The changing position of the Taiwanese semiconductor industry

SZÁVÓ Lóránd Levente[1]

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Abstract

This recearch investigates the shifting competitive dynamics between the Taiwanese and Chinese semiconductor industries, focusing on the market positions of TSMC (Taiwan Semiconductor Manufacturing Company) and SMIC (Semiconductor Manufacturing International Corporation). The study examines whether China's aggressive government-backed catch-up initiatives can close the gap with Taiwan's leading semiconductor firm, TSMC, and whether TSMC's market dominance has been affected by these efforts. The methodology involves a comparative case study approach, using a mix of secondary data, including financial reports, industry analyses, and news articles, to assess the strategic positions of both companies. Ultimately, the paper aims to provide a holistic understanding of the factors that sustain competitive advantage in the semiconductor industry, offering insights into the complex interplay of innovation, government policy, and global market forces. As a result of this research we can underline the TSMC's strong financial conditions, technology and international supply chains enable the company to maintain its leading competitive position in the semiconductor industry. It is worth mentioning that such a competitive position was achieved despite the fact that China made very significant steps forward in the competition for semiconductor development. The main obstacles in the way of SMIC include:technological barriers, sanctions, and inability to capture high demand in global markets. These findings only underline the fact that government-backed initiatives increase the potential of the industry, but are far from bridging the competitive gap with an entrenched leader like TSMC.

Keywords: Chip-industry, Semiconductor, TSMC, Developmental state, SMIC

JEL classification: L63, O32, O25, F23, F52, G30, P52

Introduction

The purpose of this study is to investigate the competitive dynamics between the Chinese semiconductor industry and its Taiwanese counterparts, specifically focusing on TSMC and SMIC. The relevance of the topic is that the impact of the emerging trends in microchip[2] manufacturing on the world economy has highlighted the weaknesses of the globalised world. This idea was brought to the fore by the covid crisis that broke out in 2020, at the same time as the consequences of the looming chip shortage, which for many people in the automotive, consumer electronics or computing industries immediately materialised. It has been undisputed for decades that 'chips have become a more important raw material than oil in terms of economic growth and Goldman Sachs estimates that up to 169 industries could be affected by the negative developments. The unfolding shortage during 2020 has shaken markets, pointing to a significant global economic exposure. This study addresses several critical research gaps in the analysis of competitive dynamics between the Chinese and Taiwanese semiconductor industries, particularly between SMIC and TSMC.

1, *Absence of Longitudinal Comparative Studies*: While numerous studies explore the competition between TSMC and SMIC, they often focus on short-term analyses or specific events. There is no existing research that systematically compares their competitive strategies,

[1] Budapesti Gazdaságtudományi Egyetem, Vállalkozás- és Gazdálkodástudományi Doktori Iskola, e-mail:szavol@gmail.com

market positioning, and performance over an extended period. This study aims to fill this gap by providing a longitudinal analysis of TSMC and SMIC from 2018 to 2023, offering deeper insights into their evolving rivalry and competitive dynamics.

2, Limited Multi-Level Competitive Analysis: Most research in this domain is confined to *micro*-level the research will offer a granular analysis of TSMC and SMIC's strategies, examining their financial health, R&D spending, and innovation outcomes over the last five years, providing a case-based understanding of how firms respond to government policies However, to fully understand the competition between TSMC and SMIC, it is crucial to consider *mezzo*-level factors like industry-specific policies, institutional support, and collaboration networks, as well as *macro*-level influences such as global market structures, trade tensions, and international alliances. This multi-level approach is currently underexplored in the literature.

3, Integration of Financial Performance with Competitive Dynamics: Although financial performance indicators such as revenue growth, profitability, and capital expenditures are frequently used to measure success, few studies have linked these metrics to the strategic competition between TSMC and SMIC. Understanding how these financial indicators reflect competitive strengths and weaknesses over time is essential for assessing each company’s strategic positioning and potential future developments in the semiconductor market.

Literature review

The research underlines that TSMC has an inescapable position in the industry and it will not be able to be replaced or bypassed by the major European/U.S. or Chinese players in the foreseeable future. In this topic, it is worth separating the European/U.S. and Chinese competitors, since TSMC itself was created as a result of an industrial development in the course of European/U.S. cooperation, and its disappearance or significant marginalisation from the alliance system is unlikely. Nevertheless, thanks to political interference, there is a will to do so. The CHIPS Act, a legislative initiative aimed at revitalizing domestic semiconductor manufacturing, is a clear indication of this strategy (Meijer, 2021). By providing financial incentives for semiconductor research and production in the U.S., the government seeks to mitigate risks associated with over-reliance on Taiwanese manufacturers like TSMC.

