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Comparative Insights for the Global South

Lianne Angelico C. Depante and Kirsten Lianne Mae C. Dedase

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Cover Image Credit

"Workers at Leader Electronics, Inc. assemble and test electronic products for export to markets such as the United States, Germany, and Singapore. Such assembly, testing, and packaging (ATP) work reflects the Philippine semiconductor industry's continued confinement to the value chain's lowest-value segment, unlike Taiwan, which moved into higher-value design and fabrication."

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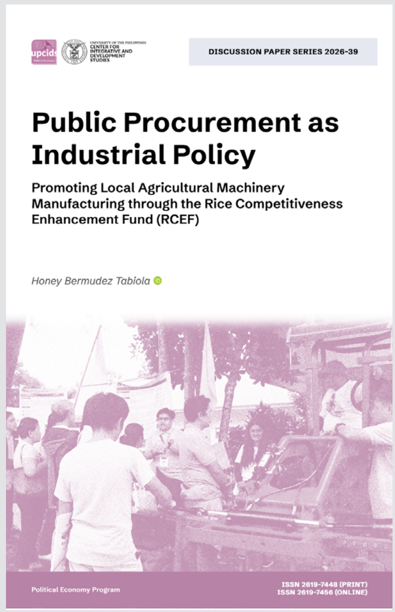

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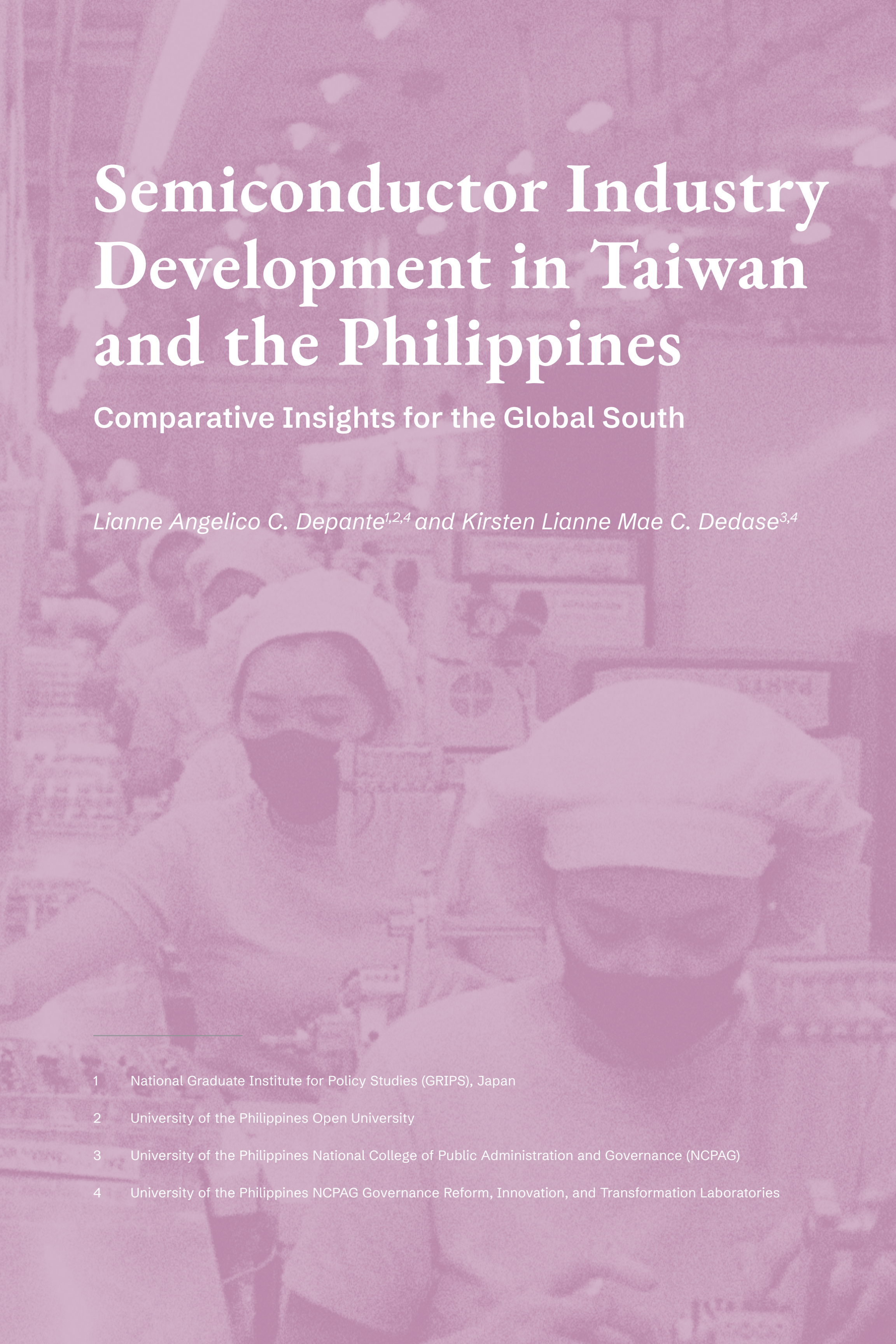

Semiconductor Industry Development in Taiwan and the Philippines

Comparative Insights for the Global South

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Key Highlights

- **Main argument:** We argue that the contrasting fortunes of the Taiwan and Philippine semiconductor industries are best explained by the differences in how their respective states deployed industrial policies and institutions in shaping development outcomes, particularly across four key areas: public R&D institutions, industrial governance and strategy, industrial clustering and state-business-academia relations, and scientific and technical human capital.

- **Policy landscape:** Today, semiconductors are the leading exports for these two political economies. Both their industries started at a more or less similar footing, tracing their origins as assembly, testing, and packaging (ATP) hubs back to the late 1960s. Their paths have since diverged: Taiwan was able to build a fully integrated ecosystem that spans design, fabrication, and advanced packaging and testing, while the Philippines remains largely confined to low-value ATP with no domestic fabrication capacity to date.

- **Methods:** The study compares Taiwan and the Philippines as cases that shared a relatively similar starting point in labor-intensive ATP in the late 1960s but diverged in outcomes. We examine the policies and institutional arrangements each deployed, particularly during the critical period from the 1970s to the 1990s, when the foundations of their respective industries were laid.

- **Findings:** Taiwan's ascent to global leadership in semiconductor manufacturing was neither haphazard nor simply the outcome of unfettered market forces, but the result of industrial vision combined with strategic orchestration of public R&D (most notably ITRI), industrial clustering in the Hsinchu Science Park, and an educational system tailored to the industry's needs — a purposeful symbiosis of the state, academia, and industry that produced a self-reinforcing ecosystem conducive to industrial upgrading. The Philippines' experience, by contrast, underscores the consequences of fragmented governance, risk-averse public R&D, and an educational system insufficiently oriented towards industrial priorities.

- **Policy recommendations:** We propose that developing countries (1) rethink the mandate of public R&D institutions to allow calculated risk-taking and a tolerance for failure; (2) have the state co-invest with the private sector in capital-intensive, strategically important segments of the value chain, socializing not only the risks but also the rewards of public investment; (3) strengthen governance arrangements and expert advisory platforms to overcome information asymmetry and coordination failures; (4) place equal emphasis on building firms' absorptive capacities along with frontier R&D; (5) anchor human capital development explicitly in industrial strategy, including TVET reform and the mobilization of diaspora professionals through "brain circulation"; (6) pursue industrial clustering as a deliberate and coordinated strategy rather than a passive by-product of investment promotion; and (7) strategically leverage the evolving geopolitical landscape to extract developmental concessions, such as technology transfer.

- **Conclusion:** For the Philippines and similarly situated economies in the Global South, moving up the technological ladder will require a more proactive approach to industrial policy, institutional reconfiguration, and a fundamental rethinking of how development is understood and pursued.

