POLITICAL REFLECTION MAGAZINE

July • August • September • 2023 ISSN: 2042-888X Vol. 9 • No. 3

Election of the Least Unwanted Candidate: 2023 Presidential Election in Türkiye

by Rahman Dag

Takeaways from the Turkish Elections May 2023

by Mark Meirowitz

PR Political Reflection Magazine

Established in 2010

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cesran international
CENTRE FOR STRATEGIC RESEARCH AND ANALYSIS - CESRAN

VOL. 9 - NO. 3

JULY
AUGUST
SEPTEMBER
2023

POLITICAL REFLECTION

e-ISSN: 2042-888X

"ADVANCING DIVERSITY"

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What the War on Exports Control Means for Globalized Supply Chains of High Tech

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Increasing export controls over semiconductor components in the Netherlands, Japan, and recently in China as a response to the former are undermining confidence in globalised supply chains.

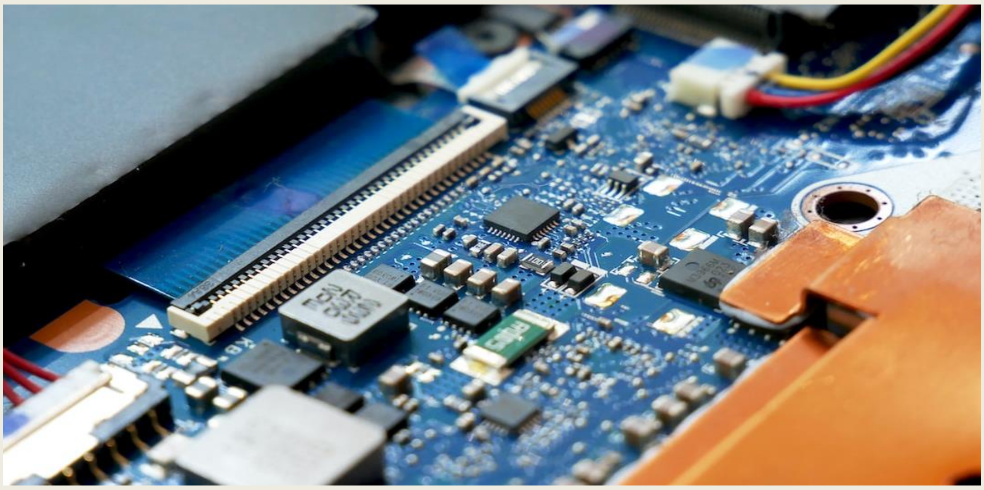

Photo by Vishnu Mohanan on Unsplash

On July 03, China's Ministry of Commerce announced the imposition of a licensing system for two critical raw materials—gallium and germanium — starting August 01, 2023, which has been interpreted as the superpower's response to the accelerating semiconductors war. While this is not an outright ban against foreign entities from buying CRMs, that the Chinese government can deny Western companies in the semiconductors industry on the grounds of national security makes the transaction less determined by the laws of supply and demand. Of course, the policy announcement constitutes China's answer to the swathe of export control policy being implemented in Japan and the Netherlands a month ago, which is largely a result of the American government's pressure to derail China's chip-making industrial capacity for several years now. But we need a better understanding of what the export control policy means. To start with, although China exercises 60% of gallium and 90% of germanium

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control over their production, the Chinese chips industry remains dependent on Japan and Europe to transform these metals into later-stage semiconductors and optical products—which is equally telling why China has taken its time before responding to the escalating semiconductor technological competition.

Europe, which held important global shares in designing semiconductors, now faces Chinese competition. Since the post-war years, Taiwan, South Korea, and Japan have staved off European companies' competitive advantage in the high-tech sector. Thus, the recent Chips War—now between China and the U.S.—has generated a regulatory response in Europe. In August 2022, a European Chips Survey was conducted, and its findings reveal the potential incapacity of the continent to catch up with the United States and East Asia (mainly Japan, Korea and Taiwan). The Survey Report highlights the following points:

- Chip demand is expected to double between 2022 and 2030, with significant increases in future demand for leading-edge semiconductor technologies,
- Companies establishing new chip fabrication facilities cite qualified labour and government regulations as key when selecting manufacturing locations,
- The supply crisis affects all the ecosystems and is expected to last until at least 2024, forcing companies to adopt costly mitigating measures.
- Semiconductor research and development funding was mostly relevant for companies on the supply side; however, the support initiatives are also relevant for the demand side.

