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Semiconductors: Powering Tomorrow's Technology

September 2023

Introduction

Semiconductors hold significance beyond mere economic value; they have already become a vested national interest of all global powers. The CEO of Intel, Patrick Gelsinger, suggested the “Oil reserves have defined geopolitics for the last five decades. Where the fabs [factories] are for a digital future is more important”, hinting that the semiconductor supply chain's geopolitical importance could surpass that of oil.

Semiconductors are integral to advanced technologies and critical infrastructure and have thereby become strategic assets of a nation's autonomy. Their production has a direct bearing on a country's security capabilities, given their essential role in defense systems, communication networks, and energy distribution. Within this intricate landscape, Semiconductors have become the lynchpin of political negotiations, trade agreements, and embargoes. Governments are out to safeguard their semiconductor industry and establish a stable supply chain to address the new-age vulnerabilities arising from dependence on external sources.



Major Supply Chain Disruptions

The existing semiconductor supply chain consists of a complex network that connects raw materials, fabrication facilities, and distribution networks. China, Taiwan, and South Korea dominate the semiconductor production market, collectively commanding around 87% of the global shares in 2021.

The lack of alternative sources enhances the risk of acute shortages in case of supply-side shocks. In 2019, Japan imposed export controls (later lifted) on South Korea for vital semiconductor production chemicals, causing temporary shortages and disruptions. Taiwan, a key semiconductor supplier, faces constant territorial tensions with China which, if escalated, can disrupt the global economy by impacting semiconductor manufacturing.



2021 saw a global semiconductor shortage due to disruptions caused by the COVID-19 pandemic, alongside a heightened demand for electronic devices driven by remote work and study arrangements. The shortage was further exacerbated by the US-China trade tensions, with the US's promulgation of the CHIPS Act 2022 decapitating China's manufacturing posture, and Taiwan's chip production declined due to severe water shortage triggered by droughts.

Additionally, the ongoing conflict in Ukraine adds to the complexity, potentially exacerbating supply chain issues for essential materials like palladium and neon, crucial for chip manufacturing.

These events represent how the semiconductor supply chains are vulnerable to trade wars, pandemics, climate change, and geopolitical conflicts. However, they also create opportunities for countries in the Global South to enter the semiconductor manufacturing landscape. Subsequent sections will briefly explore global events, mitigation strategies, and emerging possibilities.

Investments and Capacity Building

The consolidation of semiconductor manufacturing within a handful of nations raises concerns over potential disruptions and geopolitical risks to the semiconductor supply chains. Countries are actively pursuing a range of measures to counter these challenges and bolster the resilience of the semiconductor industry. These mitigation efforts are geared towards cultivating a more balanced and robust semiconductor ecosystem, one that reduces the dependence on a select few nations and simultaneously fosters innovation, collaboration, and sustainability within the sector.

The U.S. CHIPS Act 2022 has earmarked USD 52 billion for research and manufacturing, while the European Union has proposed legislation that outlines a USD 47 billion investment plan for its chipmaking industry, aiming to double the bloc's global chip output to 20% of global semiconductor production over the next decade to compete with the U.S. and China.

On the other side of the world, China is devising a substantial support package, surpassing 1 trillion yuan (USD 143 billion), to propel its semiconductor industry towards self-sufficiency in chip production. In 2022, Japan has made significant investments to support the domestic semiconductor market such as facilitating the formation of Rapidus Corporation and plans to set up a prototype production line for the advanced 2-nm semiconductors by 2025. Additionally, the 2023 EU-Japan MoU also aims to enhance semiconductor supply chain resilience.



A collaborative effort to improve coordination in critical sectors like semiconductors includes the Indo-Pacific Economic Framework for Prosperity (IPEF). Launched in 2022, by the United States and 13 partner nations, IPEF includes countries varying significantly in semiconductor production capacity. While some, in particular Japan and South Korea, possess advanced semiconductor manufacturing capabilities, other nations such as Thailand and India are keen to accelerate the domestic industry. This move hopes to reduce the over-reliance on China.

Altogether, these interventions have the potential to reshape the supply chain dynamics, albeit engendering heightened competition among nations and triggering trade constraints to safeguard their respective national interests.