Introduction

Semiconductors are an integral part of the modern world, serving as critical inputs to a wide range of technologies. Recognizing the economic and strategic importance of these high-tech commodities, many governments have made efforts to cultivate their domestic semiconductor industries (Bown and Wang 2024; Goldberg et al. 2026). Nowhere is this more evident than in Asia, where states deployed a range of policies and institutional arrangements to develop their respective semiconductor and electronics industries. At the outset, the Taiwanese and Philippine semiconductor industries shared a broadly similar starting point, hosting firms engaged in labor-intensive assembly, packaging, and testing (ATP) operations. However, over the decades, their paths diverged, with the former transforming into a global leader in advanced manufacturing, while the latter remained dependent on lower-value segments of the value chain. Understanding this divergence is key to explaining broader patterns of industrial development in the Global South, particularly in Asia, where the semiconductor industry itself has been described as "intimately linked" (Goldberg et al. 2026, 83) to the region's economic transformation (Yeung 2016).

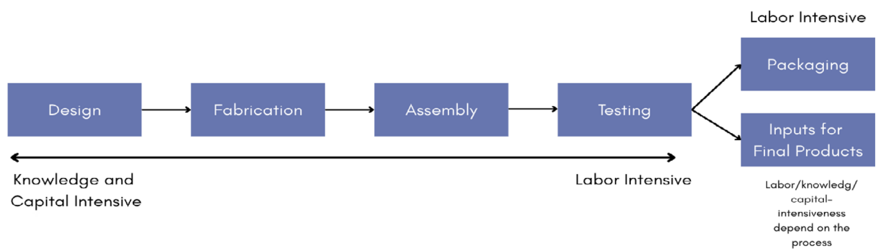
Against this backdrop, this paper will account for the differences in the performance of semiconductor industries in two contrasting Asian political economies, namely, Taiwan and the Philippines. While both boast semiconductors as their leading exports today, a closer look reveals significant differences in their industries' performance, despite starting at a more or less similar footing. In Taiwan, the semiconductor industry earned a whopping USD 231 billion in export revenues in 2023 (The Growth Lab at Harvard University 2024), with a fully integrated ecosystem spanning design, fabrication, advanced packaging and testing, and strong forward linkages (i.e., electronics). In comparison, in the same year, the Philippine semiconductor industry generated eight times less, or roughly USD 27.4 billion, despite housing, at one point in history, the largest number of semiconductor assemblers in the world (Kuo 1995; Scott 1986). Unlike Taiwan, the Philippine semiconductor value chain remains incomplete, with no domestic fabrication capability to date (Lachica 2026; OECD 2024).

What accounts for the contrasting fortunes of Taiwan and the Philippine semiconductor industries? To answer this question, our analysis begins with an overview of the semiconductor value chain, followed by a comparison of industry performance in both political economies. We then examine the policies and institutional arrangements they deployed, particularly during the critical period from the 1970s to the 1990s, when the foundations of their respective industries were laid. Ultimately, we argue that the divergence in outcomes can be attributed to differences in key areas: public research and development (R&D) institutions, industrial governance and strategy, industrial clustering and state-business-academia relations, and policies on scientific and technical human capital. Based on our comparative analysis, the study concludes by offering policy recommendations for countries trying to develop their semiconductor industries.

The Semiconductor Value Chain

Semiconductors, often referred to as integrated circuits (ICs) or chips, are the fundamental building blocks of modern technology, underpinning a wide range of applications from consumer electronics and automobiles to artificial intelligence and advanced defense systems. Behind these "tiny brains" lies an extraordinarily complex and highly capital-intensive production process, typically taking four to six months to produce and requiring tens of billions of dollars in investment (Batra et al. 2018; Yeung et al. 2023).

Figure 1. Simplified Semiconductor Value Chain



The semiconductor value chain begins with design (front end), a process where engineers develop the blueprints that define how a chip would function. Design is an R&D-intensive process, relying heavily on human capital with advanced and specialized technical expertise. As such, it emerges as the primary locus of value creation, capturing roughly half of the total value added in the chip production process (Varas et al. 2021). Precisely because it depends more on knowledge than on financial capital, design also represents a more accessible entry point for startups (whether in developed or developing countries).

The design is then translated into physical form through fabrication, the most technology and capital-intensive stage of the value chain.[5] Fabrication involves transferring a circuit pattern onto silicon wafers through photolithography, a process that uses light to etch multiple layers. Over time, fabrication has become increasingly dependent on software, precision engineering, and innovation in equipment and materials. Due to its complexity, only a few firms possess the capability of producing advanced types of chips (i.e., < 3 nm and 5 nm) used for cutting-edge applications, like artificial intelligence. These firms, all from advanced economies, include both traditional integrated device manufacturers (IDMs), such as Intel (United States), Texas Instruments (United States), and Samsung (South Korea), and foundries, like GlobalFoundries (United States), SMIC (China), TSMC (Taiwan), and United Microelectronics Corporation (UMC) (Taiwan).[6] This stage accounts for nearly a quarter of total value added in the supply chain (Varas et al. 2021).

5 In 1983, a fabrication plant cost about USD 200 million. By the early 2020s, it cost over USD 20 billion to build (Yeung et al. 2023).

6 In comparison to the traditional integrated device manufacturer (IDM) model, where all processes from design to marketing are done under one roof, the pure-play foundry model introduces greater flexibility into the semiconductor value chain by separating design and manufacturing functions, allowing different firms to specialize in each stage (Liu 2021). This separation lowers entry barriers for independent fabless firms, like AMD, NVIDIA, and Qualcomm.

Figure 2. Global Semiconductor Market Revenue Shares by Firm and Segment (by Percentage)

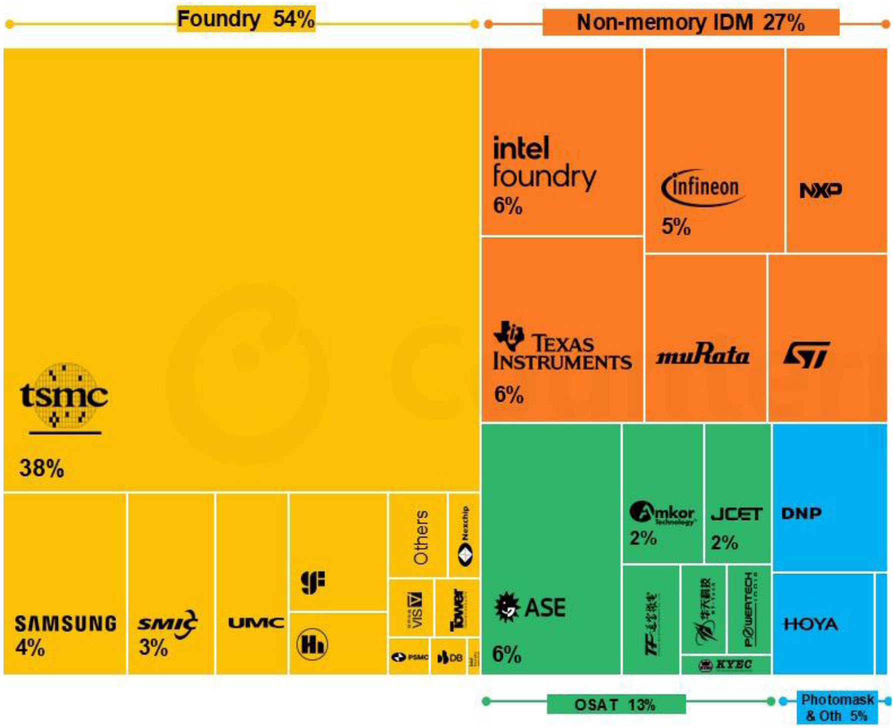


Image Source: Counterpoint Research's (2026) Foundry 2.0. Tracker

After fabrication, wafers undergo assembly, testing, and packaging (back end), where chips are cut from silicon wafers and prepared for final integration into electronic devices. Compared to the previous processes, ATP is more labor-intensive and cost-sensitive, with relatively lower barriers to entry and a thinner profit margin. As production has become increasingly fragmented and competition intensified, these activities are not only outsourced to specialized firms but also offshored to low-cost manufacturing hubs, such as the Philippines (Bown and Wang 2024).

Before we proceed, however, it is important to highlight that different segments of the value chain generate different levels of economic value. The bulk of value added is concentrated in design and fabrication, where intellectual property and R&D generate higher returns. Meanwhile, ATP sits at the lower end of the value distribution due to its commoditized and labor-intensive nature.

Against this backdrop, economies specialize in different segments of the value chain (with some diversifying across multiple segments), resulting in divergent development trajectories. As we shall see in the following section, Taiwan has successfully moved into high-value design and fabrication, while the Philippines has remained largely concentrated in ATP.

