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# From Catching-Up to Forging Ahead? China's prospects in semiconductors

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# Storyline

1. China still plays second fiddle in semiconductors, despite massive government support → Why?
2. Economic parameters of China's efforts to upgrade its semiconductor industry
3. What's new about China's Semiconductor Industry Strategy?

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# 1. What explains that, despite massive government support, China still plays second fiddle in semiconductors?

- Indicators of “Second Fiddle” status
- The State’s “Indigenous innovation policy” collides with “Global Technology Sourcing” needs of Chinese semiconductor firms

## China's Achievements

- Largest semi market in the world (since 2005) → China's 2013 share in world semi consumption is almost 56% (2003 <19%) → In 2013, China's semi consumption market grew > 10 % (worldwide market growth 4.8%)
- China's IC design industry has grown from \$200m in 2001 to \$13.2bn in 2013 (33% growth rate from 2012).
- China is #1\* in semi assembly & testing (ahead of Taiwan and Japan)
- Optical (LED), sensors & discrete devices approaching self-sufficiency
- Co-shaper of markets & standards for mobile communications

\* = value added, production revenue, employees and manufacturing floor space

## But China is still playing second fiddle - Key weaknesses

- Buying decisions for advanced ICs consumed in China are mostly made in Taiwan, Korea, US (for mobile devices), Japan, Singapore.
- The gap between semiconductor consumption & production keeps growing - from \$5.7bn in 1999 to a record \$108.2 bn in 2013 (projected to increase to \$122bn in 2015)
- China needs to import up to 80% of its semiconductor needs. → Growing imports of advanced ICs have doubled China's trade deficit in semiconductors
- In 2012, the value of China's semiconductor imports (US\$232.2 billion) even exceeded the amount it spent on crude oil (US\$221 billion).

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## Implications of IC industry weaknesses

- In China's IT industry, domestic value-added remains very limited – from 2 % (iPhone4), 5% (smart phones) to 15%. **(author's interviews)**
- FIEs' share of China's IT exports rose from 79% in 2002 to 82% in 2010 **(Congressional Research Service, August 2014)**

# Wafer fab – China still plays second fiddle

Despite massive investments...

- China's 2015 share of total worldwide semiconductor wafer production is projected to remain below 11%
- Foreign IDMs dominate (Intel, Samsung, Hynix) → Chinese foundries remain weak
- China lags behind in process technology & wafer size
- China continues to have **newer wafer fabrication plants with older technology** [*focus on LED; used equipment & technology*]
- **Chinese foundries lack process innovation capabilities**

## Major 2013 IC Foundries (Pure-Play and IDM)

2013 Rank	2012 Rank	Company	Foundry Type	Location	2011 Sales (\$M)	2012 Sales (\$M)	2012/2011 Change (%)	2013 Sales (\$M)	2013/2012 Change (%)
1	1	TSMC	Pure-Play	Taiwan	14,299	16,951	19%	19,850	17%
2	2	GlobalFoundries	Pure-Play	U.S.	3,195	4,013	26%	4,261	6%
3	3	UMC	Pure-Play	Taiwan	3,760	3,730	-1%	3,959	6%
4	4	Samsung	IDM	South Korea	2,192	3,439	57%	3,950	15%
5	5	SMIC*	Pure-Play	China	1,320	1,542	17%	1,973	28%
6	8	Powerchip**	Pure-Play	Taiwan	374	625	67%	1,175	88%
7	9	Vanguard	Pure-Play	Taiwan	520	582	12%	713	23%
8	6	Huahong Grace***	Pure-Play	China	619	677	9%	710	5%
9	10	Dongbu	Pure-Play	South Korea	500	540	8%	570	6%
10	7	TowerJazz	Pure-Play	Israel	611	639	5%	509	-20%
11	11	IBM	IDM	U.S.	420	432	3%	485	12%
12	12	MagnaChip	IDM	South Korea	350	400	14%	411	3%
13	13	WIN	Pure-Play	Taiwan	304	381	25%	354	-7%
—	—	<b>Top 13 Total</b>	—	—	<b>28,464</b>	<b>33,951</b>	<b>19%</b>	<b>38,920</b>	<b>15%</b>
—	—	<b>Top 13 Share</b>	—	—	<b>89%</b>	<b>90%</b>	—	<b>91%</b>	—
—	—	<b>Other Foundry</b>	—	—	<b>3,446</b>	<b>3,669</b>	<b>6%</b>	<b>3,920</b>	<b>7%</b>
—	—	<b>Total Foundry</b>	—	—	<b>31,910</b>	<b>37,620</b>	<b>18%</b>	<b>42,840</b>	<b>14%</b>

\*Does not include Wuhan Xinxin (now XMC) for 2012 or 2013.

