HKUST IEMS
INSTITUTE FOR EMERGING MARKET STUDIES
FALL 2022 **no.69**
iems.ust.hk

PDF & Additional Materials

THOUGHT LEADERSHIP BRIEF

China's Industrial Policy for Semiconductors: Lessons for the World

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KEY POINTS

- China's 8-year-long effort to achieve self-sufficiency in chip production has not yet been successful despite huge financial support.
- This can be explained by China's low starting point in the highest-value parts of the chip supply chain, as well as US sanctions and export bans on semiconductors.
- The United States, as well as the European Union, are stepping up efforts to upgrade their semiconductor industry but reviving industrial policy.
- Lessons should be drawn from China's experience. First and foremost, financial support does not ensure success. Second, the fab stage is extremely costly, in terms of the fixed asset investment needed, and not necessarily more important than design so not every country/region needs to aim at setting up fabs. Finally, the semiconductor is too integrated and complex for anybody to try to become self-reliant from the rest of the world.

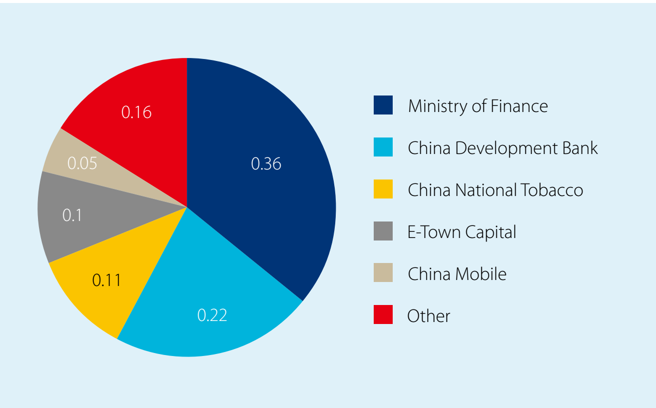
ISSUE

Semiconductors are China's main import item and essential input for many industry sectors. The US's push to restrict China's technological progress is centred around the semiconductor sector, as it is perceived to be China's technological Achilles' heel. The "Entity List", a list of Chinese entities targeted by US trade restrictions and imposed by the Trump administration, focuses on limiting China's access to high-end semiconductors. The European Union (EU) has followed suit by announcing major government support plans to strengthen the design and production of semiconductors within their borders. Pressure from the US and the EU has accelerated China's quest for self-reliance. In response, China has implemented industrial policies that aim to reduce dependence on the rest of the world (dual circulation strategy).

ASSESSMENT

China launched a comprehensive industrial policy titled "Made in China 2025" in 2015. The document identified 10 high-tech sectors of key relevance to reduce China's technological dependence on the West. In the same vein, the "National Guideline for the Development and Promotion of the IC Industry", published by the State Council in 2014, proposed a strategy to reduce import reliance in the Chinese chips industry. To that end, government support would be offered via integrated circuit funds at the national and state levels. The first investment fund, created in 2014 by the central government, raised USD 21 billion (RMB 139 billion) to be operationalized under the Ministry of Industry and Information Technology (MIIT). The Ministry of Finance disbursed 36% and China's largest development bank, China development bank (CDB) disbursed 22%.

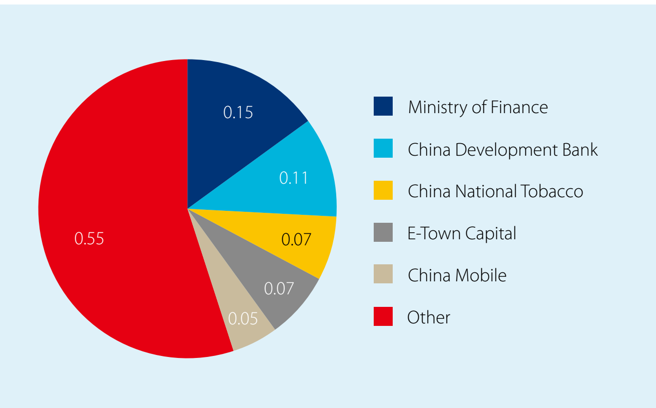
Figure 1. Largest Shareholders of the First IC Investment Fund



Source: Bruegel based on PIIE

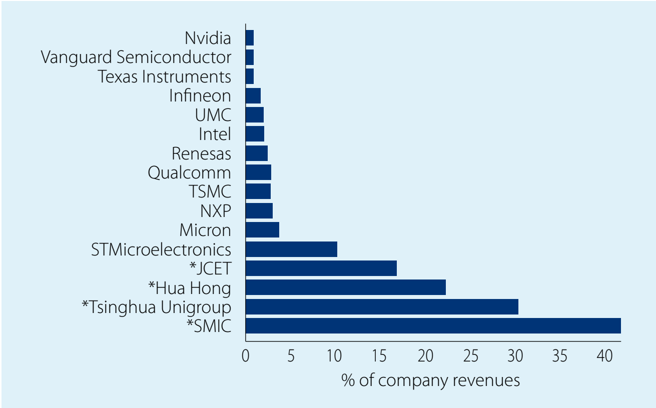
A second National Big Fund was set up in October 2019, having raised USB 35 billion (RMB 204 billion) and with similar major state-controlled shareholders (Figure 2). This time around another major state-owned financing vehicle, Shanghai Guosheng, contributed 7% of the total funding.

