 12%. Sensors was the smallest segment of this market at US\$2.0 billion, while growing at 8%, while discrete remained the largest segment at US\$9.5 billion, but with a 6% decrease in 2009.

Figure 3: China's IC and O-S-D market growth, 2000–2009



Source: CCID, CSIA

Measured in local currency, China's O-S-D market actually declined by a fractional 0.2% in 2009—still better than the 9.9% decline in the O-S-D market worldwide. As a result, China's O-S-D market grew to represent 17.9% of the country's total semiconductor market, slightly above the worldwide average of about 16%. This relative difference is expected to narrow with China's O-S-D market forecast to grow to represent 17.3% of its total semiconductor market by 2012 versus a worldwide average of about 17%.

The IC consumption market in China decreased 3.3% to US\$83.1 billion to represent 44% of worldwide consumption. Measured in local currency, the decrease in IC consumption was 5.0%.

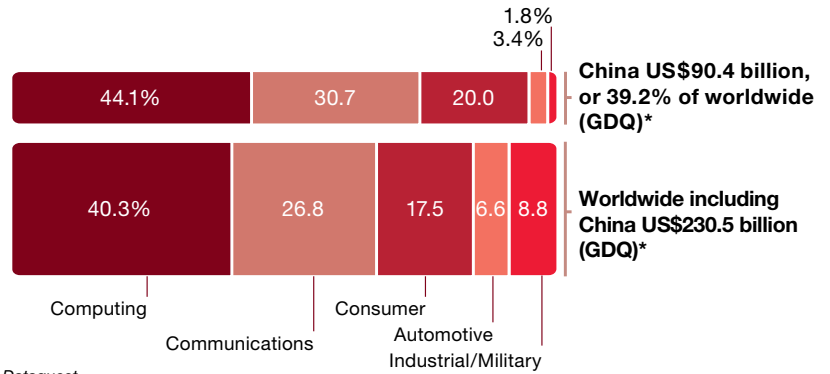
During 2009, China's IC consumption measured in US dollars decreased by about US\$3 billion, while the worldwide IC market decreased by at least US\$18 billion. This infers that IC consumption in the rest of the world other than China decreased by more than US\$15 billion—or 12.6%—compared to China's 3.3% decrease. This is the third consecutive year that China's IC consumption has achieved better than worldwide performance at the expense of displacing IC markets in other regions and represents a noticeable impact on the industry. Similarly, China's O-S-D consumption market growth has displaced consumption in other regions four times, first in 2005 and again in 2007, 2008 and 2009.

Market by application

Compared to the worldwide semiconductor market, the distribution of China's 2009 semiconductor consumption continued to be somewhat more concentrated in the communications and computing sectors, while becoming only slightly more concentrated in the consumer sector. Meanwhile, the China market became relatively less concentrated in the automotive and industrial/military sectors.

The share of China's semiconductor market consumed by the computing sector in 2009 increased by almost 5%. Consumption by the consumer and computing sectors decreased by about 3% and 2% respectively. During the last six years—since 2003—China's consumption of semiconductors for communications applications has grown at a 22% compounded annual growth rate (CAGR), while consumption for computing and consumer applications has grown at 21% and 17%. China's consumption of semiconductors for industrial/military applications is smaller, but has grown at the fastest rates of 27%, followed by automotive applications at 21% CAGR.

Figure 4: China compared with worldwide semiconductor market by application, 2009

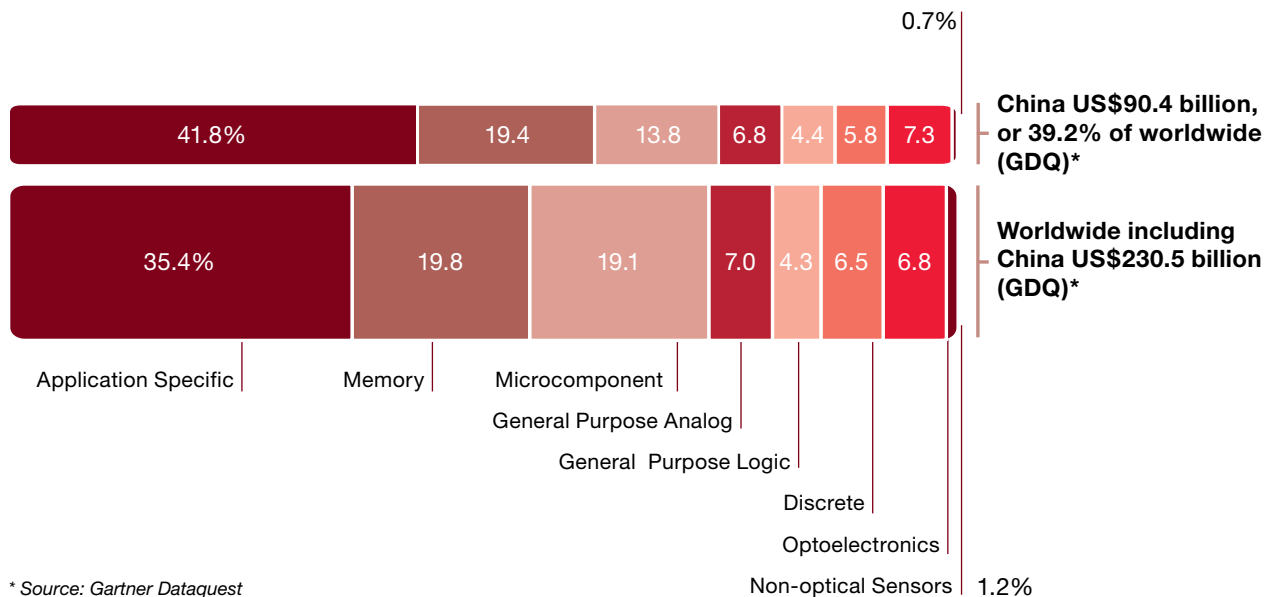


* Source: Gartner Dataquest

Market by device type

Relative to the worldwide market, in 2009, China's semiconductor consumption market remained noticeably more concentrated in the application-specific integrated circuit sector and less concentrated in the microcomponent sector. At the same time, it remained slightly less concentrated in the discrete and non-optical sensors sectors. During 2009, worldwide semiconductor consumption became slightly less concentrated in the application-specific integrated circuit sector.

Figure 5: China compared with worldwide semiconductor market by device, 2009



* Source: Gartner Dataquest

The share of China's semiconductor market filled by application-specific and general-purpose logic devices in 2009 decreased by more than 1% each. Meanwhile, the share filled by microcomponent and memory increased by less than 1% each with minor fractional share increases in general-purpose analog, discrete, optoelectronics and sensors. During the last six years, since 2003, non-optical sensors—the smallest device sector of China's semiconductor market—was the fastest growing, increasing at a 57% CAGR. Memory was the next fastest growing sector at 24%, followed by optoelectronic at 23%. The general purpose logic and discrete sectors had the slowest growth at about 10% and 17% CAGR, respectively, while all the remaining sectors grew at about 20%.

Suppliers to the Chinese market

The major global semiconductor companies continue to dominate the Chinese market. The largest suppliers to the Chinese market continue to be the same multinational semiconductor companies. Table 2 lists the top ten suppliers in terms of sales revenue in the Chinese market. With the global recession, China's consumption of semiconductor products from these largest suppliers increased by only 0.2% measured in US dollars in 2009—although measured in RMB, consumption decreased by 1.5%.

This dollar-based performance was about three percentage points better than overall market in China, which actually declined. This represents a high point for these top 10 suppliers in a year when total worldwide consumption of their products fell 6.8%, again in US dollars. Together, these 10 largest suppliers increased their share of the Chinese IC market to 53% in 2009, up from the slightly more than 51% share they had maintained for the three preceding years.

The Chinese semiconductor market has become slightly more concentrated than the worldwide market. The top 10 suppliers to the Chinese semiconductor had a 46% share of that market, while 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 44% in 2009.

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 40 suppliers to the Chinese semiconductor market in 2009.

However, a Taiwanese company, MediaTek, is one of the top 10 suppliers to the Chinese semiconductor market. The company actually had the greatest increase of any of the top 20 suppliers to the Chinese market in 2009 and, as a result, improved its ranking from number 10 in 2008 to number 9 in 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. Seven of ten companies were the largest suppliers to both markets in 2009, compared to six in 2008 and eight in 2007. The three who are in the top 10 in China—but not the top 10 worldwide—are NXP, MediaTek and Freescale Semiconductor. Conversely, three of the top 10 suppliers to the worldwide market are not among the 10 largest suppliers to the Chinese market, namely Qualcomm, Renesas Technology and Infineon Technologies (including Qimonda).

The major global semiconductor companies continue to dominate the Chinese market.

Table 2: Semiconductor suppliers to the Chinese market 2007–2009

Company	Rank		Revenue in millions of US dollars				Market share
	2008	2009	2008 IC	2009 IC	% Change	2009 Semi	
Intel	1	1	15,585	15,570	-0.1%	15,570	15.4%
Samsung	2	2	5,239	5,548	5.9%	5,681	5.6%
Toshiba	5	3	3,305	3,231	-2.2%	3,904	3.9%
Hynix	3	4	3,461	3,644	5.3%	3,644	3.6%
ST	7	5	2,908	2,704	-7.0%	3,601	3.6%
AMD	6	6	3,230	3,415	5.7%	3,415	3.4%
TI	4	7	3,363	3,127	-7.0%	3,292	3.3%
NXP	8	8	2,602	2,281	-12.3%	2,891	2.9%
MediaTek (MTK)	10	9	1,912	2,442	27.7%	2,442	2.4%
Freescale	9	10	2,305	2,057	-10.8%	2,436	2.4%
Total Top 10			43,909	44,019		46,876	46.3%
Total 10 share of							
Chinese integrated circuit market			51.1%	53.0%			
Chinese semiconductor market			42.3%			46.3%	

Note: 2009 Semi equals IC + Discrete (including LED) market. Not available for 2008.
Source: CCID IC Market China 2010 Conference - Feb. 2010

While all of the top 10 suppliers to the Chinese semiconductor market were the largest IC suppliers, only three were among the largest O-S-D suppliers. Toshiba, ST and NSP were among the top 10 suppliers to the Chinese O-S-D market. The other top 10 suppliers to the Chinese O-S-D market included Fairchild Semiconductor, ON Semiconductor, Infineon, Rohm, KEC, Renesas Technology and International Rectifier. Both China's IC and O-S-D markets are slightly more concentrated than China's combined semiconductor market. The top 10 IC companies accounted for 53% of that market, while the top 10 O-S-D companies accounted for 49% of their market in 2009.

Domestic consumption and the Chinese export market

The Chinese semiconductor consumption market has two distinct parts: 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 for the second consecutive year, to 66% in 2009. That share had risen for the three years from 64% in 2005, to 66% in 2006 and 69% in 2007 and declined slightly to 68% in 2008.

The export market consumption of semiconductors has been the major contributor to the growth of China's semiconductor market. During the five years from 2003 through 2008, the consumption of semiconductors

Table 3: Chinese semiconductor exports by segment, 2007–2009

(in billions of US dollars)

Market segment	Total sales			Export sales (% of total)		
	2007	2008	2009	2007	2008	2009
Data processing	36.4	36.9	39.9	22.2 (61%)	23.5 (64%)	24.1 (61%)
Communications	23.5	29.2	27.8	16.9 (72%)	20.4 (70%)	19.9 (71%)
Consumer	22.8	20.9	18.0	18.9 (83%)	16.7 (80%)	14.1 (78%)
Automotive	2.7	3.3	3.1	0.7 (25%)	0.9 (28%)	0.9 (30%)
Industrial		1.8	1.5		0.7 (36%)	0.6 (39%)
Mil Aero		0.2	0.2		0 (15%)	0 (18%)
Totals	85.4	92.3	90.5	58.7 (68.8%)	62.3 (67.5%)	59.7 (66%)

Source: Gartner Dataquest, PricewaterhouseCoopers 2010

Throughout the current decade China's domestic market has become of increasing significance to the global semiconductor industry.

for export products has increased by almost US\$50 billion, constituting 68% of the overall growth of China's semiconductor market. However, as a result of the global recession, that export market consumption became the overwhelming contributor to the decline of China's semiconductor market in 2009, as it decreased by more than US\$3 billion, while the consumption of semiconductors for domestic products increased by less than US\$1 billion.

Throughout the current decade China's domestic market has become 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 23% CAGR. That market has grown from US\$10 billion in 2003 to more than US\$34 billion in 2009. By itself, China's domestic consumption market has made up almost 41% of total worldwide semiconductor market growth since 2003. Meanwhile, China's economic stimulus package, with its focus on increased consumption of electronic consumer products, has had a noticeable impact on the semiconductor industry. China's domestic market grew to represent almost 17.7% of the

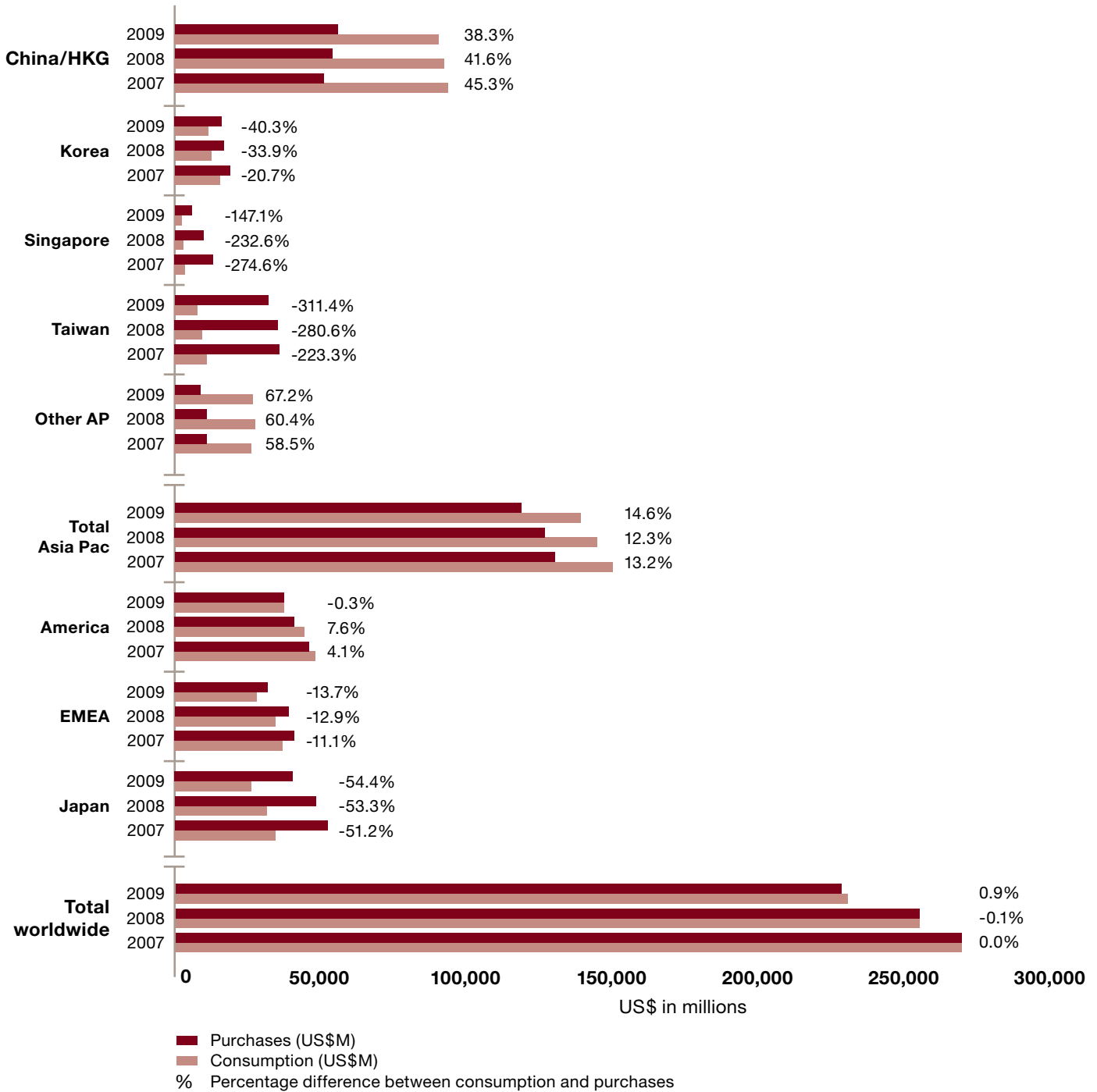
worldwide semiconductor market in 2009, up from 13.5% in 2008 and 11% in 2007. China has been credited with initiating or leading the industry's recovery from the depths of its decline in the first quarter of 2009.

Dislocated purchasing

A significant portion 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. This means that a significant portion of buying decisions—and therefore selling opportunities—for customer-specified devices consumed in China continue to be made outside of China.

During the past last four 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 Korea, Europe and Singapore.

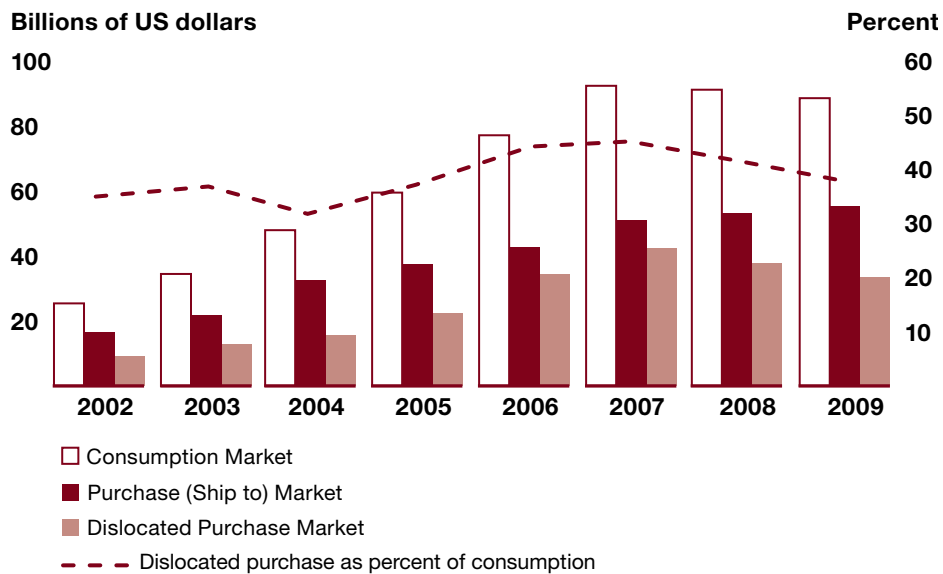
Figure 6: Analysis of 2007–2009 semiconductor consumption versus purchases: China vs. worldwide by regions



Source: 1. Consumption regional data is taken from: Semiconductor Forecast Worldwide—Forecast Database ID Number: SEQS-WW-DB-DATA 29 May 2008 & the country level data is from Semiconductor Industry Asia/Pacific—Forecast Database ID Number G00144085:25-June-2008

2. Purchases are taken from Gartner Dataquest Semiconductor Industry Worldwide Annual Market Share: Database ID Number: G00120719 “World-wide Semi market share database.zip” and Semiconductor Industry Asia/Pacific, Annual Market Share: Database ID Number: G00120721 “Asia Pac Semi market share database.zip”

Figure 7: Dislocated purchases versus China/Hong Kong consumption market, 2002–2009



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

This dislocated purchasing of semiconductors for the Chinese consumption market, which had increased noticeably from about a third in 2004 to more than 45% in 2007, decreased to 42% in 2008 and to 38% in 2009. We expect that the dislocated purchasing share of the total China consumption market will continue to decrease gradually over a number of years in the future as:

- China’s domestic market consumption increases its share of China’s total semiconductor market.
- 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.

Chinese semiconductor companies

Table 4 lists the Chinese semiconductor companies that had the largest revenues in 2009. 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. They, along with foreign semiconductor companies manufacturing in China, are included in Table 6.

The threshold for inclusion in this 2009 listing remained at US\$30 million, the same as used for the 2007 and 2008 lists. The number of qualifying companies increased from 33 to 38. All of the same companies qualified, although most changed their relative ranking in 2009. Five new IC design companies were added to the list: Nationz Technologies Inc.; Haier (Beijing) IC Design Co., Ltd.; Availink, Inc.; Shenzhen State Microelectronics Co., Ltd. and Beijing Huahong IC Design Co., Ltd. The two largest companies, HiSilicon Technologies and Jilin Sino Microelectronics, retained their number one and number two rankings, while 12 companies improved their rankings. One other company retained its rank, while 18 companies declined in rank.

While most of these companies spent 2009 coping with the challenges of the global recession, a few were able to post noteworthy performance. Four of the new companies to the list were added as a result of exceptional results. The first two, Haier and Availink, emerged from product development into a market presence in 2009 with sales increases of almost 600%. The four include:

- Haier(Beijing) IC Design Company Ltd. is a business of new advanced technology invested in and established by the Haier Group. It is located in the Beijing Zhongguan-

cun Advanced Science and Technology District. The company has in-depth knowledge and experience in digital TV and image processing, and is dedicated to developing its core chips and solutions. It has focused on IC devices such as digital audio and video decoders for digital TV. Haier (Beijing) IC Design has completed the HiPatriot series MPEG-2 decoding chips, QPSK/QAM/COFDM demodulation chips for DVB channels and Multimedia chips for digital frame applications. The company has the capability to provide high quality chips as well as, where requested, end-to-end solutions.

- Availink Inc. is a fabless IC design company founded by a group of successful entrepreneurs and technologists that focuses on digital TV, multimedia and communications. It has two operation centers: one near Washington D.C. and the other in Beijing, China. Availink has developed a series of technologies and products for the digital TV market including ABS-S (Advanced Broadcasting System-Satellite, the mandated China DTH standard), DVB-S2 (Digital Video Broadcasting-Satellite-Second Generation), DTMB (Digital Terrestrial Multimedia Broadcast, recently ratified as the Chinese national digital television broadcast standard) and SOC (system-on-chip) for multimedia applications. Availink has also completed the design of AVL4101, a decoder to offer back-end solutions for customers' various demands. As a core technology provider, Availink is driving the Chinese DTH industry, working in close collaboration with the Chinese Academy of Broadcasting Science.
- Nationz Technologies, Inc., the third new company, was formerly known as Shenzhen ZTEIC Design Co., Ltd. It is a company specializing in IC design and total solutions for information security telecommunication and consumer electronics, with system-on-chip and radio frequency (RF) technologies as its technological core. Nationz Technologies pioneered the creation of PRC's first 32-bit CPU internet authentication IC and has since been at the forefront of the information security industry in China. Other innovative products and solutions, such as secure storage, mobile payment, RFID, China Multimedia Mobile Broadcasting (CMMB) TV IC and TD-LTE RF transceivers also demonstrated various levels of technical breakthrough and leadership in their target markets. It was added to the list in the 17th position based upon its outstanding 113% revenue increase in 2009.
- The fourth new company, Shenzhen State Microelectronics Co., Ltd. (SSMEC), was added to the list in the 25th position as a result of their noteworthy 67% revenue increase in 2009. SSMEC is the first IC design company started by the national Project 909. In 2003, SSMEC spun off a subsidiary, ShenZhen Sunmoon Microelectronics, to focus on the industrial and consumer electronics markets while it remained engaged in the design and development of digital audio and video IC, embedded CPU and DSP chips and ASSP devices for government electronics.

