From catching up to forging ahead: China's new role in the semiconductor industry

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How will China's new role transform the global semiconductor industry?

China has become the largest and fastest growing semiconductor market in the world, absorbing 40% of the worldwide semiconductor shipments. For US semiconductor firms, nothing compares to the China market.

China however faces a fundamental dilemma. As the world's leading exporter of electronic products, it remains heavily dependent on imports of semiconductors and technology, primarily from the US, but also from Japan, Korea, Taiwan and Europe. At least 80 percent of the semiconductors used in China's electronics manufacturing are imported and virtually all leading-edge devices like multi-component semiconductors (MCOs). For instance, 43% of the inputs for handsets and networking equipment of China's second largest telecom company, ZTE, are supplied by US companies (Avnet, Qualcomm, Broadcom, Jabil, Intel, Microsoft, Micron, Xilinx, Nvidia and Finisar) [1].

As a result, China's trade deficit in semiconductors has more than doubled since 2005 and now exceeds the huge amount it spends on crude oil imports. To correct this unsustainable imbalance, China's new strategy to upgrade its semiconductor industry seeks to move from catching up to forging ahead in semiconductors through progressive import substitution. The "National Semiconductor Industry Development Guidelines (Guidelines)" and the "Made in China 2025" (MIC 2025, 中国制造2025) plan were published by China's State Council in June 2014 and May 2015, respectively [2]. Both policies seek to strengthen simultaneously advanced manufacturing and innovation capabilities in China's integrated circuit (IC) design industry and its domestic IC fabrication, primarily through foundry services.

As part of the Guidelines, a CNY120 billion (US$19 billion) national industry investment fund has been set up to help local foundries finance the build-up of advanced manufacturing processes, and also to assist local IC firms to form mergers and/or make acquisitions internationally. With the MIC 2025 plan, China is aiming to improve the self-sufficiency rate for ICs in the nation to 40% in 2020, and boost the rate further to 70% in 2025. MIC 2025 specifically defines the following priorities: i) Catch up with world best practice in IC design cores and design tools; ii) move to the frontier of multicomponent semiconductors (MCOs); iii) win design-in contracts from China-based electronic equipment manufacturers (both large global MNCs and Chinese firms like Lenovo or Huawei); and iv) strengthen China's capacity to design and produce high-density chip packages and 3D micro-package technology.

Both policies have already led to a major push in the development of the local IC industry, with investments in semiconductor memories, designs, foundries, OSATS, and equipment and materials. In addition, strategic partnerships, joint ventures and mergers and acquisitions have proliferated across China's semiconductor industry, both among domestic firms (to increase economies of scale and scope), and with leading global semiconductor firms (to access cutting-edge technology and best-practice management techniques).

Based on a review of policy documents and interviews with China-based industry experts, this paper explores how realistic these objectives are, and how this might affect international firms and the global semiconductor industry.

How realistic are the objectives of China's new policies?

Over the last 60 or so years, China's semiconductor industry has come a long way from being a completely government-owned part of the defense technology production system, with

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state-owned enterprises (SOEs) as the only players, toward a gradually more market-led development model. The role of SOEs has dramatically declined, and a deep integration into international trade and global networks of production and innovation has transformed decisions on pricing and investment allocation, with private firms as the main drivers. Major achievements include the rapid growth of China's IC design industry from practically zero at the turn of the century to $17.05 billion in 2014, with an almost 37% compound annual growth rate since 2003. Other achievements include the successful diversification into optical devices (especially LED-related), sensors and discrete devices; first steps to move from silicon to wide band-gap semiconductor materials; and the surge of China's semiconductor assembly, packaging, and testing (APT) industry, which has become the global market leader.

However, China's achievements are overshadowed by persistent weaknesses, despite massive government support. Buying decisions for advanced ICs consumed in China are mostly made in Taiwan, Korea, US (for mobile devices), Japan, and Singapore. Of particular concern is the large and growing gap between semiconductor consumption and production, which has ballooned to a record $ 120 billion in 2013, and is forecast to reach $ 151.5 billion in 2017.[3] Equally important, China continues to play second fiddle in wafer fabrication - China's 2015 share of total worldwide semiconductor wafer fab capacity is 11.7%,but advanced technology nodes (28nm and below) account for only 5 % of worldwide wafer fab capacity. Foreign IDMs dominate (Intel, Samsung, Hynix), and Chinese foundries have a long way to go to catch up in process technology and wafer size. Most importantly, China lags behind in innovation, especially for advanced semiconductors, despite all the government's previous plans and efforts.