Figure 2. Largest Shareholders of the Second IC Investment Fund



Source: Bruegel based on OECD

Figure 3. Estimates of Total Government Support to Semiconductor firms by the OECD – * Indicates Chinese Firms



In addition to the two National Big Funds, at least 15 local government funds have been created at the city or provincial level, totalling at least USD 25 billion in capital to invest in the sector. Estimates consider that national big funds along with local government funds might have channelled up to USD 150 billion to support the Chinese semiconductor industry from 2014 to 2020 (OECD, 2019, and Congressional Research Services, 2021).

Government support to the semiconductor sector is also offered through government grants, tax incentives and low-interest loans to an estimated amount of USD 50 billion. Tax breaks were designed to foster the production of high-end semiconductors ie. with the smallest nodes allowing for more complex and powerful electronic circuits. Additionally, firms can borrow at below-market rates as banks were encouraged to support the sector. China has invested heavily in R&D to become on par with the EU as a share of GDP, with a special emphasis on the high-technology sector and semiconductors (Figure 3). Tax incentives to conduct research and development (R&D) saw the ratio of tax deductions increase from 75% to 100%.

The government also supports chip producers raising equity in the Shanghai Stock Exchange (SSE) Science and Technology Innovation Board (STAR Market) established in 2019. On the SSE Star Market, 17% of companies were in the chips sector in January 2021, nearly half of which operated in design. Furthermore, a favourable regulatory environment allows innovations to be brought to market for mass consumption faster than for other sectors. Lastly, land to build industrial plants also appears to be sold at prices cheaper than market prices.

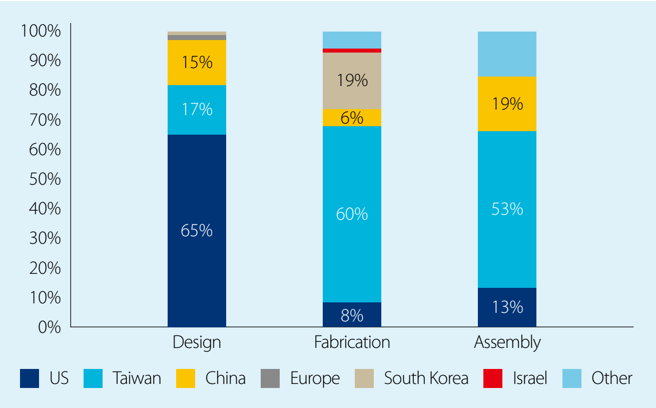
While China's capacity to fabricate chips has grown fast, notable losses include Tsinghua Unigroup defaulting on bond repayments amounting to USD 3.6 billion by January 2021. The company continues to struggle to generate positive cash flows and remains highly indebted, making it a good example of a firm receiving a lot of public funds without successfully absorbing them.

Beyond Tsinghua Unigroup, the investment in fabrication has yielded some success in the production of memory chips. Yangtze (parent company Tsinghua Unigroup) upgraded its RAND production to match SK Hyinx and Samsung. ChangXin Memory Technologies (CXMT) has also been successful in increasing its output and technology level for DRAM. These achievements, however, are underwhelming for the objective set for China's industrial policy for the sector, to become self-sufficient in the high-end smaller node logic chips.

Another important development is the increase of state participation in the sectors' key players. State participation in Semiconductor Manufacturing International Corporation (SMIC), China's biggest chip company, increased from below 15% in 2004 to over 45% by 2018. Moreover, Shanghai's local government used USD 1 billion in funding to set up a joint venture with SMIC to build a foundry in Shanghai focusing on 14nm chips. In 2021, the firm also announced plans of a new foundry in Shenzhen also based on a USD 2.35 billion joint investment with the local government. Thanks to these significant investments, SMIC managed to increase its presence to become the fifth biggest player globally. However, production upgrades are halted as the company is part of the US's entity list and suffers from export bans from key companies, in particular the European producer of lithography equipment, ASML.

Some success of China's chip policies can be seen in chip assembly (Figure 4). This is the least demanding phase in terms of capital expenditure and know-how in the semiconductor cycle. The largest player is JCET, third globally, with a market share of 14%. JCET's success was partially financed by the Big Fund in 2015, raising state control between 20 and 35% (OECD 2019).

Figure 4. Firms' Market Shares of Semiconductor Production Steps by Headquarter Location, 2019



Source: Bruegel based on IC Insights, Seeking Alpha Stiftung Neue Verantwortung

An important success is seen in large improvements made by private companies specializing in chip design. This prompted China's global market shares to grow from 5% in 2010 to 15% in 2019. However, Mainland China remains behind Taiwan and far behind the US in global market share. China's design sector has also struggled to progress since 2019 due to US sanctions and trade restrictions.