The Significance of Semiconductors for the Modern Economy

Any discussion about the European Chips Act requires a better understanding of why the sector is considered part of 'economic security' or high-tech warfare. In today's world shaped by the information revolution, semiconductor chips are fundamental to emerging technologies, e.g. artificial intelligence, cloud computing, 5G, the Internet-of-Things (IoT), and large-scale data processing and analytics and supercomputing. Semiconductors can be classified into four major product groups, mainly based on their function:

1. *Microprocessors and logic devices* are used for the interchange and manipulation of data in computers, communication devices, and consumer electronics. They perform a wide variety of tasks, such as running a word-processing program or a video game.

2. *Memory devices* are used to store information. This segment includes dynamic random-access memory (DRAM), a common and inexpensive type of memory used for the temporary storage of information in computers, smartphones, tablets, and flash memory, which retains data even when power is shut off.

3. *Analog devices* are used to translate analogue signals, such as light, touch, and voice, into digital signals. For example, they are used to convert the analogue sound of a musical performance into a digital recording stored online or on a compact disc.

4. *Optoelectronics, sensors, and discretes* (commonly referred to as O-S-D). Optoelectronics and sensors are mainly used for generating or sensing light, for example, in traffic lights or cameras.

An alternative way of studying semiconductors is to analyse the supply chain itself. In other words, we need to pay attention to the materials needed to produce the "chip"—an electronically controlled switch. As the figure below shows, an astute observation would conclude that this sector is heavily driven by research and development (R&D)—and, thus, corporate power exercised along the supply chains.

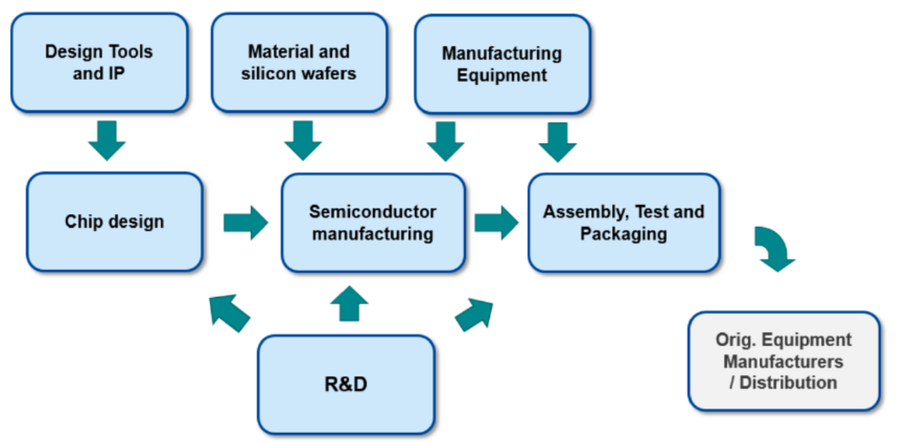
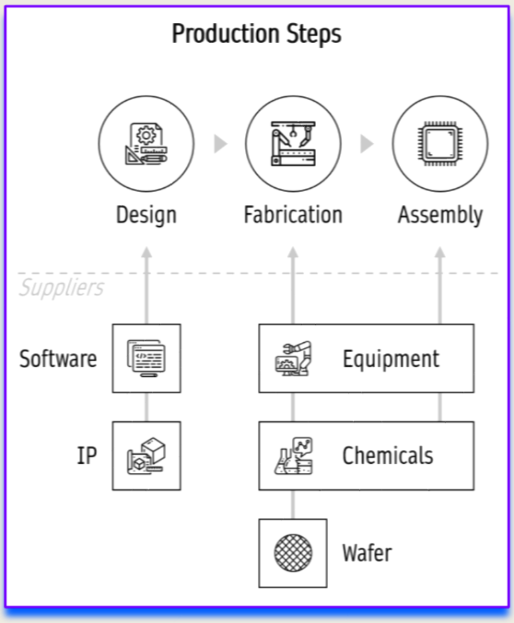


Figure 1. The semiconductor value chain

Source: European Commission Staff Working Paper (2022).