The U.S. has also been actively encouraging partnerships and technology sharing agreements with allies to diversify sources of critical semiconductor technology (Anderson, 2020). For instance, the U.S. collaboration with South Korea in semiconductor manufacturing is part of this broader strategy to ensure a more secure and resilient supply chain (Park, 2022) A minority of the relevant literature characterizes this sharp intervention in market conditions as more forward-looking, This approach, aimed at bolstering domestic production, is crucial for national security, ensuring a stable supply of critical technology in times of global crisis (Anderson, 2020).

The majority of the authors emphasize the negative consequences, stressing that this strategy might be misguided. Critics argue that the focus on building domestic semiconductor capabilities underestimates the complexity and expertise required, areas where Taiwan excels (Kuo, 2023). Taiwan's Semiconductor Manufacturing Company (TSMC) leads in advanced semiconductor manufacturing processes, a proficiency that took decades to develop and cannot be replicated swiftly or easily, Additionally, the massive investment required for semiconductor fabrication facilities, along with the need for a highly skilled workforce, presents significant challenges for the U.S. in catching up to Taiwan's capabilities (Lewis, 2022).

Some experts point out that global semiconductor supply chains are deeply integrated and that efforts to decouple could lead to inefficiencies and higher costs, ultimately harming consumers and businesses (Varas, 2021). Furthermore, the collaborative nature of the semiconductor industry, with its global networks of suppliers, designers, and manufacturers, suggests that diversification rather than decoupling may be a more pragmatic approach (Feng, 2021). Thus, while the intention of the U.S. plan is to secure the semiconductor supply chain, its execution may overlook the complexities of the global semiconductor ecosystem and the strategic value of continued collaboration with Taiwan (Casanova, 2022).

With China's increasing investment and focus on semiconductor production, there is potential for a significant shift in global industry dynamics (Brown & Linden, 2011). China has made progress in optical devices and has achieved near self-sufficiency in low-power embedded processors, sensors and discrete devices, but remains weak in cutting-edge multi-core processors, memory devices, semiconductor equipment and design tool services. The catch-up of Chinese firms in certain AI chips is already a real threat to U.S.-Taiwan dominance, although it isn't guaranteed that China will win the race to develop and deploy systems empowered by artificial intelligence, in part because this "race "isn't about a single technology but about complex systems. With the exception of computing power, China's capabilities may already equal the United States' (Miller, 2022) This view is contradicted by the fact that Chinese CPUs have few civilian customers, reflecting their lack of competitiveness in the open market. Chinese large enterprises source 95 per cent of the CPUs they use from imports. The country remains dominated by U.S. firms Nvidia and AMD in the AI market (Kahn 2021)

Beijing's release of the National Semiconductor Industry Development Guide, followed in 2015 by the "Made in China 2025" initiative, can be seen as a threat for the future. The Chinese government has set a target to produce 70 percent of the chips used in China by 2025, which represents a huge growth (Rigger, 2021). However, Beijing wasn't looking for a better position in a system dominated by America and its friends (Rigger, 2021). The Made in China 2025 plan didn't advocate economic integration but the opposite. It called for slashing China's dependence on imported chips. (Miller, 2022)

China's ambitious development plan will definitely upset the balance of power in the industry and will also increasingly tie Taiwan to itself through its economic power, almost pulling it out of the U.S. alliance system (Rigger, 2021).This claim could be plausible if Taiwan were a large foundry, or, by extension, the chronological profit shift of U.S. high-tech firms in mainland China. But the outcome Shelby outlines is contradicted by the industry's very strong entry barriers, which provide a closed ecosystem for companies operating here that Chinese firms cannot and, even more shockingly, that, recognising their unique position, they do not actually want to enter (Miller, 2022), that cutting-edge technologies in the semiconductor industry are not readily available, although countries allied with the U.S., such as Korea, have allowed the licensing of obsolete versions of manufacturing technologies at earlier stages of semiconductor sector development (Grimes (2020) China's most critical point is its lithography tools - particularly extreme ultraviolet (EUV) photolithography (Kahn 2021) Leaking industrial secrets could also be a not insignificant consideration, strengthening Chinese influence, but by the time competitors would try to replicate it, ASML (Advanced Semiconductor Materials Lithography Holding) would be ahead of them with its latest development, (Miller, 2022)[3] It is estimated that establishing a cutting-edge, all-domestic supply chain would take over a decade and cost well over a trillion dollars in that period. (Miller, 2022) The doubtful outcome of catching up is highlighted by (Grimes (2020), as the launch of a new generation of memory chips can quickly replace the previous generation, which usually suffers significant price erosion. As they are easily transportable, the global market for memory chips cannot be divided into high-end and low-end. This makes it difficult for Chinese firms to catch up in the memory market, as there is no protected low-end market for domestic products. China's leading chipmaker, Semiconductor Manufacturing International Corporation (SMIC), is the target of restrictions A key tool in this containment strategy is the Wassenaar Arrangement, a voluntary agreement among 42 nations to curb the spread of "dual-use" technology, with both commercial and military applications. Under Wassenaar, Washington and its allies have coordinated the flow of chip technology to China.

