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From Assembly Lines to Innovation Powerhouses: How Asia Transformed Its Technological Futures

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Abstract

The transformation of Japan, South Korea, and China from low-cost manufacturing bases into globally competitive innovation economies offers important insights into the institutional and organizational conditions that enable long term technological upgrading. A comparative review of these trajectories shows that innovation outcomes emerge from the interaction of aligned industrial policies, firm strategies, and education systems; the sequencing of learning before invention; the presence of organizational routines capable of converting research inputs into productivity gains; and the ability to deploy market scale and mission-oriented programs to accelerate diffusion. These shared mechanisms clarify why the three East Asian economies were able to accumulate capabilities rapidly and sustain advancement across increasingly complex technological domains. Contrasting these experiences with the contemporary cases of Mexico and Chile highlights persistent gaps in research intensity, institutional coordination, and firm level learning processes that continue to limit technology driven development in Latin America. The synthesis contributes to broader debates on latecomer innovation by identifying the institutional coherence, learning pathways, and organizational practices that underpin successful capability accumulation. The analysis also points toward future research opportunities involving digitalization, green transitions, and cross regional policy transfer, areas in which the relevance and adaptability of East Asian strategies merit further examination.

Keywords

Industrial Transformation, Technological Innovation, Japan, South Korea, China, Manufacturing Strategy, R&D Investment, Government Policy, Technology Transfer, Emerging Economies, Global Competitiveness, Chile, Mexico

1. Introduction

A unifying theme across the industrial trajectories of Japan, South Korea, and China is that their rise from low-cost manufacturing hubs to global innovation centers was neither accidental nor purely market-driven, it was the result of coordinated-long-term national strategies. Despite differences in political systems, economic structures, and development stages, all three countries adopted a set of mutually reinforcing approaches that laid the foundations for technological advancement. First, each government assumed a proactive developmental role, aligning industrial policies with national priorities through multi-decade planning frameworks that incentivized high-tech sectors. Second, they strategically leveraged foreign knowledge, using technology licensing, joint ventures, and international partnerships as mechanisms for rapid capability building while simultaneously nurturing domestic firms. Third, all three nations invested heavily in human capital, expanding STEM education, technical training, and research institutions to cultivate a workforce capable of sustaining innovation. Fourth, they pursued export-oriented growth, using global markets to scale production, increase competitiveness, and finance further R&D. Finally, each country institutionalized continuous improvement through R&D spending, national innovation programs, and incentives for corporate modernization. Together, these shared strategies created the conditions for sustained technological upgrading and the emergence of globally competitive innovation ecosystems.

A unifying theme across the industrial trajectories of Japan, South Korea, and China is that their rise from low-cost manufacturing hubs to global innovation centers was neither accidental nor purely market-driven, but reflected coordinated and long term national strategies (Johnson, 1982; Wade, 1990; Evans, 1995). Despite institutional differences, shared mechanisms include policy alignment with firm strategy and education systems, staged learning, and mission orientation that convert inputs into productivity and innovation (Freeman, 1987; Lundvall, 1992; Mazzucato, 2013).

1.1. Background and Justification

Extensive research has explored aspects of East Asia's economic and technological rise; however, much of the literature focuses on individual country cases or narrow thematic areas such as quality management (Tsutsui, 1996), chaebol dynamics (OECD, 2023), or national industrial strategies (Jin & Wang, 2025). Fewer comparative studies provide an integrated, three-country review identifying cross-cutting mechanisms that enabled long-term innovation capacity building.

A consolidated analysis is essential because Japan, South Korea, and China together represent distinct yet interrelated models of innovation-driven transformation.

Extensive scholarship covers individual themes such as quality management in Japan, chaebol dynamics in Korea, and national industrial strategies in China, yet fewer studies integrate all three countries within one comparative frame (Tsutsui, 1996; Amsden, 1989; Jin & Wang, 2025; Brandt & Rawski, 2008). A consolidated analysis is warranted because Japan, South Korea, and China represent distinct but interrelated models of innovation driven transformation (Odagiri & Goto, 1996; Lee, 2013).

Several core constructs guide the comparative analysis and provide a shared conceptual foundation. "Technological upgrading" refers to the progression from assembly-based production toward increasingly complex design and innovation capabilities, a pattern evident in Japan's quality-driven industrial ascent, Korea's move into frontier semiconductor technologies, and China's shift from OEM production to activities grounded in research and development. "Innovation transition" captures the systemic shift from learning and adaptation to sustained indigenous research and technological leadership. "Mission-oriented policy" denotes coordinated state programs that target strategic technologies (for example, Japan's postwar industrial prioritization, Korea's export-linked incentives, and China's Made in China 2025 initiative). "Organizational routines" describe firm-level practices that institutionalize learning and problem solving, including Japan's continuous improvement systems, Korea's disciplined production regimes, and China's process-intensive manufacturing cycles. Finally, "Learning before invention" highlights the latecomer trajectory in which foreign technology absorption and production experience form the essential groundwork for original innovation (Gerschenkron, 1962). Together, these definitions ensure conceptual coherence across the country's cases and anchor the analytical framework.

1.2. Objectives and Research Questions

The study aims to:

- Analyze the historical and institutional mechanisms driving the innovation transitions of Japan, South Korea, and China.
- Identify common success factors and differences across the three national innovation systems.
- Propose lessons and frameworks applicable to emerging economies.

Research Questions:

- What policies, strategies, and institutional mechanisms enabled the three countries' transitions from low-cost manufacturing to innovation leadership?
- What common factors and country-specific differentiators emerge across their innovation trajectories?
- What lessons can be generalized for other countries pursuing innovation-driven industrial upgrading?

2. Literature Review

The transformation of Japan, South Korea, and China into global innovation leaders has been studied through several influential theoretical lenses. Classical developmental state theory argues that governments can accelerate industrial upgrading by directing capital, prioritizing strategic sectors, and coordinating public and private innovation agendas (Odagiri & Goto, 1996; OECD, 2023). This perspective emphasizes the role of state institutions such as Japan's MITI or Korea's Economic Planning Board in orchestrating long term technological development and guiding firms toward globally competitive industries. Complementing this, theories of technology absorption and latecomer innovation highlight how nations can leverage foreign knowledge through licensing, joint ventures, and learning by rapidly build domestic capabilities (Carraz & Harayama, 2019). Extensive research on East Asia also supports the concept of national innovation systems, which frames innovation as the outcome of interactions across firms, universities, government agencies, and financial institutions (Soh et al., 2023). Finally, contemporary studies on China point to state enabled digital transformation, where large scale investment and rapid commercialization accelerate innovation cycles (Zang et al., 2025; Jin & Wang, 2025).