Source: IC Insights, company reports

\*\*Powerchip transitioned from an IDM foundry to a pure-play foundry in 2013.

\*\*\*Hua Hong NEC and Grace merged in 2012 (excludes Shanghai Huali).



# 2013 Foundry Capacity Comparison

Foundry	Capacity / year
TSMC	16,423,625
GLOBALFOUNDRIES	7,326,000
UMC	6,313,500
SMIC	2,682,000

**IC Insights** -Production capacity figures converted to 8-inch equivalent wafers in order to enable comparison

## Fragile IC design industry

- Leaders: HiSilicon/Huawei; ZTE Micro, SPRD\*, Rockchip, Vimicro
- Most other Chinese IC design firms
  - are too small to invest in sophisticated design capabilities
  - focus on low-end applications (mature and standardized products)
- No strong domestic suppliers of EDA tools & software
- No domestic licensors of IC design building blocks

# China's innovation gap in advanced semiconductors

- US is way ahead in Multi-Component Semiconductors (MCOs) & Multi-Chip Packages (MCP)
- QCOM leads in “multimode” wireless communication chips that integrate various wireless standards (including 4G LTE)
- Weak semiconductor patent portfolio → Foreign companies dominate China's semiconductor invention patents
- China's share of world semi patents declined from a peak of 21.6% in 2009 to 18.2% (2011), 14% (2012).

→ **Needed: detailed research of patent data bases (USPTO;SIPO; WIPO; EPO; Derwent)**

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## Explanation - Conflicting innovation strategies

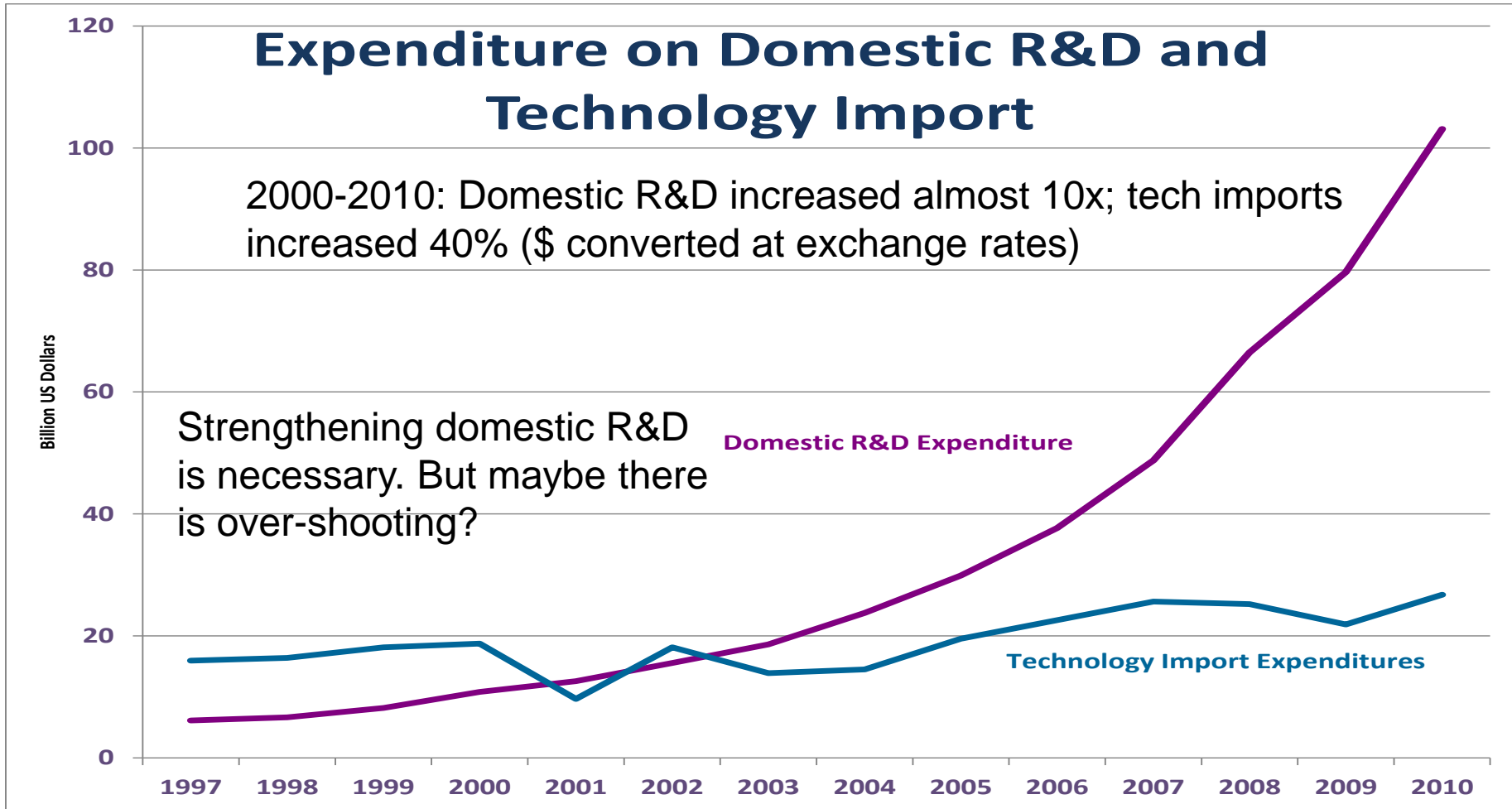
### Indigenous innovation policy ...

