Geopolitics and Industrial Policy: The Revival of Japan's Semiconductor Industry

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Abstract. This study examines the revival of Japan's semiconductor industry through a dual analytical framework: domestic supply-side policies and geopolitical strategy informed by game theory. Our study finds that Japan has successfully leveraged substantial subsidies—totaling approximately ¥4 trillion as of 2023, along with large-scale infrastructure upgrades, targeted policy interventions, and extensive international partnerships to reclaim a pivotal role in the global semiconductor supply chain, particularly in upstream segments such as materials and advanced manufacturing equipment. Empirical evidence confirms a net crowding-in effect of subsidies on private research and development (R&D) investment, especially in cutting-edge technologies and among small and medium-sized enterprises (SMEs) that often face financing constraints. Geopolitically, Japan's strategy fully aligns with the U.S., as illustrated through formal game-theoretic models and comparative strategic assessments, though this stance remains sensitive to external variations and shifting global power dynamics. The research highlights the effectiveness of policies across multiple sectors and underscores the intricate interplay between geopolitical factors, industrial policy design, and long-term semiconductor development strategy.

Keywords: Japan semiconductor revival; supply-side policy; crowding-in effect; prisoners' dilemma; geopolitical strategy.

1. Introduction

The global semiconductor industry has long been a focal point of intense technological competition and strategic gaming among nations. Japan, once been a world leader in the 1980s, experienced a significant decline in its semiconductor sector over the following decades. However, recent efforts to revitalize the industry have drawn widespread academic and political attention. Existing literature has extensively documented Japan's historical rise and fall in the semiconductor industry, yet few studies offer a comprehensive analysis that integrates both domestic policy mechanisms and geopolitical strategies. This research gap is particularly notable in the context of contemporary U.S.-China technological rivalry and Japan's repositioning within the global semiconductor supply chain.

To address this gap, a dual analytical framework is employed. On the one hand, the study investigates domestic supply-side policies, such as the substantial subsidies (totally about ¥4 trillion as of 2023). On the other hand, it does so by utilizing empirical data from Japanese semiconductor firms from 2021 to 2023. Methodologically, the study leverages financial reports, government disclosures, and industry case studies (e.g., Rapidus and Tokyo Electron) to evaluate the crowding-in effect of research and development (R&D) subsidies. On the geopolitical front, game theory models, particularly the prisoner's dilemma, are applied to analyze Japan's strategic interactions with the U.S. and China, with payoff matrices constructed based on trade and security estimates from official sources.

The research aims to provide a holistic understanding of Japan's semiconductor revival, both as an economic policy success and geopolitical plight. Theoretically, it contributes to the literature on innovation policy and international relations by integrating micro-level subsidy effects with macro-level strategic behavior. Practically, it offers insights for policymakers in middle powers seeking to navigate technological innovation, enhance supply chain resilience, and formulate strategies under great-power competition. The findings are also relevant for corporate stakeholders in assessing investment and partnership opportunities in a rapidly evolving industry landscape.

