1. Tariffs, Tech Controls, and Techno-nationalism: Korea's Semiconductor Industry in an Era of Sanctions and Strategic Competition[1]

Korea's semiconductor industry has driven decades of economic growth, but memory-dominated exports make the economy highly sensitive to global technology cycles. Rising US tech controls, potential tariffs, and the return of industrial policy globally have increased strategic risks. Domestic constraints—including limited chip design talent, weak industry-academia collaboration, and underdeveloped SMEs—challenge efforts to diversify into logic and high-value segments. Sustaining Korea's global technological leadership will require coordinated policies, innovation incentives, and strategic diplomacy.

1. **Korea's structural transformation over the past four decades has shifted the economy from labor-intensive manufacturing toward capital- and technology-intensive production, with semiconductors emerging as the central pillar of export growth.** Beginning in the 1980s and accelerating after the Asian Financial Crisis, industrial upgrading was driven by sustained investment in electronics, engineering skills, and process technologies, enabling Korean firms to move up global value chains. Semiconductor exports rose from low single-digit shares of total exports in the early 1990s to 24.4 percent in 2025, overtaking traditional heavy industries such as shipbuilding, petrochemicals, and autos (Figure A1.1). Chip exports rose 22.2 percent to an all-time high of USD173.4 billion in 2025, and the semiconductor ecosystem—including materials, equipment, logistics, and construction—accounted for an estimated 7–8 percent of GDP and a materially larger share of manufacturing investment. This transition has lifted productivity and wages but has also increased macroeconomic sensitivity to global technology cycles, capital spending, and external trade conditions, rendering the sector macro-critical for growth, employment, and fiscal revenues.

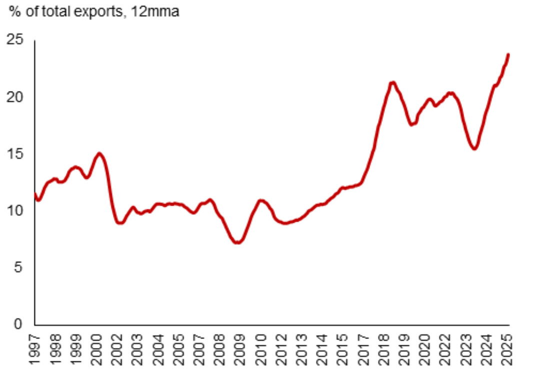
2. **Korea's semiconductor sector is highly concentrated in memory products and dominated by a small number of firms, exposing the economy to pronounced boom-bust cycles and macroeconomic volatility.** Memory chips constitute about **two-thirds of Korea's total semiconductor exports**, compared with much lower shares in economies with stronger logic or foundry segments (Figure A1.2). Samsung Electronics and SK Hynix together account for roughly three-quarters of global DRAM supply and over half of NAND flash production, positioning Korea as the dominant global memory producer but leaving exports heavily skewed toward a single product segment. Memory markets are inherently cyclical: DRAM and NAND prices can swing sharply in response to supply-demand imbalances and inventory adjustments, with historical episodes showing declines of 40–60 percent during downturns and rapid rebounds during supply-constrained periods (Figure A1.3).[2] Advanced fabrication is extremely capital-intensive, with modern fabs costing USD15–25 billion per facility, meaning investment cycles are large and procyclical.

3. **Korea's semiconductor industry faces elevated geopolitical and demand risk due to heavy reliance on China as both a key export destination and a major production base.** China (including Hong Kong) has consistently absorbed around **60 percent of Korea's semiconductor exports** over the past decade, reflecting its role as both a final market and an assembly hub within regional value chains (Figure A1.4). At the same time, a substantial share of Korean memory manufacturing capacity is located in mainland China, including major DRAM and NAND facilities operated by Samsung Electronics and SK Hynix, which together

[1] Prepared by Wee Chian Koh, Senior Economist
[2] DRAM contract prices surged by 170 percent year-on-year in Q3 2025 due to AI-demand outpacing supply.

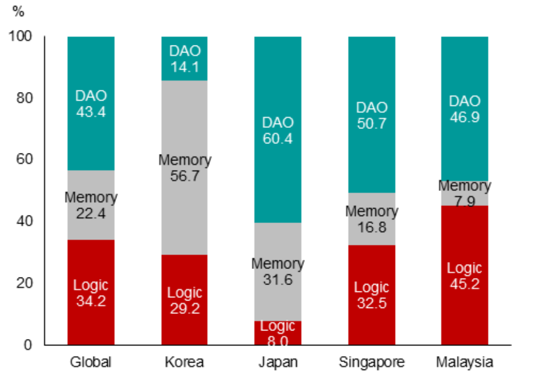
account for an estimated **30–40 percent of their respective global output.**[3] This dual exposure heightens vulnerability to China's cyclical demand fluctuations, industrial substitution policies, and potential trade disruptions. It also complicates strategic production planning, as firms must balance commercial incentives to maintain scale in China against rising regulatory and political risks associated with operating advanced technology facilities in jurisdictions subject to expanding export controls.

