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THE JAGUAR AFTER THE ASIAN TIGERS?

Mexico's technology commercialisation problem and the case for 'technological learning accelerators'

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ABOUT THE OXFORD-MEXICO CO-LAB OF INDUSTRIAL POLICY

The Oxford–Mexico Industrial Policy Co-Lab is a collaborative initiative between the Technology and Industrialisation for Development Centre (TIDE) at the University of Oxford and FuturoLab. This project aims to foster applied research and the international exchange of best practices in industrial policy aligned with the challenges and opportunities facing Mexico and other Latin American countries.

In Mexico, in collaboration with public-sector and international partners, we produce research, case studies, and tools that inform and facilitate the development and coordination of industrial policies across multiple levels of government.

ABSTRACT

Mexico stands at a pivotal moment in its economic development. Decades of integration into global value chains have yielded a sizeable manufacturing base and important productive capabilities across automotive, aerospace, electronics, medical devices, and advanced agroindustry. Yet this productive breadth has not translated into sustained productivity gains, endogenous innovation, or broader processes of capability building. Substantial assets coexist with weak technological accumulation. Mexico suffers from two compounding failures: (i) an inability to absorb and transfer foreign technology, and (ii) an inability to commercialise domestically generated knowledge. Both, this research brief argues, stem from the absence of institutions designed to govern technological learning.

A substantial body of scholarship on economic catch-up has focused on the coordinating institutions of industrial policy. Far less attention has been devoted to the distinct institutional question of how countries become efficient technological learners, and the institutional features that govern the transfer, absorption, and commercialisation of knowledge. Yet this dimension is equally foundational to catch-up. This research brief addresses that gap directly, with an explicit focus on institutional design.

Drawing on the historical experiences of Taiwan's Industrial Technology Research Institute (ITRI) and Singapore's Agency for Science, Technology and Research (A*STAR), the brief distils the institutional logic behind successful catching-up. On this basis, it proposes a concrete institutional vehicle — Technological Learning Accelerators (TLAs) — and sets out ten design principles for their implementation in the Mexican context.

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1. Introduction

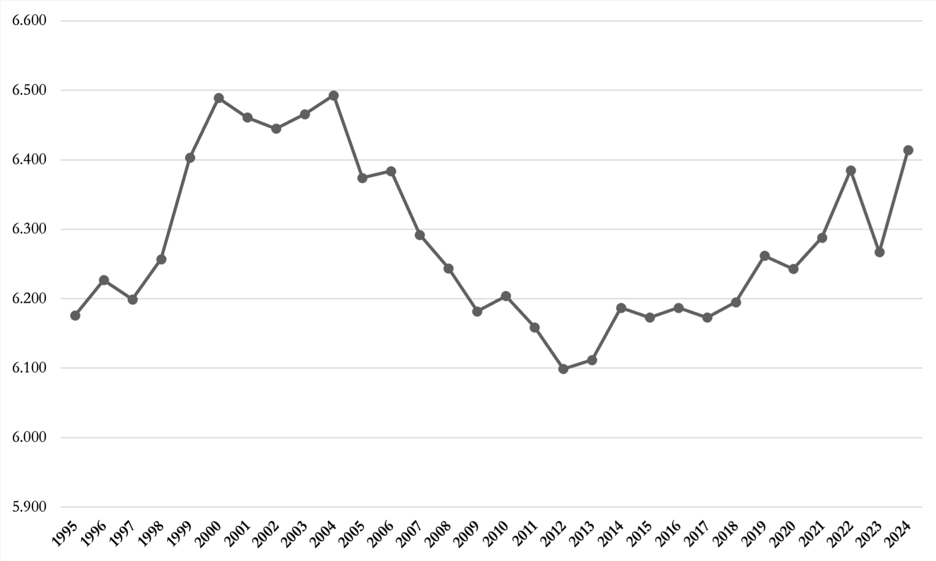
Mexico stands at a critical juncture. Over the last decades, Mexico has developed important industrial and technological capabilities across several sectors such as automotive, aerospace, medical devices, or electronics.

Yet these strengths have failed to translate into genuine industrial upgrading and export diversification, to foster the emergence of internationally competitive domestic firms in advanced sectors, and to sustain a dynamic pattern of productivity growth (Figure 1). As a result, Mexico has not only been incapable of catching up but has been relegated further behind in the global economic hierarchy (Table 1). As strategic opportunities are being created by nearshoring dynamics, thinking about how to break that trap is more important than ever.

One important factor explaining this outcome resides in the failure to build the institutional architecture that would support technological transfer, learning, and commercialisation. A key lesson from the East Asian developmental experience is that innovation is a destination and not the starting point of economic catch up. Economic and technological catch up relies on the capacity for countries to be efficient technological learners.

Mexico's institutional landscape is illustrative of some of the common barriers faced by developing countries. Most notably, it is marked by two distinctive features: (i) a failure to acquire and absorb foreign knowledge and technology, and (ii) a failure to commercialise knowledge. Both features are consequences of the absence of an articulated institutional infrastructure capable of facilitating the process of technology transfer from foreign firms to local industrial players.