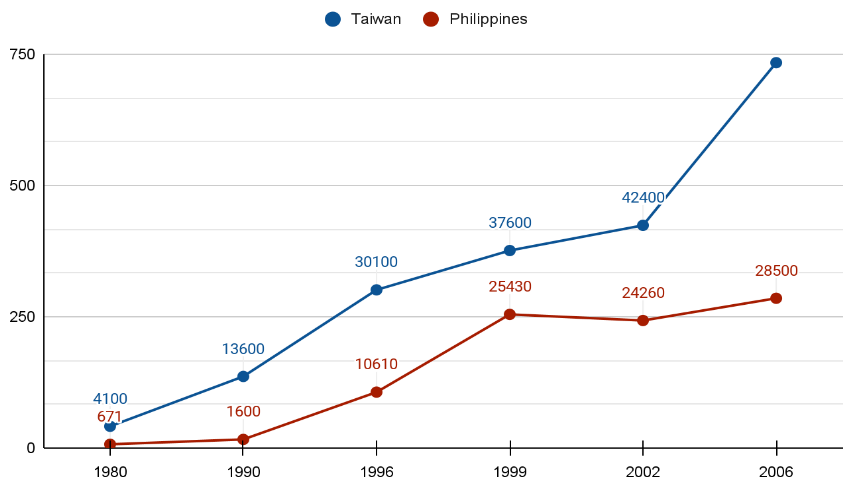
A Tale of Two Semiconductor Industries

The semiconductor industry occupies an important place in the economies of both Taiwan and the Philippines. Together, the two economies contribute significantly to a global industry valued at approximately USD 600 billion in 2021 that is projected to surpass USD 1 trillion by the end of the decade as demand for artificial intelligence, consumer electronics, and advanced computing continues to grow (Burkacky et al. 2022; Precedence Research 2024). Taiwan's semiconductor industry alone accounts for roughly a third of the country's total export revenues, while that of the Philippines makes up the single largest share of its exports, making the country the world's 9th largest chip exporter (OECD, 2024).

Both the Taiwan and Philippines' industries trace their origins back to the late 1960s when American high-tech companies began seeking cost-effective assembly and manufacturing sites amid the then-burgeoning globalization of production networks. Since then, they have grown into a leading export sector, generating billions of dollars in revenues. The industry trend has generally been upward, yet over the decades, more evidently in the late 1980s, the industries diverged dramatically in their trajectories, their capabilities, and their positions within the global semiconductor value chain.

Taiwan's rise was nothing short of remarkable. Though its semiconductor industry began with only a handful of packaging and test operations in the late 1960s, Taiwan moved aggressively up the value chain in the decades that followed. By the late 1990s, it had dislodged established European industrial powers like Germany to become the world's fourth largest semiconductor producer, trailing only the United States, Japan, and South Korea (Amsden and Chu 2003). By the end of that decade, its IC fabrication industry (and related activities) had reached sales of nearly USD 10 billion, representing roughly seven percent of the global total. Its ascent did not stop there. More importantly, Taiwan did not just grow in scale but built an ecosystem that spans the entire semiconductor value chain, from ATP and design to fabrication. Today, its domestic manufacturers, like TSMC and UMC, are considered among the world's most innovative and largest foundries, supplying over 60 percent of the total and 90 percent of the most advanced chips, a position that affords the island considerable leverage amid intensifying geopolitical tensions.

Figure 3. Electronics Exports in Taiwan and the Philippines (in USD)



Source: National Statistics Office (Philippines) (2010) and Ministry of Finance (Taiwan) (2008)

The Philippines, on the other hand, plays a more limited but still significant role within the global semiconductor value chain. The industry remains important insofar as it is the country's largest export sector, generating USD 25 billion or 19.32 percent of total export revenues in 2021 (The Growth Lab at Harvard University 2024). At the same time, however, its position remains structurally constrained by its concentration in ATP, the lowest segment of the value chain and the absence of domestic fabrication capacity to date (Lachica 2026; OECD 2024).

Historically, the Philippines was an early participant initially occupying a stronger position in global production networks, with one Taiwanese scholar even noting that it once hosted "the largest number of independent semiconductor subcontractors in the world" (Kuo 1995, 168).[7] Despite this promising start, however, the country struggled to upgrade its position over time (Athukorala 2022).[8] While there are indications of an emerging IC design industry, led by firms such as Xinyx and Silicon Verified, this segment remains relatively nascent and limited in terms of scale.

This limited upgrading is closely linked to a key structural constraint: heavy reliance on imported wafers, the core input in semiconductor manufacturing. The Philippines sources the bulk of its wafer supply from Taiwan, which accounts for roughly 70 percent of global production (Yalao 2024). This dependence underscores a much deeper limitation: in the absence of domestic fabrication capacity, the country risks remaining a processor of upstream foreign value rather than a producer of its own. In more practical terms, disruptions in the supply of wafers, whether due to geopolitical tensions, disasters, or trade restrictions, would directly threaten the country's USD 49 billion semiconductor industry and the approximately three million workers it employs (Lachica, as cited in Yalao 2024).

This dependence has also contributed to the industry's stagnating dynamism. Over the past decade, revenues and value added have largely plateaued, and the country's share of global semiconductor exports has slightly declined (OECD 2024). Increasingly, therefore, reliance on ATP alone appears insufficient to sustain long-term competitiveness of the industry and the broader economy. As value creation shifts toward higher-value activities, such as design, fabrication and advanced packaging, the Philippine semiconductor industry's continued relevance will largely depend on its ability to move up the value chain, a transition that Taiwan successfully achieved through the strategic deployment of industrial policies and institutions.

7 At the time, Stanford Microsystems stood out as the most prominent Filipino-owned company and was among the largest semiconductor firms in Asia. The company was founded by Cristino Concepcion Jr. in 1968 (as Stanford and Associates) after completing his graduate studies in the United States (Paredes 1969).

8 In addition to being involved in the ATP of chips, the country also manufactures related components, such as transistors, diodes, resistors, capacitors, coils, transformers, and printed circuit boards (PCBs) (Aldaba 2017).

Explaining the Divergent Paths of Taiwan and Philippine Semiconductor Industry

This section discusses the institutional and policy factors that shaped the divergent trajectories of the Taiwan and Philippine semiconductor industries, comparing five key areas: public R&D institutions, industrial governance and strategy, industrial clustering and state-business-academia relations, and policies on scientific and technical human capital.

1. Public R&D Institutions

Both Taiwan and the Philippines recognized early limitations of their industrial sectors, particularly in carrying out R&D needed for technological upgrading.[9] As a response, their governments established public R&D institutions to support industrial development and technological upgrading. However, despite relatively similar starting points, their semiconductor industries evolved along markedly different trajectories.

A key part of this difference lies in how public R&D institutions in these two political economies perceive their roles. In the main, Taiwan's public R&D institutions are empowered to take risks, co-invest with the private sector, and pursue measures that are adaptive to the industry's evolving needs (Ouyang 2006; Tung 2001b). They also exemplify what scholars term a "Model A" organization, which conducts R&D not only to understand, assimilate, and adapt foreign-acquired technologies domestically, but also to strengthen firms' absorptive capacities (Intarakumnerd 2011). In contrast, Philippine public

9 In the Philippines, Republic Act No. 2067, otherwise known as the Science Act of 1958, declares it the policy of the state to promote R&D amid the fragmentation of research efforts and the private sector's inability to sustain the requirements of technological upgrading, and to utilize scientific knowledge as an "effective instrument for the promotion of national progress." Similarly, in the late 1970s, Taiwan implemented the Science and Technology Development Program (STP) in recognition of the problem that the predominance of SMEs, and their with limited firm-level capabilities, discouraged private sector's participation in high-risk and capital-intensive R&D activities (C.-W. Hsu and Chiang 2001; Lin 2003).

R&D institutions have, by and large, been passive and risk-averse.[10] Unlike their Taiwanese counterparts, they typify "Model B" organizations, which conduct research on behalf of firms but do little to strengthen firms' own absorptive capacities.