Will China's policy on semiconductors this time around work better than before? Our research finds that China's new semiconductor policy does not represent a radical break with its deeply embedded statist tradition [4]. However, there are some important changes toward a more bottom-up, market-led approach to industrial policy. If sustained, these changes may considerably improve China's chances to succeed in its new push in semiconductors.

China's new semiconductor policy (as defined in the Guidelines) relies on private equity investment rather than subsidy as the tool of industrial policy. The government participates in equity investment but claims it will do so without intervening in management decisions. This is expected to reduce the cost of investment for a selected group of firms comprising a "national team" in the semiconductor industry. The underlying financial networks are complex and difficult to disentangle. Take Hua Capital Management Co., Ltd (HCM), a Chinese investment management company, which was chosen to manage the chip design and testing fund under the Beijing government's 30-billion-yuan (HK$37.8 billion) Semiconductor Industry Development Fund.

According to industry observers, the real driving force behind HCM is Chen Datong, who is HCM's chairman as well as co-founder and managing partner of WestSummit Capital, a leading China-based global equity firm focused on helping high-growth technology companies access the China market. Dr. Chen has more than 20 years of investment and operations experience in the technology and semiconductor industries, and he owns 34 US and European patents. [5] Another major player is Liu Yue, the deputy chairwoman of HCM, who also has a wealth of experience in China's IC industry. Of particular interest is her role as an early investor in China's leading foundry SMIC through Walden Capital, and her continuous involvement with SMIC. HCM's president, Xisheng (Steven) Zhang, started out in 1994 as a post-doctorate researcher at University of California, Berkeley, worked his way into senior management positions at Agilent Technologies and Silicon Valley start-up IC design companies, and joined Beijing- based private equity investment company WestSummit Capital in 2013. Zhang has over 20 years industry experience in semiconductors, and in managing start-up companies in Silicon Valley and in Beijing.

Based on this information, one might conclude that HCM qualifies as a professional fund manager with considerable knowledge of key aspects of the semiconductor industry value chain, especially related to IC design. In the view of the United States Information Technology Office (USITO), the use of professional investment fund managers, as opposed to government subsidies or investment, "suggest a new approach to industrial policy that focuses on building a strong and sustainable investment environment in China."[6] It remains unclear, however, how private equity fund managers, who are supposed to maximize the return to capital, can nevertheless serve as proxies for the government and support its policy to strengthen indigenous innovation. A final assessment thus has to wait until more information is available on how funds will ultimately be deployed.

MIC 2025, on the other hand, seeks to provide a new framework for coordinating industrial support policies, in order to overcome a persistent gap in technological, management and innovation capabilities. Improved policy coordination is considered to be essential for overcoming deeply entrenched disconnects between industry, academia and government. Over two and a half years, 50 experts from the China Academy of Engineering and the Chinese Academy of Sciences worked together with around 100 experts from industry and research institutes to design the MIC 2025 plan. An equally important objective is to reduce the fragmentation of decision-making across government agencies and

between the Central government and local governments. As an important step in this direction, 14 state-run associations from different sectors worked together and created a voluntary quality management standard for automated and intelligent manufacturing.

In short, China's government seems more open to experimentation with new approaches to policy formulation, investment finance and flexible, bottom-up policy implementation. Among Chinese technology planners, there seems to be a growing consensus that the closer China moves to the technology frontier, the less scope there is for imitation and low-level incremental innovation. Chinese firms now are encouraged to develop and protect their own intellectual property rights and accelerate the commercialization of new ideas, discoveries and inventions.

China's leadership is very conscious that the United States is far ahead in advanced semiconductors and that China has a long way to go to close the gap. But at the same time, Beijing's new semiconductor policies also convey a new sense of optimism. Global transformations in semiconductor markets and technology, including a new interest in strategic partnerships and mergers, are no longer perceived exclusively as threats. In fact, China's technology planners now seek to identify pathways to innovation- led development that could benefit from new technologies, such as the technology convergence in mobile devices, the Internet of Things in industrial manufacturing, and "green development", focusing on a reduction of energy consumption, water usage and pollution. Forging ahead in semiconductors is considered essential for realizing this potential.