Figure 1: Theil Concentration Index of Exports



Sources: UNCTADstat.

Recent Mexican industrial and science policy has been guided by the ambition of frontier innovation. Such an approach, however, risks generating research that neither diffuses to the productive sector nor builds genuine industrial competitiveness. The path forward, this research brief argues, requires developing the institutional capacity to facilitate technological learning and transfer.

Here, the concept of technological learning refers to the deliberate process through which firms, research institutions, and the productive system acquire, internalise, adapt, and ultimately improve upon technologies developed elsewhere. As such, it structurally differs from innovation, which can be understood as the production of new knowledge at the technological frontier.

Technology commercialisation, in turn, refers to the process through which knowledge and capabilities generated within research institutions are translated into products, processes, and firms that can compete in domestic and international markets. Both concepts are essential, and both are currently underserved by Mexico's policy framework.

Table 1: Mexico GDP per Capita as % of Comparators Country (Constant 2015 USD), 1990–2024

Country	1990	1995	2000	2005	2010	2015	2020	2023	2024
United States	21	19	20	18	18	18	16	16	16
Singapore	35	26	28	23	19	18	16	16	15
Japan	28	26	31	29	29	29	27	28	28
South Korea	83	57	54	43	35	33	28	28	28
Malaysia	192	138	148	131	116	104	91	90	87
China	876	516	428	274	163	123	87	82	79
Vietnam	1168	859	791	590	463	389	280	272	257

Sources: World Development Indicators

A lot of attention has been devoted, in the development literature, to the bureaucracy behind successful development models. Most notably, the concept of the developmental state was famously used by Johnson (1982, p. viii) to describe the distinctive capacity of the Japanese bureaucracy 'to make the market work for developmental goals'. One of the most important features of the developmental state, it has been noted, was a unique capacity for institutional coordination.

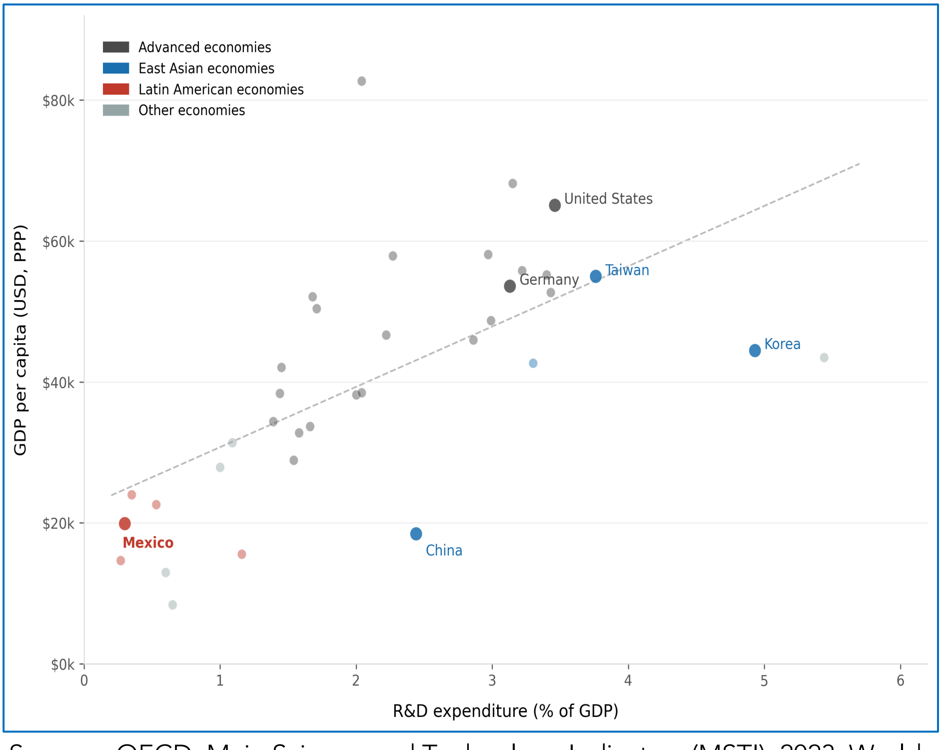
Beyond this focus on institutions, policy instruments used to nurture infant industries or push them to become global competitors have also been extensively discussed and debated. Less attention has, however, been given to the key institutional determinants that make countries efficient learners. Yet the institutions and instruments that have been used to facilitate the transfer of technological knowledge to local actors—both research centres and, most importantly, productive actors, are arguably equally essential to grasp the full depth of the institutional lessons offered by catching-up experiences.

Drawing on these historical experiences, this brief proposes an institutional vehicle that would support technological learning: Technological Learning Accelerator (TLA).

2. Innovation and Commercialisation: Frontier vs Follower

The wealth of nations is intimately tied to the capacity to compete in technologically advanced sectors. As Schumpeter extensively described, technological development is a key determinant of competitiveness, a factor of survival in the evolutionary world of capitalism. For this very reason, there is a tight correlation between the level of investments in Research and Development (R&D) and the Gross Domestic Product (GDP) per capita (see figure 2 below). Such a reality, however, does not mean that to be competitive, a country is forced to be the best at developing technologies, innovating in the strict sense of producing knowledge at the technological frontier. Indeed, the history of catching-up economies has famously been based on countries' capacity to learn, adapt and diffuse technologies (Amsden, 1992, 2001).