Developmental state analyses argue that targeted coordination by public agencies accelerates upgrading, as seen in Japan's MITI and Korea's planning system (Johnson, 1982; Wade, 1990). Latecomer and capability approaches show how licensing, joint ventures, and learning by doing build domestic technological capacity (Kim, 1997; Lall, 1992). National innovation systems scholarship explains performance as the outcome of interactions among firms, universities, finance, and the state (Freeman, 1987; Lundvall, 1992). For China, studies emphasize mission orientation and digital transformation, including Made in China 2025 and recent firm level and macro evidence (State Council of the People's Republic of China, 2015; Naughton, 2021; Jin & Wang, 2025; Zang, Teruki, Ong, & Wang, 2025; Wu, Si, & Wang, 2025; Al Midfa, 2025).

While these theories collectively illustrate how institutional coordination, technology transfer, and human capital development contribute to national innovation, the literature also presents several inconsistencies and gaps. First, although many studies examine each country individually, comparative analyses remain limited, resulting in fragmented understanding of shared mechanisms and divergent pathways. Second, prior research often emphasizes either state intervention or market dynamics, creating a theoretical imbalance that overlooks the complex interplay between policy direction, firm strategy, and global value chains. Third, studies typically investigate innovation outcomes, such as patenting or industrial performance, without addressing the underlying systems level processes, including long term talent pipelines, cross sector collaboration, or cultural factors that shape innovation behavior. Finally, there is a notable lack of transferability frameworks for emerging economies. While East Asia's experience is widely cited, the literature provides few integrated models to guide policymakers in adapting these lessons to different institutional contexts.

Although these perspectives are insightful, comparative synthesis remains limited and often underplays the interplay of policy direction, firm strategy, and global value chains, as well as the long-term talent pipelines and cross sector coordination that underpin innovation (Rodrik, 2004; Lee, 2013).

Together, these inconsistencies reveal the need for a structured, multi country comparative review that synthesizes both common success factors and country specific dynamics. This study responds to that gap by integrating empirical findings across Japan, South Korea, and China to articulate the foundational mechanisms that enabled their transitions from manufacturing led growth to innovation driven development.

2.1. Japan: Precision, Policy, and Continuous Improvement

Japan's postwar recovery combined strategic policy and quality science, which raised productivity and reliability across sectors (Johnson, 1982; Odagiri & Goto, 1996). The diffusion of statistical quality control and management philosophies associated with W. Edwards Deming, the Deming Prize, and shop floor routines such as kaizen formed the backbone of Japan's production excellence (Deming, 1986; Tsutsui, 1996; Imai, 1986; Cole, 1999). These routines were formalized through the Toyota Production System and widely documented managerial principles (Ohno, 1988; Liker, 2004; Womack, Jones, & Roos, 1990).

Japan's recovery after the Second World War represents one of the most significant industrial transformations in modern history. Although the national economy was devastated, Japanese leaders saw manufacturing not only as a source of recovery but also as an opportunity to pursue excellence in production and product quality.

Postwar capability building in Japanese consumer electronics relied heavily on formal licensing from U.S. incumbents. A widely documented example is RCA's licensing of transistor technology to Sony, which catalyzed Japan's early move from imitation to adaptation and ultimately product leadership in portable electronics (Hospitality Paradigm, 2017). Rather than emphasize any single bilateral corporate tie in telecommunications, we note more generally that foreign-supplier relationships and standards work supported learning and diffusion in Japan's communications sectors throughout the 1950s-1960s, so we avoid attributing specific collaborations where authoritative documentation is lacking.

Key Drivers of Japan's Success

- Strong government coordination through the Ministry of International Trade and Industry.
- Continuous improvement and learning manufacturing principles, which became widely adopted through the Toyota Production System.
- Consistent investment in research leads to global leadership in robotics, semiconductors, and precision engineering.
- Global branding and the rise of internationally recognized firms such as Sony, Toyota, and Panasonic.

By the 1980s, Japan had progressed from a supplier of low-cost licensed goods to a global leader in electronics and automotive innovation.

2.2. South Korea: Education, R&D, and the Rise of the Chaebols

South Korea's economic transformation, often called the Miracle on the Han River, took the country from postwar poverty to global prominence in technology and manufacturing. The process began with substantial support from the United States government through programs that supplied machinery, materials, and technical expertise.

In the 1960s, the launch of the first Five Year Economic Development Plans under President Park Chung Hee initiated rapid industrialization. In this period, U.S. multinationals became increasingly active in Korea during the 1970s, contributing capital, market access, and managerial know-how alongside the country's export-discipline regime (Hwang, 2023). Contemporary archival material assembled by The Korea Society's corporate-legacies project documents broad American business participation in Korea's 1970s industrialization, while recent scholarship tracks the evolution of Korea's inward FDI policies and inflows from the 1960s through the post-crisis liberalization period (The Korea Society, n.d.).

Korea's ascent reflects reciprocity between state and business, export discipline, and deliberate capability building by large business groups (Amsden, 1989; Amsden, 2001). Investments in education and research intensity supported movement into complex technology sectors, with policy evolution and ecosystem broadening documented in multilateral assessments (Soh, Koh, & Aridi, 2023; Hwang & Yoon, 2025).

Key Drivers of South Korea's Success

- Strong government coordination linking industry, academia, and public institutions.
- Major investments in education that rapidly increased literacy and technical skills.
- Development of large family-led business groups that drove rapid industrial growth.
- Exceptionally high levels of research spending relative to national income.

South Korea is now a global leader in display technology, smartphones, electric vehicles, and advanced communication systems.

2.3. China: Scale, Strategy, and Technological Ambition

China's development path differs significantly from that of Japan and South Korea. Initially known for low-cost labor and mass production, China has increasingly pursued technological independence and innovation.

Following the establishment of diplomatic relations between China and the United States in 1979 and the beginning of market-oriented reforms, foreign multinationals entered China predominantly through state-approved joint ventures, providing channels for technology transfer, process learning, and export-platform development; we reference this pattern without naming specific bilateral deals unless supported by primary documentation. These early ventures laid the foundation for knowledge transfer and manufacturing capability.

During the 1990s, foreign investment increased rapidly, especially in apparel, appliances, and electronics, supported by China's expanding infrastructure and the growth of Special Economic Zones. By the 2000s, global value-chain integration deepened substantially in electronics: Apple exemplifies the shift from final assembly to increasing component sourcing and production scale within China, while PC makers such as HP and Dell also built extensive manufacturing footprints before more recent diversification to Southeast Asia and Mexico (Miller & Venugopalan, 2025; SupplyChains Magazine, 2026).