The example of Huawei illustrates the threat to the Chinese semiconductor industry of a trade war with the U.S. China's plans to become self-sufficient in domestic semiconductor manufacturing, A without the help of U.S. technology, SMIC could not produce the chips in large quantities that Huawei needs for its smartphones and other handheld devices (Kharpal, 2020) are unlikely to be followed by China taking steps that would jeopardise its relationship with the chipmaker (Cheng, 2022). However, the development of China's semiconductor industry could reorganise these supply chains, which could have implications for international security and current incumbents (Kahn, 2021)

Moreover, the talent gap is a significant issue, as China lacks the same depth of experienced semiconductor professionals compared to Taiwan (Pan, 2022). Intellectual property rights concerns and allegations of technology theft have also impacted China's ability to collaborate internationally, slowing down its technological advancement (Kim, 2021). The high cost and complexity of semiconductor manufacturing, especially at advanced nodes, require not just financial investment but also time and accumulated expertise, areas where Taiwan has a clear advantage (Crawford, 2021).

In the context of emerging technologies, Taiwanese companies are well-positioned to capitalize on next-generation semiconductors, further widening the gap with China. The focus of the Chinese industry on volume and scale, rather than cutting-edge innovation, has also been a factor limiting its advancement in the high-end semiconductor market (Chang, 2020). Therefore, while China is making strides in semiconductor manufacturing, the complexities of the industry, combined with geopolitical and technological challenges, suggest that it is unlikely to catch up with Taiwanese competitors in the near future (Miller, 2022).

As the theoretical background of the study the forward and backward linkages and the concept of competitive advantages will be highlighted. The concept of forward and backward linkages has been widely studied in the context of economic development and industrialization. Backward linkages refer to the relationship between an industry and its suppliers, while forward linkages describe the relationship between an industry and its buyers or customers. (Morris & Fessehaie, 2014) In the semiconductor industry, these linkages have played a significant role in shaping the industry's dynamics and evolution. (Angel, 1994) The semiconductor industry is a highly interconnected ecosystem where various stakeholders, including chipmakers, suppliers of enabling technologies, and subsystem providers, collaborate closely to ensure the timely development and delivery of cutting-edge technologies that meet the evolving demands of the market (Yang et al., 2013). To stay at the leading edge of technology, semiconductor firms must acquire or exchange resources with their supplier or buyer partners, as the industry is characterized by extreme competition, not only in terms of product features but also in pricing (Pai & Yeh, 2015).

The concept of competitive advantage has been a central focus in strategic management literature, with Michael Porter's seminal work "Competitive Advantage: Creating and Sustaining Superior Performance" (Porter, 1985) laying the theoretical foundation. Competitive advantage refers to a firm's ability to outperform its rivals by creating more economic value for customers (Rothaermel, 2016), which stems from the company's unique resources, capabilities, and competencies. In semiconductor industry, where technological innovation and rapid change are the norms, understanding and leveraging competitive advantage is crucial for sustaining long-term success. Exploring the semiconductor industry through the lens of competitive advantage theory reveals several important considerations. First, the industry's highly capital-intensive and knowledge-intensive nature creates significant barriers to entry, conferring advantages to incumbent players. Latecomer firms must therefore adopt specialized strategies to overcome these barriers, such as targeted technology transfers, benchmarking, and leapfrogging approaches. (Cho et al., 1998)

Methodology

This research will employ a multi-level approach to analyze the potential *position change of the Taiwanese Semiconductor Manufacturer company* in shaping the competitive advantage of TSMC and SMIC, with a primary focus on the micro-level. At the *micro-level*, the study will utilize a comprehensive longitudinal analysis of financial indicators from 2018 to 2023. These indicators include *Profitability Indicators* (net profit margin, ROE, ROA[4]), *Liquidity and Solvency Indicators* (current ratio, quick ratio), and *Market Performance, R&D and Productivity Indicator* (EPS[5], R&D, Turnover per Employee). The data will be sourced from a self-developed database compiled from the historical financial reports of both companies, enabling an in-depth examination of their financial health and strategic responses to policy changes over time. The financial statements will be obtained from publicly available sources such as company annual reports, SEC filings, and other financial disclosures. Databases like Bloomberg, Reuters, and company websites will be used to gather the required financial data