Figure A1.1. Share of Korea's semiconductor exports



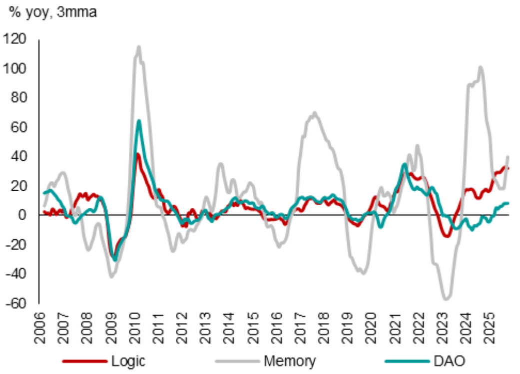
Source: CEIC, Ministry of Trade, Industry and Energy, AMRO staff calculations

Figure A1.2. Composition of semiconductor exports in selected economies



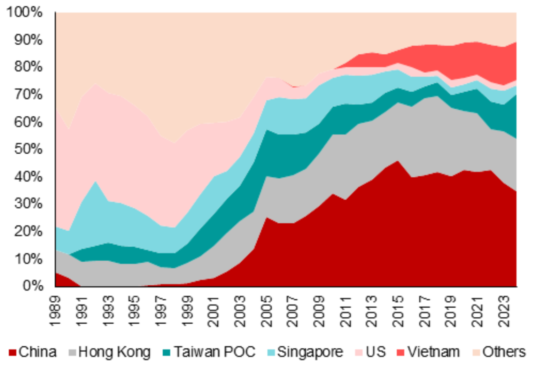
Source: S&P Global Atlas, UN Comtrade, AMRO staff calculations
Note: Shares are 2019 to 2024 average. DAO refers to discrete, analog, and others (including optoelectronics and sensors).

Figure A1.3. Global semiconductor sales by product



Source: World Semiconductor Trade Statistics; AMRO staff calculations.
Note: DAO refers to discrete, analog, and others (including optoelectronics and sensors).

Figure A1.4. Share of Korea's semiconductor exports to major markets



Source: S&P Global Atlas, UN Comtrade, AMRO staff calculations

4. **Expanding technology controls imposed by the United States and allied economies are increasingly shaping where Korean firms can invest, upgrade, and deploy advanced manufacturing capabilities.** Export restrictions on advanced semiconductor manufacturing equipment, electronic design automation (EDA) software, and AI-related chips limit the ability of Korean firms to upgrade China-based facilities beyond mature process nodes, effectively segmenting production networks by geography.[4] Although

[3] According to industry reports, SK Hynix's fab in Wuxi produces roughly 35-40 percent of the company's total DRAM output, while its Dalian facility (acquired from Intel) accounts for about 35-37 percent of its NAND flash production. Samsung's Xian facility produces roughly 30-40 percent of its global NAND flash memory output.
[4] The US has progressively tightened export controls to restrict China's access to advanced semiconductor technology on national security grounds. Beginning with broad measures in 2022 targeting advanced logic chips, AI accelerators, and manufacturing tools, the US Commerce Department's Bureau of Industry and Security (BIS) expanded the controls to include DRAM chips of 18 nm half-pitch or less, NAND flash with more than 128 layers, and key equipment and software used in advanced fabrication and AI systems. These rules use the Foreign Direct Product Rule (FDPR) to limit shipments of US and foreign-produced items incorporating US technology to Chinese facilities.

temporary waivers have allowed continued operation of existing fabs, their periodic renewal creates policy uncertainty that discourages long-term capital investment and impedes technology migration.[5] Compliance with extraterritorial regulations has also raised operational complexity and costs, as firms must establish parallel supply chains, segregated engineering teams, and differentiated IT systems. These frictions weaken scale efficiencies and lengthen product development cycles in an industry where time-to-market is critical and where delays in process upgrades can erode competitiveness, particularly in fast-moving segments such as high-bandwidth memory (HBM) and advanced packaging.