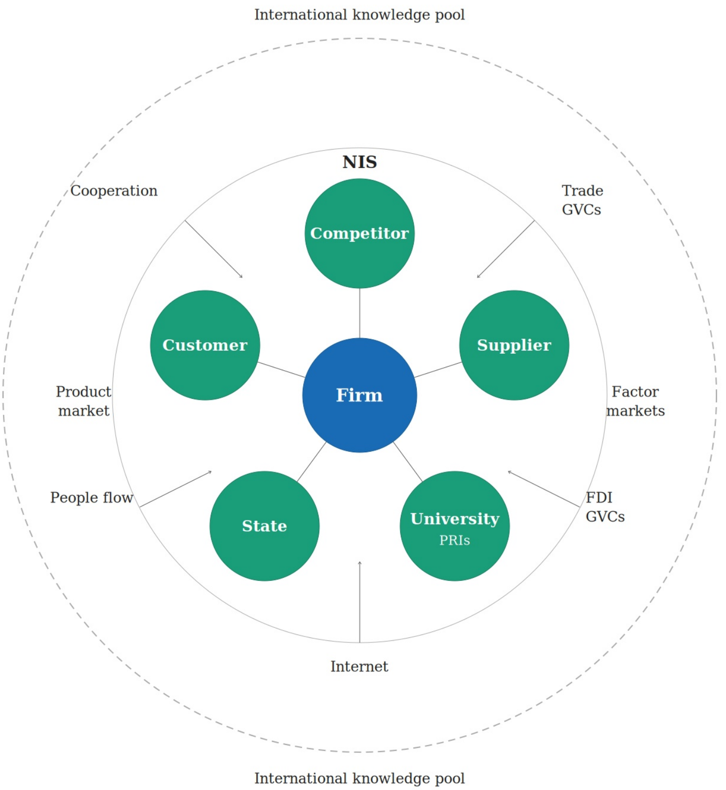
Figure 2: R&D Investment and GDP per Capita, Selected Economies



Sources: OECD, Main Science and Technology Indicators (MSTI), 2023; World Bank, World Development Indicators (WDI), 2023.

According to the neoclassical literature, growth and technological development in catching-up nations is principally determined by two factors: (i) the openness of the economy to foreign capital, (ii) the quality of human capital. While the first factor is essential to allow innovation and knowledge to be diffused, the capacity of latecomers to take advantage of this diffusion ultimately relies on the latter. Importantly, as Jimenez (2019) writes, such an approach often assumed 'that the acquisition and mastery of foreign technology are "automatic"' given certain horizontal conditions and existence of adequate factors of production.

Figure 3: Open National Innovation System (ONIS)



Source: Fu, 2015

Mexico's current industrial and science policy discourse is animated by a vocabulary of frontier innovation development. The implicit assumption is that competitiveness in the twenty-first century economy is fundamentally a function of proximity to the technological frontier, of investing in the production of new knowledge. Yet this framing, however politically appealing, rests on a fundamental misreading of how late-industrialising economies have historically built productive capacity.

This was one of the most important insights of Alice Amsden's work on the East Asian miracle. Amsden (1992, 2001) demonstrated that the developmental success of late-industrialisers—e.g., South Korea, Taiwan, Singapore—was not predicated on their capacity to innovate in the frontier sense. These were not economies producing path-breaking technologies. They were economies that had mastered the art of technological learning. As she wrote, '[i]f industrialization first occurred in England on the basis of invention, and if it occurred in Germany and the United States on the basis of innovation, then it occurs now among "backward" countries on the basis of learning' (Amsden, 1992, p. 4).

For Amsden, East Asian catching-up experiences relied on a strategy of 'learning by doing' and 'borrowed technologies' rather than innovation. As she explains, '[t]he shopfloor tends to be the strategic focus of firms that compete on the basis of borrowed technology. The shopfloor is the focus because it is here that borrowed technology is first made operational and later optimized' (Amsden, 1992, p. 5). The East Asian miracle, she argued, relied on the development of an economic environment in which firms systematically internalised the tacit knowledge embedded in production processes.

This cumulative process of capability-building unfolds through distinct and sequenced stages, each with its own logic, bottlenecks, and institutional requirements, moving from (i) technological adoption, (ii) technology assimilation, (iii) technology adaptation, (iv) technology improvement, and (v) innovation and commercialisation. Table 2 below describes the activities and capabilities associated with the different stages from adoption to innovation and commercialisation.