At the *mezzo-level*, the research will incorporate a *graded SWOT analysis* and a *graded Porter Five Forces model* to assess the impact of national industrial policies in Taiwan and China. The graded SWOT analysis will quantify strengths, weaknesses, opportunities, and threats in a systematic manner, while the graded Porter Five Forces model will evaluate competitive forces such as the bargaining power of suppliers and buyers, the threat of new entrants, and the intensity of rivalry within the semiconductor industry. This dual approach will provide a deep understanding of how institutional frameworks and policy environments influence TSMC and SMIC's competitive positioning and innovation capabilities. The Graded SWOT analysis method is a combination of qualitative and quantitative approaches.:

Qualitative Aspect: The identification of Strengths, Weaknesses, Opportunities, and Threats is inherently qualitative, as it relies on subjective judgment and insights drawn from research, expert opinions, or company data, reports from market research firms such as Gartner, IDC, and McKinsey will be reviewed. These reports often include comprehensive analyses of market share, technology trends, and competitive landscape

Quantitative Aspect: The numeric grading system adds a quantitative element, as each qualitative factor is assigned a numerical value based on its impact, relevance, and likelihood. This allows to quantify subjective assessments, making the analysis more objective and measurable.

Applying a Porter's Five Forces analysis with a numeric grading system offers a structured and quantifiable approach to evaluating competitive dynamics within an industry. This method enhances objectivity by assigning specific values to each force, which facilitates a clearer comparison between companies. The numeric grades provide a concise summary that is easier to interpret and communicate, especially when dealing with complex competitive environments. By breaking down each force into subcategories, this approach allows for a more granular analysis, revealing strengths and weaknesses in different aspects of competitive pressure. Despite these limitations, integrating quantitative grades with traditional qualitative analysis can provide a more comprehensive understanding of competitive forces. This hybrid methodology aids strategic decision-making by highlighting key areas for competitive advantage or improvement.

For the *macro-level*, the research will analyze the available literatures for global semiconductor market dynamics and the role of government policies in shaping international competition and cooperation. This will involve studying the effects of trade policies, geopolitical tensions, and global value chain disruptions on the strategic behavior of TSMC and

SMIC. The findings from this level will contextualize the mezzo and micro-level analyses, linking global market forces to firm-level outcomes.

The choice of a comparative case study approach for analyzing TSMC and SMIC is rooted in the need to understand the nuanced differences and similarities between two leading firms within the semiconductor industry. A comparative case study allows for an in-depth exploration of each company's strategies, performance, and contextual factors, providing a rich, holistic view that cannot be captured through other methods.

Future direction

As a future direction, researchers could explore the impact of technological innovations in AI chips and 5G technologies on the competitive dynamics between TSMC and SMIC. This study would investigate whether China's heavy investments in AI and 5G technologies, driven by state-led initiatives, are helping SMIC narrow the technological gap with TSMC. The research could focus on the R&D investments and patent developments in AI and 5G technologies from both companies, assessing how they translate into competitive advantages.

Furthermore, if it can be explored how the government policies in both Taiwan and China support such technologies, it would provide even better insight into the long-term competitive outlook for the semiconductor industry. This research would be focused on the next-generation technologies; therefore, it would be able to present a forward-looking view on how innovation can shape the competitive landscape between TSMC and SMIC. It would also be useful to see how financial health is linked to investment in emerging technologies like AI, 5G, and state-of-the-art chipmaking. This will help the researcher understand the relationship between financial health and R&D spending and provide context to the sustainability of every company's competitive position.

The role of international alliances in the framing of the competitive nature of the semiconductor industry may be one future research direction, especially between TSMC and SMIC. The study could focus on the partnership like the U.S.-South Korea alliance and how such collaborations influence global semiconductor supply chains and technology sharing. While these alliances are likely to help TSMC gain access to new markets, advanced technologies, and strategic resources to improve the competitive advantage of its firms, the research may analyze those alliances' implications on SMIC in light of the recent trade restriction and geopolitical tension. What's more, regional diversification arising from such alliances could study the impact of the strategic positioning of the two companies operating in the market. Such a research approach would explain the strategic role of global alliances in clearer detail about the evolving competition between TSMC and SMIC amidst a rapidly changing geopolitical environment. Overall, the potential conclusions drawn from this study emphasize TSMC's continued leadership in the semiconductor industry, bolstered by strong financial management, innovation, and effective use of assets. In contrast, SMIC's challenges, including technological barriers and external sanctions, limit its ability to compete effectively despite government support. The research potentially concludes that while government catch-up programs are beneficial, they are insufficient on their own to overcome the entrenched advantages held by industry leaders like TSMC.

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