Table 4: Major Chinese semiconductor companies by revenue, 2009

Name of Company	Rank		Sales revenue (RMB:100M)			Sector	Revenue (US\$M)		
	2008	2009	2008	2009	Change		2008	2009	Change
HiSilicon Technologies Co., Ltd.	1	1	30.94	39.11	26.4%	D _F	445	572	28.6%
Jilin Sino Microelectronics Co., Ltd.	2	2	10.48	10.88	3.8%	D _c	151	159	5.6%
Shenzhen ZTE Microelectronics Technology Co., Ltd.	8	3	7.02	10.00	42.5%	D _F	101	146	44.9%
No. 55 Research Institute of China Electronics Technology Group Corporation	7	4	7.07	8.34	17.9%	I	102	122	20.0%
Wuxi China Resources Huajian Microelectronics Co., Ltd.	3	5	9.32	8.30	-11.0%	I D _c	134	121	-9.4%
RDA Microelectronics, Inc.	23	6	3.47	8.09	133.0%	D _F	50	118	137.1%
Spreadtrum Communications Inc.	6	7	7.48	7.18	-4.0%	D _F	108	105	-2.4%
BCD Semiconductor Manufacturing Ltd.	11	8	6.30	6.81	8.1%	I	91	100	10.0%
Datang Microelectronics Technology Co., Ltd.	5	9	8.36	6.47	-22.5%	D _F	120	95	-21.2%
Tianjin ZhongHuan Semiconductor Co., Ltd.	4	10	8.90	5.89	-33.8%	D _c	128	86	-32.7%
Hangzhou Silan Microelectronics Co., Ltd.	16	11	5.39	5.88	9.2%	D _F	77	86	11.1%
Wuxi China Resources Semico Co., Ltd.	13	12	6.24	5.75	-7.9%	D _F	90	84	-6.3%
Suzhou Good-Ark Electronics Co.,Ltd.	18	13	5.00	5.55	11.0%	D _c	72	81	12.9%
Beijing Vimicro Co., Ltd.	14	14	6.22	5.20	-16.4%	D _F	89	76	-14.9%
Shanghai Belling	20	15	4.43	5.13	15.7%	I F	64	75	17.7%
Shenzhen Si Semiconductor Co. Ltd.	17	16	5.20	4.90*	-5.8%	D _c	75	72*	-4.1%
Nationz Technologies Inc.		17	2.19	4.66	113.0%	D _F	31	68	116.7%
CEC Huada Electronics Design Co., Ltd. (HED)	15	18	5.81	4.63	-20.4%	D _F	84	68	-19.0%
Tongfang Microelectronics Company	21	19	3.97	4.50	13.4%	D _F	57	66	15.3%
Changzhou Galaxy Electrical Co., Ltd.	12	20	6.30	4.26	-32.4%	D _c	91	62	-31.3%
Haier (Beijing) IC Design Co., Ltd.		21	0.59	4.04	585.1%	D _F	8	59	597.0%
Availink		22	0.60	4.01	569.1%	D _F	9	59	580.7%
Shanghai Huahong IC Co. Ltd.	22	23	3.68	3.62	-1.6%	D _F	53	53	0.1%
Shantou Huashan Electronic Device Co.,Ltd.	26	24	2.73	3.28	20.2%	D _c	39	48	22.3%
Ningbo Hualong Electronics Co.,Ltd.	19	25	4.80	3.23	-32.7%	D _c	69	47	-31.5%
Ningbo KangQuiang Electronics Co.,Ltd.	9	26	7.00	3.22	-54.0%	D _c	101	47	-53.2%
Shanghai Fudan Microelectronics Co., Ltd.	25	27	2.81	3.22	14.6%	D _F	40	47	16.6%

P T Packaging & Testing
 D Design
 D_F Design (Fabless)
 F Foundry
 D_c Discrete
 I IDM

Name of Company	Rank		Sales revenue (RMB:100M)			Sector	Revenue (US\$M)		
	2008	2009	2008	2009	Change		2008	2009	Change
Shenzhen State Microelectronics Co. Ltd. (SSMEC)		28	1.88	3.14	67.0%	D _F	27	46	69.9%
Foshan Blue Rocket Electronics Co., Ltd.	24	29	3.40	3.05	-10.2%	D _C	49	45	-8.7%
Beijing Huadazhibao Electronic Systems Co., Ltd.	31	30	2.24	2.76	23.1%	D _F	32	40	25.2%
Chendu Sino Microelectronics Systems Co., Ltd.	30	31	2.29	2.60	13.4%	D _F	33	38	15.3%
Actions Semiconductor Co., Ltd	10	32	6.78	2.52	-62.8%	D _F	98	37	-62.1%
Huaya Microelectronics Company	32	33	2.20	2.52*	14.5%	D _F	32	37*	16.5%
Forward Semiconductor Company	27	34	2.46	2.32*	-5.7%	D _C	35	34*	-4.1%
Hangzhou Youwang Electronics Co., Ltd.	33	35	2.15	2.28	6.2%	D _F	31	33	8.0%
Yangzhou JingLai Semiconductor (Group) Co. Ltd.	28	36	2.40	2.26*	-5.8%	D _C	35	33*	-4.2%
China Electronics Technology Group Corporation No. 58 Institute	29	37	2.32	2.22	-4.3%	D _C	33	32	-2.6%
Beijing Huahong IC Design Co.		38	1.88	2.05	9.0%	D _F	27	30	10.9%

* Note: 4 companies estimated based upon sectors' average 2009 growth
Source: CCID, CSIA, GDQ, GSA, PwC 2009-2010

Other noteworthy performances

The most notable improvement of a previously listed company was achieved by RDA Microelectronics, Inc. which increased its revenue by an outstanding 133% in 2009 to move up to number 7 from the 23rd position in 2008. RDA is an IC design (fabless) company founded in 2004 that is focused on the development and marketing of RF ICs (radio frequency integrated circuits). RDA has built a highly efficient team that has expertise in Analog and RF Circuit, Digital RF, Advanced Transceiver architecture, GaAs based PA Device, RF Front End Modules and DSP Assisted RF Technologies. With several CMOS based transceiver and GaAs based PA products, RDA has shipped billions of units of RF ICs. In fact, after four years' rapid growth and concentrated

development efforts, RDA has become a leading RF IC company in China. RDA intends to build upon its leadership in the Chinese semiconductor industry and leverage its RF design expertise to become a leading player in the global RF semiconductor market.

And for the second consecutive year the largest of the Chinese semiconductor companies, HiSilicon Technology Co. Ltd., had the largest absolute increase in revenues in 2009. It also had the sixth highest growth rate, more than 26% in RMB (or 29% in US dollars). The company is the former chip R&D center of the Huawei Company, spun out in 2005. With more than 1,000 employees and design centers in not only China but also North America and Europe, the company boasts a solid foundation for communication ASIC chip R&D. Its technical level ranks among the top tier of China's IC design companies with capabilities of design-

ing at the 0.11µm technology node. With double-digit or better revenue growth every year since 2006, HiSilicon Technology Co., Ltd. has demonstrated continuing improvement of its market competitiveness and can be expected to remain a leading Chinese IC design enterprise for years to come.

Measured in local currency, three more of China's top semiconductor companies had 2009 revenue growth of 20% or more: Shenzhen ZTE Microelectronics, Shantou Huashan Electronics Device and Beijing Huadazhibao Electronic Systems. Of the remaining 29 companies, seven had double-digit and five had single-digit revenue growth, while 17 had negative revenue growth in 2009.

ever, only 16 of these companies were included in third-party research firm Gartner Dataquest's "Top Companies (ALL) Revenue from Shipments of Total Semiconductors—Worldwide (Millions of US dollars)", a database ranking 271 companies by their 2009 revenues.

Six of the top 10, however, were included. HiSilicon Technologies, China's highest 2009 revenue performer, ranked 81st among worldwide semiconductor companies. According to Gartner Dataquest, HiSilicon's ranking among worldwide semiconductor companies has improved from 156 in 2007 to 108 in 2008 and to 81 in 2009.

The majority of the largest Chinese semiconductor companies missing from the Gartner Dataquest database continue to be discrete companies, an indication of the industry's general lack of awareness of the significance of China's discrete semiconductor industry sector. The Gartner Dataquest database did include three additional Chinese semiconductor companies with 2009 revenues less than US\$30 million for a total of 19 Chinese companies. This is the same number as included in their 2008 and 2007 database of 277 worldwide companies, but an increase from the 15 out of 227 in their 2005 database.

The most notable oversight is the complete absence of Intel Products Co. Ltd. from any listing of major semiconductor manufacturers in the CCID and CSIA annual reports for 2008 and 2009. Measured by production revenue, Intel Products became China's largest semiconductor manufacturer in 2009 and had been among the top 10 manufacturers for the last three years. Such an omission seems inexplicable and raises concerns about China's industry reporting.

Industry awareness of Chinese semiconductor companies continues to be slowly increasing.

Overall, the combined revenue of the 38 companies on the list increased by almost 8% in 2009, to US\$3.1 billion, representing 11% of China's semiconductor industry. These top 38 companies together constituted 50% of China's IC design sector and 6% of China's discrete sector. Overall, these 38 companies reported an average 8% increase in revenues measured in US dollars (and a 6% increase measured in RMB), which is better than the 7% decrease measured in US dollars (or 9% measured in RMB) reported for China's semiconductor industry and notably better than the 9% decrease reported for the worldwide semiconductor industry for 2009.

Industry awareness of Chinese semiconductor companies continues to be slowly increasing. By definition, all of these largest Chinese semiconductor companies should be included in the semiconductor market share reports compiled by industry analysts. How-

Table 5: Chinese top OEMs by revenue and semiconductor consumption 2008–2009 (US\$B)

Name of company	Revenue			Semiconductor Consumption (Design TAM)			Purchase TAM
	2008	2009	Change	2008	2009	Change	2009
Huawei	17.7	21.8	23.7%	2.1	2.3	6.1%	2.3
Haier	17.6	18.2	3.7%	0.3	0.3	-7.7%	0.3
Lenovo	16.6	16.6	0.1%	3.4	3.5	2.7%	2.5
ZTE	6.4	8.8	38.4%	1.1	1.4	26.7%	1.4
Hisense	7.0	8.2	16.5%	0.2	0.2	50.3%	0.3
TCL	5.5	6.5	17.3%	0.7	0.6	-16.0%	0.8
Founder	6.1	6.4	5.5%	0.4	0.4	-0.3%	0.3
BYD	3.9	5.8	49.9%	0.1	0.3	106.3%	0.3
Great Wall Technology	3.2	5.4	70.0%	0.1	0.1	-10.8%	0.1
Changhong	4.3	4.6	6.5%	0.2	0.2	-8.5%	0.2
Total	88.2	102.4	16.1%	8.7	9.3	6.7%	8.5
% Semi Penetration				9.8%	9.0%		
Midea	6.6	6.9	4.5%				
Gree	6.2	6.2	0.0%				
Skyworth	2.0	2.9	45.0%		0.3		
Konka Group	1.8	1.9	10.5%	0.4	0.2	-50.0%	

Source: MIIT, Thomson Reuters, Gartner Dataquest 2009 & 2010

Domestic OEM buying power

Table 5 is a listing of the top 10 Chinese OEMs (original equipment manufacturers) taken from China’s Ministry of Industry and Information Technology (MIIT) report of “Top 100 Chinese Electronic Information Enterprises in 2009”. Each had 2009 revenues of US\$5 billion or more. As one of the apparent consequences of China’s economic stimulus package, these 10 largest Chinese OEMs had a 16% increase in their combined revenues during 2009 to reach a record total of US\$102 billion. Their combined revenue increase was noticeably better than that of China’s electronic and information industry, which increased only 1.8% measured in US dollars (or 0.1% reported in RMB). Assuming the

semiconductor content of their products was 22.9% (the average for all of China’s electronic systems production in 2009), these 10 Chinese OEMs could have been responsible for semiconductor consumption of US\$22.2 billion, or 21.9% of China’s total semiconductor market.

Two other Chinese OEMs with 2009 revenues greater than US\$5 billion, Midea and Gree, had been included in PwC’s prior listings. But these are no longer included in the MIIT report because they are now classified as appliance enterprises with relative modest semiconductor consumption in 2009.

The US\$ 22.2 billion semiconductor consumption that these top OEMs could have been responsible for is usually identified as “Brand TAM” (total available market). This means the total semiconductor devices consumed in all the products branded with any of the OEM’s brands or names even though some of those products were designed and/or manufactured by other EMS or ODM companies. For example, the motherboards of Lenovo PCs are usually made by ODMs such as Quanta rather than by Lenovo itself.

This year we had analysts estimate the semiconductor consumption by OEMs based upon design (semiconductor selection by OEM engineers) which is identified as “Design TAM”. We feel this provides a more meaningful insight relative to the market influence of the various Chinese OEMs. The top 10 OEM 2009 Design TAM semiconductor consumption was reported to be US\$9.3 billion, an increase of about 7% from 2008, but only 9% of China’s total semiconductor market, up from slightly more than 8% in 2008. The calculated Design TAM semiconductor content of the combined revenues of these top 10 OEMs declined from 10% in 2008 to 9% in 2009. Some of this decrease is believed to be a reflection of the intense competitive price pressure these large OEMs were able to exercise on their semiconductor suppliers during the business downturn.

Another way of measuring the influence of these OEMs on semiconductor consumption is based upon their direct purchases: known as “Purchase TAM”. The top 10 OEM 2009 Purchase TAM semiconductor consumption was reported to be US\$8.5B. This value is less than their Design TAM because

some of the OEMs (for example Lenovo) will design a product specifying specific key components and then consign manufacturing and purchasing to an EMS (electronic manufacturing services) company.

There were three Chinese and four Taiwanese OEM/ODM companies based upon 2009 Design TAM within the top 30 semiconductor consuming companies. The Chinese companies include Lenovo (12), Huawei (19) and STE (30). The Taiwanese include Acer (9), ASUSTek (13), Hon Hei (19) and Compai (23), with their aggregate consumption representing over 8% of total worldwide semiconductor consumption in 2009. (The world’s top five worldwide semiconductor consuming OEMs include Hewlett-Packard, Samsung Electronics, Nokia, Apple and Sony.)

As a result of this analysis, we continue to believe that Chinese OEMs influence and/or 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 could affect the design and sales operations of several international semiconductor companies.



3

Chinese OEM/ODM companies are within the top 30 semiconductor consuming companies: Lenovo, Huawei and STE.

4

Taiwanese OEM/ODM companies are within the top 30 semiconductor consuming companies: Acer, ASUSTek, Hon Hei, and Compai.

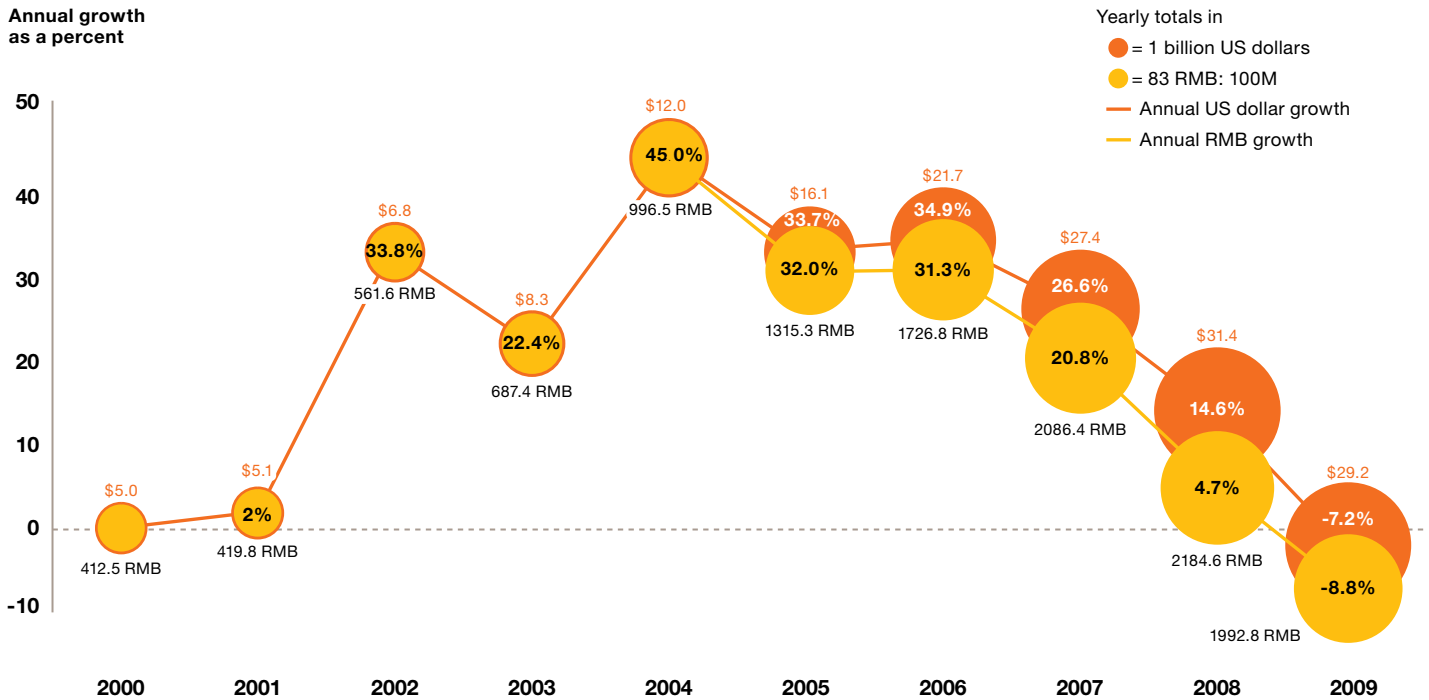


An uphill battle

The semiconductor industry in China

As a result of the global recession, China's semiconductor industry experienced its first annual decline in more than 20 years. Measured in US dollars, China's semiconductor industry (production) revenues decreased from US\$31 billion in 2008 to US\$29 billion in 2009, a decrease of more than 7%.

Figure 8: China's semiconductor industry revenue and growth, 2000–2009



Source: CCID, CSIA

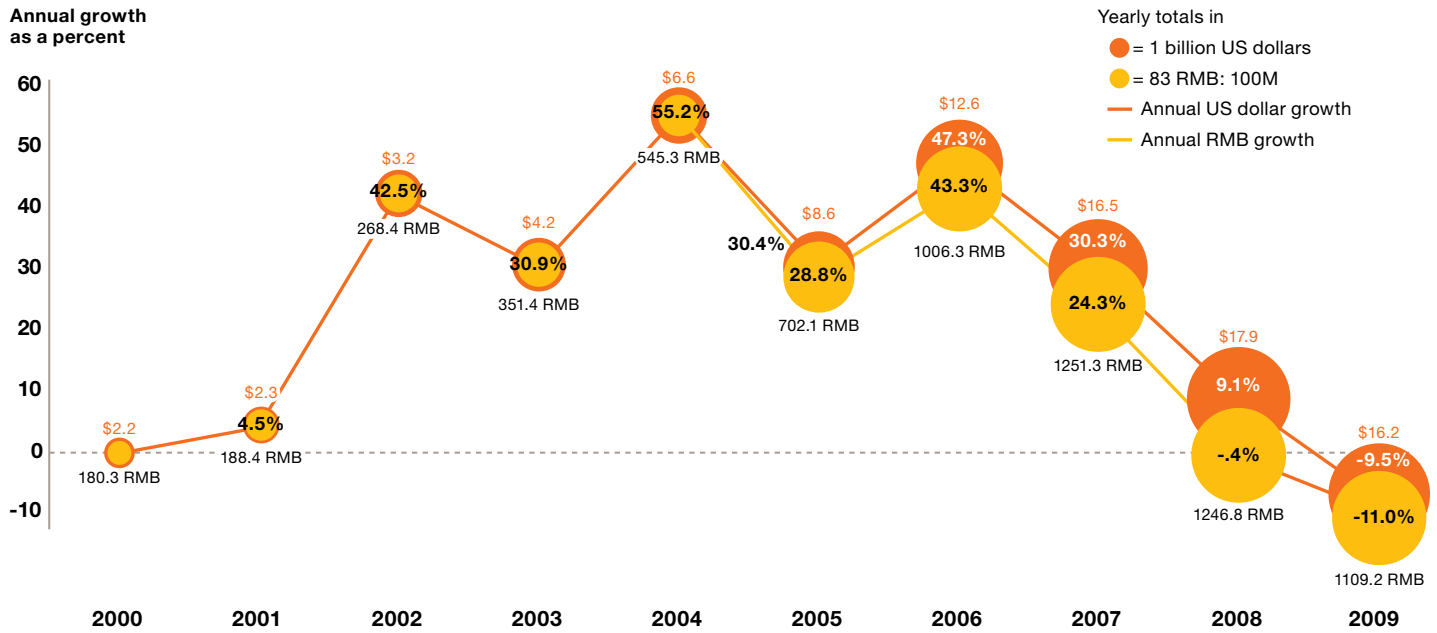
Production growth

As a result of the global recession, China's semiconductor industry experienced its first annual decline in more than 20 years. Measured in US dollars, China's semiconductor industry (production) revenues decreased from US\$31 billion in 2008 to US\$29 billion in 2009, a decrease of more than 7%. When reported in local RMB currency, China's semiconductor industry (production) revenues decreased by almost 9%, or just slightly less than the 9% decrease reported by the worldwide semiconductor industry. China's semiconductor industry is now being affected by the global industry cycles.

China's industry growth peaked in 2004 with a growth rate of 45%, gradually declined since, with 2008 being the first year with a single-digit growth rate and 2009 being the first year with negative growth.

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 11.0% of the worldwide semiconductor industry in 2009, up from 10.7% in 2008 and, more significantly, up from just 2% in 2000. Although this measurement is probably

Figure 9: China's IC industry revenue and growth, 2000–2009



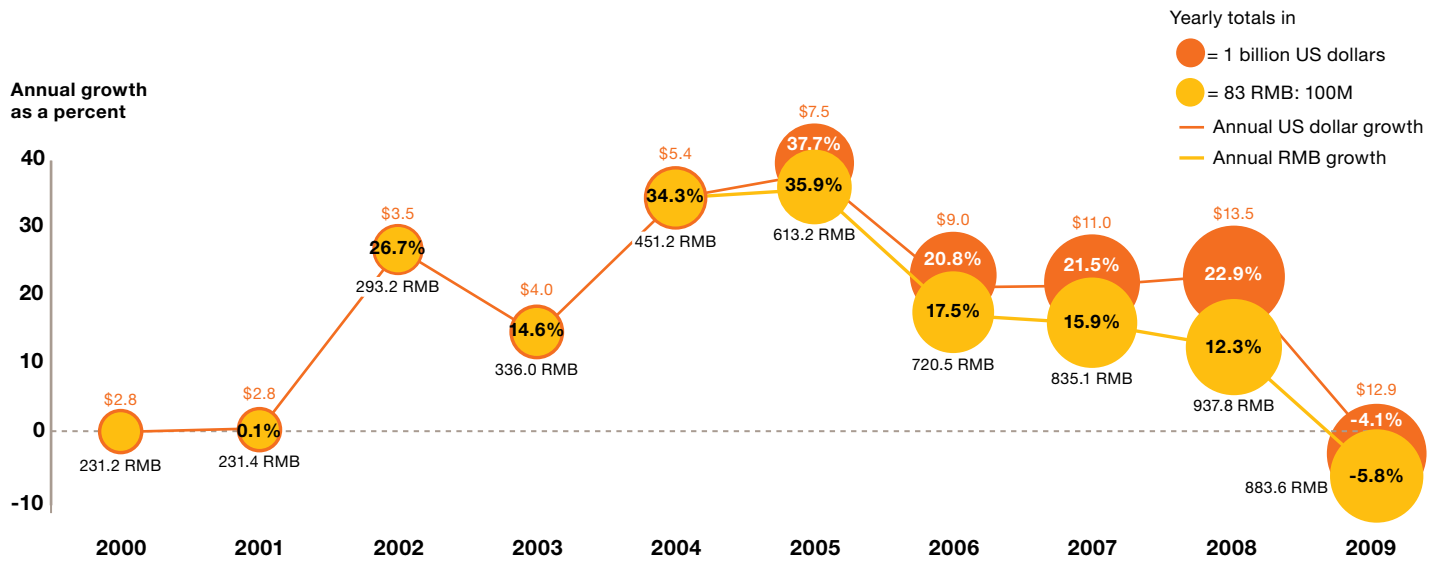
Source: CCID, CSIA

overstated, a more conservative comparison against the sum of device sales revenue, plus the value of all wafer fabrication and packaging, assembly and test production indicates that China's semiconductor industry accounted for at least 7.5% of the worldwide semiconductor industry in 2009. The trend continues: China's share of the worldwide semiconductor industry is growing, becoming noticeable and significant.