- focuses on challenges (licensing costs; cyber-security), but neglects the vast opportunities that result from integration into the global semiconductor value chain (learning; best-practice management capabilities & institutions)

### Chinese semiconductor firms...

- Seek access to core technologies & capabilities from global industry leaders
- feel constrained by Indigenous Innovation policy;
- but also seek to benefit from government procurement & investment support, in order to gain market share against established global players.

# “Indigenous Innovation” has changed the balance between global sourcing and domestic R&D



## Global value chain integration lowers entry barriers for Chinese IC design firms

*“The availability of IC design tools, semiconductor fab services, and open-source smartphone software [Android] allows Chinese firms to circumvent their weak spots and develop their strengths in hardware, IC design, and integration.”*

**(Interview with CEO of Spreadtrum, June 29, 2012)**

- *Deep integration enables Chinese firms to globally source technology & capabilities*
- *Global semiconductor industry depends on the China market  
→ This enhances China's bargaining power in global technology sourcing*

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## China's policy dilemma

- **Can China combine the benefits of both innovation strategies – “Indigenous Innovation” and “Global Technology Sourcing”?**

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## 2. What basic economic factors shape China's efforts to upgrade its semiconductor industry?

- demand pull from mobile devices;
- new opportunities for China's foundries in trailing-node semiconductor technologies
- changes in the IC foundry industry landscape
- a new interest in strategic partnerships and mergers and acquisitions (M&A).



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## Demand Pull from mobile devices

### China as lead market has...

- three times as many mobile handset subscribers as in the US (> 1 bn to 331.6m)
- 22% of global smart phone market (US=16%)