The value chain can be understood in three phases, with three major inputs needed to produce a chip. Let me explain the supply chain in detail here:

Software and intellectual property (design tools)—specialised software tools or electronic design automation (EDA) tools provided by companies such as Cadence Design Systems, Synopsis and Mentor Graphics/Siemens. Almost 70% of sales are controlled by American companies. Other companies are involved in intellectual property (IP) blocks, which are offered by UK-based companies. Together, these two elements forge the chip design processing segment of the supply chain.



Chemicals, materials and silicon wafers—chemicals include boron, indium, germanium, gallium, etc. Because chip making requires about 500 processes, there are many key suppliers involved: Shin-Etsu Chemicals, Sumitomo Chemicals, Mitsui Chemicals (Japan), BASF, Linde, Merck KGaA, Air Liquide (EU), Taiwan Specialty Chemicals Corporation, and in Dow/DuPont (US). As semiconductors become more complex and technologically advanced, more suppliers enter the market. Importantly, access to raw materials becomes crucial at this stage. China's export license system in August will, therefore, directly affect some of the companies participating in this segment of the value chain.

Silicon wafers serve as the substrate material and undergo a variety of complex process steps before being diced and packaged as chips. Japan's Shin-Etsu and Sumco are the world's largest silicon wafer makers, respectively, followed by Taiwan's GlobalWafers, Germany's Siltronic, Korea's SK Siltron and France's Soitec.

Specialist vendors provide more than 50 different types of sophisticated equipment for each step in the chip fabrication process. Key suppliers include ASML (NL), Applied Materials (US), Tokyo Electron (JP), Lam Research (US), and KLA Tencor (US) ASM-I (NL). The supply of certain pieces of equipment is extremely concentrated: for example, ASML holds a worldwide market share above 80% in the supply of lithography equipment, with a peak of 100% in the Extreme ultra-violet (EUV) lithography equipment. The Dutch export control can therefore be understood as an effective way to curb China's ambition to move up in the value chain of high tech—this explains why the Chinese Embassy has given stern warnings against the policy as soon as it was announced.

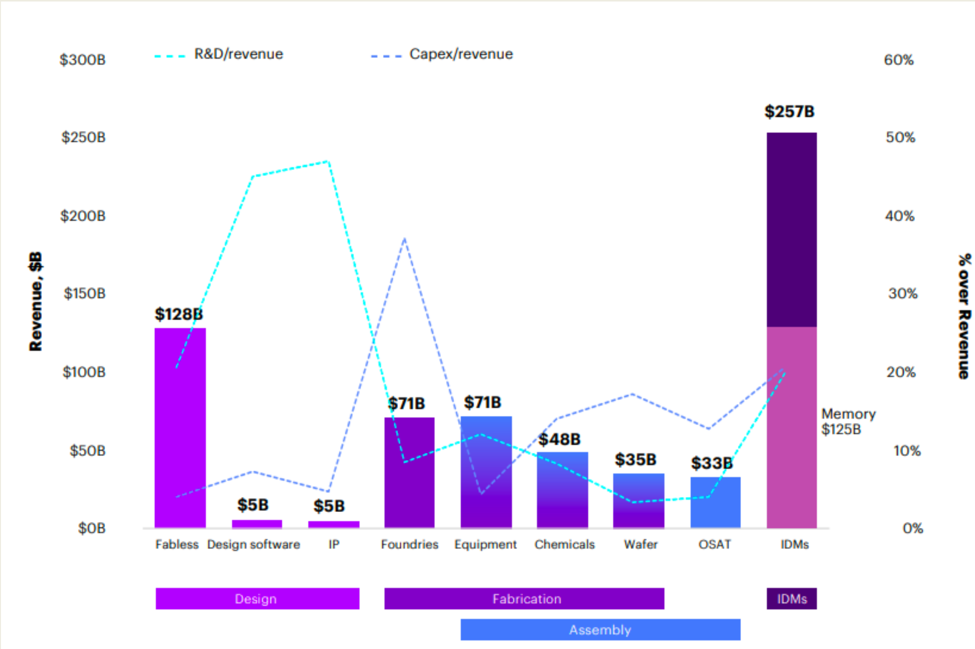
Back-end manufacturing (assembly)—This includes the packaging of chips into a form that ensures reliability and enables connectivity with other circuit components. Each individual chip in the wafer is tested before the wafer is sliced into individual dies. The dies that pass the wafer test are packaged, and the packaged chips undergo a fully functional and performance test.