China's IC industry (the sum of IC design, IC wafer manufacturing and IC packaging and testing) reported negative US dollar sales growth for the first time ever in 2009. China's IC industry revenues measured in US dollars decreased by 9.5%, to slightly more than US\$16B in 2009. When reported in local RMB currency, the same industry revenues decreased by 11.0% to 1109 RMB:100M in 2009, after decreasing by 0.4% to 1247 RMB:100M in 2008.

The three sectors of China's IC industry were affected quite differently by the global recession. Thanks to a booming domestic demand driven by China's economic stimulus policies, the IC design sector grew against all odds. China's IC design (fables) sector revenues increased by almost 17% measured in US dollars (almost 15% in local RMB currency) to reach a record US\$4 billion in 2009. The other two sectors, with greater export dependence and multinational company involvement, were much more adversely affected. IC manufacturing, which includes China's wafer foundries, was affected earlier with reduced orders, causing lower capacity utilization. This resulted in year-over-year revenue declines of 4% and 14% in the third and fourth quarters of 2008. Revenues then crashed another 35% and 28% in the first two quarters of 2009. From there, revenue declines softened to only 13% in the third quarter before a 20% turnaround in the fourth quarter. The overall sector result is a revenue decrease of nearly 12% measured in US dollars or more than 13% reported in RMB.

Figure 10: China's O-S-D industry revenue and growth, 2000–2009



Source: CCID, CSIA

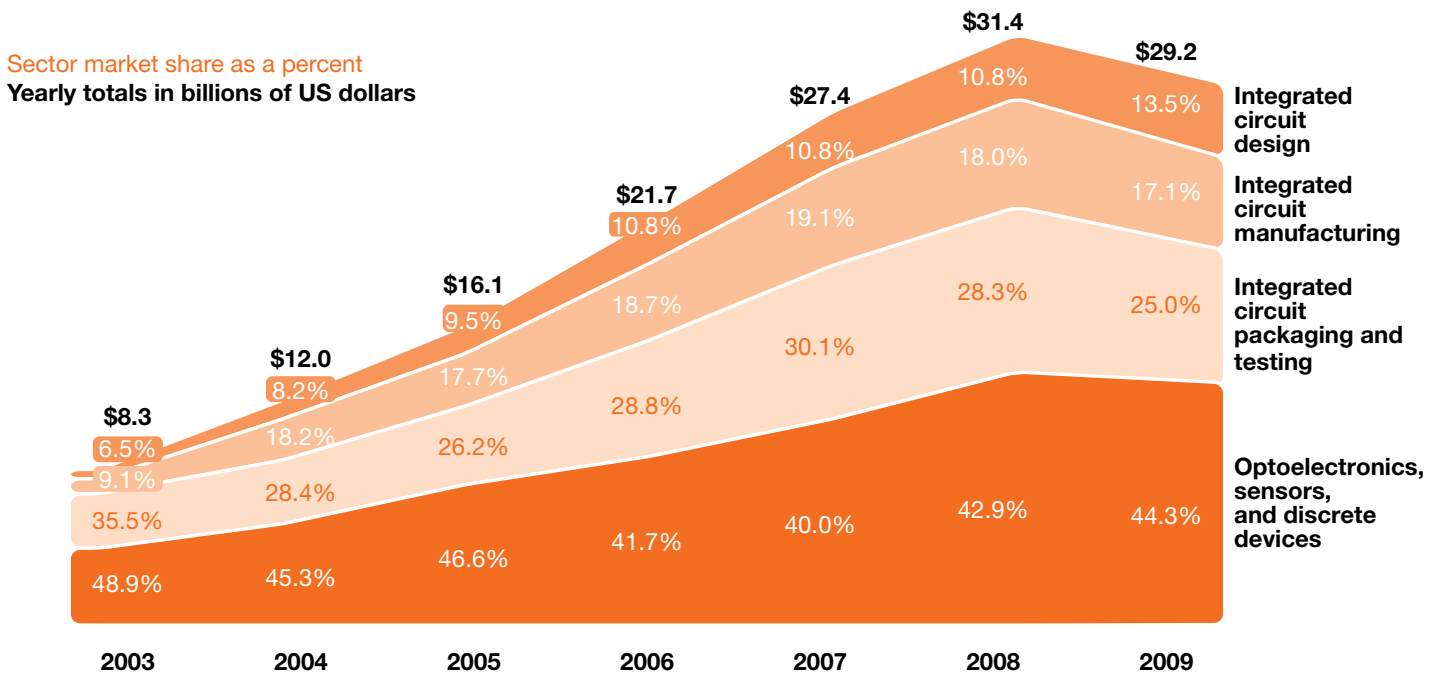
IC assembly and test, which includes both multinational SATS (semiconductor assembly and test services) and captive facilities, was affected later but much more severely. Here, reduced or cancelled orders led to capacity underloads and a 39% year-over-year revenue decline in the fourth quarter of 2008. This was followed by a further 50% decline in the first quarter of 2009. The bankruptcy driven closure of the Qimonda plant and the closure of two other multinational plants contributed to further significant year-over-year revenue declines in the second and third quarters of 2009. As a result, IC assembly and test sector revenues decreased 18% measured in US dollars or almost 20% reported in RMB during 2009.

China's O-S-D sector performed somewhat better than worldwide industry average, but still suffered a decline in revenues. China's O-S-D production unit output increased by about 7% in 2009, while intense competitive pricing pressure resulted in a 11% decrease

in ASPs (average selling prices). As a result, China's O-S-D sector revenues decreased slightly more than 4% measured in US dollars (almost 6% reported in RMB) in 2009.

Compared to China's IC industry revenue decrease of 9.5% in 2009, the O-S-D sector's relatively better performance was mainly due to growth in LED and automotive electronics. China's LED production revenues increased 12.6% in 2009 to represent almost 25% of China's O-S-D sector, up from an average of about 21% during the prior four years. China's LED industry had been experiencing double-digit growth for several years prior to 2008 since the implementation of China's national semiconductor lighting project. That growth rate dropped to 9% in 2008 as a result of the global recession's impact on export production, but recovered to almost 13% in 2009 with the help of government policies. During

Figure 11: China's semiconductor industry by sector 2003–2009



Source: CCID, CSIA, PwC 2004-2009

2009, more than 85% of China's LED industry revenues came from packaging and testing, almost 10% from IDM and chip manufacturing, and less than 5% from design (fabless) companies.

Industry by sector

The distribution of China's semiconductor industry continued to change in 2009 as a result of the exceptional growth of the IC design (fabless) sector in an otherwise negative and diverse environment. (See Figure 11). The IC design sector has been the fastest growing sector over the past eight years, with a US dollar revenue CAGR of just over 47%. It has grown from less than US\$200 million in 2001 to almost US\$4 billion in 2009. It had represented almost 11% of China's semiconductor industry for each of the prior three years and grew to represent 13.5% in 2009. The sector's growth has slowed

from 54% in 2006 to 27% in 2007 and 14% in 2008 before increasing to almost 17% in 2009.

IC manufacturing, which includes the IC wafer foundries, has been the second fastest growing and most variable sector over the past eight years. During the past eight years it has experienced annual dollar revenue growth ranging from a 2004 peak of 190% down to a new 2009 low of an almost 12% decrease (for an eight year average CAGR of more than 38%). The IC manufacturing sector dollar revenue had grown from less than US\$400 million in 2001 to US\$5.6 billion in 2008 before declining to US\$5 billion in 2009. It represents 17% of China's 2009 semiconductor industry revenue, down from 18% in 2008 and 19% in 2007.

IC packaging and testing includes multinational and Chinese SATS (semiconductor assembly and test services) as well as multinational captive facilities. This grouping remains the second largest sector of China's semiconductor industry. Over the past eight years its dollar revenue has grown at a 20% CAGR from less than US\$2 billion in 2001 to almost US\$9 billion in 2008 before dropping to just slightly more than US\$7 billion in 2009. Because of the large drop in first half production, this sector had the greatest 2009 dollar revenue decrease at slightly more than 18%. This, in turn, results in a drop in its share of China's 2009 semiconductor industry revenue to 25%, down from 28% in 2008 and 30% in 2007.

Although it is the least celebrated or promoted and is often the slowest growing sector of China's semiconductor industry, the O-S-D sector has remained the largest sector for at least the last eight years. Since 2001, the O-S-D sector grew from US\$2.8 billion in 2001 to US\$13 billion in 2009 for a CAGR of just over 21%. Measured in US dollars, the O-S-D sector suffered a relatively moderate 4% decline in 2009 revenue which made it the second best performer. As a result, the O-S-D sector actually gained industry share in 2009, to reach more than 44% of China's semiconductor industry—and remain the largest sector.

The top Chinese semiconductor manufacturers

Table 6 lists the 50 largest semiconductor manufacturers in China—those reporting 2009 revenues of US\$57 million or more. This revenue threshold is down from the US\$72 million threshold of the top 50 in our 2009 report.

This table includes five groups that each own one or more companies in the various sectors of China's semiconductor industry. These groups are listed in place of listing their several 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 current reporting practice, which reports the group totals (by industry sector) in response to requests by the groups.



Table 6: Major Chinese semiconductor manufacturers (including groups) in 2009

Name of Company	Rank		Sales revenue (RMB: 100M)			Sector	Revenue (US\$M)		
	2008	2009	2008	2009	Change		2008	2009	Change
Intel Products (Shanghai & Chengdu) Co., Ltd.	5	1	109.11	161.21	47.7%	P _T	1,570	2,360	50.3%
Hynix-Numonyx Semiconductor	1	2	122.07	106.39	-12.8%	I	1,756	1,557	-11.3%
SMIC (Semiconductor Manufacturing International Corp.)	3	3	93.03	73.09	-21.4%	F	1,339	1,070	-20.1%
Freescale Semiconductor (China) & (Suzhou) Co.,Ltd.	2	4	116.08	65.98	-43.2%	P _T D	1,670	966	-42.2%
RFMD (RF Micro Devices (Beijing) Co.,Ltd.	8	5	45.01	52.85	17.4%	P _T	648	774	19.5%
XINCHAO Group	9	6	39.88	42.24	5.9%	P _T	574	618	7.8%
HiSilicon Technologies Co., Ltd.	12	7	30.94	39.11	26.4%	D _F	445	572	28.6%
China Resources Microelectronics (Holdings) Ltd.	7	8	45.45	36.86	-18.9%	I D _C D	654	540	-17.5%
Renesas Semiconductor (Beijing & Suzhou) Co.,Ltd.	6	9	45.50	29.55	-35.1%	P _T	655	433	-33.9%
Shangahi Panasonic Semiconductor Co., Ltd.	10	10	39.07	29.53	-24.4%	P _T	562	432	-23.1%
Shanghai Huahong (Group) Company Ltd.	13	11	29.95	28.06	-6.3%	D _F	431	411	-4.7%
ST Microelectronics	11	12	35.50	27.91	-21.4%	P _T	511	409	-20.0%
Natong Fujitsu Microelectronics Co., Ltd.	14	13	26.60	27.20	2.3%	P _T	383	398	4.0%
Leshan Radio Co., Ltd. (incl ON Semiconductor JV)	17	14	21.25	21.63	1.8%	D _C	306	317	3.5%
Samsung Electronics (Suzhou) Semiconductor Co.,Ltd.	16	15	21.90	20.80	-5.0%	P _T	315	305	-3.4%
ASE Assembly & Test (Shanghai) Ltd.	18	16	17.45	19.92	14.1%	P _T	251	292	16.1%
Infineon Technologies (Wuxi) Co.,Ltd.	15	17	23.19	18.58	-19.9%	P _T	334	272	-18.5%
STATS ChipPAC	19	18	14.66	16.84	14.9%	P _T	211	246	16.8%
China Huada Integrated Circuits Design (Group) Co., Ltd.	21	19	14.43	14.41	-0.2%	D _F	208	211	1.6%
Chipmore Technology Corporation Ltd.	24	20	11.60	12.67	9.2%	P _T	167	185	11.1%
SanDisk Semiconductor (Shanghai) Co. Ltd.	45	21	6.34	12.47	96.7%	P _T	91	183	100.1%
HeJian Technology (Suzhou) Co., Ltd.	23	22	13.40	12.20	-9.0%	F	193	179	-7.4%
Shanghai Grace Semiconductor Manufacturing Co., Ltd.	20	23	14.56	10.98	-24.6%	F	210	161	-23.3%
Jilin Sino Microelectronics Co., Ltd.	27	24	10.48	10.88	3.8%	D _C	151	159	5.6%

P_T Packaging & Testing
 D Design
 D_F Design (Fabless)
 F Foundry
 D_C Discrete
 I IDM

Name of Company	Rank		Sales revenue (RMB: 100M)			Sector	Revenue (US\$M)		
	2008	2009	2008	2009	Change		2008	2009	Change
Shenzhen ZTE Microelectronics Technology Co., Ltd.	41	25	7.02	10.00	42.5%	DF	101	146	44.9%
Hangzhou Silan Microelectronics Co., Ltd.	30	26	9.32	9.58	2.8%	DC F	134	140	4.6%
Tianshui Huatian Microelectronics Co., Ltd.	32	27	9.27	9.60	3.5%	PT	133	140	5.3%
Amkor Technology China Ltd.	35	28	9.24	9.54	3.2%	PT	133	140	5.0%
TSMC (Shanghai) Co., Ltd.	26	29	11.00	8.69	-21.0%	F	158	127	-19.6%
UTAC Dongguan Ltd.	29	30	9.46*	8.54	-9.7%	PT	136	125	-8.2%
No. 55 Research Institute of China Electronics Technology Group Corporation	40	31	7.07	8.34	17.9%	I	102	122	20.0%
RDA Microelectronics, Inc.		32	3.47	8.09	133.0%	DF	50	118	137.1%
Shougang NEC Electronics	22	33	14.35	7.34	-48.8%	F	206	108	-47.9%
Spreadtrum Communications Inc.	37	34	7.48	7.18	-4.0%	DF	108	105	-2.4%
Fairchild Semiconductor (Suzhou) Co., Ltd.	36	35	7.73	7.12	-7.9%	PT	111	104	-6.3%
Siliconware Technology (Suzhou) Co., Ltd.	28	36	10.37	6.87	-33.7%	PT	149	101	-32.6%
BCD Semiconductor Manufacturing Ltd.	46	37	6.30	6.81	8.1%	I	91	100	10.0%
Datang Microelectronics Technology Co., Ltd.	34	38	8.36	6.47	-22.5%	DF	120	95	-21.2%
ASMC (Advanced Semiconductor Manufacturing Co., Ltd.)	31	39	9.33	6.42	-31.2%	F	134	94	-30.0%
Shangahi Kai Hong Electronics Co., Ltd.	39	40	7.39*	5.98*	-19.1%	PT	106*	88*	-17.7%
Tianjin ZhongHuan Semiconductor Co., Ltd.	33	41	8.90	5.89	-33.8%	DC	128	86	-32.7%
Beijing Vimicro Co., Ltd.	48	42	6.22	5.20	-16.4%	DF	89	76	-14.9%
Nationz Technologies Inc.		43	2.19	4.66	113.0%	DF	31	68	116.7%
Tongfang Microelectronics Company	54	44	3.97	4.50	13.4%	DF	57	66	15.3%
GEM Electronics (Shanghai) Co., Ltd.	31	45	7.51	4.44	-40.8%	PT	108	65	-39.8%
China Wafer Level CSP Ltd. (Suzhou)	44	46	6.63	4.30	-35.1%	PT	95	63	-34.0%
Changzhou Galaxy Electrical Co., Ltd.	47	47	6.30	4.26	-32.4%	DC	91	62	-31.3%
Haier (Beijing) IC Design Co., Ltd.		48	0.59	4.04	585.1%	DF	8	59	597.0%
Availink		49	0.60	4.01	569.1%	DF	9	59	580.7%
Quimonda	4	50	85.95	3.90	-95.5%	PT	1,237	57	-95.4%

* Note: 2 companies estimated based upon sectors' average 2008 & 2009 growth
Source: CCID, CSIA, PwC 2009-2010

The five groups with their most significant companies are:

	Revenue (US\$M)		
	2007	2008	2009
China Resources Microelectronics (Holdings) Ltd.	613	654	540
Wuxi China Resources Microelectronics Co., Ltd. (CR Micro) (former CSMC)—Foundry	143	154	144
Wuxi China Resources Huajing Microelectronics Co., Ltd.—Discrete	110	134	122
Wuxi China Resources Semico Microelectronics Co., Ltd.—IC Design	112	90	84
XINCHAO Group	497	574	618
JECT (Jinangsu Changjiang Electronics Technology Co., Ltd.)—Pkg & Test	304	342	347
Shanghai Huahong (Group) Co., Ltd.	461	431	411
HHNEC (Shanghai Huahong NEC Electronics Co., Ltd.) – Foundry	319	279	240
Shanghai Huahong IC Co., Ltd.—IC Design	90	88	95
Shanghai Beiling Stock Co., Ltd.—IDM / Foundry	52	64	75
China Huada Integrated Circuits Design (Group) Co., Ltd. (CIDC Group)	192	208	211
CEC Huada Electronics Design Co., Ltd.—IC Design	74	84	68
Beijing Huada Zhaibao Electronic Systems Co., Ltd.—IC Design	23	32	40
Nationz Technologies Inc.	20	31	68
Hangzhou Silan Microelectronics Co., Ltd.	128	134	140
Hangzhou Silan Microelectronics Co., Ltd.—Design	108	76	86
Hangzhou Silan Integrated Circuit Co., Ltd—IDM/Foundry	43	56	59
Hangzhou Silan Azure Co., Ltd—LED	N/A	26	29

In addition to these five groups, Table 6 also lists a single entry for each of several multinational semiconductor companies that have more than one manufacturing facility in China though each facility may be legally organized as a separate company in China. These companies include Freescale, GEM Electronics, Intel, Renesas, RFMD and ST Microelectronics. Each listing reflects the combined revenues of all the companies' manufacturing facilities in China.

The combined 2009 revenues reported for these top 50 enterprises is US\$15.6 billion, representing 53% of China's total 2009 semiconductor industry revenue of US\$29 billion. China's industry remains significantly less concentrated than the worldwide industry, where the top 50 companies represent slightly more than 82%, and the top 14 companies 54% of the total market.

The combined reported RMB revenues of these top 50 China-based manufacturers dropped more than 12% in 2009 while their US dollar revenues decreased by almost 11% which was, in both cases, almost 4% greater than the decrease reported by China's total semiconductor industry. Four companies are new to the list and one company is a returnee. Their 2009 ranking is as follows:

- RDA Microelectronics, which had emerged as one of China's leading semiconductor companies in 2008, reported a further 137% increase in dollar revenue for 2009 to qualify. It debuts at number 32 on the list.
- Nationz Technologies was re-registered from ZTE IC Design in May 2009 and reported a 117% increase in dollar revenue for 2009 to qualify—achieving the number 43 position.



- Availink emerged as another of China's new leading semiconductor companies in 2009, reporting a 580% increase in US dollar revenue to earn the 49th position.

Conversely, there were five 2008 top 50 manufacturers that did not qualify for the 2009 list. They are:

- EEMS Co., Ltd., which experienced an operations interruption for the first six months of 2009 due to the insolvency of their major customer Qimonda (ranked 25 in 2008).
- Ningbo KangQiang Electronics Co., Ltd., which reported a 53% decline in 2009 dollar revenue to just miss the qualifying threshold which had decreased 37% (42 in 2008).
- Actions Semiconductor Ltd., which reported a 62% decline in 2009 dollar revenue, therefore failing to meet the qualifying threshold (43 in 2008).
- Shenzhen Si Semiconductor Co., Ltd.'s, whose revenue was not reported for 2009. But had its revenue declined at merely the O-S-D sector average, the firm might still have qualified. (It ranked 49 in 2008.)
- Suzhou Zhenkun Technology Co., Ltd., which reported a 52% decline in 2009 dollar revenue, failing to meet the qualifying threshold. (It ranked 50 in 2008.)

Four new start-up companies were added to our listing of China's Top 50 Semiconductor Manufacturers.

- Tongfang Microelectronics had been dropped from the 2008 listing due to a decline in revenues, but reported a 15% increase in US dollar revenue for 2009 to re-qualify at number 44.
- Haier (Beijing) IC Design emerged as one of China's new leading semiconductor companies in 2009, reporting a 597% increase in US dollar revenue to debut at 48.

Measured in US dollars, China's reported semiconductor industry revenues decreased by 7.2% or US\$2.3 billion during 2009. China's top 50 manufacturers accounted for more than 80% of that decrease. While 23 of the top 50 manufacturers reported revenue increases totaling US\$1.6 billion, their growth was more than offset by total decreases of US\$3.5 billion from the other 27. Much of these decreases came

Both of the top two Chinese semiconductor manufacturers have completed evolutionary extensions that could result in a paradigm shift in the semiconductor industry. Both Intel and Hynix have reached another significant milestone by becoming truly vertically integrated IC manufacturers within China during 2010.

from multinational rather than local domestic semiconductor companies. Four of the top five contributors to those decreases in reported revenues were multinational companies:

- Qimonda (contributing 33.5% of the total decrease)
- Freescale Semiconductor (20.0%)
- Renesas Semiconductor (6.3%)
- Hynix-Numonyx (5.7%)

The one Chinese company among the top five contributors to the 2009 revenue decrease was:

- SMIC (contributing 7.6% of the total decrease)

However, 23 of the top 50 manufacturers did report revenue growth during 2009 totaling US\$1.6 billion. The five manufacturers reporting the largest of increases during 2009 included three multinational and two Chinese companies:

- Intel Products (contributing 48.7% of the total growth)
- HiSilicon Technologies (7.8%)
- RF Micro Devices (7.8%)
- SanDisk Semiconductor (5.6%)
- RDA Microelectronics (4.2%)

The Intel Products performance is noteworthy. The company has more than doubled its capacity and output during the past two years as a result of a corporate manufacturing restructuring initiative undertaken before the start of the recession. Intel, meanwhile, closed several older packaging and testing facilities in Asia, including the one in Pudong, Shanghai, transferring most of their production volume to Chengdu. As a result, Intel Products (Chengdu) has moved up to the number 1 position among China's semiconductor manufacturers, overtaking Hynix-Numonyx in 2009 reported revenue.

Both of the top two Chinese semiconductor manufacturers have completed evolutionary extensions that could result in a paradigm shift in the semiconductor industry. Although they are extending from different directions, both Intel and Hynix have reached another significant milestone by becoming truly vertically integrated IC manufacturers within China during 2010.

Hynix, which established its first 200mm Hynix-Numonyx wafer fabrication facility in China in 2005, rapidly grew to become China's largest semiconductor manufacturer in 2008 and now operates China's largest and most advanced 300mm wafer fabrication facility. Although many of Hynix's finished IC devices are consumed in China, all of its wafer output had been exported from China to be packaged and tested at Hynix facilities in Korea. That changed when Hynix completed an IC packaging and testing facility in Wuxi, China that started production in July 2010.