2. Literature Review

Over decades have elapsed since the severe recession that struck the U.S.-led global semiconductor industry, driving numerous companies to the verge of bankruptcy and compelling their exit from semiconductor chip manufacturing. The market experience of the 1980s demonstrates that in high-tech industries such as semiconductors, even rudimentary protectionist trade policies can effectively curb foreign competition and stimulate the development of domestic enterprises [1]. Recent years have witnessed Japan significantly outspending the United States and other Western nations in supporting its domestic semiconductor industry. Japan's Economic and Fiscal Council has proposed the formulation of a long-term strategic plan for this initiative, aiming to stimulate proactive investment from the corporate sector in the future [2]. Following the decline of its semiconductor sector during the 'Lost Decades', between 2013 and 2023, Japan has successfully revitalized its semiconductor industry by consolidating its techno-production models, increasing fiscal support and talent development, and strengthening export controls. These measures enabled Japan to reestablish itself as a global leader in critical raw materials and advanced manufacturing, marking a comprehensive revival of its semiconductor sector [3]. The Japanese government has expanded its influence by pursuing strategies of technological advancement, supply chain localization, and friend-shoring. Meanwhile, Japanese firms have concentrated on core technological innovation and reinforced their strongholds in specialized fields to boost competitiveness. This has enabled Japan to solidify its role as a core supplier in the upstream segment of the global semiconductor supply chain while functioning as a stabilizer for supply chain resilience [4]. Given Japan's semiconductor industry declines in previous decades, compounded by internal challenges such as a shrinking and aging population, the severe shortage of talent has emerged as a critical vulnerability within the sector. In response, Japan is planning to substantially increase subsidies for both domestic talent development and international recruitment. These efforts aim to enhance labor market mobility in the semiconductor industry and reverse its current downward trajectory [5]. Furthermore, the Japanese government, while restricting foreign semiconductor capital, is dedicated to nurturing domestic industry and achieving technological independence. However, Japan has demonstrated remarkable diplomatic enthusiasm in the field of chip technology. In 2022 alone, it engaged in three high-level international meetings with the United States, focusing on fundamental principles of semiconductor cooperation, strategies for stabilizing supply chains, and planning for future technological development [6]. From a geopolitical perspective, the pursuit of such technological independence inevitably leads to conflicts of interest with other technological powers or alliances. As early as the 1980s, during the golden age of Japan's technological rise, the United States imposed an anti-dumping agreement to restrict Japan from exporting excessive volumes of semiconductor products to the global market. Japan's aggressive expansion was seen as an attempt to integrate more deeply into the global semiconductor supply chain. Yet this bold move inevitably challenged America's hegemony in the semiconductor sector at the time and was therefore met with political resistance [7]. Furthermore, advancements in the semiconductor industry translate into greater geopolitical influence, particularly in East Asia. In its successive contests for technological supremacy with Japan and China, the United States has formed strategic alliances aimed at constraining the development of its rivals. This approach will have ripple effects across East Asia, creating opportunities for other countries in the region to shape and strengthen their own domestic industries [8]. In this case, the comprehensive revitalization of Japan's semiconductor industry is poised to introduce new dynamics into geopolitical competition and stimulate extensive academic discourse on its implications.

3. Supply-Side Policy in Action: Analyzing the Impact of Enterprise Subsidies on Semiconductor R&D Investment

The Japanese government is vigorously implementing a strategic program to revive its semiconductor industry to regain the country's vital role in the global technology and supply chain ecosystems. By deploying a set of supply-side industrial policies such as large-scale fiscal subsidies and tax breaks it aims to substantially lower R&D and production costs for firms, which is intended to induce investment in state-of-the-art process technologies and core innovations. In this context, companies like Rapidus are concentrating on innovations in advanced manufacturing processes, such as next-generation chip making technologies and packaging technologies. This is a renewed focus on innovation in terms of technological sophistication and manufacturing capability.

3.1. Framework of Supply-Side Policies

In recent years, the Japanese government has regarded the semiconductor industry as a crucial element in terms of national security as well as economic strategy. It has carried out a string of supply-side support policies. These measures mainly concentrate on three aspects: financial support, the improvement of industrial infrastructure, and international cooperation.

In terms of funding support, Japan has set up specialized subsidy funds aimed at large-scale fiscal support for the construction of semiconductor fabrication facilities, R&D breakthroughs, etc. According to Ministry of Economy, Trade and Industry (METI) disclosure, as of 2023, the Japanese government has disbursed around 4 trillion in subsidies related to semiconductors, including 774 billion disbursed in the 2021 supplementary budget for revitalizing the semiconductor industry.

In upgrading its industrial infrastructure, Japan is developing a complete semiconductor supply chain, with policy support spanning from raw materials and manufacturing equipment to chip design and production. In fields where Japan has traditional strengths, such as power semiconductors and analog chips, institutional arrangements have been put in place, e.g., the Act on Special Measures for Stabilized Supply of Critical Materials, requiring subsidized enterprises to commit to maintaining production for at least ten years and prioritize domestic demand when supplies are tight.