A major shift occurred in 2015 with the introduction of the Made in China 2025 program. This initiative sought to upgrade the nation's technological capabilities in areas such as robotics, aerospace, and high technology equipment. The government also expanded science and engineering education as well as scholarship programs to develop a highly skilled workforce.

These policies allowed companies such as Huawei, DJI, BYD, and Xiaomi to move from contract manufacturing to original design and ultimately to the creation of their own branded products.

China's trajectory moved from export platform to technology ambition through Special Economic Zones and later mission-oriented programs (Brandt & Rawski, 2008; State Council of the People's Republic of China, 2015). Evidence shows how SEZs catalyzed institutional learning and upgrading, while later programs targeted advanced manufacturing and digital technologies (World Bank & Zeng, 2010; World Bank & Zeng, 2015; Wang, 2013; Naughton, 2021). Firm and sector analyses illustrate the rise of domestic champions in telecommunications, batteries, electronics, and artificial intelligence (Al Midfa, 2025; Jin & Wang, 2025)

Key Drivers of China's Success

- Long term national planning through programs that encourage climbing the value chain.
- Continuous acquisition and adaptation of foreign technology.
- Large domestic markets that support rapid scaling of new technologies.
- Growth of powerful technology firms that lead globally in telecommunications, artificial intelligence, and electric vehicles.

2.4. Mexico: Innovation Constraints, Institutional Fragmentation, and Learning Gaps

The literature on Mexico's technological development highlights a persistent disconnect between its relatively diversified manufacturing base and its limited progress in innovation-driven upgrading. Numerous analyses show that Mexico remains an outlier among upper-middle-income economies due to its chronically low research intensity, which has hovered near 0.27 percent of GDP, far below the OECD average and insufficient to sustain cumulative capability building (OECD, 2025a; UNESCO Institute for Statistics, 2025). This structural underinvestment is widely documented in national innovation assessments and comparative R&D indicator series, which consistently place Mexico at the bottom of the OECD and significantly below emerging Asian peers (University of Cambridge Policy Links, 2024; World Bank, 2025; OECD, 2025c).

A recurring theme in the literature concerns institutional fragmentation, where weak coordination among federal agencies, research institutes, universities, and industry constrains coherent innovation policy. National reports and policy analyses identify inconsistent implementation, short planning horizons, and limited alignment between industrial priorities and STI programs as critical barriers to capability accumulation (Wilson Center, 2024; University of Cambridge Policy Links, 2024). These governance challenges contrast sharply with East Asian developmental experiences, where structured missions and strong public-private linkages played central roles in technological upgrading (Amsden, 1989; Lee, 2013).

Firm-level studies reinforce this systemic picture. Sectoral analyses indicate that although Mexico is deeply embedded in global value chains—particularly in automotive, aerospace, and electronics—domestic firms capture limited learning benefits, remaining concentrated in assembly activities with shallow technological absorption (Inter American Dialogue, 2024; Trade.gov, 2024). Supplier upgrading programs, structured capability-building initiatives, and collaborative R&D mechanisms are comparatively rare, reducing opportunities for "learning before invention," a dynamic central to latecomer innovation (Lall, 1992; Kim, 1997). Innovation surveys find low R&D investment, weak university-industry collaboration, and limited progression toward engineering, design, or original product development (Wilson Center, 2024).

Strategic analyses further argue that Mexico has not leveraged its large domestic market as a platform for innovation, lacking mission-oriented programs capable of mobilizing firms, ministries, and research institutions around frontier technologies. While recent initiatives in digital transformation and green technologies signal emerging priorities, they remain fragmented and modest in scope compared with large-scale missions implemented in Japan, Korea, and China (Rodrik, 2004; Mazzucato, 2013). Overall, the literature converges on three interrelated constraints (low research investment, fragmented STI governance, and weak firm-level learning routines) that hinder Mexico's transition from incremental modernization to innovation-driven upgrading.

2.5. Chile: Natural-Resource Strengths, Innovation System Bottlenecks, and Coordination Challenges

Chile's innovation trajectory is marked by strong macroeconomic performance and global leadership in natural-resource sectors, yet persistent limitations in building technology-intensive industries or sustained innovation capabilities. Comparative R&D statistics consistently place Chile's research spending at 0.36 - 0.39 percent of GDP, similar to Mexico's and far below levels observed in East Asian economies (IMF, 2025; International Monetary Fund, 2025; UNESCO Institute for Statistics, 2025). Analyses by the OECD and international STI observatories highlight that Chile's low and stagnant research intensity restricts capability development and limits movement into higher-value segments of global value chains (OECD, 2025b; WIPO, 2025).

A central theme in the Chilean literature involves institutional fragmentation and weak coordination across the innovation system. Multiple country reviews identify overlapping mandates, insufficient inter-agency collaboration, and limited alignment between long-term development goals and innovation policy (OECD, 2025b; UK Department for Science, Innovation & Technology, 2025a, 2025b; United Kingdom Government, 2025). Although Chile has launched prominent programs through CORFO—especially in green hydrogen, solar energy, and advanced materials—these initiatives often operate in isolation rather than as part of a unified national mission. This stands in contrast to East Asian models, where mission-oriented policy frameworks integrated industrial strategy, education reform, and firm-level capability building (Freeman, 1987; Lundvall, 1992).

Firm-level evidence shows that while Chile has developed pockets of excellence in mining services, renewable energy, and agrifood technologies, overall innovation diffusion remains slow, particularly among SMEs. National innovation surveys report limited university-industry collaboration, low patenting outside natural-resource technologies, and weak supplier ecosystems capable of absorbing and adapting advanced technologies (WIPO, 2025; OECD, 2025a). These patterns mirror Mexico's constraints, insufficient learning mechanisms, limited coordinated upgrading, and weak incentives for firms to invest in engineering and R&D.

Comparative studies emphasize that although Chile has strengthened regulatory frameworks and maintained macroeconomic stability, it has not deployed large-scale industrial missions or long-horizon technology programs akin to those in East Asia (Lee, 2013; Amsden, 2001). Its smaller domestic market further limits opportunities to leverage scale-driven learning, increasing the importance of strategic coordination and targeted capability building. Consequently, Chile remains positioned as a resource-competitive, high-income economy with incomplete innovation system development and slow progress toward diversified technological upgrading.