To explore this difference in depth, we first focus on Taiwan's foremost public R&D institution, the Industrial Technology Research Institute (ITRI). Established in 1973 to promote innovation in an SME-dominated industrial structure, ITRI—together with its subsidiary, the Electronics Research and Service Organization (ERSO)—played a significant role in developing the island's semiconductor industry. Rather than functioning as a traditional R&D organization (i.e., directly conducting the R&D itself), it operated as a technology intermediary between domestic manufacturers and international laboratories and firms (Wessner 2013). In more concrete terms, the Institute sent its staff abroad to acquire the latest technologies and diffuse them for local adaptation (Meaney 1994). Among its most significant achievements was the landmark technology transfer deal with RCA, providing Taiwan access to specialized integrated circuit technology, laying the foundation for the industry's manufacturing capacity (Tso 2004). This trajectory illustrates how public R&D institutions in Taiwan's early stages avoided rushing into basic or frontier research, instead prioritizing applied R&D (i.e., acquiring foreign technologies and reverse engineering) and the development of firms' absorptive capacities (Wessner 2013).

As the industry matured and firms attained a certain level of production capacity, ITRI's role evolved from simply acquiring and diffusing foreign technologies to a more functional and facilitative role typical of "Model A" organizations. This evolution manifested in two ways. First, the Institute provided comprehensive support services, including the organization of R&D consortia (see next section) and provision of R&D tax incentives and technical services, while also selectively undertaking R&D projects when the complexity exceeded the capabilities of the private sector (Wessner 2013). Second, and

10 Absorptive capacity refers to the "ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends" (Cohen and Levinthal 1990, 128). In developing context, firms often struggle to build such capacity due, among others, to resource constraints. In this context, intermediate organizations, like Taiwan's ITRI, play a critical role by translating the knowledge generated by highly advanced firms, such as multinational corporations, into forms that are better suited to the needs, capabilities, and technological level of recipient organizations, e.g., SMEs (Intarakumnerd and Goto 2018).

more importantly, ITRI deployed a spinoff strategy in light of the need to overcome the private sector's lack of initiative to pursue risky investments. Through this strategy, ITRI was able to incubate and foster spin-offs, most notably UMC and TSMC, that would eventually go on to become leading players in the industry globally (Meaney 1994).

The establishment of UMC in 1980 marked the first major spinoff from ITRI, which provided crucial capital, equipment, and personnel support (Chang and Yu 2001; Meaney 1994). Several years later, in 1987, TSMC pioneered the pure-play foundry model—a business model focused exclusively on manufacturing semiconductors for other companies that design chips—with the state contributing as much as 49 percent of its initial capital.[11] The significant public investment through the spinoff strategy underscored the willingness of Taiwan's political leadership to take risks and back an unproven technology to drive industrial upgrading. Notably, the model not only lowered entry barriers for fabless design firms and strengthened Taiwan's domestic supply chain but also facilitated greater integration with lead firms, particularly from Silicon Valley (Hong 1997; Hung and Yang 2003; Liu 2021). This coupling engendered a "silicon shield," which bolstered Taiwan's strategic leverage vis-à-vis its delicate geopolitical situation (Addison 2001).

By contrast to Taiwan, the Philippines had a head start in establishing a national science body, the National Science Development Board (NSDB), in 1958, which was later reorganized into the National Science and Technology Authority (NSTA) in 1982 and the Department of Science and Technology (DOST) in 1987. The Board, comprised of the economic planning minister, other cabinet members, sectoral representatives, and experts in science and technology, was created to promote and coordinate R&D in the country and to facilitate the utilization of scientific knowledge for national development (Custodio 2025).

On paper, the institutional infrastructure appeared robust. However, in practice, these agencies suffered from the well-documented challenges of "inadequate infrastructure, limited funding, and insufficient human resources" (Custodio 2025, 1). Additionally, they struggled with persistent policy incoherence, a

11 See Footnote 6 for a discussion on the difference between IDMs and the pure-play foundries. TSMC's initial funding came from the National Development Fund (government) (49 percent), domestic capitalists (27 percent), and the Dutch electronics giant Philips (24 percent) (Hong 1997).

problem that post-democratization reorganization has only partially resolved (Abrenica and Tecson 2003). Moreover, R&D was often poorly aligned with industry needs, as research agendas tended to reflect researchers' academic interests rather than market demand, resulting in public R&D institutions pursuing frontier science prematurely without a strong industrial base to commercialize their outputs (Abrenica and Tecson 2003). As a result, their relevance to the semiconductor industry remained limited, which continues to be concentrated in low-value ATP activities (Reyes-Macasaquit 2008).

The DOST's seemingly low place within the broader political landscape, reflected in the paltry budget it has received over the years (less one percent of the total budget) (see Table 1 below), does little to advance its cause however well-intentioned its initiatives may be.

Table 1. DOST Budget as a Share of Total New Appropriations, Selected Years (Nominal)

Year	DOST / NSTA Budget	Total Budget*	Share (%) of Total Budget
1987	704,034,000	79,321,042,000	0.89%
1990	920,332,000	156,558,100,000	0.59%
1993	2,452,535,000	309,437,000,000	0.79%
1996	2,890,812,000	394,855,182,000	0.73%
1999	2,603,805,000	585,097,506,000	0.45%
2002	2,819,805,000	575,123,728,000	0.49%
2005	2,447,880,000	597,663,400,000	0.41%
2008	5,204,254,000	1,066,179,857,000	0.49%
2011	5,989,859,000	1,000,387,764,000	0.60%
2014	11,928,821,000	1,608,503,084,000	0.74%
2017	20,773,016,000	2,499,486,952,000	0.83%
2020	20,274,130,000	3,066,514,469,000	0.66%
2023	24,531,730,000	4,478,253,923,000	0.55%

Source: General Appropriations Act (Various years). Note that total budget here excludes automatic and continuing appropriations and other special funds

Part of the reason for this, as evidenced by the very nature of the country's semiconductor and electronics industry and the lack of policies to promote supply chain localization and technological transfer, is the longstanding belief in many in the technocracy that technological capacity-building will emerge naturally as a by-product of market competition and liberalization (Abrenica and Tecson 2003). Yet, as the experience of neighboring countries demonstrates, while liberalization and participation in global value chains may open up opportunities for climbing the technological ladder (Yeung 2016), they cannot, by themselves, guarantee successful upgrading nor generate enough developmental impulse needed to sustain such efforts (Mathews and Cho 2000). Such a mindset has reinforced a risk-averse approach to public policymaking and implementation, particularly in industrial development and science and technology, in the country.

This incoherence and risk-averse mindset are to some extent reflected in the way the government views its role vis-à-vis wafer fabrication, a critical upstream process in the semiconductor value chain. Unlike Taiwan, the Philippines has no domestic wafer fabrication facilities to date (Lachica 2026; OECD 2024). While it hosts numerous domestic and multinational ATP plants, the country has missed multiple opportunities to develop upstream segments of the value chain. In the early 1980s, the Marcos Sr. administration declared semiconductors a "vital industry" through Executive Order No. 815 (1982) and considered allocating funds for a fabrication facility, though the project failed to materialize.[12] Another attempt in the 1990s through a legislative initiative aimed at attracting investments in fabrication did not prosper (Computer Business Review 1999; U 2005). More recently, in collaboration with the government, the Semiconductor and Electronics Industries in the Philippines Foundation, Inc. (SEIPI) attempted to acquire legacy fabrication equipment from Taiwan (Venzon and Gao 2024). To be sure, while new proposals to establish a domestic fabrication facility have emerged amid supply chain realignments brought about by the US CHIPS and Science Act, these remain largely exploratory, with no clear indication yet of sustained investments. Nevertheless, the current geopolitical landscape is not without openings. Compared to before, the country finds itself with more space to leverage its strategic position, which could be tapped for developmental purposes, such as technology transfer (Depante et al. 2026). However, whether this translates into meaningful industrial upgrading will depend less on external opportunity alone and more on the state's capacity and political will to negotiate, coordinate, and sustain long-term commitments to capacity-building and technology transfer.

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12 The Asian Reliability Co. Inc. (ARCI) obtained loans from the Philippines Export and Foreign Loan Guarantee Corporation (now PHILGUARANTEE). Instead of building a wafer fabrication plant, ARCI used the funds to acquire equity in Dynetics, then one of the largest locally owned ATP firms (Pacific Studies Research Center 1985).