5. Potential US tariffs on semiconductors remain a material downside risk for Korea and could prove more damaging if extended to downstream electronics and display products. Direct tariffs on chips would affect only a portion of Korea's shipments to the US, since a significant share of Korean memory is exported to China, Taiwan Province of China, and ASEAN economies for assembly and integration. Moreover, Samsung and SK Hynix are expanding US production capacity, which could qualify for firm-specific tariff exemptions based on current indications.[6] However, the greater vulnerability lies in potential tariffs on downstream products—such as servers, smartphones, PCs, networking equipment, and automotive electronics—where Korean chips are embedded but final goods are assembled abroad, particularly in China and Southeast Asia. In such cases, tariffs would reduce end-market demand, compress margins across the value chain, and indirectly cut orders for Korean memory and components even if the chips themselves are not directly taxed. This effect is magnified by the structure of memory demand: hyperscale data centers, consumer electronics, and EVs account for a large share of global consumption, and demand in these segments is highly price-elastic and sensitive to capital and consumer spending. Moreover, downstream tariffs would interact with inventory dynamics—original equipment manufacturers (OEMs) typically respond to demand shocks by drawing down existing stock before placing new orders—amplifying short-term volume declines for memory suppliers. As a result, while US localization of some production reduces headline tariff exposure, broad-based tariffs on electronics would transmit through global supply chains and materially weaken Korean semiconductor exports, capital spending, and profits, reinforcing the sector's already procyclical contribution to Korea's business cycle.

6. Rising techno-nationalism and subsidy competition are reshaping global investment incentives, increasing the risk of inefficient capacity allocation and fiscal burdens. Major economies have launched large-scale semiconductor support programs, including the US CHIPS Act, the EU Chips Act, and China's multiyear state-backed funds, collectively amounting to well over USD200 billion in announced public commitments. In response, Korea has expanded tax credits, infrastructure subsidies, and financial assistance, with total announced semiconductor support now exceeding KRW30 trillion (about USD23 billion). The Korean government also plans to launch a KRW150 trillion National Growth Fund (about USD100 billion) to support strategic industries, including semiconductors and AI. This initiative aims to boost technological capabilities, industrial value chains, and strategic self-sufficiency. While such measures are intended to preserve competitiveness and attract strategic investment, they also encourage geographically fragmented production and reduce the role of market-based location decisions. This raises the risk of global overcapacity during

[5] The US has also revoked or restricted "validated end-user" waivers that previously allowed Samsung Electronics, SK Hynix, and other foreign firms to ship US-origin tools to their China fabs, requiring individual annual licenses instead.

[6] Samsung is building an advanced fab in Taylor, Texas, and has operational fabs in Austin, Texas. SK Hynix has announced plans to build an advanced packaging facility in West Lafayette, Indiana. Both firms are recipients of US Department of Commerce subsidies under the US Chip Act. US President Trump has mentioned that firms that invest or commit to invest in the US will be exempted from tariffs.

downturns, compressing margins and potentially lowering long-run returns on capital, while simultaneously increasing contingent liabilities for public finances should investment projects underperform.

7. Strong AI-driven demand presents a near-term structural opportunity for Korea's leading memory producers, particularly in high-bandwidth memory (HBM). The rapid expansion of generative AI, cloud computing, and high-performance computing (HPC) applications has sharply increased HBM content per server. HBM demand is growing at an estimated **40–50 percent annually**, outpacing conventional DRAM growth, and Korean producers—Samsung Electronics and SK Hynix—collectively dominate global HBM supply. These products command significantly higher margins than standard DRAM, supporting earnings and internal cash flows for reinvestment. However, competitors in the US and China are emerging in this segment.[7] Sustaining technological leadership will require continued R&D investment, advanced packaging integration, and alignment with logic chip roadmaps.

8. Korea is strategically pursuing diversification into logic and foundry segments to reduce dependence on memory, but the transition is constrained by structural and external factors. Korea's semiconductor industrial policy aims to build an integrated value chain that includes design, IP development, and advanced logic production, rather than relying primarily on commoditized memory exports. However, the strategy faces domestic bottlenecks. Despite world-class process engineering, Korea faces a shortage of expertise in chip architecture, system-level integration, and AI-hardware co-design, which limits its ability to move beyond memory into high-margin logic and packaging-intensive segments. Coordination among fabless firms, system integrators, and research institutions remains limited, reducing opportunities for technology spillovers and slowing commercialization of new designs. The domestic SME ecosystem is also underdeveloped, with few specialized suppliers for advanced materials, semiconductor chemicals, and niche equipment, creating dependence on imports and exposing the sector to supply chain disruptions.[8] **Externally,** competition from TSMC and Intel in the global foundry market further narrows the window for Korea to capture premium logic market share.[9]

9. Addressing Korea's barriers to diversification into logic and foundry markets requires a coordinated set of policies informed by successful international models and tailored to Korea's context.