3. Methodology

A qualitative comparative research design is employed to investigate the mechanisms through which Japan, South Korea, and China evolved from manufacturing-centered economies into innovation-driven industrial leaders. A qualitative approach is appropriate because the aim is to understand complex institutional dynamics, long-term policy frameworks, and strategic national decisions rather than quantify performance indicators. Secondary data drawn from peer-reviewed journal articles, books, policy reports, and publications from international organizations form the foundation of the analysis. Sources were selected based on their relevance to national innovation systems, industrial policy, technological capability development, and East Asian economic transformation, with emphasis on works published between 1990 and 2025 to incorporate both historical context and contemporary developments.

The literature search followed a systematic set of procedures. Searches were conducted across major academic and institutional databases, including Web of

Science, Scopus, JSTOR, Google Scholar, the World Bank Open Knowledge Repository, the OECD iLibrary, and the UNESCO Institute for Statistics portal. Keyword combinations included terms such as "technological upgrading," "latecomer innovation," "industrial policy," "national innovation systems," "mission-oriented policy," "organizational routines," "learning before invention," and country-specific labels such as "Japan innovation," "Korea technological development," and "China industrial transformation." Inclusion criteria prioritized peer-reviewed studies, scholarly monographs, and authoritative policy analyses offering empirical evidence related to capability building or system-level innovation dynamics. Exclusion criteria removed sources lacking analytical depth, documents composed primarily of anecdotal accounts, or materials not directly addressing institutional or technological mechanisms. Sources meeting these criteria were then grouped by country according to whether they provided sustained empirical analysis of Japan, South Korea, or China, or contributed cross-national insights.

Data collection followed a structured review process in which literature was identified, screened, and examined for recurring patterns involving state intervention, technology transfer, education systems, industrial strategies, and investment in research and development. More than thirty sources meeting these criteria were included. The analytical process incorporated descriptive coding to identify emergent themes, thematic synthesis to connect findings with established theoretical frameworks, and cross-case comparison to highlight similarities and differences among the three national experiences. This integrated approach facilitates a coherent understanding of the mechanisms that have shaped innovation trajectories across the region.

The coding process used for thematic synthesis unfolded in several stages. First, descriptive codes captured recurring topics such as state coordination, technology absorption, human capital formation, export discipline, and firm-level learning routines. Second, these descriptive codes were consolidated into analytical categories corresponding to the core constructs defined in the conceptual framework, including technological upgrading, innovation transitions, mission orientation, and learning before invention. Third, comparative coding matrices were created to map how each theme manifested across the three country cases, supporting a structured assessment of convergences and divergences within their innovation pathways. This approach ensured that thematic interpretation remained grounded in the evidence base while preserving conceptual coherence across the comparative analysis.

The selection of a qualitative comparative design is justified by the systemic nature of national innovation processes. Innovation capacity arises from interactions among governments, firms, universities, and global markets; consequently, qualitative methods offer a more comprehensive interpretation of these relationships than quantitative techniques alone. Reliance on secondary sources is appropriate due to the extensive availability of scholarly and policy literature examining

East Asian industrial upgrading, which provides a robust empirical foundation without requiring primary fieldwork. A comparative perspective further strengthens the methodological approach by revealing shared strategies while recognizing contextual distinctions.

Validity is supported through triangulation, using evidence from a wide range of academic and institutional publications to corroborate major findings. Reliability is enhanced by prioritizing peer-reviewed and authoritative sources and by employing a transparent coding process that reduces interpretive bias.

A qualitative comparative design is appropriate for analyzing institutional dynamics and policy strategy, supported by established approaches in industrial policy and innovation systems (Rodrik, 2004; Lundvall, 1992). Where international indicators are used to triangulate claims on research effort and outcomes, the analysis draws on OECD MSTI, UNESCO Institute for Statistics, World Bank Data, and the United States National Science Foundation's NCSES series (Organization for Economic Cooperation and Development, 2025a; United Nations Educational, Scientific and Cultural Organization Institute for Statistics, 2025b; World Bank, 2025; U.S. National Science Foundation, National Center for Science and Engineering Statistics, 2025).

Mexico and Chile are incorporated into the research design as comparative reference cases because both countries possess relatively strong macroeconomic foundations and diversified export structures, yet neither has succeeded in developing technology-intensive export sectors or in transitioning toward sustained innovation-led growth. Their inclusion allows for a systematic contrast between economies that have accumulated production capabilities without achieving technological upgrading and the East Asian economies that have progressed into globally competitive innovation systems. The assessment of Mexico and Chile relies on a consistent set of empirical sources aligned with the categories used for Japan, Korea, and China. Claims regarding research and development intensity draw on data from the OECD Main Science and Technology Indicators, the UNESCO Institute for Statistics, and World Bank R&D expenditure series. Evidence concerning coordination challenges is sourced from OECD country reviews, national innovation policy assessments, and reports from international financial institutions examining inter-agency alignment and institutional fragmentation. Firm-level learning patterns and capability constraints are analyzed using innovation surveys, productivity studies, and sectoral reports produced by organizations such as the Wilson Center, CORFO, and the Inter-American Dialogue. Each dimension (technological upgrading, innovation transition, mission orientation, organizational routines, and learning before invention) is examined using the same comparative framework applied to the East Asian cases, enabling a coherent evaluation of why Mexico and Chile have not yet achieved similar innovation outcomes despite their economic scale and productive potential.

4. Results

Across the three economies, state enabled capability building, strategic absorption of foreign technology, human capital driven productivity growth, and mission-oriented research underpin the transition from assembly to innovation leadership (Freeman, 1987; Lundvall, 1992; Mazzucato, 2013). Export markets and continuous improvement routines helped firms translate inputs into process and product innovation (Liker, 2004; Womack et al., 1990). Comparative indicators on innovation performance and research effort corroborate the broad shift toward higher value activities (Our World in Data, 2025; WIPO, 2024; United Nations Educational, Scientific and Cultural Organization Institute for Statistics, 2025a; Organization for Economic Cooperation and Development, 2025b, 2025c).

The combined evidence from Japan, South Korea, and China shows that the shift from low-cost assembly to technology leadership resulted from consistent investment in capability building supported by the state. The three countries absorbed foreign knowledge strategically, developed human capital, and increased research investment while using export markets to scale production and fund further technological advancement.

Japan's transformation involved a national commitment to quality improvement and international competitiveness. South Korea's rise was shaped by a coordinated state industry system and exceptionally high levels of research and education investment. China's rapid ascent followed a sequential process that began with Special Economic Zones and continued with large scale innovation programs that encouraged digital manufacturing and extensive patenting activity.