Intel, which established its first packaging and testing facility in China in 1996, has grown steadily to become China's largest semiconductor manufacturer (based upon die included packaging

and testing revenue) in 2009. All of the chipset and microprocessor wafers used by Intel's packaging and assembly operations in China had been imported from Intel facilities in other countries. This will also change as Intel started IC chipset wafer production at its new 300mm Fab 68 in Dalian in October 2010.

Completion of these extension programs will provide China with two large vertically integrated advanced technology IC IDM (integrated device manufacturing) operations. Since Intel and Hynix are among the top five suppliers to China's semiconductor consumption market, a noticeable portion will soon be satisfied by IC devices manufactured completely within China. Although not indigenous Chinese companies, the success of these two vertically integrated IC IDM operations in China has the potential to impact the semiconductor industry because of their size, revenue, prominence, technology and manufacturing prowess.

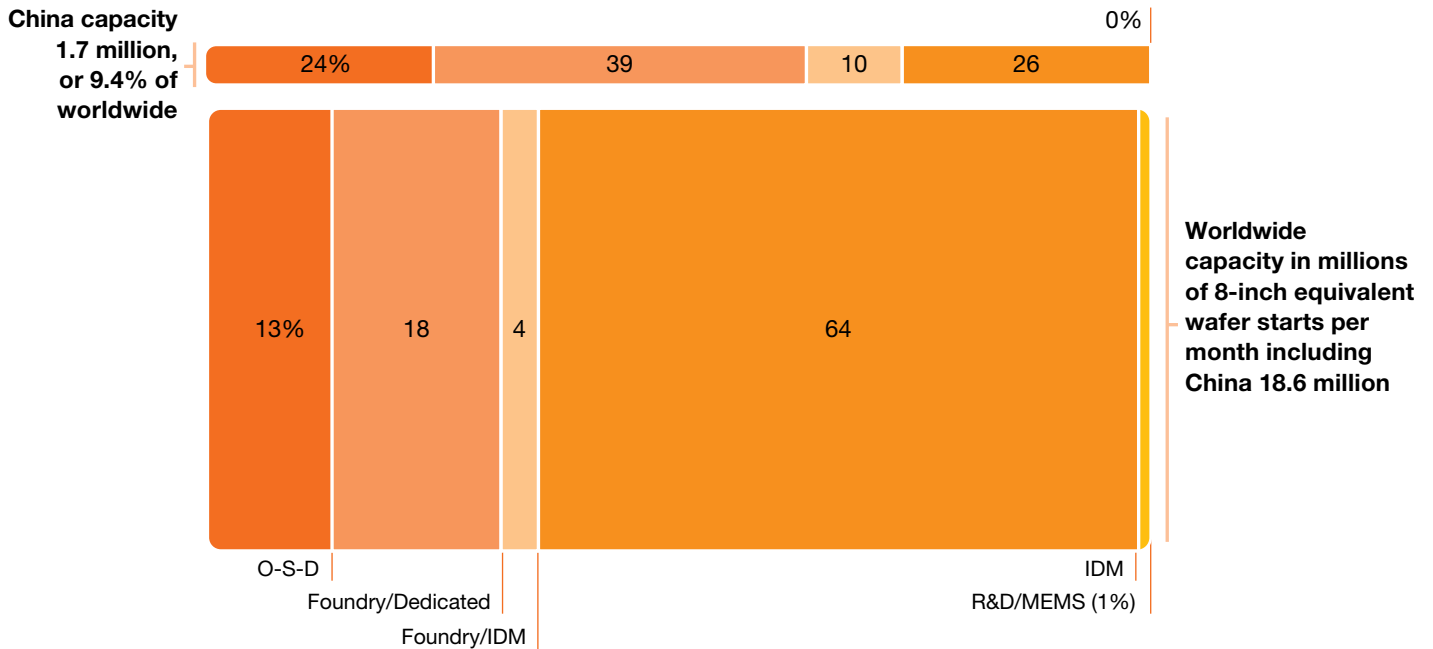
Wafer fab capacity

Prior to 2009, China had increased wafer fab capacity faster than other regions every year during the decade. That trend was suspended in 2009. For the first time in recent semiconductor history China's current wafer fab capacity did not noticeably increase during 2009. During the year, China discontinued production at four IC fabs, while starting production at one new IC fab and four new discrete/LED fabs. China thereby increased the net number of fabs in production by one, less than 1%, without adding to its net capacity during 2009. By comparison, worldwide capacity increased by 3.3%.

However, based upon their current capabilities (rather than intentions, i.e., World Fab Watch, WFW, Probability ≥ 1.0), China will still have been able to increase their share of total worldwide semiconductor wafer production from the $\leq 2\%$ realized in 2003 to $\geq 9.4\%$ by 2012 by just fully equipping and ramping to full capacity at mature yields all of their existing wafer fabrication modules. While this would almost quintuple their share of worldwide wafer production compared to 2003, it also represents a slight decrease in China's relative capacity during the past year from 9.6% to 9.4% of worldwide capacity.

During the past year the WFW database added 26 of China's existing wafer fabs, this in addition to the 13 added in 2008. With the exception of two Lishan Microelectronics foundry/IDM fabs, these were mostly small discrete/LED wafer fabs that began production between 2000 and 2008 but were previously unrecorded. Their addition represents a growing recognition of the significance and impact of China's local O-S-D sector. As a result, China's 2008 current wafer fab capacity was revised to 1,743.9 K Wafer Starts per Month (a 2% correction) which then represents 9.7% of worldwide capacity.

Figure 12: Current wafer fab capacity comparison, China and worldwide
(WFW probability ≥ 1.0)



Source: SEMI Wafer Fab Watch May 2010

China's current wafer fabrication capabilities continue to lag the worldwide industry in moving to leading-edge capabilities.

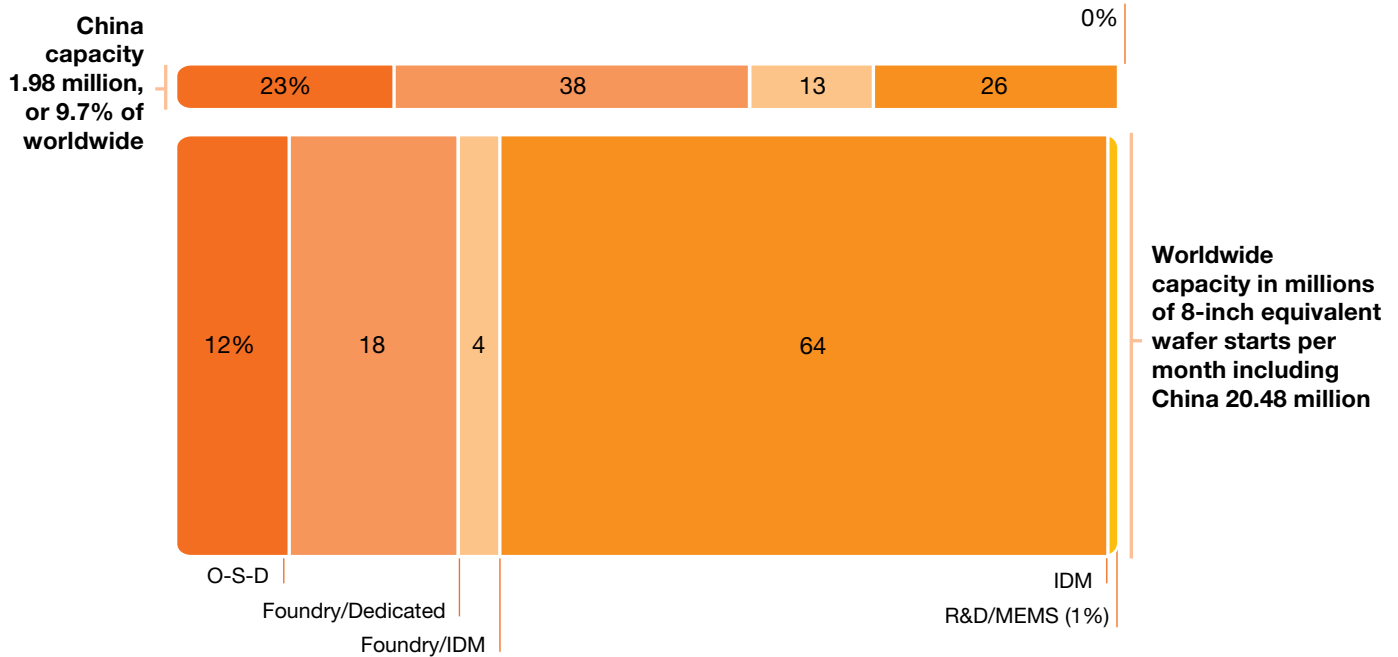
China currently has 12 additional wafer fabs that are committed and under construction. They are almost a third in number of the total of 40 additional committed fabs under construction worldwide, but represent only slightly less than 13% of their capacity. China is getting less capacity per new wafer fab plant because they are adding a greater proportion of smaller 4" (100mm) and O-S-D fabs than other regions and a lower proportion of 12" (300mm) plants.

During the past four years, the number of wafer fabrication modules committed and under construction in China had decreased from 20 in 2006 to eight in 2008 before again growing to 12 in 2009. These 12 modules under construction have the potential to further increase China's wafer fabrica-

tion capacity by 14%, which is more than the 10% increase in potential worldwide capacity from the total of 40 modules under construction worldwide. If and when these wafer fabs are complete, China will have resumed increasing wafer fab capacity faster than other regions.

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 its share of total worldwide semiconductor wafer production from the $\leq 2\%$ realized in 2003 to $\geq 9.7\%$ by 2014. This would require financing, completing the 12 wafer fabrication plants currently under construction and fully equipping and ramping to full capacity at mature yields those new plants plus all of the existing wafer fabrication modules. If this comes to pass, it would increase

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



Source: SEMI Wafer Fab Watch May 2009

China's share of worldwide wafer production by slightly less than five times, exacting a moderate impact on the semiconductor industry.

Capacity by process node and wafer size

From a geometry/technology node distribution standpoint, China's current wafer fabrication capabilities continue to lag the worldwide industry in moving to leading-edge capabilities. When fully equipped and ramped, China will only have 25% of its capacity at the leading-edge $<0.08\mu\text{m}$ node compared to a worldwide industry distribution of 46%. By contrast, China will have 25% at the less advanced <0.16 to $\geq 0.08\mu\text{m}$ nodes versus 15% worldwide, and 22% at the mid-range <0.4 to $\geq 0.16\mu\text{m}$ nodes versus 16% worldwide. Probably because of its heavier focus on discrete

production, China will also have 29% of its capacity at the mature $>0.4\mu\text{m}$ nodes versus worldwide 19%.

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

- 38% of its capacity in 6-inch or smaller wafers versus the worldwide mix of 23%;
- 35% of its capacity in 8-inch wafers equal to the worldwide mix of 32%; and
- 27% of its capacity in 12-inch wafers compared to the worldwide mix of 45%.

Table 7: Comparison of current wafer fab capacity, 2009

Geometry	China		China's % of Worldwide	Worldwide	
	Capacity	%		Capacity	%
≥ 0.7 μm	384.5	22%	15.6%	2,463.4	13%
< 0.7 to ≥ 0.4 μm	120.3	7%	11.5%	1,047.2	6%
< 0.4 to ≥ 0.3 μm	153.6	9%	13.5%	1,138.0	6%
< 0.3 to ≥ 0.2 μm	30.6	2%	3.0%	1,018.3	5%
< 0.2 to ≥ 0.16 μm	190.0	11%	21.1%	900.9	5%
< 0.16 to ≥ 0.12 μm	150.0	9%	9.6%	1,559.6	8%
< 0.12 to ≥ 0.08 μm	276.5	16%	21.3%	1,299.7	7%
< 0.08 μm	438.8	25%	5.1%	8,603.3	46%
N/A			0.0%	542.0	3%
Total	1,744.2	100%	9.4%	18,572.4	100%

Wafer Size					
≥ 4"	178.7	10%	20.8%	858.4	5%
5"	149.8	9%	18.6%	804.7	4%
6"	330.5	19%	12.7%	2,610.5	14%
8"	615.0	35%	10.3%	5,970.1	32%
12"	470.3	27%	5.6%	8,328.7	45%
Total	1,744.3	100%	9.4%	18,572.4	100%

Capacity = 1000s 8" Equivalent Wafer Starts per Month (KWSpm)
 Current Capacity = World Fab Watch Probability ≥1.0

Source: SEMI World Fab Watch, 2010

China has newer wafer fabrication plants with older technology.

Of the 83 12-inch (300mm) wafer fabrication plants currently in production worldwide, only five are in China, constituting 5.6% of worldwide 300mm capacity. As a result, for at least the next three years wafer fab plants in other locations will continue to have the capabilities for retaining low mix/high volume advanced technology (e.g., DRAM NAND Flash) wafer manufacturing cost leadership.

China does have three additional 12-inch (300mm) wafer fab plants committed and under construction. But they are only three out of 14 committed worldwide. When completed and if fully equipped and ramped to full capacity—which could be three years

from now—they could increase China's 300mm capabilities to constitute 33% of its total wafer fab capacity. But this would increase China's share of worldwide 300mm capacity to 6.5% when all 14 of the 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 worldwide average concentration of 6-inch and smaller fab capacity. China currently has 93 6-inch or smaller wafer fabs in production, constituting 36% of total capacity compared to a worldwide average of 23%.

Table 8: Comparison of committed future wafer fab capacity, 2009

	China			China's % of Worldwide	Worldwide		
	# Fabs	Capacity	%		# Fabs	Capacity	%
Geometry							
≥ 0.7 μm	7	46.6	19%	34.0%	13	137.0	7%
< 0.7 to ≥ 0.4 μm	0				5	39.0	2%
< 0.4 to ≥ 0.3 μm	0				3	6.6	0%
< 0.3 to ≥ 0.2 μm	1	N/A			2	45.0	2%
< 0.2 to ≥ 0.16 μm	0				0		0%
< 0.16 to ≥ 0.12 μm	0				1	30.0	2%
< 0.12 to ≥ 0.08 μm	2	98.8	40%	86.9%	3	113.7	6%
< 0.08 μm	2	99.0	41%	6.4%	13	1,545.9	81%
N/A	0				0		
Total	12	244.4	100%	12.7%	40	1,917.2	100%
Wafer Size							
≥ 4"	7	46.6	19%	84.1%	12	55.4	3%
5"	0				0		0%
6"	1	N/A			8	116.1	6%
8"	1	20.0	8%	26.2%	6	76.2	4%
12"	3	177.8	73%	10.6%	14	1,669.5	87%
Total	12	244.4	100%	12.7%	40	1,917.2	100%

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

Source: SEMI World Fab Watch, 2010

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. Fifty-three of China's current 115 wafer fab plants started production after 2004 and represent 54% of China's current capacity. By contrast, worldwide wafer fab plants starting production after 2004 represent only 32% 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 transferred, used equipment and technology.

From a business model standpoint China's wafer fabrication capabilities remain noticeably different from worldwide capabilities. Foundry capacity continues to dominate both China's current and committed capabilities. For example, when fully equipped and ramped to volume, foundry production will occupy almost 50% of China's current capacity compared to just under 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 51% of China's capacity versus 23% worldwide.

China's wafer foundries accounted for about 12% of worldwide wafer foundry revenues in 2009, further decreasing from 13% in 2008 and 14% in 2007. China's wafer foundry revenues suffered an 18% decrease in 2009, which was noticeably more severe than the worldwide average 11% decrease. The most significant revenue declines were recorded by SMIC, Shougang NEC Electronics and HeJian Technology.

Based upon its current capabilities China should be able to increase its share of worldwide foundry production to slightly more than 21% by 2012 by fully equipping and ramping to full

China's share of current wafer fab capacity allocated to IC IDMs continues to diverge further from the worldwide average. Primarily as a result of the 26 additional and mostly discrete/LED existing Chinese wafer fabs that were added to the WFW database during 2009, IC IDM capacity now only represents 26% of China's current wafer fab capabilities versus 64% worldwide. It could remain 26% through 2014, even if all of the committed wafer fabs under construction are completed and ramped to full production. In either case, China represents only slightly less than 4% of worldwide IC IDM capacity. This divergence is likely the result

From a business model standpoint, China's wafer fabrication capabilities remain noticeably different from worldwide capabilities. Foundry capacity continues to dominate both China's current and committed capabilities. Based upon its current capabilities China should be able to increase its share of worldwide foundry production to slightly more than 21% by 2012 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.

capacity at mature yields all of their existing wafer fabrication modules. This could have a significant impact on the semiconductor industry. China could slightly further increase its share of worldwide foundry production to almost 22% by 2014 if all of the committed wafer fabs under construction are completed and ramped to full production.

The combination of China's larger proportion of foundry capacity incorporating older technology is leading to commoditization of the sector. This is a factor contributing to lower worldwide foundry average selling prices (ASPs), especially for similarly dated technologies.

of the timing of China's opening of the semiconductor sector to foreign investments, an election to mimic the Taiwanese foundry model and the very weak market position of China's state-owned semiconductor companies. It is now being continued by China's focus on developing the IC design (fab-less) sector. Currently there are only four foreign IDMs with some form of invested IC wafer fabrication capacity in China: Hynix, Intel, NEC, (Hua Hong & SG JVs) and ProMOS.

At the same time, China's share of wafer fab capacity allocated to the O-S-D sector has increased. O-S-D capacity now represents 24% of China's current wafer fab capabilities versus 13% of worldwide. It could decrease to 23%

for China versus 12% worldwide by 2014 if all of the committed wafer fabs under construction are completed and ramped to full production. However, in either case, China represents more than 17% of worldwide O-S-D capacity. Currently there are eleven foreign companies with some form of invested O-S-D wafer fabrication capacity in China: AUK, Epistar, FOREPI, KEC, Lextar, Littelfuse, MEMSIC, NXP, SemiLEDs, Toppan and Walsin Lihwa.

As of the May 2010 WFW, there were ten additional new wafer fabs announced and/or planned (i.e., WFW probability of $\geq 0.45 < 0.80$) for China that had not been committed by the start of construction. This is two more than a year ago and represents 31% of the 32 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 and then 40 to 32 in the last two years. 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 $\leq 2\%$ realized in 2003 to 9.9% 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 semiconductors. Three of the ten are planned to be 12-inch (300mm) fabs which would account for 53% of the potential additional capacity. Five are 8-inch (200mm) fabs and account for 46% of the potential additional capacity. The other two are 2-inch (50mm) specialty LED fabs. Six of the ten are planned for foundry and two for IC IDM production. Taiwan-based UMC (He Jian Technology), Powerchip, Tyntek and United LED are involved with four of these ten possible additional wafer fabs, including the smallest, United LED, and one of the two largest, UMC, and representing 31% of the possible additional capacity.



Only the strongest survive Design in China

Thanks to a booming domestic demand, China's IC design industry grew against all the odds. Integrated circuit design was the only segment of China's semiconductor industry that achieved positive year-over-year growth in 2009. It remained the fastest growing segment of China's semiconductor industry for this decade.

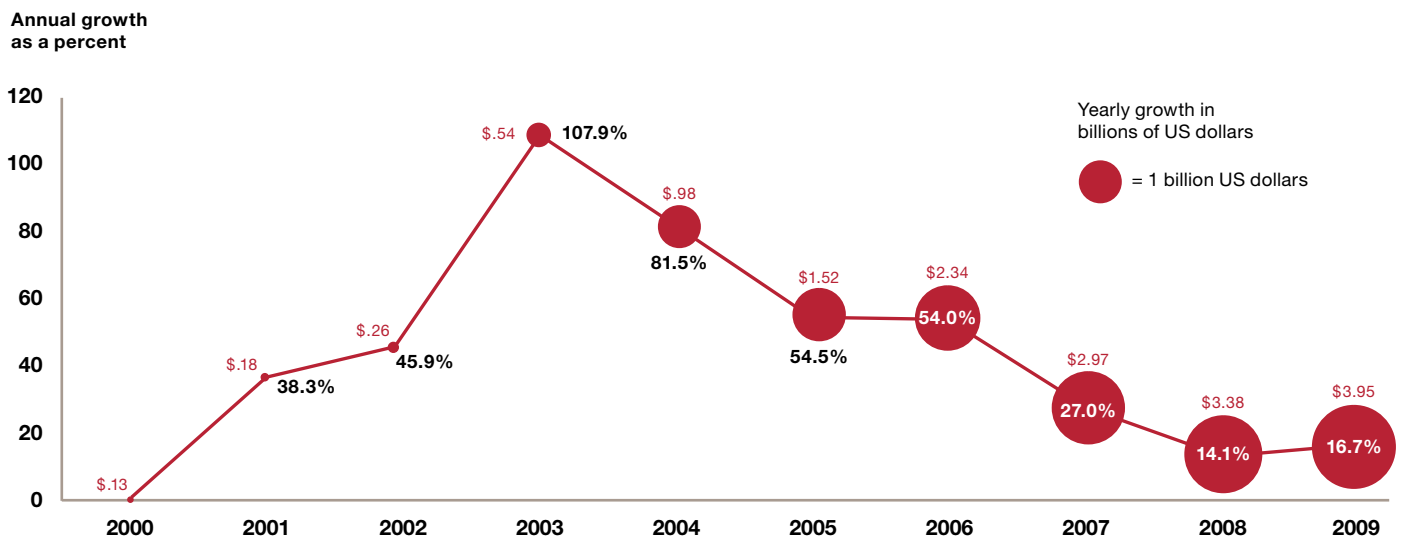
IC design revenues grew from US\$178 million in 2001 to US\$3.95 billion in 2009—experiencing a compounded annual growth rate of just over 47%. As this sector has grown larger its year-over-year growth rate has decreased from a peak of 108% in 2003 to a plateau of about 55% in 2004 and 2005. This was followed by decreases to 27% (2007) and 14% (2008), improving to 17% in 2009. Notably, however, China's IC design sector dollar revenues grew by 14.1% and 16.7% in 2008 and 2009, despite a 2.8% and 9.0% decline in the worldwide semiconductor market for those years.

Integrated circuit design

Integrated circuit (IC) design was the only segment of China's semiconductor industry that achieved positive year-over-year growth in 2009. It remained the fastest growing segment of China's semiconductor industry for this decade. Thanks to a booming domestic demand, China's IC design industry grew against all the odds. Demand was driven by a series of domestic stimulus policies introduced by the government. These policies included subsidies for home appliance sales in rural areas, old-for-new home appliance replacement subsidies, 3G network building and infrastructure construction.