### China as co-shaper of mobile telecom standards

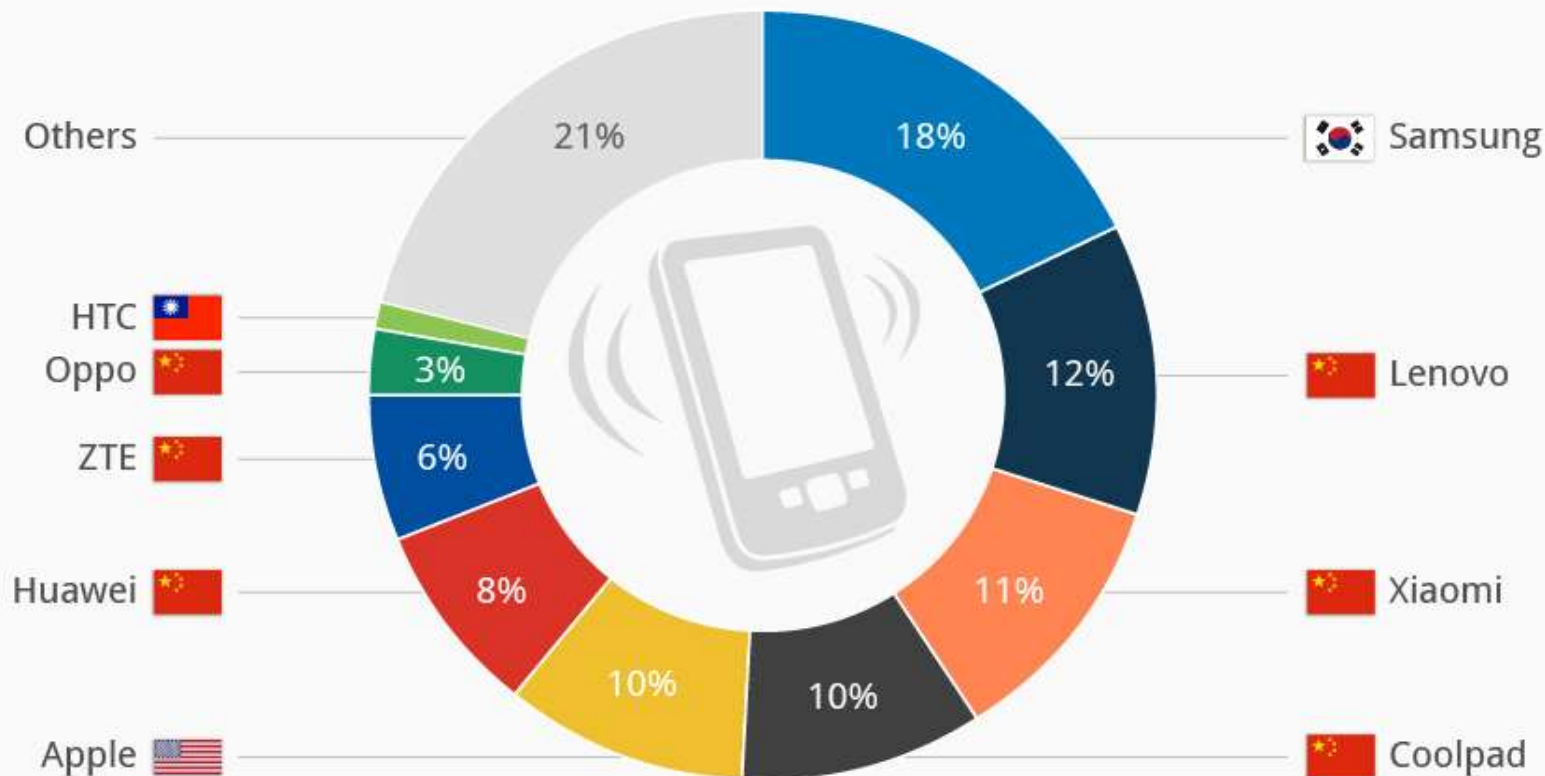
- Both TD-SCDMA and TD-LTE standards have fostered the development of technical capabilities in Greater China IC design companies (MTK; SPRD; RDA)

**→ As a result, global device vendors & leading IC companies are all searching for ways to ensure long-term access to the China market.**

- Global market share of mobile phones produced in China has almost doubled from 44% (2008) to 81% (2013) \*

# Domestic Vendors Stand Strong in China's Smartphone Market

% of smartphone shipments in China in Q1 2014



**Chinese vendors have 50% share of China market**



@StatistaCharts Source: Counterpoint

statista

# China's smart follower strategy for trailing-node process technology (28nm and above)

- Trailing nodes are reported to return higher margins, because they are being manufactured at present in fully depreciated wafer fab facilities.
- Producing devices at 20nm and below (14nm, 10nm) is extremely expensive, resulting from the escalating cost of equipment and tools. → The current consensus position is that barriers to such cost reductions will remain substantial for a considerable time.

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## A smart follower strategy for trailing-node process technology, cont'd

- SMIC may have a limited window of opportunity to compete in trailing node technologies
- However, adding new facilities with additional depreciation expenses will reduce margins.
- And if more foundry capacity would be added, leading to excess capacity, the resultant cost increases would erode profit margins.