Table 2: The Technological Capability Ladder

Stage	Activities	Capabilities Developed	Examples
1. Adoption	• Import foreign technology • Use as-is •Follow instructions	•Basic operation • Maintenance • Imitation	Using imported tractors, following manuals
2. Assimilation	•Understand how it works •Train local workers •Minor modifications	•Technical understanding •Skill development •Minor troubleshooting	Training technicians to repair equipment
3. Adaptation	• Modify for local conditions • Improve efficiency • Substitute local inputs	• Engineering capability • Problem-solving • Reverse engineering	Adapting software to local language, adjusting machinery for local materials
4. Improvement	• Make incremental innovations • Enhance performance • Reduce costs	• Process innovation • Quality improvement • Efficiency gains	Korean firms improving Japanese car designs
5. Innovation	• Create new products/processes • Patent own technology • Export technology	• Frontier R&D • Original innovation • Global competitiveness	China's high-speed rail, mobile payment systems

What Table 1 shows technological capability development needs to be segmented in stages, each demanding qualitatively distinct sets of institutions. At the adoption and assimilation stages, trade policy, licensing frameworks, and investment in applied research institutions must be calibrated to maximise firms' exposure to foreign technologies (Lall, 1992; Kim, 1997). In a second moment, as firms move into adaptation and improvement, competition policy and export discipline become essential so that firms face sufficient market pressure to convert accumulated capabilities into innovation.

Only once genuine frontier capacity has been established do subsidies for basic research or patent regimes, become the most relevant instrument (Nelson, 1993; Mazzucato, 2013). Deploying frontier innovation instruments at Stage 1 or 2 is largely useless because the absorptive capacity required to deploy that support does not yet exist (Cohen & Levinthal, 1990). Supporting the learning process, rather than leapfrogging is one of the key lessons from successful developmental states.

This distinction is directly relevant for Mexico. The country's geography, integration into North American value chains, could offer favourable conditions for the kind of technology absorption and capability accumulation described by Amsden. In the last decades, Mexico has successfully integrated into global value chains and attracted large inflows of foreign direct investment—in 2023, Mexico was the 9th biggest recipient of FDI inflows (UNCTAD, 2025).

Yet, as previously noted, the institutional infrastructure to actualise this potential remains largely absent. Generous fiscal incentives attract foreign direct investment but few mechanisms exist to ensure that investment translates into genuine knowledge transfer to domestic firms (Furlan-Magaril & Valdés, 2025; Gallagher & Zarsky, 2007). Unlike East Asian developmental experiences, where public support was embedded within reciprocal arrangements and conditioned on technological upgrading, Mexico relied largely on expectations of passive diffusion.

In the next section, we propose to discuss in more detail the current structure, shortfalls, and bottlenecks of Mexico's technological development institutional landscape.

3. Mexico's Technological Development Institutional Landscape

Mexico's institutional landscape is characterised by various structural barriers to the transfer of technology both from foreign players and towards national ones. The first structural barrier, that is shared by most developing countries, is the structural disconnection between the science and technology and economic policies. At the level of the federal state, this is illustrated by the traditional disconnection between economic and science and technology institutions. Mexico lacks an East Asian Tigers-style pilot agency such as Japan's MITI, South Korea's Economic Planning Board (EPB), or Singapore's Economic Development Board (EDB).

The golden age of import-substitution industrialisation involved very little technological capabilities' development. As Carlota Perez (2015, p. 8) reminds us, '[a]lthough the assembly of products designed elsewhere, under the supervision of foreign experts or following process manuals, led to little technological learning and left scant space for innovation (Bell and Pavitt 1993), the process did generate demand for complementary activities in which real learning and innovation could take place'. As a result, Science and Technology policies in Mexico have primarily been oriented towards basic research, as an extension of the educational system.

Mexico's research agenda has, between 1970 and 2024, been governed by the National Council of Science and Technology (Conacyt). The institutional design of Conacyt has followed the model, widely adopted in Latin America of a decentralised public agency, endowed with operational autonomy and in charge of the formulation of public policies to promote scientific research and innovation (Torres, n.d.). Despite its de jure autonomy, until the early 2000s, it was institutionally located under the Ministry of Public Education (SEP). From a financial perspective, Conacyt's budget, in addition to being very limited, in absolute terms, has historically, from a relative standpoint, relegated technological development to a marginal position (less than 10% of Conacyt's total budget) (Dutrénit, 2010; Gonzalez-Brambila et al., 2007).[1] As a result, Conacyt has been de facto oriented to the development of researchers and basic research programmes, with little interaction with the productive sphere.

In 2002, Conacyt's institutional position was elevated as it was relocated under the direct authority of the president. Despite this institutional change, little changed in practice. Notably, Conacyt was limited by the reluctance of the ministry in charge of budget and economic policy to extensively support technology development programmes. This latter tendency, in turn, was a consequence of the broader conventional wisdom characterised by a high distrust in the potential benefits of industrial policy and adherence to the principles of laissez faire and comparative advantage (Chang, 2011, 2013). These institutional fragilities and absence of an industrial policy agenda, explain why the growing penetration of FDI in the country did not translate in any structural way into technology transfer, acquisition and diffusion.

Technology absorption and technological capabilities accumulation have largely been taking place on an expectational basis, with punctual success stories that have primarily relied on idiosyncratic factors (Dutrénit, 2010). While this is primarily true at the firm level, it is also the case at the institutional level. From its early days, Mexico has established an extensive network of public research centres with explicit applied research mandates and covering a wide range of sectoral focus—e.g., advanced manufacturing, applied chemistry, electronics, aerospace engineering, agro-industrial technology (see Table 3) (Arriaga-Cárdenas et al., 2022). Most of these centres have been, since 1992, coordinated by Conacyt.[2]

[1] For more recent data, see https://www.foroconsultivo.org.mx/documentos/acertadistico/ciencia_tecnologia_innovacion/series_historicas.pdf.