In summary, Taiwan's semiconductor industry thrived thanks in large part to the state's adaptive and strategic public R&D efforts. Public R&D institutions such as ITRI and ERSO functioned not simply as research organizations, but as technology intermediaries that acquired and diffused foreign technologies while simultaneously strengthening firms' absorptive capacities. As the industry matured, these institutions evolved into more functional and facilitative "Model A" organizations that coordinated R&D, provided technical and financial support, and undertook risky investments through spin-off strategies that gave rise to globally competitive firms such as UMC and TSMC. By contrast, the Philippines, despite establishing institutions (e.g., DOST), failed to adopt a similar adaptive approach, with its public R&D bodies struggling to fulfill their mandates amid ideological and institutional constraints. The result is a semiconductor industry that remains externally dependent and confined to low-value segments. For economies trying to catch up and climb the ladder, public R&D institutions need both the mandate to co-invest and take risks, as well as a parallel commitment to building firms' absorptive capacities.

2. Industrial Governance Shaping Industrial Strategy

A similar divergence is evident in the realm of industrial governance, where Taiwan and the Philippines adopted fundamentally different approaches. Differences in advisory structures, mechanisms for inter-agency coordination, and the degree to which the private sector is integrated into the policy process created distinct institutional contexts that led to contrasting outcomes.

In Taiwan, industrial policymaking was concentrated within a relatively small set of agencies closely linked to its top political leader (Wade 1990). The Industrial Development Bureau (IDB), under the Ministry of Economic Affairs (MOEA), exercised authority over key functions including industrial planning, subsidy allocation, industry guidance, and the administration of science parks (Haggard and Zheng 2013; Mathews 1997). Unlike fragmented bureaucratic arrangements where responsibilities are scattered across competing agencies, the IDB combined policy coordination and implementation functions, allowing it to act decisively, especially during the early years.

Another key feature of Taiwan's industrial governance, particularly in electronics and semiconductors, was the pivotal role of high-level, expert-driven advisory bodies. In the early 1970s, the Technical Advisory Committee (TAC)—later formalized as the State Technology Advisory Group (STAG)—

brought together global experts, including overseas compatriots and scholars, engineers, and executives from top American universities and firms such as RCA (formerly Radio Corporation of America), IBM, and Bell Labs (Tso 2004).[13] Meeting regularly and enjoying direct access to Taiwan's top political leadership, this expert body not only helped guide Taiwan's entry into semiconductor manufacturing but also, at times, offered "hard-hitting critiques" that served as an external check on bureaucratic inertia (Greene 2008, 162; Ouyang 2006).

STAG's influence is perhaps most evident in its role in facilitating the landmark technology transfer deal between RCA and ITRI in the 1970s and, later, in advancing the adoption of very-large-scale integration (VLSI) technology in the 1980s. The latter was highly contested due to its substantial capital requirements and the limited capabilities of domestic firms and research institutions to undertake frontier semiconductor production, prompting resistance from senior policymakers and bureaucrats. Nevertheless, STAG advisors, most notably IBM executive Bob Evans, successfully advocated for its adoption, culminating in the launching of the five-year VLSI development plan in 1983 (San 1990). This decision was consequential for strengthening domestic design and fabrication capabilities that laid the groundwork for Taiwan's transition into higher value-added segments of the value chain (Hong 1997; Mathews and Cho 2000; Meaney 1994).

Apart from these expert advisory bodies, Taiwan set itself apart through its deliberate integration of private sector actors into policymaking. Inputs from industry associations such as the Taiwan Semiconductor Industry Association and the Taiwan Electrical and Electronic Manufacturers Association were systematically incorporated into policymaking (Chu 1999; Kuo 1995; Wade 1990). Their effectiveness was not incidental: financial support from the government was crucial to the development of these organizations' capacity. This support enabled them to deliver club goods (e.g., legal services, marketing advice), coordinate R&D efforts, mediate disputes, establish technical standards, and facilitate exchange of information among member firms. In turn, these

13 STAG consisted of 5-15 members appointed by the premier for a three-year term, with its membership drawn from the government, academia, and industry. Between 1980 and 1992, it comprised 21 foreign advisers, all of whom were well-established professionals with strong academic credentials and industry experience, mostly from the United States but also from France, Germany, Italy, and Japan. It advised on national R&D policy, evaluated program implementation, and facilitated state-industry-academia linkages, particularly in technology transfer (Greene 2008).

associations, more than lobbying platforms, served as intermediaries that aligned industry interests with the state's industrial vision, contributing to a collective drive for technological upgrading (Mathews 1997; Oh et al. 2005).

Complementing these associations, the government became directly involved in shaping collective action in the private sector by supporting and organizing industry consortia themselves. More than just a venue for consultation, these consortia enabled firms to pool resources and adopt common standards, while also strengthening the state's capacity to overcome coordination failures. A well-known example in the electronics industry was the Notebook PC Consortium, which streamlined component compatibility, promoted vertical integration, and created strong downstream demand for semiconductors (Wessner 2013). Such efforts not only helped in solving "network failures among local firms in the same industry" (Intarakumnerd and Goto 2018, 1315) but also fostered collaboration among firms.[14] At the same time, not all initiatives of these consortia were successful: efforts such as the Chinese-character word processor and software under the Software Engineering Environment Development (SEED) program, as well as the development of a two-stroke engine with automotive firms, did not work out as planned (Mathews 2002). Nevertheless, these failures reflected a mindset in which experimentation and tolerance for failure were treated as integral to policy learning and long-term capacity-building. This collaborative model remains highly relevant today, particularly for fabrication and design, where the high cost and risk of R&D deter individual investment.[15]

Against this backdrop of a learning-oriented mindset and institutions that promote networking and coordination, Taiwan was able to cultivate vertical and horizontal integration among SMEs and large firms, creating a network

14 Network failures refer to the stagnation or collapse of collaborations between different entities, such as firms, universities, and government R&D organizations, that are necessary for technological development (Keller and Negoita 2013). Examples of such network failures include weak linkages among firms, limited information-sharing on technological and market opportunities, duplication of R&D efforts, and the absence of institutions for skill development, standard-setting, or collective problem-solving.

15 One possible pathway for applying this model is to establish an R&D consortia centered around a shared laboratory and training facility. This hub could provide collective access to expensive electronic design automation (EDA) tools and infrastructure while offering hands-on technical guidance. By centralizing these resources, the state can lower risks among firms and ensure a steady supply of skilled workers.

of “hidden champions.”[16] This, in turn, helped prevent the emergence of an enclave economy, where large firms, particularly multinational corporations, operate in isolation from the local economy.

In contrast, the Philippines has long struggled with fragmented industrial governance. While successive administrations have sought to promote industrial development, inter-agency coordination has remained weak. As Nolasco (1999, 92) observes, the departmental backdrop has been “loose and chaotic,” exacerbated by the absence of a lead coordinating agency with clear authority. Strategic priorities have often diverged across agencies: NEDA’s identified sectors have not consistently aligned with the priorities of the Department of Trade and Industry (DTI) and the Board of Investments (BOI), while trade and investment initiatives did not always cohere with foreign, science and technology, and economic policy objectives (Abrenica and Tecson 2003; Nolasco 1999).[17] For example, prior to the establishment of the National Innovation Council, S&T targets were often revised because fiscal incentives could only be granted to activities listed under the DTI’s Investment Priorities Plan (IPP), which was formulated independently of the S&T plan (Abrenica and Tecson 2003). For much of the time, this weak coordination meant the S&T agenda was largely an afterthought, rather than as an integral component of industrial strategy. This is hardly surprising, as the DOST, which was expected to take a leading role, has been constrained by paltry institutional and budgetary support, as discussed earlier.

In this context, the private sector is expected to serve as a counterweight to keep the government in check. However, industry participation was similarly fragmented. This is because the industry, especially during its formative years, lacked unified sectoral representation. In the 1970s, organizations such as the Electronics Manufacturers Association of the Philippines (ECAP) and the Philippine Chamber of Electronics Industries (PCIE) competed for voice and failed to articulate a coherent long-term vision for the sector (Kuo 1995; Rodmann 2021). Accounts from the period suggest that these groups functioned primarily as social or networking associations rather than as

16 Unbeknownst to many, the Taiwanese semiconductor industry, led by companies like TSMC, is supported by a strong network of more than 1,200 suppliers, most of which are SMEs (Siu 2023).