Above all, the role of the government appears to be gradually shifting away from the selection of priority sectors and technologies toward the facilitation of an interactive learning process led by the private sector. In this new model of industrial policy, which is slowly taking hold in China's semiconductor industry, the government role is to provide incentives and remove regulatory constraints to empower the private companies that are most capable of realizing China's domestic innovation potential.

It is however an open question whether China's transition to innovation-led growth in semiconductors could be derailed, for instance, by the threat of overcapacity or by the Leadership's (cyber-) security objectives. As is typical for China, the implementation of the semiconductor policy is left to the local governments who have become masters in producing overcapacity due to misaligned incentives that are focused exclusively on the region's GDP growth.

China's policy on cyber security seeks to protect China-based information systems against perceived threats to national and public security. [7] In response to Edward Snowden's disclosure of US National Security Agency (NSA) global surveillance practices in China and elsewhere, China's concern with cybersecurity receives prominent attention in the Guidelines. It is unclear at this stage whether the drumbeat on security is used primarily as a tactic to mobilize support for aggressive investment funding? [8] Or is this focus on security an overriding concern for China's leadership that will cast aside many of the aforementioned economic considerations?

In the end, there is reason for cautious optimism that pragmatism will continue to shape China's policy for semiconductors [9]. Learning from global industry leaders will play a critical role, based on a quite realistic set of expectations: "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's enterprises will gain experience."[10] More than before, such pragmatism will be shaped by economic constraints, such as the country's rising debt and dwindling foreign exchange reserves due to the collapse in Chinese exports [11].

Implications for international firms and the global semiconductor industry

As U.S. and other foreign semiconductor companies heavily depend on the China market, they seem to have little choice but to adjust their strategies to China's new semiconductor policy. Intel, for instance, now depends on China for one-fifth of its revenues, while Qualcomm relies on the China market for nearly half of its income. In fact, U.S. and other foreign firms are quite explicit that they would be willing to accede to Chinese demands to transfer technology and form joint ventures with its firms, if only they could expand or at least sustain their share of the China market.

Examples include Intel's substantial investment in Spreadtrum, one of China's leading IC design firms, and Qualcomm's investment in China's leading IC fabrication company, SMIC. As foreign firms seek to cooperate more closely with Chinese firms in exchange for continued market access, this raises the question to what degree this might amplify China's policies. Might foreign firms in some cases actually provide more effective support than the Beijing government in expanding China's semiconductor industry?

To conclude, both Chinese and U.S. semiconductor companies have much to gain by learning from each other as they each face their own upgrading imperatives. While they compete in global markets, they would both benefit from cooperation in advanced semiconductor manufacturing and technology to solve the challenges of economic growth, better and lower-cost health systems, and a greener environment. Given the importance of both countries in the global semiconductor

industry, it is striking to see that such cooperation remains as yet quite limited.

There is however ample scope to extend such cooperation. While China is catching-up in semiconductors, the US is still way ahead in overall innovation capacity. China's persistent innovation gap implies that Chinese firms continue to need access to American technology, whether in terms of equipment, core components, software or system integration. For America, this implies that China's new policies for semiconductors creates new markets for American firms, provided they stay ahead on the innovation curve.

But implementing such cooperation faces many hurdles. While incumbent industry leaders seek to retain the status quo, newcomers like China seek to adjust the old rules to reflect their interests as latecomers. But progress towards greater cooperation should be possible, once China acknowledges that US semiconductor firms need safeguards against forced technology transfer through policies like compulsory licensing, information security standards and certification, and restrictive government procurement policies. The US, in turn, needs to acknowledge that Chinese firms feel disadvantaged by restrictions on Chinese foreign direct investment (through CFIUS), and by restrictions on the export of technology to China, like the recent decision of the Commerce Department to slap technology export restrictions on US suppliers of semiconductor to China's ZTE. In the end, such policies may encourage China to shift to alternative suppliers in Korea, Taiwan, and to promote more aggressively domestic suppliers.

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8. After all, security concerns as a tactic to mobilize support for public and private investment in R&D have been used in other countries before, the United States included.
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