All three countries created conditions in which firms could reinvest in more complex products, improve production processes, and expand into global markets.

4.1. Japan: From Reconstruction to Process Excellence and Global Product Leadership

4.1.1. Foundational Capability Building through Policy and Quality Science

Japan's reconstruction married sectoral policy under MITI with quality science, creating productivity and reliability gains across industries (Johnson, 1982; Odagiri & Goto, 1996). The spread of statistical quality control and the Deming Prize institutionalized continuous improvement throughout supply networks (Deming, 1986; Tsutsui, 1996).

Evidence from classic and contemporary scholarship shows that Japan's industrial reconstruction combined coherent industrial policy under the Ministry of International Trade and Industry (MITI) with quality science-driven process control, forming the bedrock for productivity gains and reputation for quality. Johnson's seminal account documents MITI's role as an "economic general staff," orchestrating resource allocation, export promotion, and technology catch up in targeted sectors from the 1950s onward. Japanese industry absorbed statistical quality control (SQC) and the managerial philosophy propagated by W. Edwards Deming beginning in 1950; the diffusion of SQC, Total Quality Control, and the institutionalization of the Deming Prize catalyzed firm level continuous improvement cycles (**Table 1**).

Table 1. Descriptive statistics of key variables.

Period	Policy or Practice	Capability Effect
1940s-1950s	MITI coordination of priority sectors; selective protection and export promotion	Reallocation toward scale industries; learning rents for capability building
1950-1952	SQC lectures and executive courses by Deming; foundation of Deming Prize (1951)	Rapid diffusion of process control, PDCA routines, supplier quality cascades
1960s-1970s	TQC/TPS adoption; supplier development within keiretsu; export upgrading	Defect reduction, cost and lead time compression, global quality reputation
1970s-1980s	Strategic push in autos, electronics, precision engineering	Breakthrough product leadership and global brand ascent

4.1.2. Mechanisms Observed in Private Companies

Firm level studies show how production leveling, standardized work, and visual control embed problem solving and learning in daily operations, sustaining reliability and innovation (Ohno, 1988; Liker, 2004; Womack et al., 1990).

Firm-level analysis demonstrates that practices embedded in the Toyota Production System (TPS) and associated practices (heijunka, jidoka, standardized work, visual control) shows how process discipline and problem solving routines institutionalized learning and uplifted the national reputation for reliability. The Toyota Way literature delineates 14 managerial principles that tightly couple long term philosophy, process design, people development, and relentless reflection, making continuous improvement a daily operating system rather than episodic projects.

4.1.3. Results Summary for Japan

The results for Japan show that policy guided sectoral bets plus quality science institutionalization generated a durable edge in reliability sensitive industries. Historical evidence supports the view that capability deepening preceded brand ascendancy, with manufacturing excellence enabling product differentiation and global standards setting in autos, electronics, and robotics.

4.2. South Korea: Developmental State, Large Business Groups, and Research Intensification

4.2.1. Coordination between Government and Industry and Emphasis on Export Performance

Korea linked support to measurable export and productivity outcomes for large business groups, creating credible long horizon investment incentives in heavy and chemical industries and later in information and communication technologies (Amsden, 1989; Amsden, 2001). Recent assessments describe a research intensive, digitally advanced system and the need to diffuse capabilities more widely (Soh et al., 2023; Organization for Economic Cooperation and Development, 2025a).

South Korea's results exhibit a strong developmental state architecture that coupled five year plans with performance conditioned support to large business groups (chaebols), creating a credible commitment to long horizon investments in heavy and chemical industries and later in semiconductors and ICT. Amsden's late industrialization analysis emphasizes reciprocity (state support in exchange for export and productivity performance) while the OECD's recent review confirms that this coordination expanded into today's high innovation inputs and digital infrastructure leadership.

World Bank synthesis on Innovative Korea documents the growth model transition from input led to productivity and innovation led growth, particularly after the Asian Financial Crisis, alongside policy refocusing toward SMEs, entrepreneurs, and technology diffusion beyond the chaebol core (World Bank, 2020).

4.2.2. Education and Research Intensity as Engine of Upgrading

Korea's human capital frontier and GERD intensity underpin the leap into complex technology domains. Comparative indicators (Table 2) show Korea as one of the world's highest R&D spenders as a share of GDP (5.00 percent in 2025) with a high share of tertiary graduates in STEM fields and strong business R&D participation, while OECD MSTI and national statistics consistently rank Korea near the top globally.

High research effort and deep STEM pipelines underpin Korea's advances into complex technologies, as reflected in internationally comparable indicators (Organization for Economic Cooperation and Development, 2025a; World Bank, 2025; United Nations Educational, Scientific and Cultural Organization Institute for Statistics, 2025a).

Table 2. R&D Expenditure as a share of GDP.

Country	Latest R&D % of GDP (2025)
Israel	6.30%
South Korea	5.00%
Taiwan	3.80%
United States	3.60%
Sweden	3.55%
Japan	3.40%
China	2.6%

4.2.3. Firm Level Outcomes: Semiconductor, Displays, and ICT Ecosystems

Results indicate that semiconductors, displays, and ICT benefited from coordinated investment, workforce quality, and export discipline. The OECD (2023) points to Korea's excellence in semiconductors and advanced connectivity, while the World Bank's Innovative Korea traces the institutional reforms that expanded innovation beyond large incumbents, including startup systems and knowledge diffusion.

4.2.4. Results Summary for South Korea

The Korean results show a high coordination, high investment development path where state discipline, chaebol scale, and world class human capital co evolved. GERD intensity, STEM pipelines, and global value chain participation jointly produced leadership in semiconductors, advanced manufacturing, and digital infrastructure.

4.3. China: Sequenced Opening, Scale Based Accumulation, and Mission Oriented Upgrading

SEZs served as experimental platforms that attracted foreign capital and enabled institutional learning, later complemented by mission-oriented programs such as Made in China 2025 (World Bank, Zeng, 2010; World Bank, Zeng, 2015; State Council of the People's Republic of China, 2015).

4.3.1. SEZs as Experimental Platforms for Opening and Learning

Documentary and analytic evidence identifies Special Economic Zones (SEZs) as pivotal experimental platforms that enabled China to introduce foreign capital, modern management practices, and export-oriented production within controlled regulatory environments (Farole, 2011). Early SEZs such as Shenzhen, Zhuhai, Shantou, and Xiamen were designed as contained spaces where policy makers could test market mechanisms without risking nationwide disruption. Comparative analyses by the World Bank, including Zeng's influential studies from 2010 and 2015, emphasize that these four initial zones not only attracted substantial foreign direct investment but also facilitated the diffusion of logistics capabilities, contract manufacturing models, and industrial clustering economies across broader regions. As reforms deepened, later generations of SEZs expanded inland and evolved into high technology parks, free trade zones, and innovation driven development corridors, creating a progressively more sophisticated ecosystem for technology upgrading and industrial diversification.