[2] There are two notable exceptions: the Mexican Oil Institute (IMP), sitting under the Secretariat of Energy, and CINVESTAV, affiliated to the Instituto Politécnico Nacional (IPN) itself sitting under the Secretariat of Public Education.

Table 3: Most Important Applied Research Centres

Name	Establishment Year
Centro de Investigación y de Estudios Avanzados del IPN (CINVESTAV)	1961
Instituto Mexicano del Petróleo (IMP)	1965
Instituto Nacional de Astrofísica, Óptica y Electrónica (INAOE)	1971
Centro de Investigación e Innovación en Tecnologías de la Información y Comunicación (INFOTEC)	1974
Centro de Innovación Aplicada en Tecnologías Competitivas (CIATEC)	1976
Centro de Investigación y Asistencia en Tecnología y Diseño del Estado de Jalisco (CIATEJ)	1976
Centro de Investigación en Química Aplicada (CIQA)	1976
Centro de Tecnología Avanzada (CIATEQ)	1978
Centro de Investigación en Alimentación y Desarrollo (CIAD)	1982
Centro de Ingeniería y Desarrollo Industrial (CIDESI)	1984
Centro de Investigación y Desarrollo Tecnológico en Electroquímica (CIDETEQ)	1994
Centro de Investigación en Materiales Avanzados (CIMAV)	1994
InnovaBienestar, successor to COMIMSA (1991)	2023

Yet, the reality is that those centres have proved structurally incapable of serving as genuine catalysts of technology transfer, either as acquirers and absorbers of foreign technology or as diffusers of applied knowledge to the productive sphere. Despite their designated focus on applied technological development, most of these centres have remained structurally delinked from the productive sphere.

Beyond the lack of resources, such poor outcomes are a consequence of both (i) the absence of incentives or disciplinary mechanisms encouraging the commercialisation of internal expertise, (ii) the lack of attractiveness and capacity to attract or repatriate global talent, and (iii) a widely shared failure to connect with foreign companies and serve as intermediaries between foreign knowledge and local firms. Thus, even when they have managed to build international reputations in their respective applied fields (e.g., INAOE, CINVESTAV), they have mostly been recognised through leading publications and global research collaborations rather than commercial success stories.

Two relative exceptions are worth discussing here. The first is IMP. IMP was established with an explicit mandate to build technological independence for Mexico's oil industry, and, most explicitly for Mexico's National Oil Company, PEMEX. Over the decades, IMP has managed to build genuine technological capacity, becoming one of the leading patent applicants among Mexican public institutions. Yet, IMP has structural limits. Most notably, it has failed to translate its genuine research outcomes into a diversified revenue. As Romo Rico & Ortíz Ubilla (2018, p. 159-160) note, '[a]lthough the IMP is one of the institutions that obtains the most patents in the country, it has a low rate of commercial exploitation'. Moreover, its research funding, priorities, and outcomes have been dependent on the fate of Pemex's budget cycles and strategic priorities—which, since 2014 and PEMEX's deteriorating financial situation has been particularly damaging for IMP.

The second is CIDESI, Mexico's Centre for Industrial Development. CIDESI is one of Mexico's few centres with a record of deep ties with international firms (e.g., Texas A&M, Tecnalia). CIDESI's international alliances, however, have functioned as client-project relationships, that is, have been used by foreign actors on a contractual basis, with knowledge then retained and commercially used in the latter rather than in the former. Such a passive form of interaction is the mirror opposite of the institutional structure of transformative models of FDI attraction like those of China and Singapore discussed above. As a result, in the most technology-intensive clusters of Mexico, e.g., Guadalajara, the involvement of public research centres in joint-research initiatives and technology absorption has been very limited (Gallagher & Zarsky, 2007).

In recent years, some transformation has, however, been taking place in the direction of a greater support for technology development and the commercialisation of innovation. In 2024, under President Claudia Sheinbaum, Conacyt was replaced by the Ministry of Science, Humanities, Technology and Innovation (SECIHTI) which is organised around two sub-ministries: one for science and humanities, and one for technology and innovation (with stated priority areas including electromobility, semiconductors, or satellite observation). Several of the Sheinbaum government's strategic industrial projects have, moreover, been assigned to SECIHTI (most notably, Kutsari, a national semiconductor design initiative; Olinia, a national electromobility project).

Recent efforts under Plan Mexico suggest an emerging attempt to reconnect industrial strategy with technological development. Beyond flagship initiatives such as Olinia and Kutsari, the strategy incorporates broader instruments including strategic sectors prioritization, industrial infrastructure expansion, public procurement, and selective incentives. Yet the central challenge remains institutional. Mexico structurally lacks the organisational capabilities required to coordinate, implement and sustain technological upgrading. From a technological learning perspective, the use of foreign technology should not be interpreted as evidence of failure. For example, what matters is not whether Olinia initially relies on foreign technologies, but its development leads to domestic capability accumulation. Without dedicated institutions and target instruments such as joint research, domestic supplier development, there is a risk that Olinia reproduces the enclave dynamics that historically characterised Mexico's development.