The diagram below can give you a snapshot of the complex production process of semiconductors.

The industry generates multi-billion revenues, with participation from a wide range of companies specialised in improving chip-making technologies.

For businesses, the race was to make the chips as small as possible while increasing their processing technology capacities as much as possible. Simply put, the race to build smaller chips is one that is clearly driven by competition for research and development (R&D) and, importantly, very much a case of private sector-driven innovation. And, because of the complexity of the chip-making supply chain, there is NO single company or geography controlling the design and manufacturing of semiconductors. To further develop the supply chain, all companies remain reliant on the interdependent and globalised production of components, which then transform chips into inputs for high-tech products we use in our modern life.

Revenues by Segment of Chips Value Chain



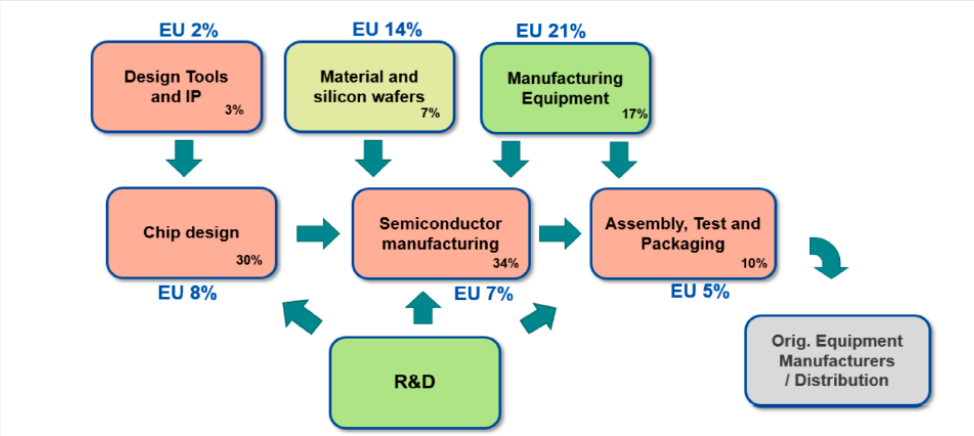
Historically, South Korea and Taiwan managed to catch up with the Americans, Europeans, and Japanese through the semiconductor industry. Thanks to concerted efforts at supporting the private sector—we now call them national champions like TSMC, Samsung, and LG—their industrial policies were able to create globally competitive exports of high-tech semiconductors.

While some companies exercise partial control over specific segments of the production chain, the whole industry would collapse if chokepoints and disruptions in supply chains were not resolved.

Europe's Chips Act — A Catch-up Strategy?

In Europe, the heart of the semiconductor industry lies in manufacturing powerhouse Germany, with four large investment projects made by

American companies Intel and GlobalFoundries and Europe-based Bosch and Infineon. The European market share of the global semiconductors market is highly variable, but it is clear that any industrial strategy to support growth in the sector must focus on very specific segments of the value chain (see figure below).



Source: European Commission Staff Working Paper (2022).

According to the World Economic Forum, there are four ways Europe can catch up in the technological race:

(1) Emphasise and double down on collaboration, especially in the manufacturing segment of the chip supply chain.

(2) Bring Europe's historical expertise in laboratory research and academia together with improvements in (high-tech) manufacturing capabilities.

(3) Build technical skills and invest in human capital—mostly in STEM—to provide the right skill set for the workforce.

(4) Rebuild the semiconductor industry with greener and more sustainable methods of production so as to align technological competition objectives with the green transition.

To move forward, it is almost certain that manufacturing will play a wider role in the European strategy for high-tech competition. The Commission itself admits that without reinvestments in the manufacturing of chips, the EU Chips Act could simply be a regulatory mechanism, which would be ineffective at creating incentives for businesses.

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