17 To be sure, technocratic agencies such as the Board of Investment held the highest economic policymaking authority, especially during the Marcos Sr. administration. Yet, even within the technocracy, internal factions with differing priorities and ideological differences existed (Sicat 2014).

strategic intermediaries between firms and the state (Kuo 1995). As a result, there was little collective effort to push for common standards, joint R&D, and technology upgrading.

The establishment of the Semiconductor and Electronics Industries in the Philippines Foundation, Inc. (SEIPI) (formerly SEIFI) in 1984 marked a significant step toward collective action within the industry. Initially conceived as a platform for technical training for engineers and technicians, the association later evolved into a representative industry body. In this capacity, SEIPI provides a range of club goods, including lobbying and policy advocacy, drafting of industry position papers, guidance on regulatory compliance (e.g., in pollution control and workplace safety), advice on financial and operational issues, and sponsorship of internships and other human capital development initiatives (Kuo 1995; SEIPI, n.d.). By consolidating industry representation under a single umbrella organization, SEIPI improved inter-firm coordination and strengthened the industry's ability to articulate shared interests to the government.

For much of the period, however, coordination between the state and industry was limited and ad hoc, with formal mechanisms only recently institutionalized through the Semiconductor and Electronics Industry Advisory Council (SEIAC) (Campos 2025a). Established to address longstanding fragmentation in coordination, SEIAC's effectiveness will depend on its ability to evolve into an interface that can consistently and substantively incorporate industry and expert voices (both domestic and international à la STAG), facilitate systematic sharing of information and know-how among stakeholders, and function as a mechanism of mutual accountability that supports policy coordination and implementation.[18] At present, however, its composition is dominated by government stakeholders, with one private sector representative—not necessarily from SEIPI, the industry association—sitting. With limited inclusion of experts (or the absence of a dedicated technical advisory panel), the council risks operating as an administrative coordination body, rather than functioning as a more technically grounded advisory interface akin to STAG.

18 The Philippines also has members of its diaspora with extensive experience in the electronics and semiconductor industry. Among them was the late Dado Banatao, a renowned Filipino engineer and entrepreneur from Cagayan, who played a pioneering role in Silicon Valley and is widely credited with founding one of the earliest fabless semiconductor design firms in the world.

To sum it up, the divergence between Taiwan and the Philippines in the semiconductor industry reflects, among other factors, differences in industrial governance. Taiwan built a system characterized by centralized bureaucratic authority, institutionalized expert advisory mechanisms (i.e., STAG), and the deliberate incorporation of private sector actors into the policy process, allowing it to move up the technology ladder. The Philippines, by comparison, was constrained by fragmented institutions, weak inter-agency coordination, and a lack of unified sectoral representation during its formative years, resulting in missed opportunities for industrial upgrading. These differences in institutional governance help explain why Taiwan was able to successfully build an extensive value chain and innovation ecosystem, while the Philippines is only recently, through bodies like SEIAC, attempting to institutionalize the coordination necessary to move beyond ATP.

3. Industrial Clustering and State-Industry-Academe Linkage

Both Taiwan and the Philippines employ industrial clustering as a policy instrument to promote economic growth and sectoral development, but they differ in terms of coherence and substance. Taiwan's model is anchored on a deliberate strategy of fostering synergy between academia, government, and industry, whereas the Philippines has largely lacked this level of integration.

Taiwan's semiconductor industry, largely anchored in the Hsinchu Science Park (HSP), exemplifies the benefits of an integrative clustering strategy. Established in 1980, HSP is strategically located near two top engineering universities, National Tsing Hua University and National Chiao Tung University, and in proximity to key public research institutions, such as ITRI and its subsidiaries (Wessner 2013). This co-location facilitated collaboration, cross-pollination of ideas, and continuous knowledge exchange among researchers, engineers, and bureaucrats (J.-Y. Hsu 2005). Beyond information sharing, clustering brought together designers, fabs, assemblers, and other firms in the electronics and semiconductor value chain, which lowered transaction and logistical costs (Tung 2001a). Such an alignment enabled Taiwan to transition from low-value ATP to high-end manufacturing and R&D, creating a self-reinforcing ecosystem and a supply chain that encompasses all the major processes, most notably fabrication and design (as exemplified by firms like MediaTek).

Table 2. Number of Firms in Taiwan's Semiconductor Value Chain (1986 - 1998)

Year	Design	Fabrication	Package	Testing	Wafer Material	Mask	Chemical	Lead Frame
1986	4	1	N/A	0	0	1	0	1
1990	56	8	19	1	0	2	1	N/A
1994	64	11	18	4	0	2	1	4
1998	115	20	36	30	3	5	6	9

Source: Adapted from Tung (2001a)

This clustering strategy was underpinned by a developmental approach to foreign investment. While full foreign ownership was generally allowed in its economic zones—a reflection of the ruling party's aversion to external debt—the state remained highly interventionist when it came to its governance (Haggard and Zheng 2013; Thurbon and Weiss 2006). Investment proposals, for example, were rigorously screened for their technological and export contributions, as well as their alignment with national development plans (Wade 1990). In strategically important sectors such as semiconductors, as noted earlier, the government went further by entering into joint ventures directly with foreign firms (e.g., technological transfer deal with RCA). More importantly, foreign investment was conditioned on the willingness of investors to support domestic suppliers in upgrading their operations and technologies, thereby embedding learning and spillover requirements into the investment regime.

In addition, the government reinforced these dynamics by ensuring a reliable and affordable water and electricity supply, as well as by offering incentives, such as tax breaks, dedicated public infrastructure (including housing, educational, and other amenities for families), and regulatory support, to encourage firms to settle and grow within the cluster (J.-Y. Hsu 2011). Additionally, locators receive market and product development assistance, information services, low-interest loans, and help with land acquisition (Chen et al. 2013). All these helped HSP to build "one of the deepest reserves of high-tech talent in the world" (Einhorn 2005).

The Philippines' application of clustering strategies through its export processing zones (EPZs) has historically been less integrated and strategic. Although inspired by models such as Taiwan's Kaohsiung Export Processing Zone, the country's first ecozone, the Bataan Export Processing Zone (BEPZ), was established primarily to attract foreign investment and generate employment (McKay 2006). Through a combination of fiscal and non-fiscal incentives, including the provision of physical infrastructure and government-guaranteed financing and policies permitting full foreign ownership and duty-free production (Villegas 1989), it was able to, to a certain extent, succeed in attracting global giants, such as Intel, Motorola, Philips and Texas Instruments (McKay 2006). Seeing the potential of the clustering approach in bringing in foreign investments, the government established more EPZs in other parts of the country, particularly in Baguio, Cavite, and Cebu.

Despite this, the strategy lacked the pieces needed to build a cohesive ecosystem. One major constraint was that the locations of most ecozones were far from major academic and commercial centers, which limited their potential to generate knowledge spillovers and facilitate technology transfer among firms (Madani 1999). Site selection was not solely determined by economic or logistical factors but also by political considerations (Raquiza 2012), which influenced the placement of several zones and, in some cases, reinforced their spatial disconnect from key hubs of industry and knowledge. For BEPZ in particular, its mountainous location and remoteness from the capital region undermined its competitiveness, a challenge further exacerbated by the inadequate infrastructure at the time (Warr 1987). Recognizing the issue, a proposal to establish a more centrally located electronics ecozone in Metro Manila, through Letter of Instructions No. 900 (1979), was put on the table in the late 1970s but never materialized (IBON Databank Phils., Inc. 1990; Rodmann 2021).

Over time, the Philippine government shifted from a relatively developmental to a more regulatory role, especially following the passage of the Philippine Economic Zone Authority (PEZA) Law in 1995 (McKay 2006).[19] This shift resulted in the proliferation of ecozones, most of which are privately operated and scattered across the archipelago. While this market-oriented

19 Since 1995, PEZA (formerly Export Processing Zones Authority) no longer develops its own public ecozones. Today, its role is primarily regulatory and facilitative in nature, with zone development undertaken by the private sector (Kleibert 2014).

approach improved investors' access to the ecozones, it also likely reduced the strategy's potential to use clustering as a way to align academia, industry, and government around more ambitious industrial goals. Unlike in Taiwan, where ecozones are spatially and institutionally anchored to the national innovation system, Philippine zones often operate as enclaves with minimal integration into the domestic economy (Busque 2016). This lack of integration is further compounded by weak linkages between multinational and local firms within these zones, as well as by the paucity of deliberate policies to localize supply chains or promote technological learning among domestic enterprises (Aldaba 1995; McKay 2006).