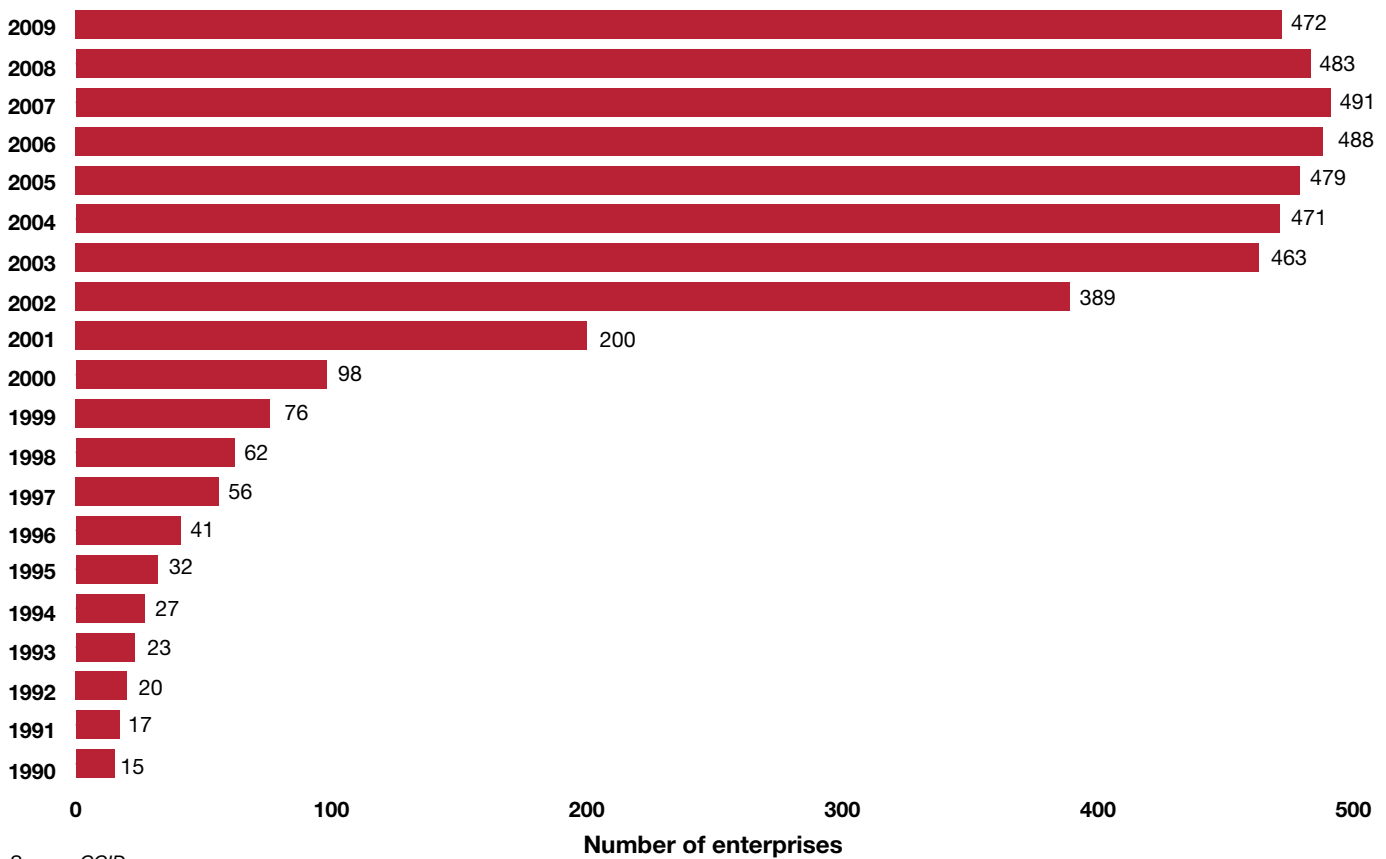
China's IC design revenue growth of 17% in 2009 exceeded that of China's IC manufacturing, IC packaging and testing, and much larger O-S-D sectors. Consequently, the IC design sector's share of China's semiconductor industry increased to 13.5% in 2009 after having remained flat at 10.8% for three consecutive years through 2008. Most of the revenue in this sector can be

Figure 14: China's integrated circuit design industry revenue and growth, 2000-2009



Source: CCID, CSIA

Figure 15: Number of IC design enterprises in China, 1990–2009



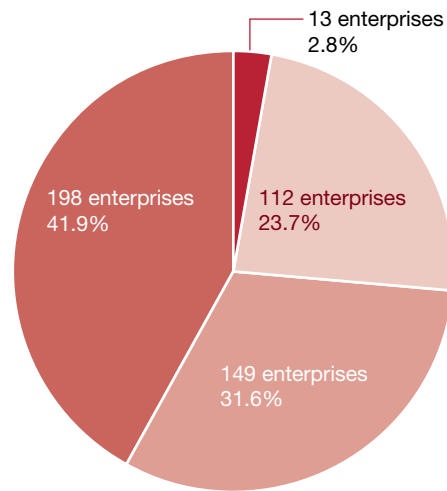
contributed by China’s fabless semiconductor companies, which in 2009 constituted about 7% of the US\$57 billion worldwide fabless IC industry, up from a 1% share in 2001 and a 3% share in 2004. Much of the resilience of China’s IC design sector during the 2009 semiconductor industry downturn has been attributed to those fabless firms that have concentrated on designing for China’s growing domestic market

Design enterprises

China had 472 IC design enterprises at the close of 2009, 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 continuation of a consolidation and survival of the fittest phase.

With a significant slowdown in the Chinese and worldwide semiconductor market growth in 2008, 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 the start-up of new markets further restricted the operations of some IC design enterprises focusing on those markets. This environment has put a severe strain on many of China’s IC design enterprises and several have had

Figure 16: China's IC design enterprises by employee count, 2009



Size of enterprise by number of employees

- > 500
- 100-500
- 50-100
- < 50

Source: CCID

18 of the top 25 multinational semiconductor companies and 24 of the top 100 semiconductor-consuming OEMs. The reasons these multinational companies maintain design activities in China are many and include:

- Protecting their long-term local market by demonstrated 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 relatively low-cost talent;
- Participation 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.

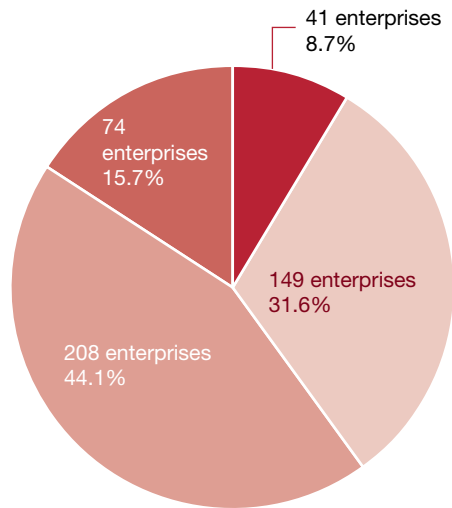
difficulty surviving. Some IC design enterprises went bankrupt in 2008 and even more did so in 2009. It is estimated that no more than 100, possibly less than 50, of the local indigenous IC design enterprises are currently viable.

Of the 472 IC design enterprises reported at the end of 2009, approximately 100 were the design units or activities of foreign-invested or subsidiary multinational companies. Of this group, PwC's 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

Design employees

Although the number of reported IC design enterprises in China decreased by more than 2% to 472 in 2009, the number of employees has increased by at least 30%. There has been a reported increase in the employee density among the IC design enterprises. Compared to 2008, the number of enterprises with more than 100 employees has increased by 36%—or 33 enterprises—while the number with less than 50 employees had decreased by 21% or 54 enterprises. Similarly, by the end of 2009, more than 40% of China's IC design enterprises had less than 50 employees, which is a reduction from more than half so reporting at the end of 2008.

Figure 17: China's IC design industry by process technology, 2009



Process technology design line width (microns)

- ≤ 0.090
- 0.11-0.25
- 0.35-1.0
- >1.0

Source: CCID

However, this increase in employee density has resulted in reduced productivity for several of China's better recognized public IC design companies. Of the five Chinese IC design companies that were reported in the Global Semiconductor Alliance (GSA) Global Financials Report, only one, Spreadtrum Communications with 674 employees, had a sales per employee productivity level that was more than one-third that of the GSA's worldwide 183 fabless company 2009 average of US\$475,000 per employee. The company achieved sales per employee of only US\$156,000 in 2009, up from US\$141,000 in 2008. The other four were lower: Vimicro

with 663 employees (US\$124,000); Shanghai Fudan Microelectronics with 416 employees (US\$109,000); Actions Semiconductor with 658 employees (US\$67,000) and Beijing Baida Jade-Bird with 634 employees (US\$51,000).

Design focus

China's IC design industry continued to achieve some notable qualitative improvements during 2009. There was a further migration of design capabilities to finer design line widths. According to CCID, the number of design enterprises with design capabilities of equal to or less than 0.25 micron has increased to almost 40% of all enterprises. In particular, 41 of these enterprises had design capabilities for equal to or less than 90 nanometers. At the same time, the number of IC design enterprises with low technologies has decreased as has their percentage.

Design industry outlook

The IC design field will continue to be dominated by consumer products. In China's IC industry, most products are now consumer goods, especially low- and middle-end products such as color TVs, sound systems, clocks, electronic toys, small home appliances and remote controls. Meanwhile, new high-end products such as MP3 players, frequency change controllers and digital audio and video decoding chips are now gaining a growing market share. In China's IC market, traditional

consumer products will continue to be in high demand. In addition, new products such as digital TV, STB and digital cameras will greatly drive the further development of the whole consumer IC market. Consumer products will still determine the main technology R&D and market focus direction and remain the mainstream products for China's IC design industry during the next three years.

The 2008/09 worldwide semiconductor downturn has brought a degree of greater realism to local expectations. CCID's current forecast is that China's IC design sector industry will grow by almost 16% in 2010 to US\$4.48 billion, which is a reduction of almost 40% from their forecast of two years ago. If this forecast is realized, China's IC design industry will represent more than 9% of worldwide fabless semi-

conductor revenues and about 2% of the worldwide IC market. IC design continues to be the most dynamic sector of China's IC industry. A number of domestic IC design companies are now actively planning their IPOs. If their IPO plans can be realized, China's IC design industry will get a huge amount of development funds. More importantly, the wealth effect could attract more venture capital and local and overseas high-end talent to enter China's IC design field, which would greatly promote the further development of the industry. On this basis, CCID has forecast the revenue of China's IC design industry will have a CAGR of 16.6% over the next three years.

The 2008/2009 worldwide semiconductor downturn has brought a degree of greater realism to local expectations.

The challenge of hard times

China and the semiconductor value chain



The impact of the global recession was greater on the aggregate semiconductor value chain in 2009 than on the industry itself. The semiconductor value chain revenues decreased 13.5% compared to the industry's 9% decline.

Value chain revenue

The impact of the global recession was greater on the aggregate semiconductor value chain in 2009 than on the industry itself. The semiconductor value chain revenues decreased 13.5% compared to the industry's 9% decline. Only the fabless sector of the value chain reported a modest 2% increase in 2009 revenues. All other sectors of the value chain reported double-digit decreases in revenue, with the semiconductor equipment sector experiencing the most severe relative decline at 46% followed by semiconductor materials at 18% and SATS (semiconductor assembly and test services) at 14%. The IDM (integrated device manufacturer) sector reported the largest decline in absolute value, with a drop of US\$23.5 billion, or 12%.

Table 9 lists worldwide semiconductor value chain revenues for 2000, and 2007-2009 compared with forecasts for 2010. For comparison purposes only, the 2010 forecast and the compounded annual growth rate for the ten-year period remain unchanged from our original 2004 report. The global recession has significantly changed industry performance from earlier expectations. The current consensus is that 2010 will result in a record year for semiconductor industry revenues as well as for foundry and SATS revenues. Semiconductor equipment and materials revenues are also expected to recover significantly in 2010, but not to exceed those of 2007. This will mean that although semiconductor value chain revenues may increase by almost 35% in 2010, they will have only realized a compounded annual growth rate of 3.5% 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 9: Worldwide semiconductor value chain revenue and forecast, 2000–2010
In billions of US dollars

	Actual				Original report	
	2000	2007	2008	2009	2010	CAGR 2000-2010
Electronic Design Automation	3.8	4.8	4.2	3.8	7.8	7
Semiconductor Intellectual Property	0.7	1.9	1.5	1.3	2.3	13
Equipment	52.5	42.8	29.5	15.9	43.3	-2
Materials	26.6	42.7	42.5	34.6	35.7	3
IDMs	184.0	203.3	193.2	169.7	291.7	5
Fabless	20.4	53.0	55.4	56.6	44.6	9
Foundries	7.4	23.9	24.4	21.7	49.6	21
SATS	10.9	20.6	20.1	17.2	26.0	9
Totals	306.3	393.0	370.8	320.8	501.0	5

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

Table 10 presents our current analysis of China's estimated contributions to worldwide semiconductor value chain revenues for 2009. 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, IC IDM assembly and test operations and foundry operations; and somewhat significant in SATS (semiconductor assembly and test services) operations. In 2009, China contributed more than 33% of worldwide discrete device revenues; almost 20% of worldwide IC packaging and testing revenues and almost 14% of worldwide wafer foundry revenues. China has grown to become the dominant supplier of several lines of low-cost commodity discrete devices such as small signal diodes and transistors for major IDMs who either have their discrete manufacturing operations in China or have entered into rebrand-

ing 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.

China's IC design (fabless) sector was able to surmount the effects of the global recession and grow in 2009 by almost 17%. As a result, China's fabless revenues have increased by 160% in the last four years to now represent slightly less than 7% of worldwide fabless revenues. However, during the same time period China's IDM, including O-S-D revenues, were impacted by the global recession and decreased by almost 16% during 2009. As a result, China's IDM, including O-S-D revenues, have increased by almost 75% in the past

Table 10: China's contribution to worldwide semiconductor value chain revenue, 2009

In billions of US dollars

	Worldwide	China		China's role
	Revenue	Sales	Consumption	
Electronic Design Automation	3.8	N/A	0.27	Software user, not EDA producer
Semiconductor Intellectual Property	1.3	N/A	0.12	Licensees by IC design & foundries; not licensor
Equipment	15.9	0.07*	0.94	First-tier & wafer-fab buyer; used equipment favored; solar & second or third-tier producer
Materials	34.6	0.34*	3.26	First-tier buyer, solar and second or third tier producer
IDMs	169.7	13.8	76.8	Plant location for MNC IDMs' SPA&T & 2 fabs; local source of OSD and smaller IC IDMs
Fabless	56.6	4.0	24.4	Small but continually growing local capabilities
Foundries	21.7	3.0	9.7	Substantial; 23% worldwide foundry capacity by 2011
SATS	17.2	6.0	7.7	Substantial: almost 20% worldwide SATS capacity
Totals	320.8	26.7	123.18	

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

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

four years, to represent slightly more than 8% of worldwide IDM revenues. In aggregate, China's semiconductor value chain production revenues decreased less severely than the worldwide value chain revenues in 2009 to represent more than 8% of those revenues.

On the consumption side, China's role has remained, first and foremost, as a consumer of semiconductor devices. It is expected that this role will continue through the recovery from the global recession and remain predominant well into the next decade. While less than 66% of the semiconductors devices China consumed in 2009 were used in the manufacture of electronic products for export from China, more than one-third were used in electronic products for domestic consumption within China. The portion of semiconductors used for electronic products for domestic consumption within China increased by US\$1 billion during 2009. That share is expected to increase further as a result of China's economic stimulus package, other government initiatives and increasing middle-class consumption.

With the recovery, China will continue to be a growing buyer of materials, a cyclical user of equipment and a modest licensor of semiconductor intellectual property and electronic design automation tools. Due to China's relatively large and growing share of semiconductor packaging, assembly and test production, its use continues to be somewhat more concentrated in back-end materials rather than in wafer fab materials. China's semiconductor value chain aggregate consumption decreased less severely than worldwide and in the last four years has increased by more than 81%. It now represents more than 38% of the worldwide semiconductor value chain (2009) compared to 21% (2005).

Packaging, assembly and test production

Despite a decrease in IC packaging and testing industry revenues, China achieved a notable increase in share of worldwide semiconductor packaging, assembly and test (SPA&T) capacity during 2009. As a consequence of the global recession, 2009 was a year of overall SPA&T capacity reduction. During 2009, 16 existing worldwide SPA&T facilities were closed, three new facilities started production and overall manufacturing floor space was reduced by more than 4%. As part of these changes, three multinational IDM SPA&T facilities in China were closed in 2009 by International Rectifier, National Semiconductor and Qimonda. Although there were no new Chinese SPA&T facilities that started production in 2009, the total manufacturing floor space of the remaining existing facilities increased by almost 12%.

As a result, China had 110 existing SPA&T facilities by the end of 2009. These 110 facilities now represent 20% of the total number of worldwide SPA&T facilities, 20% of worldwide SPA&T manufacturing floor space and slightly more than 20% of reported worldwide SPA&T employees. In effect, a noticeable share of worldwide SPA&T capacity had been transferred to China during 2009. By the close of 2009,

Figure 18: Comparison of China and all remaining countries' SPA&T resources, 2009

China	Rest of world
20.2%	Number of facilities 79.8%
20.4%	Number of employees 79.6%
20.2%	Amount of floor space 79.8%
20.3%	Value of production 79.7%

Source: Gartner Dataquest 2010

China's SPA&T facilities ranked first in share of worldwide SPA&T manufacturing floor space capacity at 20%, up from 17% a year ago. This also means China now surpasses Japan (19%) and Taiwan (at slightly less than 19%) for the first time ever.

During 2009 the number of existing SPA&T facilities reported in China increased by a net of three facilities (3%) to a total of 110 while the number reported worldwide decreased by a net of three facilities (0.5%) to a total of 545. All of the increase in number of facilities in China was the result of the better reporting of previously existing SPA&T facilities that had gone unreported before 2009. There were no SPA&T facilities in China that started production in 2009. However SPA&T manufacturing space reported in China increased by a net of 1.7 million square feet (12%) during 2009, while SPA&T manufacturing space reported worldwide decreased 3.6 million square feet (4%) to a total of almost 79 million square feet. China's share of newly reported worldwide SPA&T manufacturing space in 2009 was more than 50%. This relatively large share was mostly the result of better reporting of prior listed but not measured facilities and actual expansions plus newly listed facilities.

China continues to have the largest share of planned future SPA&T facilities. Of the 14 SPA&T facilities planned worldwide at the end of 2009, five were located in China compared to two each in Japan and Vietnam, and one each in five other countries. These five represent 36% of the planned facilities and more than 50% of the planned manufacturing space.

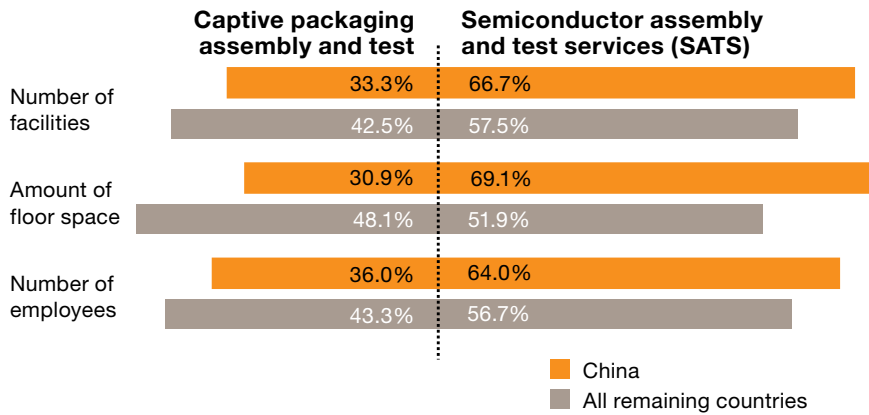
There were moderate changes in the ownership demographics of China's SPA&T facilities during 2009. Of the total 110 SPA&T facilities in China, about 36% belong to Chinese companies with just over 28% of manufacturing space and 38% of employees, compared to 33%, 29% and 28% in 2008. A further 16% of China's SPA&T facilities belong to companies from Taiwan (12%) and Hong Kong (4%). Although reduced by three closures in 2009, the largest foreign ownership continues to be that of companies from the US who now own just over 18% of China's SPA&T facilities.

China continued to gain share of worldwide SPA&T production value during 2009. Although the value of China's IC SPA&T production decreased in 2009, worldwide production value decreased even more, so China's share grew to represent just over 18% of the value of worldwide production in 2009, up from 15% in 2007. The value of China's O-S-D production also decreased, but remained an estimated 32% of worldwide production in 2009, equal to 2008 levels. The composite weighted average of China's 2009 SPA&T production value is estimated to be slightly more than 20% of worldwide SPA&T production value, up from 18% in 2008.

China's increase in share of worldwide SPA&T value during 2009 was the result of its increased share of worldwide production volume offsetting decreases in ASPs (average selling

China achieved a notable increase in share of worldwide semiconductor packaging, assembly and test (SPA&T) capacity during 2009.

Figure 19: Comparison of China and all remaining countries' SATS share of SPA&T capacity, 2009



Source: Gartner Dataquest 2009

prices). 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 accounted for about 28% of worldwide unit volume in 2009, up from 26% in the prior two years. Meanwhile, China's O-S-D SPA&T accounted for about 68% of worldwide unit volume in 2009, noticeably more than 58% in 2008 and 54% in each of 2006 and 2007.

Semiconductor assembly and test services (SATS)

Figure 19 shows China's share of its 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 69% of China's SPA&T manufacturing floor space and 67% of China's SPA&T facilities versus 52% and 58% for all other countries.

At the end of 2009, 74 SATS facilities were in production in China. Of these, 37 were owned by Chinese companies and 37 by foreign companies. Each of the five largest and nine of the ten largest multinational SATS companies had one or more facilities in China. By

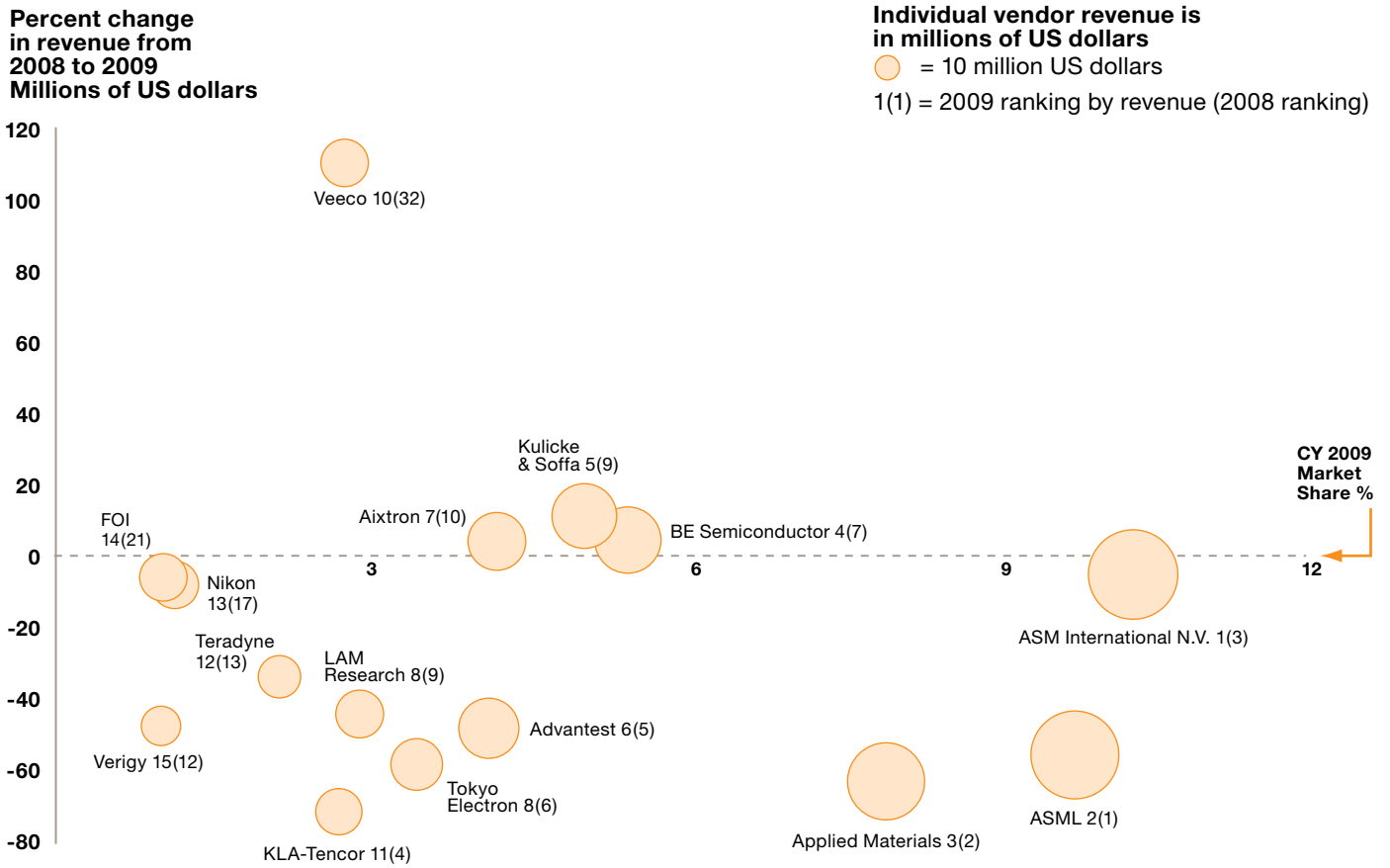
comparison, 35 of the 37 IDM SPA&T in production in China by the end of 2009 were owned by foreign companies and only two, Jingsu Chiangjiang and Wuxi China Resources Huajing Microelectronics, were owned by Chinese companies.