# Apple's switch to TSMC from Samsung changes the foundry landscape

- TSMC's production capacity was almost fully booked for 4Q14.
- Prices for 20nm foundry services will now be negotiated between a monopsonist (Apple, the dominant customer for 20nm) and a monopolist (TSMC, the dominant foundry supplier).
- **This has negative consequences for Chinese fabless companies that seek to move to higher-end devices**
  - They are likely to be charged higher prices
  - Chinese fabless companies have low MOQ (minimum-order-quantity), and may well end up having to wait for a long time to get its chips fabricated

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## Global partnerships in the Foundry Industry: Qualcomm/SMIC

- If Qualcomm would share critical knowhow, this would allow SMIC to implement its trailing-node upgrading strategy in 28nm technology.

For Qualcomm, the deal could ...

- generate goodwill with China's government (NDRC antitrust pressure)
- Reduce shortage of 28nm production capacity
- diversify foundry suppliers to get better pricing at SMIC, but also to induce price reductions by TSMC
- enhance Qualcomm's chances to outmaneuver Taiwan's MediaTek and China's Spreadtrum in the low end of the smartphone market

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## Domestic M&A in IC design - Spreadtrum and RDA

- Create a credible competitor in the IC design market for low-end budget smart phones, not only against Taiwan's MediaTek, but also against the challenge from Qualcomm.
- Funded by state-owned Tsinghua Holdings, the Spreadtrum/RDA merger is expected to deliver a new, state-owned, consolidated entity that might be able to generate sufficient economies of scale and scope.

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### 3. The two faces of China's IC industry strategy

**Defensive:** respond to a combination of persistent domestic weaknesses & new threats to China's security & international competitiveness

**Assertive:** Disruptive changes in technology may weaken global oligopolies → Exploit four global transformations in semiconductor markets & technology:

- the demand pull from mobile devices
- new opportunities for China's foundries in trailing-node semiconductor technologies
- changes in the IC foundry industry landscape;
- a new interest in strategic partnerships and mergers and acquisitions (M&A).



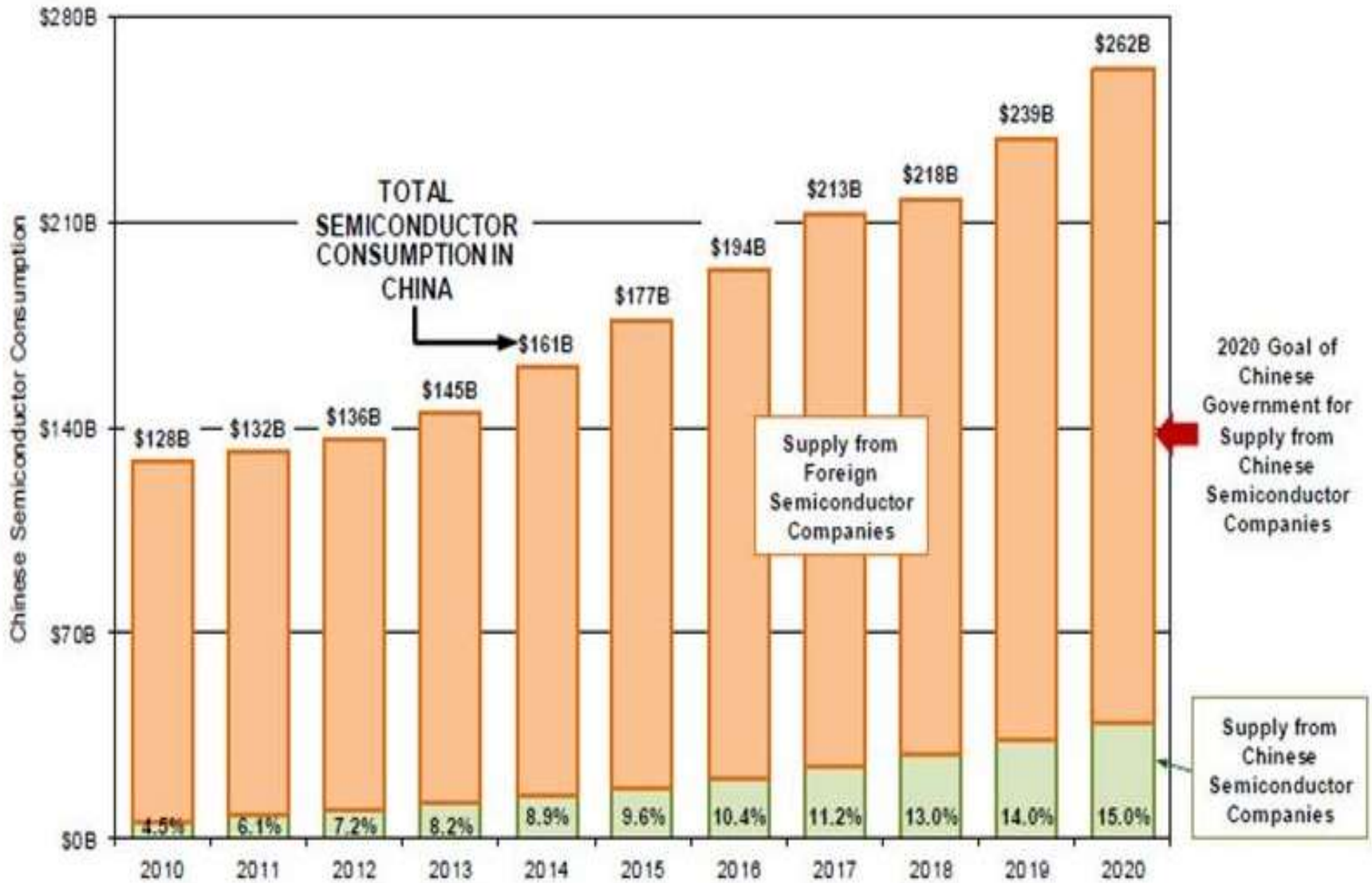
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## Guidelines to Promote National Integrated Circuit Industry (MIIT, NDRC, MoF, MoST, June 2014)