Table 3. China's opening and upgrading milestones.

Period	Policy or Practice	Capability Effect
1978-1984	Policy of reform and opening; first SEZs (Shenzhen, Zhuhai, Shantou, Xiamen)	FDI inflow, export platforms, institutional experimentation
1990s	Expansion of development zones and coastal liberalization	GVC integration, rapid manufacturing scale up
2000s	Depending on OEM to ODM transitions in electronics; robotics adoption rises	Process sophistication, partial domestic design competencies
2015 onward	Made in China 2025 and related programs	Mission oriented upgrading in 10 strategic sectors; mixed firm level effects on productivity/R&D in listed companies

Historical syntheses by scholars such as Barry Naughton and Brandt and

Rawski place SEZs within China's broader reform narrative, arguing that their success reflects a combination of gradualism, pragmatic experimentation, and evidence-based policy adaptation (**Table 3**). SEZs served as institutional laboratories where policy makers observed firm behavior, calibrated incentives, and incrementally shifted the national economy from factor accumulation toward productivity driven, innovation-oriented growth.

4.3.2. Mission Oriented Industrial Policy and Sectoral Outcomes

Made in China 2025 (MIC2025) articulates targets for domestic content and leadership in ten strategic sectors (e.g., advanced ICT, machine tools and robots, EVs, biopharma). Independent assessments from MERICS highlight the program's techno nationalist logic and heavy use of state instruments to accelerate "smart manufacturing." Evidence on outcomes is heterogeneous: a firm level difference in differences analysis on listed companies found increased access to innovation promotion subsidies for MIC targeted firms but limited near term gains in productivity, R&D spending, patenting, or profitability, indicating time to impact or allocation frictions. At the same time, global indicators document very high patenting volume and rapid diffusion of industrial robotics, consistent with accelerated capability deepening across multiple manufacturing chains.

Firm level and macro indicators show mixed short run productivity effects but strong increases in patenting and rapid adoption of advanced production technologies (Jin & Wang, 2025; WIPO, 2024; Wu et al., 2025; Zang et al., 2025).

4.3.3. Indicators of Innovation System Maturity

China's innovation trajectory can also be assessed through internationally comparable indicators that capture research effort, patenting, and automation. All indicators below refer to observed values rather than projections, and the time basis has been standardized to the most recent reporting years (2023-2025):

- **Patenting:** WIPO's 2024 release on the 2023 filing year records China as the world's leading patent filing jurisdiction by a wide margin, with Japan and Korea ranking among the top five; Asian offices account for a dominant share of global patent, trademark, and design filings. While counts do not equate to quality, they signal the scale and breadth of inventive activity and IP formalization.
- **Robotics diffusion:** China became the world's largest industrial robot market by installation volume during 2022-2023, driven by upgrading in automotive, electronics, and electric-vehicle supply chains. This pattern is documented in several assessments of Chinese manufacturing upgrading (Wu, Si, & Wang, 2025), which link rising robot density to productivity and process-quality improvements. All reported values reflect verified installations rather than projected adoption rates.
- **R&D intensity:** Internationally comparable data place China's GERD at 2.6 percent of GDP, reflecting sustained increases though still below Korea and Japan on a relative basis.

4.3.4. Results Summary for China

China's findings reveal sequenced institutional change and mission oriented industrial policy interacting with vast market scale to accelerate capability accumulation. While micro evidence on firm productivity effects of MIC2025 is mixed in the short run, macro scale indicators (patent filings, robotics acquisition, and deepening supply chains) point to rapid movement toward higher value-added production and export sophistication.

4.4. Cross Country Comparative Results

4.4.1. Convergent Mechanisms

- **State strategic coordination**: In all three economies, public agencies signaled long term priorities, lowered investment risk in targeted sectors, and created selection environments that rewarded learning and export performance. MITI's role in Japan, Korea's planning bodies and STI governance, and China's SEZ to program architecture represent varied but functionally equivalent means of aligning actors and mobilizing resources for upgrading.
- **Technology absorption and localization**: Each country institutionalized learning from foreign technology through licensing, joint ventures, standards work, and supplier development, then reinvested savings from process gains into design and engineering capability. Japan's early licensing and SQC based process mastery, Korea's export tied performance obligations, and China's SEZ enabled OEM learning platforms exemplify this pattern. National innovation system literature provides a theoretical bridge explaining how system level interactions among firms, universities, and government agencies translate external knowledge into domestic capability.
- **Human capital and R&D intensity**: The three countries converged on STEM heavy education pipelines and rising GERD, though Korea's intensity leads. These inputs complement process improvement and design capability, supporting transitions from volume to complexity.
- **Export discipline and** scale: Export markets imposed a discipline of reliability, cost, and lead time that fed continuous improvement in Japan and Korea; China added domestic scale as an accelerant for fast learning cycles, aided by policy tools that funded automation and manufacturing innovation (Table 4).

Table 4. Comparative mapping of drivers and outcomes.

Mechanism	Japan	South Korea	China
State coordination	MITI guides sectors, export promotion	Developmental state, performance tied support	SEZs to MIC2025, multi-instrument missions
Learning from foreign tech	Early licensing + SQC/TQC	OEM supplier upgrading + chaebol integration	JV platforms, OEM to ODM to OBM
Human capital	Engineering culture, QC circles	STEM surge, tertiary attainment	Massive STEM expansion, re skilling
R&D intensity	High and steady	World leading share of GDP	Rising quickly from lower base
Export and scale	Quality brand leadership	Global niches, semiconductors	Export plus large home market for iteration

4.4.2. Divergent Pathways and Institutional Fingerprints

Japan's process centric improvement system arose from early quality science diffusion and keiretsu supplier ecosystems, embedding tacit routines that scaled across sectors. Korea's discipline plus scale regime developed around chaebol state reciprocity, enabling capital intensive bets in semiconductors and heavy industry with exceptional R&D intensity. China's pathway features experimentation at scale and mission programs designed to push indigenization and reduce foreign tech dependence, with very high patenting and automation reinforcing capability deepening.