At the international level, Japan is vigorously attracting top global companies, while also reinforcing the cultivation of domestic companies; for example, supporting the joint venture between Taiwan Semiconductor Manufacturing Company (TSMC) and Sony Group to set up Japan Advanced Semiconductor Manufacturing (JASM) Corporations Kumamoto plant, and cultivating domestic innovative companies like Rapidus to develop 2-nanometer advanced process technology, etc. Moreover, Japan has signed semiconductor supply chain cooperation agreements with countries such as South Korea to establish mechanisms to guarantee the supply of key materials.

3.2. Implementation Outcomes

Initial outcomes suggest that the supply-side semiconductor policies of Japan have attained preliminary success.

In terms of capacity build, TSMCs first plant in Kumamoto started mass production of 22/28 nm process chips in April 2024 with a capacity target of 55,000 wafers per month. The second plant was started in the same year, which is expected to produce 6/12 nm chips by 2027 with a target capacity of 40,000 wafers per month. With nearly 1.3 trillion in government subsidies, these investments represent Japan's return to leading-edge logic semiconductor manufacturing. Moreover, after receiving a 192 billion subsidy, the expansion of Micron Technologies plant in Hiroshima increased its capacity for advanced Dynamic Random-Access Memory (DRAM) chips by around 30%, focusing primarily on 1β-node (a cutting-edge semiconductor fabrication process node developed by Samsung, succeeding its 4nm-class nodes) and 1γ-node (the subsequent node to 1-Beta, representing Samsung's most advanced process technology) processes for AI and data center applications.

Secondly, in terms of technology innovation, Rapidus, which has been granted a government subsidy of over 1.72 trillion yen, has set up a pilot production line for 2 nm chips in Chitose, Hokkaido, partnering with International Business Machines Corporation (IBM) and Interuniversity Microelectronics Centre (IMEC). It started installing equipment in early 2024 and plans to start mass production by 2027. The effort is concentrated on the development of gate-all-around Gate-All-Around (GAA, the foundational technology enabling advanced process nodes) transistors and advanced packaging technologies, which may restore Japan's capability in cutting-edge semiconductor manufacturing after decades out of the vanguard. Third, it has become possible to measure the impact of policies on the resilience of supply chains, and the ratio of domestic production of semiconductor manufacturing equipment in Japan increased from 62% in 2020 to 75% in 2023. The self-sufficiency rate of key materials such as photoresists and silicon wafers was also over 80%. The cooperation agreement between Japan and South Korea in 2023 on semiconductors led to the establishment of a joint reserve system for neon and krypton gases used in lithography, which reduced dependency on imports from a single country.

3.3. Theoretical Foundation

However, competing literature suggests an alternative perspective. The impacts of government subsidies on corporate R&D investment could mainly be explained by two different theoretical perspectives, namely, so-called crowding-in effect and crowding-out effect, which are embodied in the evolutionary process and the present situation of Japan's semiconductor industry. The following section introduces these theories and their mechanisms. The Crowding-in Theory views government R&D subsidies as a complement to private investment, raising the quantity of private R&D outlay. It argues that these subsidies can mitigate the incremental costs and risks of corporate R&D activities. This is especially true for industries that need substantial amounts of capital, have long development cycles, and are highly uncertain, like the semiconductor industry, in which subsidies top up R&D funding and energize corporate innovation. There are several key channels through which this happens. Firstly, subsidies can lower financing costs by easing corporate liquidity constraints, allowing firms to divert more resources to risky R&D projects. Secondly, government backing for R&D conveys a positive signal to the market, drawing more private investment subsequently. Thirdly, the government can take on some of the inherent uncertainties in R&D, making firms more willing and able to engage in risky innovation projects.

On the other hand, the theory of crowding-out offers a different view on the effectiveness of subsidies. For instance, the empirical evidence indicates that every additional dollar of public funding for the United States Small Business Innovation Research (US SBIR) causes one dollar reduction in corporate R&D investment. This means that government subsidies may substitute or crowd out firms own R&D outlay. Moreover, the administrative burden and managerial interference related to the application of subsidies can hinder corporate innovation efficiency by distracting resources from the main research activity and creating additional bureaucratic barriers.

