WHAT'S HAPPENING IN SEMICONDUCTORS? THE NEXT CHAPTER

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We recently wrote about semiconductors from the perspective of capital spending and government policies aimed towards encouraging further capital spending and ultimately semiconductor independence.

However, we'd be remiss to not at least touch on some of the current geopolitics.

A simplified look at the semiconductor supply chain

If one simplifies a rather complex set of interrelationships across countries, we can see a triangle with three distinct corners[1].

- **Foundries:** These companies are manufacturing the physical chips. There are not too many individual players, as the capital expenditures to enter this space are extremely high. Additionally, they don't all have the same capabilities. Taiwan Semiconductor Manufacturing Co. (TSMC) is well known for being able to reliably manufacture the most advanced chips in the world. Samsung Electronics, Intel and Global Foundries represent other important players.
- **Intellectual Property Companies:** These companies make and sell different layouts and designs. ARM, the company currently owned by SoftBank, is one example with a huge presence across the internet of things (IoT).
- **Electronic Design Automation (EDA) Tools:** EDA was only $10 billion in 2021, a small part of the overall $595 billion semiconductor market, but it is essential if chip manufacturers are to determine if a design is feasible prior to production. Cadence, Synopsys and Mentor Graphics are the three leading players in this space. Together, they control about 70% of the global market.

Behind each of these points on the triangle is a lot of history embedded as experience, and it is important to recognise this since it is what makes it particularly challenging for an outside player—in this case China—to just copy it.

The ASML example

Lithography is the term used for the practice of etching the appropriate designs on the silicon that allow for the functional operation of the transistors. More transistors spaced more closely together, simply put, means a more efficient and capable chip. Today's Apple M1 chip contains 16 billion transistors[2].

The degree of precision engineering required to be able to put 16 billion transistors on something that is not the size of multiple city blocks, much less could fit within a laptop or smartphone, is one of the most impressive feats of human ingenuity that the world has ever seen. The short version of the story is that a company in the Netherlands, ASML, was in a position to take a big risk in the 2000's—the pursuit of extreme ultraviolet lithography (EUV).

EUV was needed because there needed to be shorter wavelengths of light used to almost shave atom by atom away from the silicon to make the transistors small enough, basically 5-nanometres. This light is generated by flashing a specific type of laser 50,000 times per second at molten tin[3].

Developing EUV was so capital intensive that only a single company did it: ASML. Components for the machines that do this fill four 747 airplanes and are sourced from specific companies all over the world. Operating the machines at scale requires an incredible depth of experience[4].

Given the flavour of the topic, you have probably already guessed the geopolitical implications. Some of the components of the EUV machines do come from the United States. Then, there is the relationship between the US government and the government of the Netherlands. As a result of those discussions and where we are presently, EUV machines are not being sent to China.

The Nvidia case

In August 2022, the US took a further step to limit China's artificial intelligence (AI) ambitions through further restrictions on the export of very specific semiconductors[5]:

- Nvidia will be restricted from selling the A100 graphics processing unit into China, Hong Kong and Russia
- Nvidia will also be restricted from selling its forthcoming H100 series of graphics chips into these same markets
- users of the A100 include Alibaba, Tencent and Baidu—the companies that provide some of China's largest cloud computing infrastructure

Nvidia is the most visible company with respect to these types of chips, and as of this writing it had the largest market cap amongst the semiconductor companies. It would not surprise us if other firms that have chips of similar types of capabilities could be named in the future.

Conclusion: Can China 'go it alone'?

We might take a step back at this point and think, wait, China has massive resources. Why don't they just make their own chips? We don't discount the fact that China absolutely could make its own chips, but it would be more a question of how long it would take and how advanced those chips could be. The EUV process was something that took both massive investment and about 20 years. ASML is able to manufacture the machines that it does and support companies like TSMC operating at scale because they have the benefit of learning from all the mistakes along the way. China can certainly make efforts along the path, but simply spending money is not going to lead to an effective EUV process that can manufacture the most cutting-edge chips at scale—the key being 'at scale without a high defect rate.'

During the four years ended 2024, China is slated to complete 31 major semiconductor factors. By 2025, 40% of the world's capacity to produce chips with 28-nanometre nodes is expected to be in China[6]. This tells us that China is making big investments away from the absolute cutting edge—and we have to remember that the world does need those chips as well.

It will be very difficult for any country to fully take in all aspects of the semiconductor supply chain, but we are seeing notable efforts to that end in 2022 that will likely continue.

Sources

[1] Source: Yang, Zeyi. "Inside the software that will become the next battle front in US-China chip war." MIT Technology Review. 18 August 2022

[2] Source: https://en.wikipedia.org/wiki/Apple_M1

[3] Source: Thompson, Clive. "Inside the Most Complicated Machine on the Planet." MIT Technology Review. Volume 124, Number 6, November/December 2021

[4] Source: Thompson, November/December 2021

[5] Source: Lin, Liza & Dan Strumpf. "Latest U.S. Chip Curbs Deliver Setback to China's AI Ambitions." Wall Street Journal. 1 September 2022

[6] Source: Strumpf, Dan & Liza Lin. "China Bets Big on Basic Chips in Self-Sufficiency Push." Wall Street Journal. 24 July 2022

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