The Mexican state is also experimenting with novel governance models for public research centres. The most notable example is InnovaBienestar, established in November 2023 as the successor to COMIMSA, a former research centre specialised in material research, with ties to the metallurgical industry. InnovaBienestar was constituted simultaneously as a Sociedad Anónima Promotora de Inversión (S.A.P.I. de C.V.), a legal structure allowing InnovaBienestar to hold equity stakes, enter joint ventures, and receive licensing revenues. A second important initiative is iSensMEX, a platform pooling the capabilities of various public research centres (i.e., INAOE, CIDESI, CIMAV, CIATEQ, and COMIMSA) toward the development of intelligent sensors and actuators for applications in energy, health, and security.

While these are meaningful institutional innovations, these initiatives currently leave unresolved various important concerns discussed in this brief. Chief among them is the capacity for the SECIHTI to articulate its own agenda of technological development with the efforts of the Ministry of the Economy towards building an industrial policy (Plan Mexico). Indeed, Asian Miracle economies themselves relied on the existence of a leading agency capable of coordinating technology and industrial policy (Cherif et al., 2026; Cherif & Hasanov, 2025). Second, while strategic projects and initiatives could lead to the development of new champions in their respective sectors, this will be conditioned by the capacity of the state to impose strict conditionalities based on commercial performance (Amsden, 2001).

More generally, in the absence of complementary mechanisms that would allow for broad-based technological learning, acquisition and absorption of foreign technology, and diffusion of knowledge to the productive sector at large rather than to a narrow set of flagship projects, there are serious risks that these initiatives will reproduce the same enclave dynamic that has characterised Mexico's relationship with foreign technology for the last four decades.

The challenge today is to build organisational structures capable of governing technological learning itself: institutions able to coordinate actors, align incentives, and transform external knowledge into sustained processes of domestic capability building. Against this background, the next section proposes to reflect on the historical experience and lessons from successful institutional models of technological transfer, learning, and commercialisation.

4. Institutional Forms of Technological Learning

This section will explore two key institutional modes of technological learning: that of Taiwan's Industrial Technology Research Institute (ITRI) and that of Singapore's Agency for Science, Technology and Research (A*STAR).

ITRI is a not-for-profit applied research organisation sitting under Taiwan's Ministry of Economic Affairs (MOEA). It was established in the early 1970s, in a period when Taiwan was facing important economic and political challenges. Its export model based on labour-intensive manufacturing was increasingly exhausted. Rising wages were putting pressure on the competitiveness of domestic producers. Moreover, the 1973 oil shock put the country in a state of acute macroeconomic vulnerability. Taiwan understood that if it was to maintain its catching-up trajectory and lessen its external fragility, it needed to compete in technologically advanced sectors.

Yet Taiwan's ambition to move up the technological ladder had to overcome structural problems that had impeded the domestic emergence of indigenous technology competitive firms. Private firms in Taiwan were too small and resource-constrained to act as a catalyst of higher-technology development (Chang et al., 1994; Mathews, 1997, 2000). As Hsu (2005) notes, '[i]n the 1970s, (…) most enterprises did not have any concept of R&D or R&D investment'. Public research institutions, for their part, did not possess any strong capacity in the development of applied technologies. Most of them possessed limited resources and were primarily focused on basic research and training. At the same time, Taiwan was losing a massive number of trained individuals that decided to move abroad for their study and only a few would return (Chang, 1992). It was in this context that the Taiwanese state resolved to establish an applied research institution capable of diffusing technologies to the economy.

In 1972, Yun-Suan Sun, then Minister of Economic Affairs, proposed merging the Union Industrial Research Institute, Union Mining Research Institute, and Metal Industry Research Institute into one research organisation. The organisation could operate as an independent legal entity, with flexibility in talent acquisition, salary, and directional liberty. In 1973, ITRI was created and placed under the authority of the Ministry of Economic Affairs. ITRI was tasked with acquiring, adapting, and diffusing advanced technologies to Taiwan's industrial base. ITRI's head was appointed by the President of Taiwan. Yet the strategic direction extensively relied on consultative mechanisms involving technology experts, most of them working overseas, and often in the private sector.

Given the technological gap between Taiwan and advanced countries, it was considered that technological development would necessitate technology transfer from foreign actors (Chang et al., 1994). As Mathews & Hu (2007, p. 1016 [emphasis in the original]) note, the institution's strategy has been characterised by the principle of 'fast followership, through which ITRI identifies key technologies and builds expertise and capabilities in these technologies, before spinning off the technology and associated capabilities as rapidly as possible to the private sector'.