4.4.3. Quantitative Indicators of Innovation Outcomes

Global IP and R&D indicators triangulate the results narrative. Patent filings in 2023 were led by China, followed by the United States, Japan, and Korea, with Asian offices now accounting for roughly two thirds of global filings. R&D intensities show Korea as global outlier on spending share, with Japan also high and China rising rapidly. These external benchmarks corroborate the transition from manufacturing scale to innovation breadth, while also highlighting ongoing differences in knowledge quality and diffusion that are the focus of current policy debates.

4.5. Thematic Deep Dives by Country

4.5.1. Japan: Quality as a Platform for Innovation

Archival and scholarly records make clear that quality methods did more than reduce defects; they created a distributed problem-solving capability that accelerated equipment assimilation, supplier upgrading, and product development cycles. The Toyota Way emphasizes leader development, genchi genbutsu, and consensus decision making, which together produce organizational learning at scale. This learning infrastructure transformed imported technologies into superior products and set global standards in automotive systems and consumer electronics.

4.5.2. South Korea: From Performance Reciprocity to Frontier Technologies

Table 5. Selected Korean strengths and system tensions.

Dimension	Strength	System Tension
Inputs	High GERD, STEM graduates	SME adoption gap relative to chaebols
Infrastructure	5G, ICT backbone	Services productivity lag
Global linkages	Strong GVC integration	Need to diversify innovation beyond large firms

Historical comparisons show that Korea's reciprocity principle (linking state support to export and productivity targets) created hard budget constraints and accelerated learning (Table 5). Over time, this evolved into frontier innovation in semiconductors, with system scale investments, process R&D, and a deep domestic supplier base, while policy has more recently focused on broadening diffusion to SMEs and service sectors. The OECD (2023) points to imbalances between chaebols and SMEs and between manufacturing and services, implying a next stage centered on inclusive diffusion and demand side innovation.

4.5.3. China: Mixed Micro Effects Amid Macro Scale Acceleration

The dual reality in China's results deserves careful interpretation. On the one hand, firm level econometric evidence (e.g., listed firms) shows muted short run gains in productivity and R&D from MIC2025, suggesting policy allocation frictions, measurement lags, or the need for complementary governance and market reforms. On the other hand, system level indicators—robot installations, patent filings, and the maturation of EV, battery, and electronics chains—reveal swift capability deepening, consistent with state orchestrated missions, massive market scale, and rapid adoption cycles.

4.6. Integrated Interpretation of Findings

4.6.1. Systems Logic of Latecomer Innovation

The literature on national innovation systems and latecomer strategies helps generalize these results. Freeman's analysis of Japan and Liu & White's framework for China underscore that innovation performance depends on how system activities (R&D, education, implementation, end use, and linkages) are organized and coordinated, not simply on input levels. In all three cases, state coordination structured those linkages, export markets raised performance thresholds, and firm routines ensured that learning was cumulative.

4.6.2. Role of Scale, Speed, and Missions

Japan and Korea show how process excellence and R&D intensity can move a nation to the global technology frontier; China layers on sheer scale and mission programs to compress timelines, achieve fast adoption of automation, and push up the domestic content of complex equipment. Yet missions can yield uneven micro-outcomes if governance, market signals, or capability thresholds limit the conversion of subsidies into productivity during initial phases.

4.6.3. Quantitative Corroboration and Caveats

Table 6. GERD Comparative mapping of drivers and outcomes.

Indicator	Japan	South Korea	China
GERD (% GDP) (2025)	3.4	5.2	2.6
Patent filings rank (2023)	Top five	Top five	Number one
Industrial robotics status	Longstanding leader in reliability/precision	High robot density in electronics/auto	Largest market and user by volume

Cross checks against R&D intensity (Table 2) and IP filings confirm that all three economies allocate substantial resources to innovation and codify knowledge at large scale, albeit with differences in quality composition and commercial impact that require further micro data evaluation (triadic patents, citation weighted measures, export unit values) (see Table 6).

5. Discussion

The comparative analysis of Japan, South Korea, and China reveals several cross-cutting mechanisms that reinforce and extend insights from the developmental state, latecomer innovation, and national innovation system literatures. Across all three cases, the results show that innovation transitions are not solely the outcome of market forces or isolated policy interventions; instead, they emerge from the interaction of institutions, firm behavior, and long-term learning trajectories. Together, these elements create the cumulative foundations on which sustained capability upgrading becomes possible.

A first major finding concerns the importance of institutional alignment. The evidence indicates that capability accumulation accelerates when industrial policy, firm strategy, and education systems evolve in mutually reinforcing ways. Japan's postwar quality institutions (built around statistical control and continuous improvement) represent one mode of alignment; Korea's reciprocity mechanisms between the state and large business groups represent another; and China's mission-oriented programs illustrate a more centralized and directive variant. Although these institutional forms differ, they converge in their ability to coordinate expectations, channel resources, and sustain long term upgrading. This reinforces earlier arguments that it is institutional coherence (rather than any single institutional design) that underpins the success of late industrialization.

Building on this, a second key finding highlights that learning consistently precedes invention at scale. Across all three countries, firms initially engage with foreign technologies through licensing, joint ventures, and reverse engineering; only later do they progress toward indigenous design, research and development, and eventually brand leadership. This staged learning trajectory aligns with latecomer innovation theories that emphasize absorptive capacity and accumulated production experience as prerequisites for original innovation. Japan's mastery of quality manufacturing, Korea's disciplined export performance, and China's large scale technology adaptation each demonstrate that imitation, adaptation, and capability absorption form the essential foundation for more advanced inventive activity.

A third insight concerns the critical interaction between resources and routines. High levels of research investment translate into frontier innovation only when firms possess organizational routines that convert inputs into productivity gains. Practices such as the Toyota Production System (TPS), structured problem solving, process control, and continuous improvement show how managerial discipline amplifies the impact of national research spending. Korea's growing scientific and engineering workforce and China's expanded research infrastructure create the potential for innovation; however, it is firm level routines (standardization; experimentation; incremental advancement) that determine how effectively this potential becomes sustained competitive advantage.

A fourth finding relates to the role of scale. The analysis shows that scale compresses time yet creates heterogeneity. China's vast domestic market and mission-oriented programs accelerate technology diffusion, patenting, and movement up the value chain; however, the breadth and speed of these reforms generate uneven firm level responses. Some sectors advance rapidly, while others lag because of differences in governance quality, managerial capability, or local institutional support. This suggests that scale alone does not guarantee uniform productivity gains; instead, program design and implementation quality are essential for translating national missions into consistent results at the firm level.