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 3.6% and 2.3% worldwide 2009 market share respectively. They have grown to reach a sizeable scale in the leadframe segment of the SATS sector and they have the ability to make an impact on pricing.

Equipment sales and market share

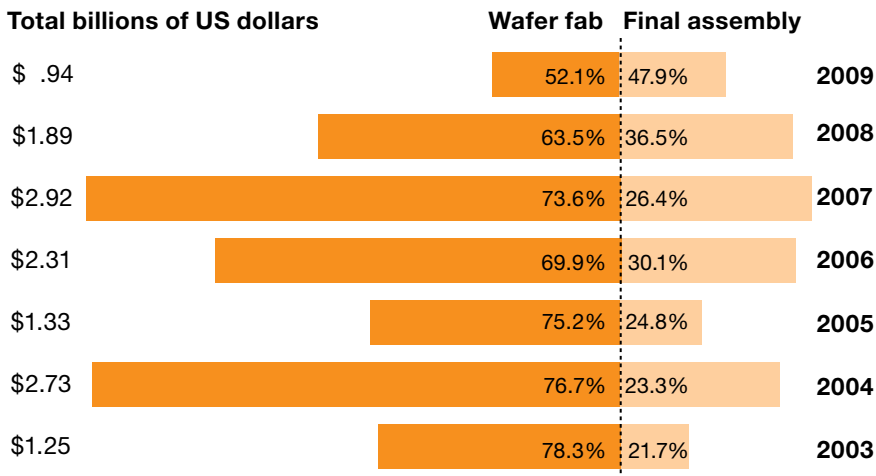
The global recession continued to exert a direct impact on equipment sales in 2009. Semiconductor equipment sales to China decreased by 50% in 2009 to US\$0.94 billion, the lowest value since 2000. This compares with worldwide equipment sales which fell by 46% in 2009 to US\$16 billion, the lowest

Figure 20: Equipment sales to China by vendor revenue, 2009



Source: Gartner Dataquest 2009

Figure 21: China's semiconductor equipment market and growth



Source: SEMI, Solid State Technology 2006-2009

since 1994. Note that the semiconductor equipment market is much more volatile than the semiconductor device market. Still, China's 50% decline in equipment sales in 2009 was not as severe as that of Europe or Japan, which recorded respective declines of 60% and 68%.

China's semiconductor equipment market holds a relatively small share of the worldwide market, increasing from 5.7% of worldwide equipment sales in 2003 to 7.0% in 2007 before declining to 6.4% in 2008 and 5.9% in 2009. It is now expected to recover to 6.9% of a much-improved worldwide market in 2010. More than anything else, these swings in semiconductor equipment sales in China reflect the equipping and ramping to full production of a few very large 300mm wafer fab installations:

- Hynix-Numonyx and SMIC Wuhan fabs in 2007 and 2008;
- Intel Dalian fab in 2009 and 2010;
- HuaLi (GSMC/HHNEC JV) and SMIC Beijing Fab 5 fabs in 2010 and 2011.

During 2009 the distribution of China's equipment market shifted slightly from 63% wafer fab equipment in 2008 to 52% in 2009, with the remainder split 36% packaging and assembly equipment and 12% testing equipment.

At the end of 2009, China had 12 wafer fab plants that were committed and under construction, representing 30% of the 40 new plants under construction worldwide, but only slightly

less than 13% of their capacity. China continues to be adding less capacity and spending less on equipment per new wafer fab plant because they are adding a greater proportion of smaller 4-inch (100mm) and O-S-D fabs than other regions and a lower proportion of 12-inch (300mm) plants.

According to Gartner Dataquest, the sales of the 15 largest semiconductor equipment suppliers to China decreased 40% in 2009 to US\$0.90 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) changed somewhat in 2009, with Dianippon Screen, Oerlikon and Novellus being displaced by Veeco, Nikon and FOI. Eight of these 2009 top 15 supply wafer fab equipment, four packaging and assembly equipment and three testing equipment.

In addition to the recognized international suppliers to the China semiconductor equipment market, there are a large and growing number of other suppliers, including many regional and about 80 indigenous Chinese suppliers, that are trying to establish a viable presence in the market. These other suppliers as a group were also impacted by the 2009 global recession as their sales in China decreased by 39% during the past year.

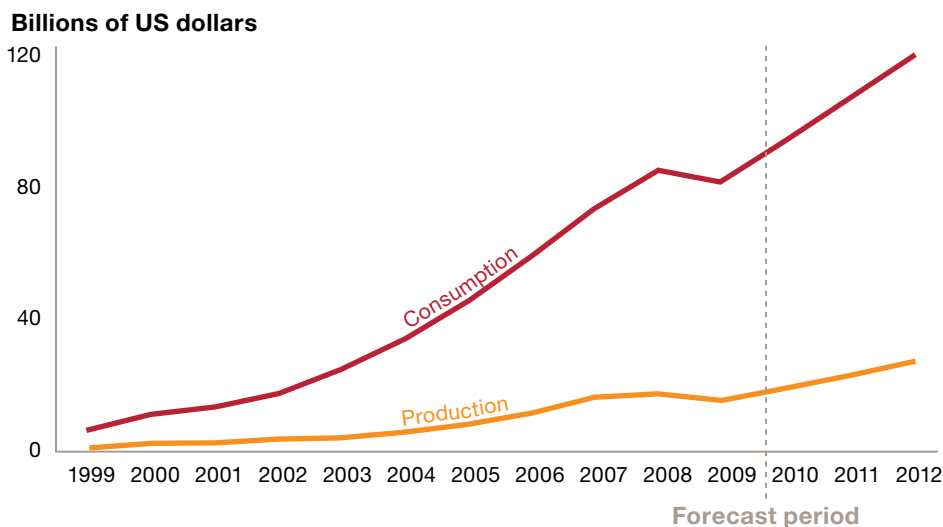
Similarly, the China Electronic Production Equipment Industry Association (CEPEIA) reports that among that group the indigenous Chinese semiconductor equipment industry had its sales of semiconductor equipment decrease by 28% in 2009 to about US\$71 million. However, the CEPEIA also reports that the Chinese semiconductor equip-

ment industry total sales reported in RMB grew 5% in 2009 to US\$367 million, with the remaining 81% of revenue coming from the sale of solar cell equipment, which increased 13% during the year.

Integrated circuit consumption/production gap

One of the results of the global recession in 2009 was the first annual decrease in China's IC consumption/production gap. This gap is the difference between IC consumption and IC industry revenues. Although the recession had a greater relative negative impact on China's IC industry revenue in the first three quarters of 2009 than it did on China's IC market, its absolute impact was greater on China's IC market. Reported in RMB, China's IC industry revenue (production) decreased by 11% in 2009 for a reduction of 137.6 RMB:100M, while China's IC market decreased by 5% for a reduction of 296.9 RMB:100M.

Figure 22: Comparison of China's integrated circuit consumption and production: 1999–2012



Actual annual average FX rates used for 1999-2009, & 2009 average FX rate used for forecast 2010-2012
 Source: CCID, CISA, PwC 2004-2010

Measured in US dollars, China's annual IC consumption decreased 3.3%, US\$2.8 billion, while IC production decreased only US\$1.7 billion, a 9.5 % reduction. Consequently, China's IC consumption/production gap decreased by US\$1.1 billion to reach US\$66.9 billion for 2009. This modest reduction was a unique consequence of the global recession as this gap had continued to increase despite all of the Chinese government's plans and efforts to contain it. Prior to 2009 this annual gap had grown from US\$5.7 billion in 1999 to a record US\$68 billion in 2008 and the Chinese authorities expected that it would continue to increase through at least 2012.

Now, according to the China Semiconductor Industry Association (CSIA) 2010 report, China's IC market is forecast to grow to US\$119 billion by 2012 with IC industry revenues expected to reach US\$25 billion. This forecast implies a further widening of China's IC consumption/production gap to US\$94 billion. While recovery from the 2008/09 global recession may

have changed 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.

China's IC consumption/production gap, which decreased in 2009 due to decreases in both China's IC market and industry revenues, will continue to increase thereafter through 2012 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.



An aerial photograph of a coastal city, likely Hong Kong, showing a dense urban skyline with numerous high-rise buildings. A large harbor is visible on the left, with a marina filled with many small boats. A prominent road interchange with multiple overpasses is visible in the lower right. The sky is overcast with grey clouds.

Looking outside China's border

Greater China

Although the global economy is not yet restored to full health, the semiconductor industry within the Greater China region, particularly in Taiwan, is enjoying a good 2010 thanks to an accelerated recovery in demand for electronics products across the board.

Although the global economy is not yet restored to full health, the semiconductor industry within the Greater China region, particularly in Taiwan, is enjoying a good 2010 thanks to an accelerated recovery in demand for electronics products across the board. Government stimulus projects, including the build out of China's 3G wireless infrastructure, have further boosted the chip rebound. So too have closer economic links to China itself.

Taiwan's IC industry revenues as a whole fell 7.2% to US\$37.9 billion in 2009, according to the Taiwan Semiconductor Industry Association, but are expected to jump 31% to US\$49.6 billion in 2010. The

a domestic high-tech industry, China has become one of the most important markets for Taiwanese technology companies since the global financial crisis in 2008.

Foundries: Taiwan lets chipmakers invest in Chinese counterparts

Growing confidence in the faster-than-expected recovery in global chip demand prompted Taiwan's pure-play semiconductor foundries to allocate bigger capital spending for 2010 to boost capacity and upgrade their process technology. Taiwan Semiconductor Manufacturing Co. (TSMC), the world's largest contract chipmaker and industry bellwether, plans to spend a record-

Government stimulus projects, including the build out of China's 3G wireless infrastructure, have further boosted the chip rebound. So too have closer economic links to China itself.

majority of the increase is projected to come from foundries and DRAM chipmakers (60%), followed by the packaging and testing sector (28%), and then from IC design (12%).

Besides strong demand, the semiconductor industry may receive an added boost from the Taiwanese government's decision in February 2010 to ease its restrictions on Chinese investments in a range of areas. These include thin film transistor-liquid crystal display (TFT-LCD) plants, semiconductor manufacturing, chipset packaging and testing and low-end IC design. The change could help companies become more competitive and open new investment opportunities.

While Taiwan's semiconductor industry remains far ahead of China's in spite of Beijing's decade-long efforts to create

high of US\$5.9 billion to meet growing demand. The other major foundry in Taiwan, United Microelectronics Corp. (UMC), will spend about US\$1.8 billion, nearly triple its 2009 expenditure. TSMC and UMC together account for about two-thirds of the total worldwide pure-play IC foundry market.

These capital expenditure plans reflect the growing trend for IDMs to outsource their production of advanced chips to foundries, freeing up investment US dollars to pour into design. At the same time, Taiwan's foundries are seeing strong demand for lower-priced chips from the Chinese market. TSMC's revenues from Chinese customers have reportedly expanded at a compound annual growth rate of 63% since the company's 8-inch wafer fab in Shanghai commenced production in 2004.

New investment rules announced by the Taiwanese government in early 2010 will allow Taiwanese chipmakers



to take a stake in or fully acquire their Chinese counterparts, but only in companies that use process technology at least two generations behind that being used in Taiwan. While still barred from building advanced 12-inch wafer fabs in China, Taiwanese chipmakers may now apply to upgrade their process technology to 0.13 micron from 0.18 micron at the 8-inch fabs already in operation. So far, only TSMC and ProMos Technologies Inc. have established semiconductor plants in China, while the third approved fab has yet to be built by Powerchip Semiconductor Corp.

In June 2010, the Taiwanese authorities approved the first formal tie-up between a Taiwanese and a Chinese chipmaker. TSMC received permission to take up the 8% stake in Shanghai-based Semiconductor Manufacturing International Corp. (SMIC) that it was awarded as part of a legal settle-

ment over a trade secrets dispute. The settlement includes an option to buy an additional 2% in SMIC within three years. TSMC says it will play no part in the management of SMIC, which the regulator cited as a key reason for the approval. Similarly, UMC has filed an application with the Taiwanese authorities to acquire the 85% stake it doesn't already own in Suzhou-based chipmaker Hejian Technology (Suzhou) Co. Ltd., but this controversial case may prove less straightforward.

DRAM: Long-term prospects remain cloudy despite market upturn

Taiwan's DRAM manufacturers are also enjoying a vigorous business upturn on the back of growing demand, especially from China. While better off than

a year ago, their long-term business prospects remain cloudy. They still face numerous challenges, including excess capacity and high debt as a result of previous over-expansion. There is also the problem of a chronic lack of proprietary technology, leaving them highly dependent on overseas partners. Indeed, many Taiwanese memory chipmakers may struggle to enter the race for next-generation manufacturing processes. Such competition will likely be fierce. Note in May 2010, South Korea's Samsung Group, the world's biggest electronics maker, announced that it will invest about US\$10 billion to upgrade technology and expand capacity at its semiconductor manufacturing facilities over the next few years.

The upturn in the worldwide DRAM market has helped diminish the need for a government bailout rescue. The Taiwanese government first announced in March 2009 the formation of Taiwan Memory Co. (TMC) to spearhead consolidation of the local DRAM industry and facilitate technological transfers from foreign players. TMC was to work with Japan's Elpida Memory Inc. to develop new DRAM products and manufacturing technology which local chipmakers could use at no charge. Essentially, the idea was to transform Taiwan into a developer of DRAM technology instead of simply a manufacturer dependent on licensing technology from foreign companies.

Taiwan's lawmakers oppose the DRAM restructuring plan. They passed a resolution in November 2009 to axe it, saying the opportune time to inject capital had passed and the government should not waste taxpayers' money. The plan appeared dead in March 2010, when lawmakers formally voted down a proposal to inject US\$250 million into TMC via the government's National Development Fund. Three months later

the economics ministry resurrected its plan to use TMC in the chipmaking business, announcing that it would now focus solely on developing NAND flash memory in collaboration with local chipmakers. It remains to be seen whether this will help revive TMC.

IC assembly: Overstretched Taiwanese chip assemblers scramble to expand

Taiwan's IC assemblers are also boosting capacity to meet rising demand. Advanced Semiconductor Engineering Inc. (ASE), the world's largest chip packaging and testing company, plans to spend US\$450-500 million on expansion in 2010. In addition to constructing new factories in Taiwan and China, ASE is looking at acquisition possibilities to increase capacity, and reportedly plans to buy two plants in Singapore and China from Italy's EEMS Group. Many of Taiwan's other IC assemblers, including Siliconware Precision Industries Co., have also mapped out aggressive expansion plans. They all aim to take advantage of the government's decision in early 2010 to completely remove its restrictions on investment in IC back-end operations in China.

IC design: Growing Taiwanese interest in China's IC design sector

Taiwan's fabless IC design houses are also performing strongly on the back of strong demand, in particular from China's handset market. MediaTek Inc., a leading Taiwanese fabless chip company that was spun out of chipmaker UMC, has grown to be the biggest supplier of chips in China, first for optical disc drives in computers, then DVD players and now mobile phones. Its

chipset technology and low-cost chips have helped revolutionize the manufacture of mobile phones in China, and enabled it to grab market share from larger US rivals. MediaTek is now looking to translate its success into the growing market for more advanced 3G phones in China.

With the Taiwanese government relaxing its rules on investment in China's low-end IC design sector, several Taiwanese companies are looking to gain a better understanding of the Chinese chip market in order to capture more business opportunities. In June 2010, MediaTek said it would invest US\$7.5 million in Shanghai Walden Semiconductor Venture Capital Enterprise, a new Chinese venture capital fund that targets IC design start-ups. It is the second Taiwanese company to do so. TSMC announced in May 2010 that it would invest US\$5 million in the same fund, saying it hoped the investment would bring profits in the long term from China's booming chip designing business.

Taiwan continues go slow on China tech transfer

Taiwanese technology companies have generally welcomed the new rules on high-tech investments in China, but the changes were less than they had hoped for. That's because the government continues to take a slow approach to opening the door for Taiwan's tech sector to transfer technology or build advanced factories in China, citing the need to adhere to US regulations on technology transfers under the Wassenaar Arrangement. The government's stance is that semiconductor companies will be allowed to invest only in Chinese plants that are less advanced than those in Taiwan, and the value of their investments in China should not be more than in Taiwan.

Taiwanese chipmakers have fretted for years about the government's inhibitive China investment policies, which they argue has left them behind a number of their Chinese and foreign rivals in terms of the technology they are able to use in their factories in China. SMIC, for example, can produce chips using advanced technology on 12-inch silicon wafers in China, while TSMC is barred from doing so by Taiwanese rules. This is in spite of the fact that even the US government has allowed Intel Inc., the world's largest chipmaker, to build a 12-inch fab in China. TSMC's chairman, Morris Chang, predicts Taiwan will likely follow the US and allow 12-inch fab investment in China by 2012.

No ECFA impact on semiconductor industry

In another sign of warming ties across the Taiwan Strait, in June 2010, Taiwan and China signed a landmark trade deal, formally known as the Economic Cooperation Framework Agreement (ECFA). The trade pact will substantially affect Taiwan's overall economy, but it is not expected to have any impact on the semiconductor industry, as it doesn't cover IC products nor does it further ease restrictions on technology transfers. In any case, most electronics products exported from Taiwan to China, like semiconductors, are already almost tariff-free—the average rate is 0.6%.

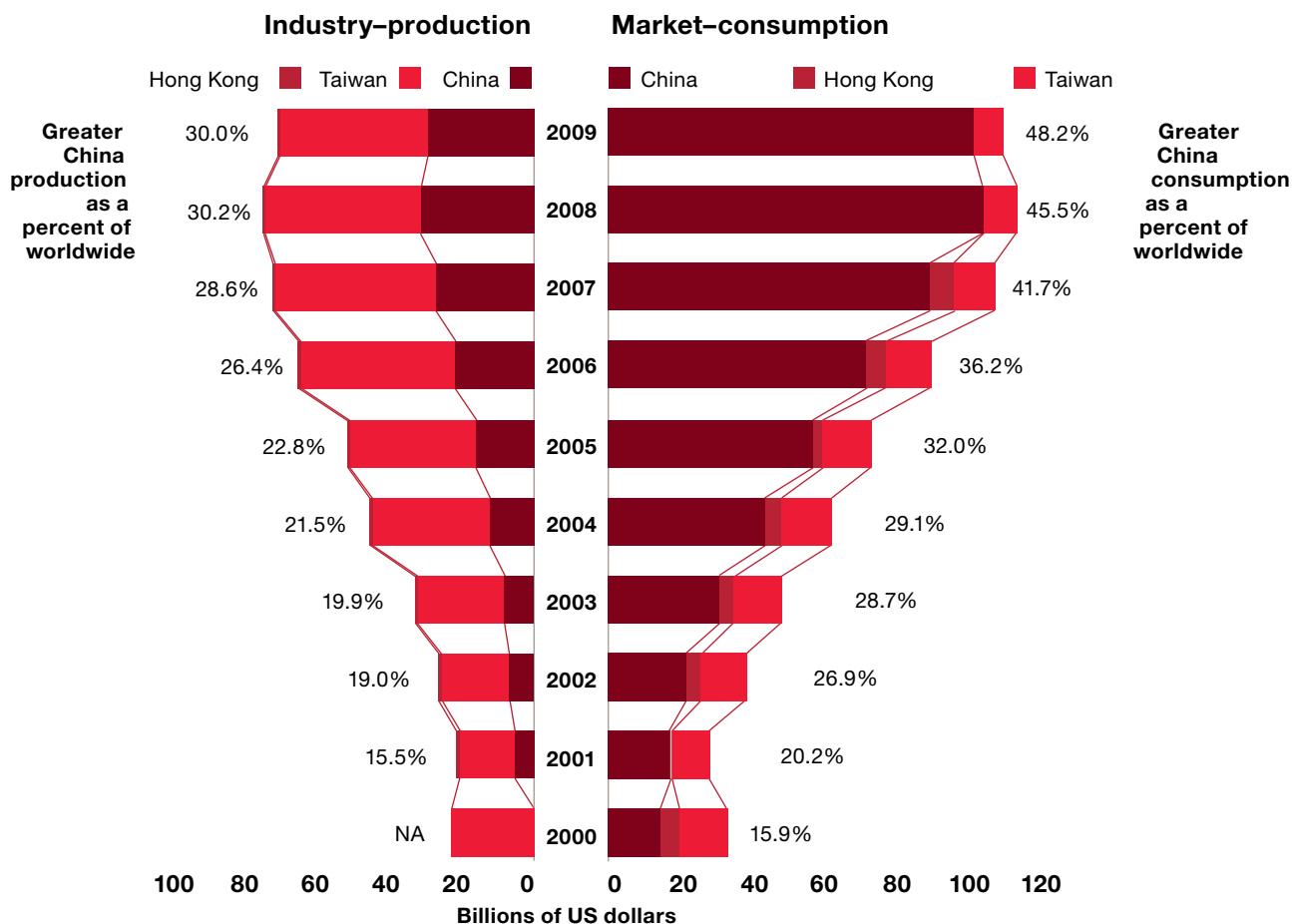
The trade pact represents the first phase in trade liberalization rather than a comprehensive free trade agreement. China will cut import tariffs on 539 categories of Taiwanese goods, worth US\$13.8 billion annually in trade, over the next two years with scope for more to follow. The early harvest list for immediate tariff concessions covers the textile, auto parts, machinery and petrochemical sectors. China will also open 11 service categories, including banking. Taiwan in turn will reduce tariffs for only 267 categories of imports from China, worth US\$2.9 billion.

Besides the ECFA, Taiwan and China also signed an agreement on intellectual property rights (IPR) protection, creating a mechanism for resolving IPR disputes arising from increasing cross-strait business exchanges. Under the agreement, which is independent from the ECFA, Taiwan and China agreed to mutually recognize trademarks and patents that have been registered on each side, push for information exchanges, join forces in copyright certification and enhance efforts to prevent falsification. Taiwanese technology companies can expect to benefit from this new agreement.

Greater China's impact on the semiconductor industry

Within Greater China, the global recession continued to have a more noticeable impact in Taiwan than in China. Taiwan's semiconductor (consumption) market declined a further 16% in 2009, to US\$7.8 billion, while China's market only suffered a 3% drop to US\$101 billion. However, Greater China fared better during the downturn than the total industry. Over the last two years, Greater China's consumption market increased 2%, while the worldwide market dropped 12%. This is because China's consumption market increased 6%, while Taiwan's decreased 30%.

Figure 23: Greater China share of the worldwide semiconductor industry, 2000–2009



Source: CCID, Gartner Dataquest, ICI, TSIA, WSTS, PwC 2004–2009

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. In fact, in 2009, China's consumption of semiconductors had grown to thirteen times that of Taiwan. A conspicuous portion of that market consumption in China was created by Taiwanese electronic manufacturing service (EMS) and original design manufacturer (ODM) companies. As a result, although Greater China's semiconductor market decreased 4% in 2009, it remained 2% greater—at US\$109 billion—than it had been in 2007 and its share of the worldwide market increased from 42% in 2007 to 48% in 2009.