Simultaneously with ITRI's establishment, the Technology Advisory Committee (TAC) was created with the mission to steer Taiwan's technological development strategy (Chang et al., 1994; Mathews, 1997, 2000). The TAC's convenor, Wen-Yuan Pan, was director of RCA Laboratories—the research arm of Radio Corporation of America (RCA), and one of the most important American electronics conglomerates of the time—and, through his influence, integrated circuits (IC) emerged as the Committee's strategic priority. IC manufacturing technology was, at that point, sufficiently mature and well-documented to be absorbed by Taiwanese firms. In 1974, the decision was formalised with the creation of what would become the Electronics Research and Service Organisation (ERSO).

Two years later, in 1976, ITRI concluded a technology licensing agreement with RCA. At the time, RCA as a corporation was retreating from the semiconductor business as it failed to compete with Intel and Texas Instruments. As Mathews (1997) notes, the arrangement made sense for both sides. For RCA, ITRI licensing allowed the firm to earn royalties on a technology it struggled to exploit profitably. ITRI, for its part, gained access to a mature and absorbable technology in a nonetheless advanced and rapidly evolving technological segment. By 1977, ITRI had developed a full pilot plant capable of producing its first commercial-grade integrated circuit.

Yet unable to attract private firms willing to bear the risks of entering such a sector, ITRI decided to spin off United Microelectronics Corporation (UMC) in 1980 which became the first IC manufacturing company in Taiwan. At the same time, it transferred ERSO's personnel, technology, and equipment to UMC (Chang et al., 1994; Mathews, 1997). In 1986, Morris Chang, a former Texas Instruments executive with extensive experience in the semiconductor industry, was appointed to head ITRI. A year later, TSMC was established as an ITRI spinoff with a joint venture with Philips and funds from private investors. As in the case of UMC, ITRI provided the initial laboratory facilities, personnel, and technology base (Chang et al., 1994; Mathews, 1997).

Since then, ITRI has established itself as the most important institution of Taiwan's economic power. As Mathews (2000, p. 190) writes, it is 'arguably the most capable institution of its kind in the world in scanning the global technological horizon for developments of interest in Taiwanese industry, and executing the steps required to import the technology (…) and then absorbing and adopting the technology for

Taiwanese firms to use'. Its model is firmly grounded on a sequenced approach to technological development that was behind the semi-conductor success story. Commercialisation remains the ultimate horizon of ITRI's activities. This not only means that ITRI maintains tight links with domestic and foreign industrial firms, but also that its research is focused on pre-competitive R&D in domains strategically relevant to Taiwan's industrial development (e.g., Smart Medtech, Green Energy System & Environment Technology, Low Carbon Manufacturing, Electronic and Optoelectronic, Autonomous Mobile System), and that there are clear exit options—either through explicit industry collaborations or internal catalyst support (Wang et al., 2021).

Singapore's experience offers a complementary institutional model whose logic differs in important respects from ITRI. Whereas Taiwan's challenge in the 1970s was to build technological capacity autonomously, Singapore's ambition has been to leverage an economy deeply penetrated by Multinational Corporations (MNCs) as a genuine engine of technological learning and industrial upgrading (Wong, 1999).

It is against this background that A*STAR was established, in 2002, as the successor to the National Science and Technology Board[3], and sitting under the authority of the Ministry of Trade and Industry. A*STAR is a statutory board, meaning that it retains high autonomy and the clearly defined mission of supporting technological development in Singapore. The agency coordinates a network of public research institutes (PRIs) that span various sectors such as biomedical sciences, advanced manufacturing, materials, and digital technologies.

It relies on two pillars that are particularly relevant for Mexico. The first is a 'collaborative R&D' approach. Thus, rather than acting as a passive recipient of FDIs, A*STAR's research institutes actively establish joint programmes with MNCs. MNCs can co-fund and co-direct research programmes and take advantage of A*STAR's scientific capabilities while local firms and researchers gain access to frontier industrial knowledge (Cheah et al., 2016; Koh & Phan, 2010). One example is the 'Lab-in-Fab' programme. Under this programme, A*STAR's Institute of Microelectronics (IME) embeds research teams inside the production facilities of MNCs working in the semiconductor sector (e.g.,

[3] Its institutional origins date back to 1967, and the creation of the Science Council of Singapore.

STMicroelectronics, ULVAC). The tacit knowledge embedded in these firms thus becomes accessible to Singaporean researchers and can then be diffused through A*STAR's wider network of domestic SMEs.

Another key pillar of A*STAR is human capital attraction, which mirrors in important respects ITRI's strategy of mobilising the diaspora. Thus, the agency funds fellowships at leading universities or research centres, with an explicit expectation that researchers will return and contribute to the work of either A*STAR's institutes or domestic industries.

Together, ITRI and A*STAR cases illustrate two complementary institutional logics. On the one hand, the history of ITRI offers valuable lessons for how to build indigenous technological capability through technological learning, from technology absorption through progressive capability accumulation to spinout. On the other hand, A*STAR is a model designed to maximise knowledge spillovers from MNC.

The next section proposes to reflect on key design principles for what we term 'Technological Learning Accelerators', i.e., applied research centres oriented towards technological learning and driven by clear commercialisation mandates.