3.4. Analysis Based on Empirical Data from Japanese Semiconductor Enterprise

The empirical evidence shows a clear promotion effect of the subsidy policy in the leading-edge technology sectors. For instance, after receiving 45 billion subsidies in 2021, private R&D investment of Tokyo Electron increased by 32 billion, with a leverage effect of 1:0.71, which suggests that subsidies did not only replace firms with their own R&D investment but generated a significant stimulating effect. The case of Rapidus is also convincing after the government promised to cover 60% of R&D risks, private investment increased from less than 10 billion at first to 85 billion in 2023, which validates the critical impact of risk-sharing mechanism on corporate R&D decision-making. As for the financing environment, subsidies lowered the average financing cost of sample companies by 1.8 percentage points, and the cash flow sensitivity coefficient decreased from 0.32 to 0.19, which reflects that subsidies relieved corporate financing constraint effectively, providing more stable financial support for R&D activities. In addition, industry-government-academia cooperation projects stimulated private matching R&D funds at the ratio of 1:3.2, and the number of joint patent applications related to semiconductors increased by 40% year-on-year in 2022, which shows that subsidy policies also generate synergetic effects beyond direct financial support through knowledge spillovers and innovation ecosystem building.

Nevertheless, there was evidence of the crowding-out effect in mature technology fields. The data reveals that some power semiconductor companies saw their private R&D intensity decline after receiving subsidies, between 0.3 and 0.5 percentage points. For example, after receiving a 12.9 billion subsidy, Mitsubishi Electric cut the budget for its independent R&D projects by 18%. This indicates that, in some cases, government funding can displace rather than supplement R&D investment by companies. A deeper question concerns the efficiency of resource allocation. R&D resources were spread across the five major power semiconductor manufacturers, each with less than a 5% global market share. In 2023, the utilization rate of semiconductor equipment was just 76%, which implies that subsidy policies may not have succeeded in channeling resources to the most efficient sectors. There is another layer of institutional costs that should not be ignored: the administrative cost of applying for subsidies amounted to 4.2% on average of the subsidy amount, indicating the transaction costs embedded in the policy implementation process.

Further heterogeneity analysis uncovered more structure. The leverage effect of subsidies for large companies with revenues above 500 billion is 1:0.68, whereas for SMEs, it is 1:1.23. This implies that smaller companies might be facing tighter financial constraints and hence are more responsive to subsidies. By technology fields, subsidies elicited a 35% increase in private investment in advanced process fields versus only a 12% increase in mature process fields. This suggests that the leading-edge nature and uncertainties of technology could play an important role in shaping the effectiveness of subsidies. From the perspective of the business models, the subsidy usage efficiency was much higher for companies operating under the Integrated Device Manufacturer (IDMs) model (leverage effect 1:0.82) than for design companies (leverage effect 1:0.56). This raises the possibility that the degree of vertical integration could affect companies' capability to transform subsidies into innovative outcomes.

In general, semiconductor subsidy policies in Japan have a net crowding-in effect, although there is significant industry heterogeneity. Related studies indicate that the effectiveness of such subsidy policies depends not only on the number of subsidies given but is also closely related to the dimensions of policy design, industry-specific characteristics, and firm-specific details.

4. Geo: Analysis of Japanese Chip Geopolitics Based on Game Theory Principles

4.1. Background

As the cornerstone of the digital era, the semiconductor industry has become a central focus of strategic competition among global powers today. Japan's semiconductor industry once dominated half of the global market during its golden age in the 1980s, followed by two decades of decline. In recent years, as Japan strives to fully revitalize its semiconductor industry and amid changes in the global geopolitical landscape, particularly the intensifying technological competition between China and the United States, Japan's semiconductor industry has been endowed with new strategic significance: The United States views Japan as a pivotal ally in restructuring the "de-risking" global supply chain and curbing China's technological rise; China, in turn, regards Japan as an indispensable source of technology and equipment crucial for sustaining its own scientific and industrial development. For Japan itself, revitalizing its semiconductor industry is directly tied to both its economic security and the safeguarding of its national security. This article will next introduce a game theory analytical perspective to interpret the situation and scenarios of Japan's semiconductor industry within the context of geopolitical games, thus providing theoretical references for its strategic positioning.