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

	2007	2008	2009	Change (2009-2007)
Greater China	42%	45%	48%	+6%
Japan	19%	19%	17%	-2%
Americas	16%	15%	17%	+1%
Europe	16%	15%	13%	-3%
Rest of world	7%	6%	5%	-2%

Taiwan's semiconductor industry continues to be larger, use more advanced technology and feature more renowned companies than China's. But it was also more vulnerable to the 2008/09 semiconductor downturn. Measured in US dollars, Taiwan's IC industry revenues declined a further 11% (7% in local currency) in 2009 to US\$37.8 billion. This took place as China's IC industry experienced a decline of 9% to US\$16.2 billion.

During the past two years Taiwan's IC industry revenues decreased 15%, while China's increased 7%. As a result, Greater China's industry fared a bit better than the worldwide semiconductor

industry, decreasing only 7% compared to a worldwide drop of 12% over the last two years.

The majority, 54%, of the two-year decrease in Taiwan's IC industry revenues was reported by the IDM/IC manufacturing sector, reflecting the crash of the worldwide DRAM market. Another 20% of the decrease came from each of Taiwan's foundry and packaging + testing sectors. The remaining 6% came from IC design, although the sector reported 3% growth in 2009 after a 6% decrease in 2008. As a result, Taiwan's IC industry revenue remained slightly less than two and a half times as large as China's in 2009.

China's annual IC consumption/production gap (value of consumption less production) had been growing since 2000 to reach over US\$68 billion in 2008. But for 2009, this decreased

slightly to US\$66.9 billion. By comparison, Taiwan's annual production/consumption surplus, which reached over US\$33 billion for the second consecutive year in 2008, decreased to US\$30 billion in 2009. Therefore, Greater China had a semiconductor consumption/production gap of US\$37 billion in 2009, a further increase from US\$35 billion in 2008 and US\$24 billion in 2007. While it is still significantly less than that of China alone (PRC), this gap has now grown to be about 17% of the total worldwide semiconductor market.

The 2008/09 semiconductor downturn somewhat abruptly altered or suspended the capacity expansion of many semiconductor companies in Greater China during the latter half of 2008.

Several of those projects have since been resumed. From the end of 2008, 11 new wafer fabs began production in Greater China, representing 50% of all the new fabs starting production worldwide and 36% of capacity.

In addition, there are currently (May 2010) 20 additional wafer fab facilities under construction in Greater China, representing 50% of all fabs under construction worldwide and 48% of capacity. If and when all these fabs are completed, put into production, fully equipped and ramped to full capacity, Greater China will have 29% of total worldwide wafer fab capacity. This will include 71% of pure-play foundry capacity, 32% of 300mm capacity and 31% of advanced \leq 80nm capacity.

One of the three new semiconductor package, assembly and test facilities that were added worldwide since 2008 was located in Greater China. As a result, Greater China continues to account for 39% of total worldwide semiconductor package, assembly and test capacity.

In summary, in 2009 Greater China represented:

- 48% of the worldwide semiconductor (consumption) market;
- 30% of the worldwide semiconductor industry (production) revenue;
- 50% of all new wafer fabs and 48% of all fab capacity under construction;

- 27% of current worldwide wafer fab capacity;
- 29% of committed worldwide wafer capacity;
- 71% of committed worldwide pure-play foundry capacity;
- 32% of worldwide 300mm fab capacity;
- 31% of worldwide advanced, \leq 80nm fab capacity;
- 39% of worldwide semiconductor package, assembly & test capacity; and
- 57% of worldwide SATS (semiconductor assembly & test services, or contract) capacity.

In 2009 Greater China represents:

50%
*of all new wafer fabs
under construction*

48%
*of all fab capacity
under construction*

71%
*of committed worldwide
pure-play foundry capacity*



Things are changing
Government

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

probationary periods, redundancy, liquidated damages, severance pay, collective bargaining, non-compete and part-time employment.

A shortcoming, however, is that the Implementing Rules for the LCL fail to clarify the terms for permitted uses of labor, such as the temporary, auxiliary and substitute positions for labor dispatch employees. This will create ambiguity which will have to be resolved by labor arbitrators or courts on a case-by-case basis.

The trend toward increasing numbers of labor disputes (both arbitration and litigation) has continued. To reduce the

The hands of China's workers have been strengthened by the new LCL and by the basic laws of supply and demand. Recent months have seen increasing reports of labor unrest and widespread upward adjustments in minimum wages. The most prominent incidents did not directly involve the semiconductor industry, but have affected China's overall labor environment.

Revised labor law and employee matters

Two new laws affecting almost all high-tech companies with operations in China became effective January 1, 2008. They were the revised Corporate Income Tax (CIT) Law and the Labor Contract Law (LCL). As discussed in the 2008 and 2009 updates, we believe these new laws could have an impact on the semiconductor supply chain and industry in China.

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 jurisdiction. When implemented, it included sections on

pressure on the labor arbitration system, the Ministry of Human Resources and Social Security (MOHRSS) issued Circular 124 on Strengthening Labor Dispute Mediation. This requires all companies with trade unions to set up mediation committees and all companies without them to set up both trade unions and mediation committees. Nonetheless, most semiconductor companies in China have been able to continue successful operations without establishing formal trade unions.

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The semiconductor companies we interviewed in China for this update reported experiencing employee turnover rates ranging from 10% to 80% per year, with the median being about 29%.

For example, in the first five months of 2010, 13 Foxcon employees committed or attempted suicide at Foxcon's two campuses in Shenzhen, raising concerns about working conditions not just at Foxcon, but at factories throughout China. Foxcon has since announced a 33% increase in basic salary effective June 1 2010. This was followed four days later by a further 75% increase, subject to performance conditions, to be effective October 1, 2010. At the same time, Foxcon announced it was moving its major factory expansion to inland China.

Meanwhile, workers at Honda in Foshan, Guangdong went on strike for two weeks for higher wages and a reduced wage gap between Chinese and Japanese workers. Their total package was increased 24% as a negotiated settlement of the strike. As a result, minimum wage increases of an average of 20% have been put into effect in at least 18 provinces since February 2010 and increases in minimum wages will likely spread to nine more provinces before the end of the year. This is a noticeable change from the past several years, when the average annual growth in real wages for basic unskilled workers increased from 3.3% per year from 1992-96; to 7.5% from 1997-2001; and to 9.7% from 2002-2008.

China's semiconductor industry has been more concerned by increasingly high voluntary turnover and salary rates. For the first half of this decade China's overall average staff turnover had been relatively consistent, averaging less than 14% per year according to China's National Bureau of Statistics. Since 2006 that rate has increased to almost 18%. However during that same time period staff turnover in Shenzhen and other high-tech industrial zones has increased to almost double the national average—more than 37% in Shenzhen. The semiconductor companies we interviewed in China for this update reported experiencing employee turnover rates ranging from 10% to 80% per year, with the median being about 29%. That seemed high compared to their experiences outside of China and was of concern to almost all of those companies.

According to the Conference Board China Center, these recent labor strikes, reported labor shortages and increases in minimum wages in numerous major cities and provinces are rooted in wage structure imbalances that emerged in the early 1990s that have since grown

more pronounced. Those key wage imbalances, which have widened significantly, are between:

- Unskilled and skilled workers;
- Male and female workers;
- Skill intensive and low-skill, labor intensive industries; and
- Eastern and northeastern, western and central regions.

At the same time, the combination of a demographic shift, caused by 30 years of the “one child policy” and increasing university enrollments, is now beginning to reduce the pool of labor available for semiconductor operator and other electronic manufacturing jobs.

Authorities estimate that the Chinese semiconductor industry had about 300,000 employees at the end of 2009. That number includes all the employees in China’s O-S-D, IC design (fabless), IC manufacturing (foundries + IDM), and packaging and testing (IDM + SATS) industry sectors. China’s 300,000 employees would represent about 29% of the equivalent worldwide industry employees. Compared to the 200,000 employees reported for 2005, this represents an average growth of 10.7% CAGR. Compare this to the 10.9% CAGR in revenues for China’s semiconductor industry reported in RMB or 16.1% CAGR reported in US dollars. During the same period, total US semiconductor employees decreased from 220,000 in 2005 to 185,000 in 2009, representing a -4.1% average compounded annual rate of decrease.

Based upon China’s reported 2009 total semiconductor industry revenue of US\$29 billion, these 300,000 employees would yield overall sales per employee of slightly more than US\$97,000. By comparison, this is only 38% of the equivalent worldwide sales per employee productivity of US\$256,000. Similarly, the CSIA reports that during 2009, China’s IC industry produced 41.4 billion units

and its O-S-D industry 263.7 billion units. With 300,000 employees, this results in a unit per employee metric of slightly more than 1 million, which is 193% of the equivalent worldwide unit per employee metric of about 526 thousand.

While these two comparisons are relatively broad and imprecise, they demonstrate two important characteristics of China’s current semiconductor industry. One, it is more employee intensive than the worldwide industry and has a lower sales value per employee. But two, it has a higher unit output per employee than the worldwide industry. While these differences in industry characteristics reflect differences in product and sector mix (e.g., higher concentration of discretely and IC packaging), company size and industry maturity, they may also reflect less experienced employees (especially in the IC design sector), higher employee turnover rates and lower capacity utilization.

Revised corporate tax law and related matters

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 which were discussed in our 2009 update.

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%. Qualifications relate to issues such as 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.

Based on public statistics released by local authorities, during 2009 a total number of about 11,000 enterprises—down from about 14,000 in 2008—passed the assessment and obtained NHTE certification. Around 10% to 25% of those NHTEs were Foreign Invested Enterprises (FIEs), while the rest were domestic enterprises. About 130 of the 11,000 enterprises qualified in 2009 were identified as being

Local authority assessments are still subject to review by the Ministry of Finance and State Administration of Taxation (SAT). Such authorities will conduct on-going review of the NHTE qualification status of the approved NHTEs during the three-year period of validity. Consequently, companies should carefully document their NHTE application package. In addition, they should put in place controls to continuously monitor eligibility to retain the tax incentive.

During 2009, the government published regulations governing qualification for a new Technology Advanced

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%. About 130 of the 11,000 enterprises qualified in 2009 were identified as being engaged in the semiconductor value chain, including about 45 Foreign Invested Enterprises.

engaged in the semiconductor value chain, including about 45 Foreign Invested Enterprises. Of the 95 semiconductor companies listed in the CSIA “Statistical Report of China Semiconductor Industry—2009 Entire Year”, 57, including six FIEs, had been granted NHTE status in 2008 or 2009. The number of approved NHTEs was higher than initial expectation. Several of the companies we interviewed for this report qualified for NHTE certification, while other similar companies had not.

There are several key variables which play a role in obtaining the qualification, including:

- Attitude of the local authority;
- More FIEs are registering IP in China;
- Availability/reliability of third-party reports.

Service Enterprise (TASE) status. Such status will also entitle companies to be eligible for tax and other incentives between 2009 through 2013. The qualifying criteria include being engaged in information technology outsourcing, business process outsourcing, or knowledge process outsourcing services and located in one of 20 designated trial cities, including Beijing, Shanghai, Guangzhou, Shenzhen, Suzhou, etc.

One of the criteria for qualification for NHTE status is core proprietary intellectual property (IP) rights. Over the past five years, China’s share of worldwide semiconductor technology-focused patents published by year has increased from 13.4% in 2005 to 21.6% in 2009. According to the Derwent worldwide patent database, that figure will reach 33% in 2010.

More significant is the growth of China’s share in the first instance of a semiconductor patent’s publication, referred to as the patent basic statistic.

China had no semiconductor patents basic issued in 2005 or 2006. However, this increased from 4.7% in 2007 to 24.1% in 2009 and is now forecast to account for 18.7% in 2010. This means that an increasing number of patents on semiconductor inventions are being first issued in China. Further research with the Innography patent data base reveals that these Chinese semiconductor patents are being issued to companies registered outside of China (this might include SMIC which is incorporated in the Cayman Islands), but that the majority of the listed inventors are identified as Chinese residents.

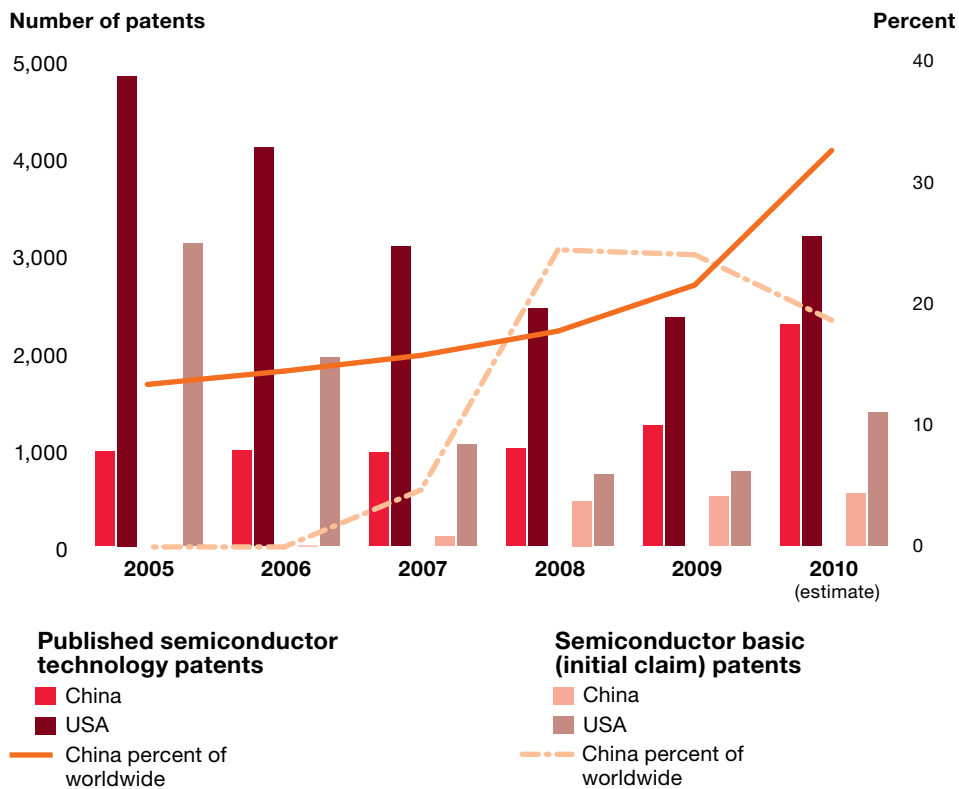
In January 2010, China's State Council amended the Implementing Regulations of the Patent Law of the People's Republic of China (Amended Implementing Regulations or AIR). This is an important revision to statutory compensation rules which will impact semiconductor companies that have R&D activities in China. While the employer is still the rightful owner of an issued patent for any invention made by an employee in the course of employment, the AIR created a broadly applicable statutory compensation scheme benefiting the employee-inventor.

In the absence of a prior agreement between an employer and an employee, the employer shall pay the employee-inventor (1) a percentage of all profits derived from exploiting the patent equal to 2% for invention or utility model patents and 0.2% for design patents, and (2) 10% of all royalties related to any licenses granted to third parties regarding the patent. This rule applies to every patent application filed after February 1, 2010.

The AIR specifies two exceptions when these compensation rules would not apply. First, if there is an agreement between an employer and an employee-inventor, then the terms of that agreement governing the compensation received by the employee-inventor would apply. Second, as an alternative, the method and amount of compensation may also be defined in the Employment Handbook. While every company with operations in China should ensure that they have such a provision in the Employment Handbook as a default position, those companies with significant R&D activities should ensure that they implement a system that clearly and formally defines the amount of compensation that an employee-inventor receives.



Figure 24: China versus worldwide semiconductor patents 2005–2010



Source: Derwent 2010

The statutory compensations scheme provided by the AIR has the potential to create a significant expense for any semiconductor company that develops significant patents in China. Therefore it is important that multinational semiconductor companies in China with significant R&D or design activities are aware of these statutory compensation rules and take steps to control such potential costs. By completing an agreement early-on with each potential employee-inventor, companies can avoid being required to pay an unexpected large sum of statutory compensation later on.

A series of policies from 2006 to 2010 seem to be developing a framework establishing preferential treatment for products containing “indigenous”

intellectual property. These policies potentially discriminate against foreign and foreign-invested Chinese companies, deterring them from developing and marketing innovative products in China. For example, Order 618 of the proposed National Indigenous Innovation Product (NIP) Catalog for Government Procurement of November 2009 explicitly connected “indigenous innovation” to government procurement. This scheme should be of concern to foreign-invested semiconductor companies, as it would discriminate against their products on the basis of the geographic location of the registration of the patents and trademarks upon which their products were developed and marketed.

Financial markets and IPO funding

During the past five years, China has emerged as a significant source of new companies, and more recently, of financial funding for semiconductor start-ups. According to Thomson Financials, Chinese domiciled companies represented the third largest group of semiconductor IPOs (initial public offerings) completed between 2005 and 2009. During this period, there were a total of 297 semiconductor IPOs completed worldwide, including 47 by Chinese, 50 by South Korean and 97 by Taiwanese companies. The 47 Chinese IPOs represented 16% of the number of IPOs and 28% of the proceeds realized.

However, less than half (22) of these Chinese IPOs were completed in China’s financial markets. That trend is shifting significantly with the opening of two exchanges: the Shenzhen Stock Exchange Small and Medium Enterprise (SME) Board and the ChiNext Board. ChiNext, it should be noted,

Table 11: China versus worldwide semiconductor IPOs 2005–2009

	2005	2006	2007	2008	2009	1Q/09	2Q/09	3Q/09	4Q/09	1Q/10	2Q/10
Worldwide semiconductor IPOs											
Number of IPOs	73	91	69	28	36	8	6	6	16	13	9
Proceeds (US\$ millions)	3,006.0	3,663.8	3,727.1	678.2	1,693.6	28.3	11.0	327.6	1,326.6	1,436.2	1,325.5
Chinese semiconductor company IPOs											
Number of IPOs	5	17	15	1	9	0	0	1	8	12	5
% of worldwide	6.8%	18.7%	21.7%	3.6%	25.0%	0.0%	0.0%	16.7%	50.0%	92.3%	55.6%
Proceeds (US\$ millions)	407.9	743.6	1,109.5	37.4	1,308.9	0.0	0.0	117.2	1,191.7	1,332.4	1,013.6
% of worldwide	13.6%	20.3%	29.8%	5.5%	77.3%	0.0%	0.0%	35.8%	89.8%	92.8%	76.5%
Chinese market semiconductor IPOs											
Number of IPOs	0	7	7	1	7	0	0	1	6	12	4
% of worldwide	0.0%	7.7%	10.1%	3.6%	19.4%	0.0%	0.0%	16.7%	37.5%	92.3%	44.4%
Proceeds (US\$ millions)	0.0	285.5	351.6	37.4	1,270.7	0.0	0.0	117.2	1,153.5	1,332.4	949.4
% of worldwide	0.0%	7.8%	9.4%	5.5%	75.0%	0.0%	0.0%	35.8%	87.0%	92.8%	71.6%

Chinese semiconductor company = domiciled in China

Source: Thomson Reuters 2010

was launched in 2009 and offers a new capital platform for Chinese enterprises engaged in innovation and other growing industries. Both entities will facilitate fund-raising for small and medium-sized enterprises and growing venture enterprises.

There was a significant rebound of IPO activities in the Greater China capital markets in the second half of 2009, even though other capital worldwide markets were still suffering from the global recession and contracting economies. As a result, nine Chinese companies represented 25% of the 36 semiconductor IPOs completed in 2009 and 77% of the funds raised. Seven of those nine IPOs were completed in China's financial markets, accounting for 75% of all worldwide semiconductor IPO funding raised during 2009.

This momentum is continuing, with 17 Chinese companies completing more than 75% of the 22 semiconductor IPOs completed in the first half of 2010. Sixteen of these were executed in China's financial markets, raising 85% of the funding realized.

During the last four quarters, as the semiconductor industry recovered from the global recession, Chinese companies have accounted for more than half of all semiconductor IPOs completed worldwide. Meanwhile, the Chinese financial markets have provided more than 80% of all the semiconductor IPO funding. Should this trend continue, it will likely impact the semiconductor industry by influencing the organization and location of new fabless start-ups.

Economic stimulus programs

The government of China reacted to the global recession by implementing an RMB 4 trillion (US\$586 billion) economic stimulus package. First announced in November 2008, details of that stimulus package are described in the 2009 update report.

It was estimated that the two most immediate programs in that package, the “Electronics Go to Farmers Subsidy Program” and the “Home Appliance Replacement Subsidy Program”, could account for more than US\$50 billion in additional semiconductor consump-

tion. During 2009 there were many anecdotal reports of how the results of these programs contributed to the early turnaround recovery of both local and worldwide semiconductor demand. While it is not possible to measure their worldwide impact, we can reasonably estimate that they contributed to at least a US\$4 billion increase to 2009 domestic semiconductor consumption. Also during 2009, total retail spending in China increased by 15.5%. The RMB 4 trillion economic stimulus package and appropriate loose monetary policy have helped to spur China’s economy toward recovery, growing 9.1% year-over-year and 11.1% in first half 2010.

China’s leadership has stated its priority of transitioning from its previous investment and export-driven growth model to something it deems more sustainable. The new model is premised on the concepts of “balanced growth”, “innovative society” and “harmonious society”. The global recession and resulting financial stimulus package may actually be accelerating this transformation.

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 semiconductor recovery from the global recession. 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 largest population. 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 continue to accelerate the use of computers and other emerging technology devices in the country and will help further the market’s recovery.

Currency exchange rates

Prior to 2005, China had maintained the value of its Renminbi currency at a relative fixed exchange rate to the US dollar at 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. As a reaction to the global recession, China noticeably slowed the rate of increase beginning in the third quarter of 2008. So by the fourth quarter of 2009, the quarter average exchange rate was RMB 6.83 = US\$1.00 and the annual average rate for 2009 was RMB 6.8311 = US\$1.00.

The government of China reacted to the global recession by implementing an RMB 4 trillion (US\$586 billion) economic stimulus package. It was estimated that the two most immediate programs in that package, the “Electronics Go to Farmers Subsidy Program” and the “Home Appliance Replacement Subsidy Program”, could account for more than US\$50 billion in additional semiconductor consumption.

The four and a half year gradual increase in the RMB exchange rate has had some impact on the global semiconductor industry.

There is no doubt that the four and a half year gradual increase in the RMB exchange rate has had some impact on the global semiconductor industry, especially for those companies with operations in China. However, the magnitude of that impact varies depending upon each company's business model. Since July 2005, companies with sales transacted in US dollars have seen the RMB value of their sales revenue decrease by 17.5%. Meanwhile, companies with costs incurred in RMB have seen the US dollar value of those expenses increase by 21% (with most of both changes experienced prior to 2009). The possibility exists that China will allow the RMB exchange rate to increase further in late 2010 and 2011 which could have a noticeable impact on the semiconductor industry next year. As China continues to maintain non-convertible status of the RMB, multinational companies have been unable to offset the negative impact of the foreign exchange fluctuations through hedging activities.

Most multinational companies operating in China and local companies serving international markets earn most of their revenues in US dollar 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 dollars and have a relatively higher percentage of US dollar-based costs. Depreciation on dollar-based imported equipment is a large portion of their expenses and most of their direct material costs are also US-dollar based.

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 China consumption market and use local foundries and SATS suppliers. However, this can be difficult to achieve because of customer and supplier preferences driven by financial considerations.

Companies in the semiconductor packaging and testing sector—and especially those that are SATS suppliers—are probably the most impacted by these exchange rate shifts. For these companies, most of their sales are transacted in US dollars. However, they meanwhile 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 (a) their US dollar cost per lead equivalent unit pricing very rarely increases due to worldwide competition and (b) their local expenses are increasing in equivalent US dollar costs, these companies are experiencing a noticeable cost/price squeeze. This currency-driven profitability pressure is driving such firms to pursue significant efficiency improvements.