- A persistent **funding gap** prevents Chinese IC companies to finance investment and R&D.
- Firm-level **innovation capabilities** remain **weak** → The industry continues to lag far behind the US in its competitiveness and in its capacity to support innovation and China's cyber security.
- little **coordination** across China's IC industry value chain → industry development remains disconnected from market demand.
- the large and growing **gap between semiconductor consumption & production** remains a critical roadblock to catching-up and forging ahead in this industry.

# Ambitious targets

## Chinese Government's 2020 Goal



## Key Policy Instruments

- **IC Industry Support Small Leading Group** for ministerial coordination of high-level national strategies
- To improve investment allocation, create “market-driven” regional and national **IC Industry Equity Investment Funds** “with limited government intervention”.
- **Improve efficiency** of Government financial support instruments for → companies seeking to go public; R&D tax credits; → loan insurance & credit insurance tools
- **NDRC anti-monopoly policy**
  - Pressure on Qualcomm to reduce licensing fees
  - Similar pressure on Google, Apple, Microsoft, Cisco, IBM
- **Trade policy:** delay tactics in ITA-2

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# IC Industry Support Small Leading Group

*Long tradition of Leading Groups → Is new wine now being filled into old bottles?*

## **Objectives**

- Reduce inter-agency rivalries → improve strategy coordination
- Flexible response: Speed up government response time
- Mobilize public & private resources thru PPPs

## **Composition/Governance**

- VP Ma Kai as chair; Beijing Vice-Mayor Zhang Gong
- Key ministries (MIIT, MoST, MoF, NDRC)
- Top industry leaders
- Key academics



## Inclusion of “sea turtles” (“Haigui”)

Dr. WEI Shaojun (Dean of the Microelectronics Institute at Tsinghua University, President of the China IC Design Association, key Chinese delegate to WSC) was involved in drafting China’s new IC industry policy. Dr. WEI studied and worked in Belgium, and is internationally well connected, and well respected by GSA etc. Chinese experts like Dr. WEI, who know the international scene well and are at the same time well-connected within leadership circles, are now playing a more prominent role in policy formulation.

## Broader industry dialogues - June 24 IC Industry Development Guidelines – One of the Drafting Groups



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## Initial National Fund: RMB 120bn(\$19.5bn)/3-5years

### Objectives

- Mobilize public & private funding sources to reduce investment bottleneck faced by domestic firms
- Improve investment allocation through professional fund managers
- Strengthen capabilities across the value chain → focus on the **IC design-foundry nexus**

### Investors [RMBbn;(share)]

MoF 36(30%)

China Development Bank 32 (26%)

Beijing E-Town Capital& municipal government 10 (8%)

**“Societal funds” (non-governmental) 42 (36%)**



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## Beijing IC Industry Equity Investment Fund:

- main fund & subfund #1 for equipment and manufacturing → **China Grand Prosperity Investment (CGP)**
- subfund for IC Design, Packaging and Testing → **Hua Capital Management Ltd (HCM)**
- **HCM** has substantial equity investment from **SMIC's** investment fund company, with SMIC CFO (Gao Yonggang) as driving force.
- The primary drivers behind the IC Investment Funds are SMIC & Tsinghua Unis Group, the Chinese flagships in IC fabrication and IC



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## Industry expertise - Beijing IC Investment Fund

**Gao Yonggang**, SMIC's CFO & EVP, is chairman of China Fortune-Tech Capital which manages local IC funds both in Beijing & Shanghai. A veteran of big SOEs, he was CFO at the China Academy of Telecommunications Technology and chairman at Datang Telecom Group Finance.

**Chen Datong**, HCM chairman, was Co-Founder & CTO of Spreadtrum, China's leading IC design company, and Co-Founder and Senior VP for Omnivision, a Leading US provider of digital imaging products based in Santa Clara/CA.

**Xisheng (Steven) Zhang**, HCM president, postdoc researcher at UC Berkeley (1994); has >20 years industry experience in ICs, and in managing start-up companies in Silicon Valley & in Beijing.

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## Lessons from China's IC Industry Strategy

- Industrial support policies are needed to catch-up & to develop high-tech industrial value chains (**Dick Nelson, Dave Mowery, Susan Helper, Greg Tasse**y)
- To forge ahead in the knowledge-intensive & highly globalized semiconductor industry, China needs to experiment with bottom-up, market-led industrial policy (**Philippe Aghion, Ricardo Hausman, Dani Rodrik, Dominique Foray**)
- Top-down state-led mercantilist policies simply won't work in the presence of uncertainty

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## Industrial upgrading requires industrial dialogues with private firms

- *“Firm-level upgrading”* from low-end to higher-end products, processes & manu-services.
- *“Industry-level linkages”* with support industries, universities and research institutes.

→ **Challenge:** enable firm-level and industry-level upgrading to interact in a mutually reinforcing way (“virtuous circle”)

# Is Pragmatism still shaping China's Policy?

- *“China is not averse to intervening, but it has done that against the background of a lot of liberalization. It’s paying off.” (Peter Petri, Brandeis University & EWC)*
- *“Pragmatism has been a hallmark of China’s reforms over the past 30 years, as Chinese leaders have not flinched from a realistic view of their challenges. They typically experiment with various approaches before deciding on the best ways to address major concerns.” (Ken Lieberthal, Brookings Institution)*
- “In the next ten years, there will be a large amount of M&A cases in China, but many of them will fail...**But it is better than nothing. China enterprise will gain experience.**” (Chen Datong, HCM chairman)

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## Q&A: What could derail the industrial upgrading scenario?

- Will China's push to upgrade IC industry create overcapacity like in the solar PV industry and wind power?
- Will the Leadership's (cyber-) security objectives derail the Industrial Upgrading scenario?
- Impact of new trade and investment agreements

## Will Push to upgrade IC industry create overcapacity like in the solar PV industry and wind power?

- Implementation of the IC policy is left to the local governments, who have been masters in producing over-capacity, due to misaligned incentives. → *Why should this be different for the IC foundry industry?*
- How realistic is the argument?
  - *Unlike in the PV industry, technological barriers and the huge minimum investment burdens may prevent over-investment in the IC foundry industry.*

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## Will the Leadership's (cyber-) security objectives derail the Industrial Upgrading scenario?

- Is the drumbeat on security used primarily as a **tactic** to mobilize support for aggressive investment funding?
- Would **de-coupling** work? [= separating the development of indigenous defense technology from the upgrading of the IC industry]
- Short-term: Much of the Chinese government is in **gridlock**, as no one dares to start new initiatives in light of the renewed focus on Security (under the guise of the anti-corruption campaign).
- **USSR/Japanese Galapagos syndrome**: security dominates the commercial interests and China attempts to create its own system of technologies

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## Impact of new trade and investment agreements

- China needs to engage with and co-shape new trade and investment agreements, especially with regard to IP protection, standardization, and government procurement.
- If China remains on the sidelines, current negotiations on TPP and TTIP, and plurilateral trade agreements (ITA-2, GPA, TISA) could have substantial negative impacts on China's prospects in semiconductors.