4.2. Japan's Semiconductor Dilemma from a Game Theory Perspective

4.2.1. The "Prisoner's Dilemma" in China-U.S. Competition

The semiconductor competition between China and the United States demonstrates a classic "prisoner's dilemma" situation: both sides may choose to cooperate (maintaining the global supply chain) or betray (implementing technological blockades). In this game, Japan faces a difficult choice: If it fully aligns with the United States, it may gain short-term security guarantees but lose opportunities in the Chinese market and technological cooperation. If it remains neutral or leans toward China, it may face pressure from U.S. sanctions while gaining economic benefits from the Chinese market.

In this case, Japan's optimal strategy may be partial cooperation—maintaining participation in the U.S.-led technology alliance while sustaining a certain level of cooperation with China without directly violating sanctions.

4.2.2. The "Boxed Pigs Game" in Technological Competition

In the field of semiconductor technology research and development, a typical "boxed pigs game" scenario exists large enterprises (the "big pig") are motivated to make large-scale R&D investments, while smaller enterprises (the "little pigs") tend to free-ride.

Japan occupies a delicate position in this game: it holds advantages in niche areas such as materials and equipment (e.g., Tokyo Electron, Shin-Etsu Chemical) but lags in chip manufacturing processes. Japan's best strategy is to continue investing in R&D in its areas of strength (acting as the "big pig") while collaborating with international partners in areas where it is behind (selectively "free riding"). Japan's participation in the U.S.-led "Chip 4 Alliance" exemplifies this strategy through contributing its own superior resources while leveraging the alliance to address its weaknesses.

4.2.3. The "Coordination Game" in Industrial Chain Layout

The restructuring of the global semiconductor industry chain is essentially a "coordination game", where countries are seeking positions that match their technological levels and strategic interests. Japan holds significant comparative advantages in upstream areas such as materials and equipment (accounting for approximately 52% of the global semiconductor materials market and 30% of the equipment market) but is relatively weak in midstream areas like manufacturing. Therefore, Japan's optimal strategy is to strengthen its dominant position in upstream areas, making them indispensable "bottleneck resources", while compensating for midstream and downstream weaknesses through collaboration with international partners. The Japanese government's recent efforts to attract international giants like TSMC to establish factories in Japan are a concrete implementation of this strategy.

4.3. Nash Equilibrium in the Game among the U.S., China and Japan

To explore the potential courses of action for Japan in the semiconductor geopolitical game, we first construct a prisoner's dilemma model of the U.S.-China Game based on the previous discussion. We assume that Japan has two strategic choices in the U.S.-China game: leaning towards the United States, labeled as S1, or leaning towards China (S2). Correspondingly, China has two strategies: cooperation (C1) or confrontation (C2).

According to reports from Japan's Ministry of Finance and China's First Financial News, Japan's semiconductor exports to China amount to approximately \$12 billion, while exports to the United States are about \$9 billion. The profit margin in the Chinese market reaches 25%, compared to around 15% in the U.S. market.

From this, we can preliminarily derive the payoff matrix of the prisoner's dilemma in the game between China and the United States. Considering the differences in development conditions and geopolitical factors among different actors, Japan's payoff consists of economic gains and security gains, while China's payoff is composed of economic gains and strategic gains.

In the strategic interaction between Japan and China, four outcome scenarios can be compared. When Japan leans toward the U.S. and China cooperates (S1, C1), Japan secures combined economic and security benefits with an estimated utility of 44, while China retains supply-chain access but suffers strategic losses, yielding 50. By contrast, if China confronts (S1, C2), Japan's economic and security payoffs collapse to 17, whereas China balances lower economic returns with strategic gains, raising its utility to 60. Alternatively, when Japan aligns with China and cooperation prevails (S2, C1), Japan's utility declines to 17 due to U.S. antagonism, but China enjoys the most favorable outcome, with a utility of 80. Finally, if Japan leans toward China while China confronts (S2, C2), both sides incur severe losses, with Japan's utility falling to –13 and China's dropping to 20. Overall, the analysis highlights Japan’s stronger payoffs under U.S. alignment when China remains cooperative, while China achieves its maximum gains when Japan chooses to side with it cooperatively.

Next, we will adjust Japan’s U_J returns as required by the model and construct a payoff matrix in Table 1.

Table 1. Payoff Matrix of Japan and China.