Growing in challenging times

Production growth scenarios



China's IC consumption has continued to exceed our aggressive growth scenarios for every year since 2003. China's IC production fell short of the moderate scenario in 2009.

Overview

PwC's 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 reexamined these original production growth scenarios and revised our analysis. Before the global recession, 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 current market conditions.

Needless to say, the global recession 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 global recession 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. Those revisions along with our original forecasts are shown in Figure 25, where we have also added actual consumption and production through 2009 for comparison.

Our conservative growth scenario was based upon the assumption that China would just 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 US\$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 20% compounded annual growth rate, twice the worldwide rate. It also called for China achieving 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 25 now includes China's actual performance for 2003 through 2009. 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. However, China's IC production, which continued to exceed the original conservative scenario for every year since 2003, fell short of the moderate scenario in 2009. It meanwhile totally missed the aggressive scenario in 2009 after falling short for a first time in 2008.

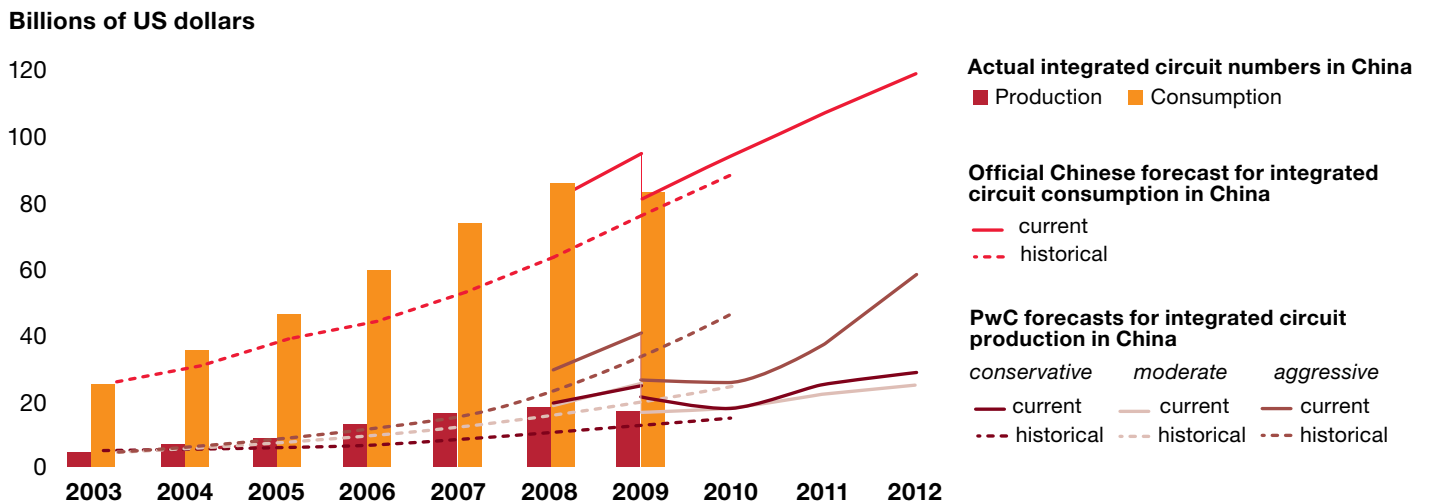
Several factors have contributed to this outcome. China's IC consumption market has grown faster than four times the worldwide rate and much faster than forecast. China's IC market has grown at a 22.2% CAGR from 2003 to 2009, while the worldwide IC market has grown at a 5.1% CAGR. The negative impact of the global recession on China's IC consumption, measured in year-over-year percentage change, occurred later and was less severe than on the worldwide market. As a result, after 2009, China accounted for more than 100% of the total net increase

in the worldwide IC market between 2003 and 2009. During those six years, China's IC consumption market grew from US\$25 billion to US\$83 billion, an increase of US\$58 billion. By comparison, the worldwide consumption market grew from US\$140 billion to US\$189 billion, an increase of only US\$49B. In short, China's IC consumption growth exceeded total worldwide consumption growth.

Going forward, China's IC market growth is now expected to moderate, moving closer to the worldwide rate. The CSIA now forecasts that China's IC market growth in local currency (RMB) will average slightly more than 12% CAGR for the next three years through 2012. This is about 1% more than is currently forecast for the worldwide market growth rate.

China's IC production was more severely affected by the global recession in 2009 than the worldwide industry. As a result, while China's IC production has increased by an average 25% CAGR

Figure 25: China's integrated circuit production and consumption forecasts compared with actual



Source: CSIA, CCID, World Fab Watch, PricewaterhouseCoopers

during the past six years, that rate was down from 40% for the first four years. This is also less than our moderate scenario and significantly less than our aggressive scenario.

The very high rate of growth achieved through 2007 was the result of extraordinary conditions. These include a 190% increase in the IC manufacturing (primarily foundry) sector in 2004, three years of greater than 50% per year growth in the IC design (fabless) sector between 2004 and 2006 and a greater than 40% increase in the IC packaging and test sector in 2006.

Conservative growth scenario

The potential capacity of all current and committed wafer fabrication plants in China as of the end of 2009 did not change significantly from that at the end of 2008—and remained double the capacity level in early 2004 when we made our original forecast. That capacity increase is the result of 19 additional plants, net of closures, being put into production plus 12 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 2009, less than 45% of their potential full revenue capacity was realized due to the severe impact of the global recession especially in the early quarters 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 plants under construction would realize only 50% of their nominal capacity by 2010. To better reflect the realities of the global recession in the 2009 update, 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 those further refined assumptions and current conditions, our conservative scenario could result in an increase in 2012 IC production revenue to US\$30 billion. This would require an additional investment of at least US\$19 billion for capital equipment and facilities. This projection represents an IC production CAGR of slightly more than 22% during the period from 2009 through 2012.

The potential capacity of all current and committed wafer fabrication plants in China as of the end of 2009 did not change significantly from that at the end of 2008—and remained double the capacity level in early 2004 when we made our original forecast.

China now has fewer but much larger wafer fabs than was expected in 2004. By the end of 2009, China had more wafer fabs in production (115) than committed (73) at the start of 2004, with significantly more capacity (1,744 versus 992K 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.

However, as a result of the global recession, China's IC production declined by 10% in 2009 and to date has recovered more slowly than the worldwide industry. China's IC production growth is now also expected to moderate. The CSIA forecasts that China's IC production in local currency (RMB) will also average almost a 16% CAGR for the next three years through 2012.

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 continue to believe that attainment of this scenario projection no longer appears probable. It appears unlikely that anyone will make such large investments in additional semiconductor capacity for anything other than advanced technology in 2010 or 2011—or otherwise, until a recovery from the world economic crises is clearly underway.

If China can 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 2012.

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 the then current FX rates) by 2010. This forecast represented a CAGR of 25% from 2004 to 2010.

According to the CSIA 2010 annual report, China's IC unit production decreased 0.7% to 41.4 billion pieces, while IC production revenue decreased 11% to 110.9 billion RMB (US\$16.2 billion) in 2009. As a result of the global recession, CSIA now forecasts IC production revenue to increase to 128 billion RMB (US\$18.7 billion at 2009 FX rates) by 2010 and to 172 billion RMB (US\$25.2 billion) by 2012. This forecast represents a CAGR of 15.8% from 2009 to 2012.

While this forecast is a noticeable improvement over that of last year, it continues to fall 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 20% 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 only the equivalent of less than seven of the larger wafer fabrication plants currently in production. This would require a further capital investment of less than US\$8 billion. The investment requirements for this moderate scenario are now less than half that of the revised conservative scenario. Achievement of this revised moderate scenario now appears to be reasonable and more probable than achievement of the revised conservative scenario.

If China can 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 2012. Realization of this scenario now means that China's IC industry will have to maintain an average 16% CAGR over the next three years and, as a result, will have achieved an average 17% CAGR (or 13% measured in RMB) for the five-year period from 2005 through 2010. That would be a noteworthy achievement over a period during which the worldwide IC market is forecast to achieve less than a 5% CAGR.

The global recession 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 were: a) that future achievements are more determined by capabilities than by intentions and b) that if you build it they will come (physical plants would ultimately be completed and utilized). These concepts were effective for the earlier years.

But with the recession it appears not all wafer fabs that have started construction will be completed. Neither will all of those starting production ever be fully equipped and ramped to full production, at least in a timely manner. The reasons for this are many. The investment requirements for large, leading-edge plants have increased significantly and investment sources have dried up. Physical plants can be initially built as lower cost shells with individual modules only completed on an as-needed or as-financed basis. Equipment investment requirements are three to four times as much as plant investment requirements. Investments are being focused on advancing technology capabilities rather than increasing capacity—and with one notable IDM exception—China continues to lag in wafer fabrication technology by more than two years.

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. However, our aggressive growth scenario will remain based upon that concept for comparative purposes.

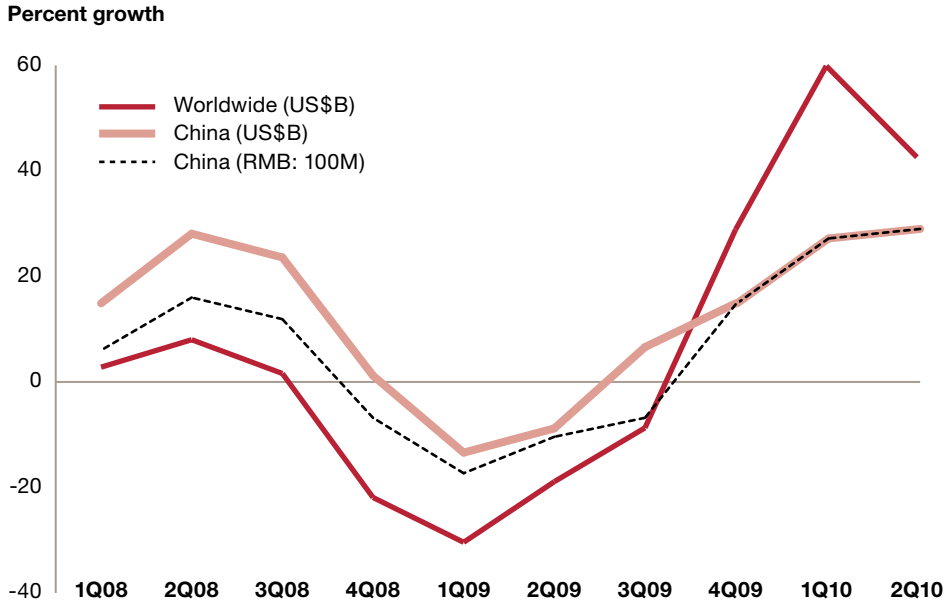
According to the CSIA 2010 report, China's IC market is now forecast to reach US\$95 billion by 2010 and US\$119 billion by 2012. That represents a 4% to 6% improvement from their 2009 report, reflecting China's better-than-worldwide performance during the global recession. Under the aggressive growth scenario, China's IC industry would now have to reach revenues of US\$47.5 billion by 2010, which is impossible. Or it would have to reach US\$59.6 billion by 2012, which would now represent a 54% CAGR from 2009 to 2012.



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.

Figure 26a: China vs. worldwide semiconductor year-over-year market growth by quarter 2008-2010

Under the most likely business model, that scenario would now require China to increase its wafer fab capacity to almost 4,500,000 8-inch equivalent WSpM (wafer starts per month) by 2012, which would require the construction and ramping to full production of at least 34 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\$50 billion further to that required for the conservative growth scenario, which also seems very unlikely. The size of the required investment and the uncertainties of being able to undertake such a plan probably explains why the growing the IC industry to equal half of the IC market goal has been indefinitely postponed.



Source: CCID, SIA 2008-2009

Figure 26b: China vs. worldwide semiconductor quarter-over-quarter market growth by quarter 2007-2010



Source: CCID, SIA 2008-2009

This scenario is most sensitive to China's IC industry business model and reporting practices. First, China would need to radically expand its design (fables) sector and achieve a business model in which all its wafer fabrication and packaging & testing production were used to support that design sector. It would meanwhile have to continue its current reporting practices, with their inherent double counting. Under these conditions, the aggressive scenario could be achieved by just completing and fully utilizing four additional new and all the current and committed wafer fabrication plants. This would reduce the required additional capital investment to about US\$5 billion, for a total investment of US\$25 billion by 2012.

Similarly, Figures 27a–27b show the impact of the global recession on China's IC industry. In this case, the impact on China's IC industry, measured in year-over-year percentage change, was somewhat later and less severe during the last two quarters of 2008. However, it became more severe than that of the worldwide industry during the next three quarters, Q1/09 through Q3/09. China's IC industry recovery during the following three quarters has been less than worldwide. China's IC industry production in the first half of 2010 was 108% that of the first half of 2008. Meanwhile, worldwide first half production in 2010 was 113% of the same period in 2008.

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. It will continue as a result of several factors. These include further 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 fueled by an expanding middle class and rising demand for mobile products. If the relative share of domestic versus export consumption increases at the

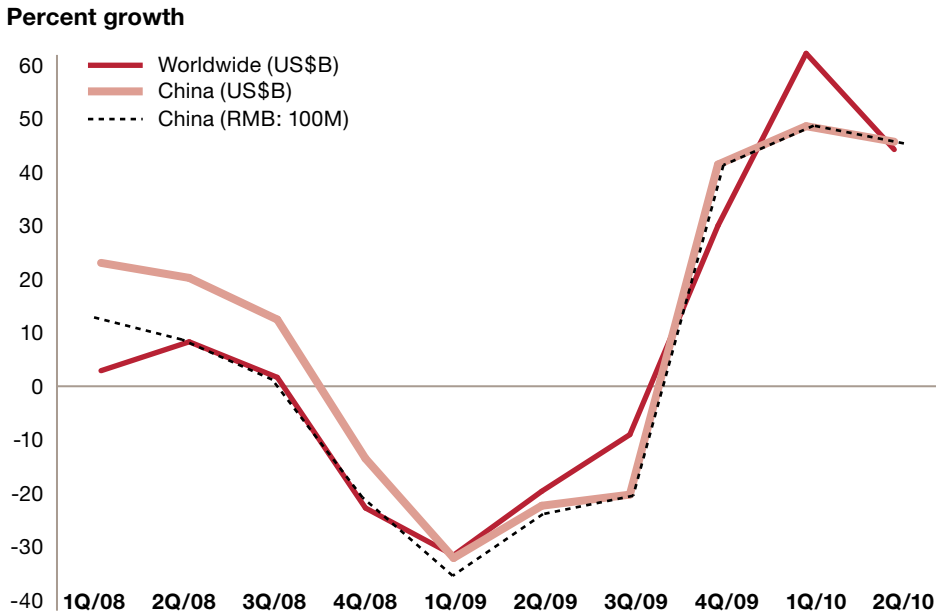
However, it would require China's design (fables) sector to grow by more than nine times during the next three years. While we consider that to be an impractical alternative, we believe it provides a valuable understanding about the impact of that business model and China's motivation for continuing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

Post-recession scenarios

Figures 26a–26b illustrate how the impact of the global recession on China's IC consumption, measured in year-over-year percentage change, during the four quarters from Q4/08 through Q3/09 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 US dollars. Correspondingly, the following three quarters of China's market recovery measured in year-over-year percentage change has been less dramatic than worldwide, but was still better than worldwide when compared in absolute values. China's first half 2010 IC market consumption was 114% of first half 2008, while worldwide was 113%.

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.

Figure 27a: China IC industry vs. worldwide semiconductor year-over-year industry growth by quarter 2008-2010

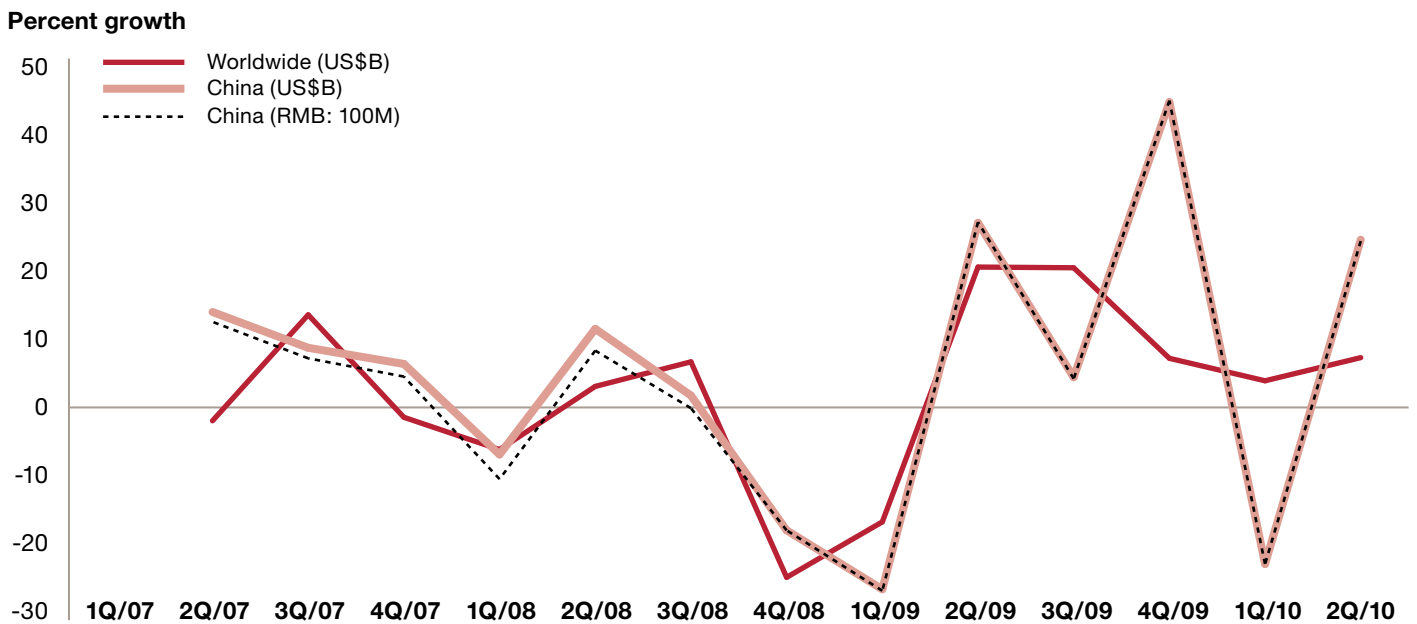


Source: CCID, SIA 2008-2009

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, ranging from white-label handsets to transportation and medical infrastructure servers. It should also increase the government’s focus and efforts to encourage the development of China’s IC design (fables) industry sector and to reduce the use of foreign-owned intellectual property.

We expect that the post-recession 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 (fables) sector will be strongly driven by China’s

Figure 27b: China IC industry vs. worldwide semiconductor quarter-over-quarter industry growth by quarter 2007-2010



Source: CCID, SIA 2008-2009

semiconductor consumption market and especially China's domestic consumption. Successful companies in this sector will continue to grow by exploiting opportunities for China's white label handsets and other consumer electronic products; cost reduced alternative products for volume electronic systems manufacturers; unique Chinese standards and requirements, such as smart cards; and designs for China's major OEMs.

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 O-S-D sector has a much larger share of both the China and the worldwide O-S-D market 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 continuation of the trend for multinational semiconductor companies to transfer O-S-D manufacture to Chinese subsidiaries or manufacturers on a rebranding basis. The sector is also expected to benefit from renewed government policy support, especially the LED segment. The investment requirements are modest compared to IC capacity. There is an adequate supply of used equipment available. 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 China's O-S-D industry will grow somewhat faster than the worldwide OSD industry, but slightly less than China's O-S-D consumption market during the next five years.

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. During business cycles they will allocate capacity loading between their different facilities based upon cost, capability, qualification, logistics 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, e.g., Vietnam, Philippines, et. al., offer increasingly competitive wage rates and 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.

More than anything else the post-recession 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. Even in China, according to SEMI World Fab Watch, the historical average investment for the twenty-seven 200 and 300mm current and committed wafer fabs is over US\$1 billion and for the later 300mm fabs is over US\$2 billion.

selling prices. They have also been 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 2007 and 2008 and the second, which will start production in Q4/10, 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 71 companies fabricating ICs on 200mm wafers, there are only 29 using 300mm wafers. The latest projection is that there may be no more than 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.

We expect that over the next five years China's IC manufacturing sector will grow along the lines of our moderate scenario, increasing by almost 100%.

Such investment costs should increase as we expect almost all new capacity additions to take the form of leading-edge technology. There seems to be more than enough mature and senior technology capacity available on a worldwide basis as such capacity was taken off line as a result of the global recession. There is a possibility that some of that excess mature technology capacity may be transferred and re-installed in China, but we do not expect that to have a significant impact on China's future IC manufacturing sector revenue growth.

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. They seem to be handicapped by high depreciation expenses and low, technology-limited,

While that is a reasonable possibility, it may be several years before it has an impact on China's IC manufacturing sector. We understand that within the last two years one major multinational IDM with the experience of successful packaging and test operations in China considered such an incentivized major wafer fabrication plant opportunity but elected not to proceed. However, the rumored acquisition of either or both the relatively new Cension and Xinxin foundry fabrication plants by different multinational IDMs could significantly shorten the time frame, if realized. 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 almost 100%.

As suggested in the 2009 update, if China really wants to leapfrog the technology barrier, there could still be a window of opportunity, owing to the ongoing reluctance of most of the worldwide industry to invest in moving to 450mm wafer production. But the nation must be willing to commit significant resources.

As for 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 if successfully executed—this could have a very noticeable impact on the semiconductor industry.



Appendix

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 policy makers.

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 Chinese 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 MIIT, 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 differences between worldwide and Chinese local average selling prices.

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 O-S-D market segments. It appears that prior to 2008, CCID included LEDs in their discrete market segment and only reported photo electrics rather than all optoelectronic devices. CCID's semiconductor monthly monitoring reports still only include 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 con-

signed 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 and the CCID and CSIA consolidate the reports from each company in an industry sector without any eliminations or offsets. The results are often industry-sector totals that are aggregates of different inputs and are 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 four of the largest SPA&T plants of foreign semiconductor companies use a wafer/die sale/buy-back business model, their reported revenues are approximately two and a half 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 36% in the 2009 revenues for the IC packaging and testing sector, 16% in the 2009 revenues of the Chinese IC industry and 9% in the 2009 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 that uses both a Chinese wafer foundry and 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.

Further assume:

- Average buys 1,000 wafers (200mm) from XMIC for US\$650 per wafer, for a total of US\$650,000.
- Average consigns the 1,000 wafers to XSE for assembly and testing in plastic QFN or PLCC packages with 1,250 net die per wafer and a die-free package cost of \$0.17 per package, for a total of 1,250,000 finished units and value of US\$212,500.
- Average sells the 1,250,000 finished units to Solectron for an average selling price of US\$1.00 per device, for a total of US\$1,250,000.

Using CCID and CSIA reporting practices, these transactions would be classified and recorded as shown in Table 12.

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 70% 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 higher 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 62-162 RMB, depending on the scenario:

- **62 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.
- **162 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

Table 12: Revenue comparison
(All revenues are in US dollars)

	Pieces	Revenue	Revenue using industry standards
IC manufacturing sector	1,000	\$650,000	Not reported
Packaging and testing sector	1,250,000	\$212,500	Not reported
IC design sector	1,250,000	\$1,250,000	\$1,250,000
Total	2,501,000	\$2,122,500	\$1,250,000

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. Still, we carefully note that these 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. Although the tendency is for these sources to overstate the size of the industry, understatement is far less likely—and it is our intention 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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During the preparation of this report, we benefited from interviews with the following executives:

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