Collaboration between academia and the semiconductor and electronics industry in the Philippines also remains limited (Frederick and Gereffi 2016). This is rather unsurprising, as most partnerships between universities and firms in the country primarily focus on internships and curriculum development, with very few instances of joint R&D and commercialization (Bernarte 2014). More recent efforts, like the Silicon Valley-dubbed UP-Ayala Technohub, were intended to stimulate innovation and spinoffs, but ultimately became dominated by business process outsourcing (BPO) companies (Flores 2025).[20] As such, technology transfer programs, while labeled as demand-driven, often fail as they do not reflect market realities (Abrenica and Tecson 2003).

Against this backdrop, the result has been an industry that has struggled to climb the technological ladder. While the Philippines hosts several multinational firms involved in ATP, it has made modest progress in moving up the value chain, underscoring the country's vulnerability to the middle-income trap. Industry observers note that government intervention has been mostly limited to minor measures (e.g., provision of access roads, administrative streamlining) rather than sustained support for industrial upgrading (U 2005). In the absence of an industrial policy that aligns key actors and pursues long-term development, the market-oriented approach to clustering in the Philippines has remained mostly facilitative in nature, with its developmental impact likely to remain limited.

20 PEZA has recently launched its first set of innovation-oriented ecozones, designated as Knowledge, Innovation, Science, and Technology (KIST) parks, located within Batangas State University and De La Salle University in Laguna (Campos 2025b). The initiative aims to strengthen collaboration between academe and industry to accelerate R&D, facilitate the commercialization of research outputs, and support the growth of innovative startups and spin-offs, among other efforts to maximize science, technology, and innovation (STI) for economic development.

However, the recently-announced Luzon Economic Corridor linking Subic, Clark, Manila, and Batangas— while largely logistics-oriented—may hold potential for more integrated development of the country's electronics and semiconductor industry, provided that appropriate policies are in place.[21] Particularly, the corridor could facilitate clustering among ATP firms, startups, higher education institutions, public R&D organizations, and prospective fabrication and design companies, potentially serving as an impetus for innovation, technology transfer, human capital development, and, ultimately, industrial upgrading.[22] This, however, would require complementary industrial and fiscal policies beyond infrastructure provision, such as support for R&D consortia for collaborative research and technology transfer; shared fabrication, design, and testing facilities; and dedicated funding mechanisms for spin-offs and industry-linked university and public research to tap into the national innovation system. Without such integrative elements, the planned corridor risks repeating history and becoming yet another primarily logistics-oriented initiative, while exposing the country to geopolitical risks without commensurate gains in development.

Bottom line, Taiwan's experience shows how clustering can support industrial upgrading when synergy among the state, academia, and industry is deliberately cultivated from the outset — an element missing from the Philippines' fragmented approach.

4. Scientific and Technical Human Capital

The semiconductor industry depends not only on infrastructure but also on a steady supply of skilled engineers, researchers, and technicians. In this regard, Taiwan and the Philippines offer varied experiences. Taiwan's rise as a global leader in the semiconductor industry stemmed, for a significant part, from strategies that aligned human capital development with its industrial strategy. In contrast, the Philippines' role has remained limited to lower-value activities largely due to weaker policy direction, a service-oriented educational system, and persistent brain drain.

21 Recently, the Philippines joined the Pax Silica initiative, which includes plans to designate a 1,619-hectare site as an economic security zone within the Luzon Economic Corridor (Dumalag 2026; Depante et al. 2026)

22 The initiative could be harmonized with the newly-passed Republic Act No. 11981 Tatak Pinoy (Proudly Filipino) Act.

Taiwan's success was underpinned by an early recognition that education had to serve the broader political and economic goal of industrialization. Compulsory schooling was extended from six to nine years in the late 1960s, producing rapid gains in literacy and enrollment. By 1980, junior high enrollments had nearly doubled, and literacy rates had reached 90 percent, up from 45 percent in 1960 (Lauridsen 2008; Tan and Clark 2011). However, what made Taiwan's strategy noteworthy was not simply mass public education but its productivist orientation — an explicit attempt to push industrialization through social policies. The government deliberately managed the number of university enrollments while channeling students into technical and vocational education and training (TVET) schools. Through successive Manpower Development plans, the ratio of university to TVET students was reversed, and by 1980, TVET students outnumbered their university counterparts by more than 50 percent (Lauridsen 2008). The "narrow gate" admissions policy thus led to more balance: engineering and applied sciences were supported, but technical and vocational education remained the backbone of the labor force. This avoided credential inflation while supplying technicians and engineers needed by their then-burgeoning electronics and semiconductor industry. The policy was lifted only after the semiconductor and electronics industry had achieved a sufficient level of maturity.

The Philippines presents a strikingly different case. While basic education is compulsory and tertiary enrollment has been high, students have historically gravitated toward law, business administration, education, and the humanities, leaving science and engineering underrepresented (and, where offered, of uneven quality) (Abrenica and Tecson 2003; Tecson 1999).[23] Unlike Taiwan, the Philippine government appears to have adopted a laissez-faire approach to higher education (Abrenica and Tecson 2003). Higher education institutions, in general, offered programs in response to short-term market demand rather than long-term national development goals. This tendency could also be seen in the TVET sector. Most TVET schools were privately run, often oriented towards the service sector, and produced graduates who did not meet the technical needs of the manufacturing sector. It comes as no surprise, therefore, that TVET graduates have been reported to have high unemployment rates (Generalao et al. 2025; Orbeta and Abrigo 2012). Longstanding cultural norms

23 Compared to neighbors, the Philippines has had a high higher education attendance rate relative to its income level (Bayudan-Dacuycuy et al. 2023). The rate was already roughly 20 percent in the 1970s and stood at 35 percent in 2021.

exacerbated the issue: for decades, a preference for white-collar professions persisted, while technical and vocational fields were commonly viewed as less prestigious (Abrenica and Tecson 2003; Caoili 1986).

Another major challenge has been the brain drain. Many Filipino engineers and scientists sought opportunities abroad due to limited career prospects at home, forming one of the largest groups of foreign-born professionals in the United States (Mani 2002). Rather than stem the outflow, the government initiated labor export policy—originally intended as a stopgap measure—in the 1970s, promoting overseas employment as an alternative source of income (Alcid 2003; Siar 2013). As a result, remittances became an important economic pillar, but the outflow of skilled workers largely hollowed out the domestic technical base. Initiatives like the *Balik Scientist* (Return Scientist) Program, modeled after Taiwan's, aimed to reverse this trend but achieved only limited success: Of 320 participating scientists in the early 2010s, more than half eventually returned abroad (Siar 2013). Although the program offered incentives such as airfare and allowances, talent retention was constrained by the country's limited industrial base. Still, it bears emphasizing that a critical mass of overseas Filipino workers (OFWs) is already engaged in high-skilled semiconductor and electronics manufacturing and R&D in East Asia, the United States, and Europe, constituting a latent source of technical expertise that could be mobilized for developing the domestic industry.

In sum, Taiwan's experience demonstrates that investing in TVET and aligning the education system with an overarching industrial vision can create a virtuous cycle of development. The Philippines, for its part, illustrates the consequences of misalignment, where a surplus of graduates in non-technical fields leads to credential inflation and underemployment. To break from this pattern, developing countries must recalibrate its educational priorities. This requires a comprehensive strategy of broadening the manufacturing base through industry-aligned TVET, targeting niche, advanced graduate studies to cultivate talent for high-value segments like design and fabrication, and aggressively incentivizing the return of technicians and high-skilled engineers and managers to transfer knowledge and accelerate technological upgrading.

Advancing a Semiconductor Industry in the Global South

The above comparative analysis underscores the crucial role of the state in semiconductor industry development. While Taiwan's success was underpinned by a developmental state that strategically aligned public R&D, industrial clustering, and human capital development with a clear industrial vision, the Philippines' experience reveals the limitations of a fragmented governance, risk-averse public R&D institutions, and an educational system insufficiently oriented towards industrial priorities.[24] For the Philippines and other similarly situated economies in the Global South, moving beyond low-value APT will require a more proactive approach to industrial policy and a reconfiguration of the institutions that underpin technological upgrading. To this end, we propose the following policy recommendations:

First, governments must rethink the mandate of their public R&D institutions to allow for calculated risk-taking. These organizations should be empowered to shape markets by enabling them to use a broader set of policy instruments, including the incubation of spin-off firms (i.e., through co-financing mechanisms and the transfer of resources and technical capabilities to start-ups à la ITRI and TSMC) and applied R&D programs explicitly aimed at building firms' absorptive capacities in higher-value segments of the semiconductor value chain (see Recommendation 4 below), such as design, advanced packaging, and lab-scale wafer fabrication. This, however, does not imply indiscriminate spending but a willingness to tolerate failure as an inherent part of learning.