- *Closing the **chip design talent gap.*** While Korea has some foundational programs in semiconductor education with industry linkages, they tend to focus more on manufacturing and memory process skills. Priority should be given to embedding curricula on semiconductor design, verification, and system architecture across multiple universities, creating dedicated industry-linked master's and PhD programs, and establishing dual-track training pathways with internships at major firms. Alongside

[7] US firm Micron Technology has been increasing its presence in the HBM market and is projected to capture roughly 20-25 percent of HBM capacity as it ramps production and expands packaging and testing facilities, supported by US Chip Act incentives. In **China**, domestic memory firm ChangXin Memory Technologies (CXMT) and Huawei are working to develop HBM and advanced stacking capabilities, supported by government investment.

[8] In July 2019, Japan imposed export controls on three key semiconductor and display materials—fluorinated polyimide, photoresists, and high-purity hydrogen fluoride—forcing Korea to seek alternative suppliers. Korea remains highly dependent on these critical inputs.

[9] Taiwan Province of China's TSMC dominates global contract chipmaking at leading nodes, accounting for over 90 percent of production at leading nodes, and provides logic foundry services to major fabless companies, including Apple, AMD, and NVIDIA. American firm Intel is investing heavily in advanced logic capacity in the US and Europe, aiming to capture market share in AI accelerators and high-performance computing chips.

strengthening the domestic talent pipeline, the government can consider relaxing current immigration policies to selectively attract foreign design talent.[10]

- *Enhancing **industry-academia collaboration**.* Many existing collaborations are oriented toward *applied research in materials and processes*, not *design ecosystems*. To reduce the translational gap between university research and industrial logic design, Korea can adapt models that have successfully bridged academic research with commercial production by co-funding targeted R&D, co-locating researchers with firms, and incentivizing joint IP generation.[11] To accelerate logic and AI chip development, Korea can consider adopting shared IP and design programs, similar to those in the US and Taiwan Province of China.[12]
- *Strengthening the **SME ecosystem.*** Experience from Taiwan Province of China and Japan demonstrates that ecosystem density—rather than sheer fab scale—drives long-term competitiveness. Korea could increase investment in **shared pilot lines, advanced packaging testbeds, reliability labs, and pre-competitive R&D platforms**, which would reduce entry costs for SMEs. Additionally, targeted support for upstream suppliers of wafers, specialty chemicals, and equipment can reduce dependence on imported inputs, mitigating exposure to export controls and global supply chain disruptions.
- *Competing with **dominant foundry leaders.*** Korea needs strategic alliances and differentiated value propositions—such as specialization in certain logic segments (automotive, IoT, AI accelerators) and co-investment frameworks similar to TSMC's Open Innovation Platform, which aggregates ecosystem partners around common design rules and process technologies.

10. Strategic diplomacy is essential for Korea to sustain semiconductor competitiveness amid growing geopolitical fragmentation. Given the industry's dual dependence—on China as a major export market and on US-allied countries for advanced fabrication equipment and design tools—Korean firms and policymakers should actively engage in multilateral forums to mitigate supply chain and policy risks. This includes participation in supply-chain governance initiatives, export-control harmonization agreements, and semiconductor-specific trade frameworks, which can reduce regulatory uncertainty, prevent unilateral restrictions from disrupting production, and facilitate cross-border investment. By cultivating strong relationships with both technology-leading allies and key customer markets, Korea can balance access to critical tools and markets, secure preferential treatment in joint R&D and infrastructure projects, and ensure that strategic partners remain aligned on technology transfer and export policies. For instance, the recent Korea Strategic Trade and Investment Deal with the US includes provisions to ensure that semiconductor trade terms are no less favorable than those offered to major competitors, illustrating how such engagement can reduce uncertainty. Strategic diplomacy, complemented with domestic ecosystem development and talent initiatives, can help Korea sustain technological

[10] In April 2025, the Korean government introduced a "Top-Tier Visa" and associated high-skill immigration pathways to attract global experts in semiconductors, AI, and other advanced industries. Under this program, foreign professionals with advanced degrees from top global universities, significant work experience at leading companies or research institutions, and competitive salaries can obtain a long-term residency visa, with eligibility for permanent residency after three years, easing settlement and family relocation. However, the criteria are relatively stringent and only nine visas have been issued as of October 2025.
[11] Examples include Germany's Fraunhofer Institutes and US SEMATECH consortia.
[12] The US SEMATECH consortium pools semiconductor design resources across companies and universities, while the TSMC Open Innovation Platform provides universities and SMEs access to commercial EDA tools, reference flows, and design libraries to speed tape-outs and reduce barriers to entry.

leadership, maintain investment momentum, and manage geopolitical risks in an increasingly fragmented global semiconductor landscape.