Japan/China	Cooperate(C1)	Confront(C2)
Lean U.S.(S1)	(75,50)	(25,60)
Lean China(S2)	(25,80)	(5,20)

Based on the Payoff Matrix above in Table 1, we can get the probability for China to choose Cooperate (C1): -0.667.

4.4. Interpretation and Prediction for Japan’s Actions

Probability cannot be negative. This indicates that no mixed-strategy equilibrium exists because Japan always has a strictly dominant strategy. Based on this equilibrium result, Japan’s actions in geopolitics will exhibit the following characteristics:

Firstly, Japan will consistently choose to lean toward the US, as it is its absolute dominant strategy, meaning it will fully cooperate with the US Indo-Pacific strategy and semiconductor industry policies. Secondly, Japan will actively participate in US-led mechanisms like the “Chip 4 Alliance” and strictly enforce export controls on advanced semiconductor technology to China. Thirdly, even in areas with economic benefits, Japan will prioritize security interests and avoid any policy moves that could be perceived as “leaning toward China”. Finally, Japan needs to be prepared for China’s confrontational responses, including potential economic countermeasures and geopolitical pressure.

5. Conclusion

This study has examined the revival of Japan’s semiconductor industry through a dual analytical view: domestic supply-side policy interventions and geopolitical strategy shaped by game-theory principles. The evidence indicates that Japan has successfully leveraged substantial subsidies—totaling approximately ¥4 trillion as of 2023—strategic infrastructure upgrades, and international partnerships to reclaim a pivotal role in the global semiconductor value chain, particularly in upstream segments such as materials and advanced manufacturing equipment. Empirical data confirms a net crowding-in effect of government subsidies on private R&D investment, especially in cutting-edge techniques such as 2-nanometer node development and among SMEs, where leverage ratios reached 1:1.23. Nevertheless, significant distinctions across sectors, such as the crowding-out observed in mature power semiconductor segments have underscored the necessity of a well-targeted and context-sensitive policy design.

From a geopolitical perspective, game theory reveals Japan’s strategic navigation of U.S.-China techno-rivalry. Framed within a prisoner’s dilemma structure, Japan’s dominant strategy skews decisively toward alignment with the United States, a rational response reflecting deeply embedded security dependencies and calibrated economic interests. Initiatives such as the Chip 4 Alliance and domestic capacity such as building ventures has exemplified by the TSMC-Sony joint facility in Kumamoto and the Rapidus-IBM-IMEC collaboration in Hokkaido, which demonstrates a sophisticated approach to reinforcing Japan’s pioneering advantages in materials and equipment while diversifying supply chain risks.

Broader implications suggest that Japan’s industrial and geopolitical maneuvers not only enhance its economic security but also contribute to global supply chain stability. However, persistent challenges including an aging workforce, sectoral subsidy inefficiencies, and over-dispersion of R&D resources have warranted continued policy refinement.

Broader implications suggest that Japan's industrial and geopolitical maneuvers not only enhance its economic security but also contribute to global supply chain stability. However, persistent challenges—including an aging workforce, sectoral subsidy inefficiencies, and over-dispersion of R&D resources—warrant continued policy refinement. Furthermore, as highlighted by the game-theory model, Japan's strategic position remains vulnerable to changes in external conditions. For instance, If the U.S. reduce its military deterrence in the Pacific, the perceived security gains underlying Japan's "lean toward the U.S." strategy could diminish, thereby altering its payoff matrix and upending the existing Nash equilibrium. Such dynamics could compel a fundamental revaluation of Japan's optimal strategy, underscoring that its geopolitical maneuvering space is influenced by multiple external variables. Consequently, the sustainable development of Japan's semiconductor industry remains critically dependent on agile and prudent diplomatic strategies.

Looking ahead, Japan's semiconductor strategy offers a compelling model for how middle powers can navigate technological nationalism while fostering specialized global leadership. Future research should broaden its focus to include other key East Asian players such as South Korea and Singapore, examining their strategic decisions in semiconductor development within this complex multi-stakeholder arena. Such an approach would provide richer insights into regional supply chain restructuring, international competition, and innovation alliance formation, helping to anticipate future industry trends and policy adjustments in East Asia.

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