Second, the state, as we learned from Taiwan's experience, must be willing to co-invest with the private sector in emerging and strategically important technologies. This is especially critical in highly capital-intensive segments of the semiconductor value chain, such as fabrication, advanced packaging, and design, where the entry costs often deter private firms from undertaking independent investment in the absence of state commitment and risk-sharing mechanisms. At the same time, however, we acknowledge the risk of moral hazard and the imperative to efficiently utilize financial resources, especially in

24 This is not to discount the equally important role of entrepreneurs or the significance of firms in the process, particularly in more recent periods. For a more comprehensive discussion of firm-level dynamics, see Yeung (2016).

developing contexts. To mitigate this, the state could consider adopting what Mazzucato (2013) describes as "socializing the risks *and* rewards of public investments." In more practical terms, this could involve the government providing equity financing to strategic semiconductor firms (especially in design, fabrication, and advanced ATP) in exchange for partial ownership, thereby enabling it to share in future returns while also influencing strategic direction. In this way, beyond managing risks, the state also functions as a market co-creator, actively shaping the direction, scale, and structure of emerging industries.

In the Philippines, one possible policy instrument would be the establishment of a dedicated semiconductor development fund focused on strategic co-investment in higher-value segments of the industry, particularly design, advanced packaging, and lab-scale fabrication. Similar to Taiwan's experience, where the state provided substantial financial backing for spin-offs and technology upgrading (e.g., in TSMC and UMC), such a fund could support domestic firms and start-ups undertaking technologically risky but potentially transformative activities. Particularly, state support may take the form of equity participation, matching grants, concessional financing, or R&D subsidies, with assistance conditioned not only on profitability but also on learning-oriented performance criteria such as technology transfer, workforce upgrading, local supplier development, patent generation, and the strengthening of absorptive capacities. To ensure alignment with industry needs, the fund should work closely with the SEIPI and, ideally, with industry experts and academics, particularly in identifying priority areas for upgrading and facilitating coordination between government, firms, and universities. The Maharlika Investment Fund, the country's first sovereign wealth fund, may be explored as one possible source of capital for such an initiative, in line with its mandate to generate long-term returns on investments and foster socio-economic development and technological transformation.

Third, improving the state's capacity to design and implement policy requires overcoming persistent information asymmetries and coordination failures, necessitating sustained financial commitment and new governance arrangements. In addition to establishing councils (e.g., SEIAC), the Philippines and other developing countries can also draw lessons from how Taiwan proactively supported industry associations and convened alternative platforms, such as R&D consortia and the STAG, which brought together policymakers, experts, academics, and industry actors. As Ouyang (2006) argues, such bodies not only provide technical know-how but also serve as a "third-party control" to bureaucratic inertia and political capture. By allowing external experts to play a role in the policymaking process, such arrangements could help create a governance structure in which industry and academe serve as accountability partners. In contexts where such mechanisms have yet to be institutionalized, governments could begin by taking stock of relevant expertise, both domestically and overseas, and creating the environment for such engagement to emerge, even if initially on an informal basis (e.g., Taiwan's TAC).

Fourth, for developing countries, an effective science and technology strategy must also place equal, if not greater emphasis on building firms' absorptive capacities, i.e., the ability to learn from, adapt, and incrementally improve upon existing technologies. This is particularly important because many firms in developing economies still lack the technical and managerial capabilities, skilled personnel, and supplier networks necessary to utilize advanced research outputs effectively. In this context, prematurely prioritizing frontier and basic research, without first strengthening firms' technological and organizational capabilities, may produce innovations that remain disconnected from domestic industrial needs and therefore difficult to commercialize. Therefore, policies aimed to strengthen firms' absorptive capacities through targeted grants and extension programs that incentivize firm-level learning in process upgrading, product development, and technology transfer (See Intarakumnerd 2015) can help ensure that R&D efforts are grounded in existing industrial capabilities, improving the prospects for commercialization and meaningful industry uptake of research.

Fifth, human capital development must be explicitly anchored in an industrial strategy. The persistent gap between the Philippines' relatively high educational attainment and its low industrial value-added points to the need for a more productivist orientation of the educational system, one that prioritizes science, engineering, and technical-vocational competencies aligned with the industry's needs. This implies revisiting curricula to integrate technical-vocational education even at the junior high school level, to spark early interest and demystify technical-vocational pathways. High-quality TVET programs, designed in collaboration with industry and tailored to semiconductor and electronics-related occupations, can also play a key role in removing societal stereotypes about vocational careers.

However, a robust industrial base requires more than just technicians. The state must therefore invest in niche, advanced studies programs that build capacity in high-value segments of the value chain, particularly semiconductor design, fabrication, and advanced packaging. Apart from offering formal programs, one way to support this is through the establishment of an R&D consortium anchored in shared laboratories and training facilities, which would provide collective access to costly electronic design automation (EDA) tools and related infrastructure while enabling structured hands-on training for students.[25] In parallel, the state can leverage the existing pool of overseas Filipino professionals already embedded in global semiconductor and electronics value chains. By shifting from a model of brain drain toward "brain circulation" (Saxenian 2007), policymakers can actively engage skilled diaspora workers, especially returnees with experience in lead firms abroad, as sources of knowledge and technology transfer. Thus, policies that facilitate reintegration, such as recognition of credentials, incentives, and initiatives that reduce adjustment burdens and ease citizenship and/or residency requirements, can help mobilize returnees as an impetus for industrial upgrading.

Sixth, industrial clustering must be pursued with a deliberate and coordinated strategy, rather than as a passive by-product of investment promotion. Effective clustering requires the intentional co-location of domestic firms (in design and manufacturing), multinational corporations, public R&D institutions, government agencies, universities, and training centers, creating dense networks that facilitate knowledge sharing, innovation, and promotion of technology transfer and local content. Equally important is the proactive removal of impediments that deter investment and constrain long-term competitiveness. This includes reducing regulatory burdens and compliance costs, providing targeted fiscal incentives, strengthening support for key industries (e.g., chemicals, steel, other materials), and accelerating the development of critical infrastructure, particularly reliable and affordable electricity, water supply, and logistics systems, all which remain perennial binding constraints in manufacturing. Because advanced manufacturing sectors, such as semiconductors and electronics, are energy-intensive, it would be prudent to explore sustainable and renewable energy sources and to ensure that industrial growth is both resilient and environmentally responsible. Without these, investments may fail to deliver the wider economic and technological gains that clusters, such as the planned Luzon Economic Corridor in the Philippines, are capable of generating.

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25 An example is the recently instituted BS Microelectronics Engineering programs at Colegio de Muntinlupa (CDM) and Mindanao State University-Iligan Institute of Technology (MSU-IIT), which reflect efforts to develop training pipelines responsive to industry needs.

Seventh, where feasible, developing countries must strategically leverage the evolving geopolitical landscape to extract developmental concessions in the form of technology transfer and investment. For the Philippines, in particular, this may involve bundling its geopolitical strategy with arrangements that attract inward foreign investment from lead firms, while also facilitating access to legacy, yet still commercially viable, wafer fabrication technologies. When coupled with policies that deliberately promote local content and technology transfer, such investments and access could help close a critical gap in the domestic semiconductor value chain, allowing higher-value production to emerge and gradually built alongside existing ATP and design activities.

Finally, while the abovementioned reforms are important, they must be accompanied by a critical reexamination of the assumptions that have long informed the way we think about development. Rather than relying solely on the belief that market forces alone will spur industrial upgrading, we must recognize that states, as in the experience of Taiwan, have a pivotal role to play in the process. Without such a paradigm shift and an effort to build state capacity, countries risk remaining ensnared in the peripheries of the global economy. Future policy must therefore be intentional, strategic, and unapologetically developmental.

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