Taking into account huge financial support, estimated at USD150 billion, China's industrial policy to develop an advanced chip industry has so far yielded mixed results. The external reliance on semiconductors continues unabated even after the acquisition of foreign firms and the building of fabrication plants. Large companies, after having received huge amounts in funds, have not been able to absorb them and have become over-leveraged, leading to defaults. This development is not unusual in highly competitive sectors where money cannot buy upgrades. This semiconductor sector is characterised by a high level of specialisation and concentration, and the US has leverage over several of the key bottlenecks in the production process. China is limited in its ability to secure production of high-end chips because of a shortage of talent, but also because of export controls put in place by the US. These high-tech bottlenecks are set to endure in the medium to long term making full supply chain decoupling impossible. But appraising the outcome of China's massive investments in the semiconductor industry is not easy as more time is needed to evaluate progress. China's ambitious chip industrial policy has certainly grown its domestic high-tech ecosystem and secured some market presence in the first steps of the value chain. But it remains short of its overly-optimistic goals of being able to master the most high-tech segments. The current state of the market reflects these realities.

RECOMMENDATIONS

The United States, but also the European Union, and more recently Japan and India, share China's ambition to increase its chip production capacities. This has led to several industrial policy endeavours, such as the US Chips Act but also the EU Chips Act. Both the US and the EU Chips Act aim at reducing semiconductor supply shortages and years of decline in semiconductor investments in the EU. In the specific case of the EU, the Act expects to boost Europe's share of global chip production capacity from 10% to 20% with funding hovering around Euro 42 billion. The US passed its own Chips Act last July with USD 52 billion of funding. While the EU and US Chips Acts can be considered commensurate with China's Two Big Funds, their starting points are very different. The US leads in the chip value chain with the most value-added design, while Europe has relevant technology (especially lithography for fabrication) and retains a strong position in R&D.

China's 8-year-long effort to achieve self-sufficiency in chip production has not been successful. Upgrading production is challenging no matter the amount of available capital. This can be seen by the difficulties Intel and Samsung have faced in producing the latest generation of chips. They trail behind TSMC which remains on the cutting edge. China's unsuccessful attempts so far can be explained by the very low starting point in the highest-value parts of the chip supply chain as well as US sanctions and export bans on designs of semiconductors. While sanctions on China's chips sector presented an opportunity for alignment between private and public entities as both aim for self-reliance, China has not managed to overcome the bottlenecks and monopolies of companies such as ASML and TSMC. US firms retain market leader status in design software and leverage export restrictions against China. In the fabrication segment, China remains confined to mature technologies. China finds some success in increasing its global market share in the assembly phase, which is both less competitive and less strategic.

Given the US dominance in design, it will be easier to create a supply chain for semiconductors, which increases the chances of making the Chips Act successful. As for the EU, the situation is different. In fact, it should aim to increase the participation of EU companies in the highest value of a chip production cycle. This should reduce the EU's dependence on this sector and help the EU keep an edge in new digital industries as well as the energy transitions for which chips are essential. China's experience should be taken into account to avoid flooding the sector with funds that do not help develop a high-end European semiconductor ecosystem but rather, create over-capacity at the lower end of the chip value chain. Furthermore, China, the US and the EU should move away from channelling investment in the fabrication part of the supply chain. Chinese companies have suffered the largest losses and are most at risk of defaulting in the fabrication sector.

Both the US and the EU should also target subsidies at the highest value-added of the semiconductor cycle. Cooperation with other countries beyond the US or the EU Member states will also help reduce the costs. Avoiding excess investments is also important considering that the sector is not only highly intensive in terms of capital, but also of energy and water. Additionally, China's increasing importance in assembly also calls for diversification strategies for the US and the EU for this final phase of the cycle. Otherwise, we can expect continued reliance on China as a provider of the final product in the semiconductor cycle.

The dependence on Taiwan for the fabrication of advanced semiconductors – and in particular on TSMC which holds 85% of the global market share – needs to be addressed given both the geopolitical risks involved and the risk of natural disasters. This alone justifies the deployment of public funds to reduce potential shortages and bottlenecks. More generally, highly concentrated sectors producing strategic or essential products increasingly require tailor-made industrial policies and the semiconductor industry cannot be an exemption. Finally, refraining from uncoordinated, unproductive government support through an EU-level chip act is crucial for the future of the industry in Europe.

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Alicia holds a PhD in Economics from George Washington University and has published extensively in refereed journals and books (see her publications in ResearchGate or Google Scholar. She is also very active in international media (Bloomberg and CNBC among others) as well as social media (Twitter, LinkedIn and Weibo) As recognition of her leadership thoughts, Alicia has recently been nominated TOP Voices in Economy and Finance by LinkedIn.

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