These comparative insights provide a useful foundation for examining the experiences of Mexico and Chile, where distinct structural gaps complicate the development of competitive technology industries. While the East Asian economies institutionalized long term industrial missions, coordinated policy frameworks, and high research intensity, Mexico and Chile continue to exhibit comparatively weak investment levels and fragmented innovation systems. Mexico allocates only 0.27 percent of GDP to research and development according to the most recent 2023 data; this level has remained stagnant for decades and is significantly below the OECD average of 2.7 percent. Chile's research spending is only slightly higher, at approximately 0.36 to 0.39 percent of GDP during the past six years, which also places it far below leading innovation economies (Germany Federal Statistical Office, 2024). These investment patterns limit the emergence of sustained learning cycles, advanced technological capabilities, and innovation oriented industrial strategies of the type observed in East Asia.

In addition to low research intensity, a second divergence involves institutional coordination and policy coherence. Mexico's 2025 national innovation outlook identifies chronic fragmentation between federal agencies, academic institutions, and industry as a central barrier to competitiveness. Policy implementation is often inconsistent and insufficiently aligned with long term industrial priorities. Comparable analyses of Chile's innovation system reveal weak inter institutional coordination, regional disparities in technological absorption, and an uneven ability to translate knowledge production into applied technological capabilities. These contrasts stand in sharp relief to Japan's coherent quality infrastructure, Korea's performance-based reciprocity framework, and China's mission-oriented approach in which ministries, firms, and training systems were strategically aligned for technological upgrading.

A third limitation for Mexico and Chile concerns firm level routines and learning mechanisms. In East Asia, supplier development programs, production discipline, and the early diffusion of managerial routines provided the scaffolding for subsequent invention and design capabilities. In Mexico, industrial activity remains heavily concentrated in assembly operations reliant on imported components; local firms exhibit limited incentives or capabilities to invest in advanced engineering and design. Chile experiences similar constraints: although it displays pockets of excellence in resource-based sectors, its innovation surveys reveal significant heterogeneity among industries, limited collaboration networks, and a low propensity to patent in many areas. These conditions diverge from the East Asian pattern in which dense supplier networks, technology consortia, and performance-based upgrading were deliberately cultivated through coordinated policy interventions.

Finally, the cases of Mexico and Chile highlight the limits of scale and strategic ambition. China leveraged its immense domestic market to accelerate multiple learning cycles, and both Korea and Japan deployed national technology missions oriented toward frontier sectors. Chile's innovation ecosystem is constrained by its smaller market size and narrower set of strategic missions, even though programs administered by agencies such as CORFO have advanced initiatives in green hydrogen, solar energy, and digital transformation. Mexico possesses a much larger market, yet it has not mobilized this scale through an integrated industrial innovation strategy that connects research investment, workforce development, and priority sectors. With private industry contributing less than one fifth of total research spending, Mexico's national research effort remains below internationally recommended thresholds. As a result, the institutional and financial foundations needed to support continuous capability accumulation are weaker than those observed in East Asia.

Together, these gaps show that the trajectories of Mexico and Chile diverge from those of Japan, Korea, and China not because of a lack of potential or entrepreneurial capacity, but because of limited investment, fragmented coordination, and incomplete development of firm-level routines. Strengthening institutional alignment, elevating research commitments, and fostering cooperative innovation networks will be essential for both countries if they wish to transition from incremental modernization toward sustained innovation driven development.

The implications of these findings extend beyond East Asia. They suggest that countries seeking to transition toward innovation driven growth must cultivate institutional coordination; prioritize staged capability building; and recognize that research investment must be paired with organizational routines and market discipline. At the same time, several limitations should be acknowledged. The analysis relies primarily on secondary sources and may obscure local variation or recent policy adjustments. The comparative approach emphasizes shared mechanisms, yet it cannot fully incorporate the historical, cultural, and political contexts that shape each national trajectory. Finally, the rapid evolution of technologies such as artificial intelligence, digital platforms, and advanced manufacturing may alter the relevance of traditional latecomer strategies and raise questions about how applicable these lessons will remain in the future.

Despite these limitations, the study reinforces the conclusion that innovation driven upgrading is a cumulative and institutionally mediated process in which learning, alignment, routines, and scale interact to shape long term national outcomes.

6. Conclusions

The comparative examination of Japan, South Korea, and China clarifies the central mechanisms that enable late industrializing economies to progress from low-cost production to sustained innovation leadership. The analysis shows that successful upgrading depends on a long-term interplay among institutional alignment, staged learning, organizational routines, and the strategic use of domestic scale. When industrial policy, firm strategy, and education systems reinforce one another, capabilities accumulate more quickly and position firms to engage in progressively more complex technological activities. Similarly, the transition from technology absorption to indigenous innovation evolves through incremental learning processes in which production experience, quality improvement, and supplier development lay the groundwork for original research. Firm level routines, including standardized work, structured problem solving, and continuous improvement, amplify the impact of national research investments and transform inputs into productivity gains. In addition, the ability to mobilize large domestic markets or mission-oriented programs can accelerate diffusion, although uneven outcomes across sectors suggest that scale requires complementary institutional design and consistent implementation.

The findings also shed light on the structural constraints facing countries such as Mexico and Chile as they pursue their own innovation ambitions. Low research intensity, fragmented policy coordination, and insufficient development of firm level capabilities continue to limit the emergence of dynamic technology sectors. While East Asian economies built coherent mission driven frameworks and cultivated dense learning networks among firms, universities, and government agencies, Mexico and Chile have yet to establish comparable mechanisms. Strengthening institutional alignment, elevating national commitments to research, and building cooperative innovation networks will be essential for any sustained shift toward higher value technological activity.

Several promising opportunities for further research emerge from these insights. Future work could investigate more closely how firm routines interact with industrial policy in emerging economies, particularly in sectors shaped by artificial intelligence, advanced manufacturing, and green technologies. Cross regional comparative studies would be valuable for understanding how political institutions, regulatory environments, and educational systems condition the transferability of East Asian developmental strategies to Latin America, Africa, or Southeast Asia. Longitudinal analysis of how innovation systems evolve across multiple generations of firms could also deepen understanding of capability accumulation and diffusion. Additional inquiry into how global disruptions such as climate transitions, digitalization, and geopolitical fragmentation influence national innovation strategies would further enrich the field.

Taken together, the evidence underscores that innovation driven by upgrading is not a single event but a long term, institutionally mediated process. Learning, alignment, routines, and scale interact in cumulative ways to shape national outcomes. Countries that succeed in coordinating these elements are more likely to sustain technological progress and build competitive positions in the global knowledge economy.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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