Emergence of Global South as an Alternative Production Hub

In this current landscape, there are emerging prospects for countries in the Global South to step into the semiconductor manufacturing domain. Nations like India, Brazil, South Africa, Indonesia, and Mexico are displaying a strong interest in the sector, diligently working on cultivating their capabilities. These countries are progressively realizing the strategic significance of the semiconductor industry and are in the process of crafting policies and offering incentives to attract semiconductor-related investments while nurturing local expertise. Various Asian countries, including India, Malaysia, Indonesia, and Vietnam among others, have managed to attract investments in semiconductor manufacturing, often offering reduced labour costs and other such incentives to semiconductor companies seeking to diversify their production base.

In 2019, India initiated the National Policy on Electronics to strengthen its global presence in electronics manufacturing. The India Semiconductor Mission, part of the Digital India Corporation, is focused on creating a strong semiconductor and display ecosystem. Various policies, including incentive schemes and clusters, have been implemented to support India's semiconductor industry. In 2021, the government approved a substantial program to boost domestic



semiconductor and display manufacturing and attract prominent chipmakers. India's growing capacities are also paving the way for cooperations with Taiwanese foundries, as well as MOUs with Japan. The U.S. semiconductor sanctions against China opened the gates for India-U.S. partnerships, also reiterating this support for diversified semiconductor supply chains during the G20 Summit of 2023.



Malaysia has solidified its position in the semiconductor industry, accounting for 13% of the global chip assembly and testing market. The nation has actively promoted its semiconductor sector through a range of policies and incentives. The Electrical and Electronics Industry Blueprint outlines strategies to enhance competitiveness and sustainability, focusing on manufacturing capabilities, innovation, and supply chain reinforcement. Incentives such as the Investment Tax Allowance encourage

investments in manufacturing facilities and research centers. The Multimedia Super Corridor further accelerates Malaysia's digital economy growth, positioning it as a semiconductor and chip manufacturing hub. A Memorandum of Cooperation on Semiconductor Supply Chain Resilience between the United States and Malaysia was signed to strengthen industry ties and enhance supply chain resilience through collaborative efforts and investment promotion.

Abutting Malaysia, Indonesia also aims to align itself with its neighboring chip industry players. Its growing interest in becoming a semiconductor-producing hub is driven by strategic government initiatives and a substantial labor force to match. Making Indonesia 4.0, the establishment of Special Economic Zones (SEZs), and R&D support have been put in place to attract investments and foster domestic growth in the semiconductor sector. It has strong prospects, owing to its plentiful resources, including silica and the largest nickel reserves in the world.

Vietnam's semiconductor industry has attracted multinational interest due to incentives, a pool of young engineering talent, and its proximity to China. The country's robust industrial and technology policies are aimed to entice semiconductor manufacturers, such as reduced corporate income tax, sales tax exemptions, and land rent waivers for high-tech projects. A special working group has been established to attract high-tech investments with customized incentives. Situated just a 12-hour drive away from Shenzhen, China's manufacturing hub, Vietnam's northern manufacturing cluster ensures minimal supply chain disruptions for diversifying companies.

Trade disputes, geopolitical conflicts and the pandemic prompted nations to pursue self-sufficiency and consider alternative production hubs. Changes in the semiconductor industry are evident from the significant investment pledges from major players such as the US, China, and the EU. Simultaneously, countries in the Global South are putting in efforts to enhance their production capacities and bridge supply gaps, thereby solidifying the redistribution of stakeholders in the semiconductor market.

Conclusion

The ever-evolving semiconductor landscape, interlinked with global supply chains and geopolitical factors, presents both intricate challenges and opportunities. Nations strive to secure positions in semiconductor procurement and manufacturing to meet society's increasing reliance on semiconductor-driven advancements. Yet, disruptions, trade disputes, and advancements in technology underscore the need for adaptable policies and collaborative efforts. Established leaders and the Global South alike aspire to drive innovation and resilience, recognizing the transformative potential of semiconductors for comprehensive global development. Amid this dynamic environment, the goal remains clear: to nurture an ecosystem that harnesses semiconductors' capabilities for the benefit of all stakeholders.



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