5. Ten Design Principles of Technological Learning Accelerators for Mexico

The idea of Technological Learning Accelerators is directly inspired by Taiwan's and Singapore's experiences. It aims to respond in a unified and institutionally integrated way to the two-fold reality faced by Mexico of (i) weak and insufficient industrial and technological spillovers from FDI, (ii) broader difficulties supporting the commercialisation of innovation and research in the country. The ambition is not to advocate for a passive reproduction of a blueprint model from one context to another but rather to distil strategic design principles. The next ten principles are thus inspired by the most important institutional design lessons offered by both ITRI's and A*STAR's institutional structures and conceived as guidelines for building innovative and adaptive institutional options for Mexico.

Principle 1: TLAs should operate as autonomous and non-profit organisations rather than public research institutes

From a legal perspective, TLAs would be constituted as independent entities, with their own governance structures, contractual rules, and revenue structure, but unlike private firms, any profit generated would need to be reinvested in the institution's research and operations. This status would allow TLAs to escape some of the rigidities of the public sector, such as civil service salary scales and impediments to the movement of researchers to and from the private sector, prohibition of spinouts, while at the same time, insulating TLAs from short-term profit pressures that would be incompatible with the long-time horizons and high failure tolerance that genuine technological learning requires. This, for example, is the case of ITRI. ITRI was established under its own Industrial Technology Research Institute Establishment Act. Its assets are defined as being of public interest, yet this status allows it to retain operational flexibility, to set competitive salaries, and the capacity to generate income from licensing and contract services. A*STAR, for its part, is constituted as a statutory board under Singapore's Agency for Science, Technology and Research Act, and operates outside the civil service pay structure and procurement rules, while remaining fully publicly owned.

Principle 2: TLAs should possess a mixed financing structure

Public research institutions are generally fully funded by public resources, e.g., legal annual funding transfers or more discretionary grants. TLAs, in contrast, should rely on a financial structure that leaves more room to private or contract-based finance. While public financial support is decisive as it guarantees a disposition to enquire into high-risk, long-term, and spillovers generating research, the pressure to acquire contracts creates market discipline. ITRI has historically followed such a logic with government grants being progressively displaced by contract-based revenues. Beyond ITRI, however, this model has characterised other applied research institutions. For example, Fraunhofer, the German applied research organisation, cannot receive more than one third of its budget from institutional base funding. That said, it is also important to insist on the necessity for TLAs to receive substantial government support in the early days of their establishment. Since the process of technological learning is costly and should tolerate failure, a sound strategy would be to adopt a sequenced financing model, heavy public support in the founding phase, with contract revenue targets introduced gradually as institutional capacity matures.

Principle 3: TLAs should be guided by deep technological expertise

TLAs should be able to rely on a strong capacity to leverage strategic industry intelligence. A capacity to engage in technological foresight is indeed essential to help the institution to make decisions that are not based on passively mimicking what other countries are doing, or on selecting the projects that appear the most attractive from a political perspective, but on decisions that are primarily based on context-based and industry specific knowledge. This relationship is not just decisive during the process of selecting technological bets but also to give TLAs a strategic capacity for adaptation against evolving circumstances, be they technological, macroeconomic, or geopolitical.

Principle 4: TLAs should support 'reverse brain drains' dynamics

TLAs should possess a clear strategy to repatriate and retain talent working in the private sector or in better funded public sectors in other countries. Such an emphasis has indeed been central to East Asian experiences. One example is offered by Korea Institute of Science and Technology (KIST). When it was established in 1966, KIST was deliberately structured to attract talent from abroad. It followed a 'small-but-top' strategy, that is, it focused on recruiting a small number of exceptional researchers. KIST offered remuneration well above civil service scales to attract Korean engineers working abroad. Yet beyond competitive pay, repatriates also received comprehensive relocation support, and high-quality living conditions. Research autonomy and institutional prestige, which included explicit and continued support at the presidential level, completed the package, and allowed returning researchers to be perceived as a 'technocratic aristocracy' (Yoon, 1992). A*STAR's National Science Scholarship and International Fellowship programme follows the same logic with competitive stipends offered for doctoral and postdoctoral researchers at top global universities, with recipients expected to return to Singapore's research institutes or industry.

Principle 5: TLAs should foster the transmission of tacit knowledge to local industries

Technology transfer involves more than just the acquisition of licensing rights or the creation of an R&D centre by a foreign company. As we have described, genuine technological learning relies on the capacity for domestic actors to absorb the knowledge embedded in technologies. An important part of the process takes place at the individual level. For this reason, beyond the repatriation of specialists, TLAs should facilitate the process of embedding local engineers and researchers in foreign frontier firms. The ITRI-RCA collaboration is an illustration of this principle. When ITRI and RCA signed an IC technology transfer agreement in 1976, a group of engineers were sent to RCA for training. They were divided into teams, each specialising in a different aspect of IC development. One team studied IC design in New Jersey, another the manufacturing processes in Ohio, a third studied verification procedures in California, and a fourth in equipment handling in Florida. Once knowledge is acquired, TLAs should be able to easily send engineers and researchers to work directly with local productive actors.

Principle 6: TLAs' research should focus on pre-competitive steps

As we have previously seen, in most developing countries public research institutions are generally biased towards basic research and disconnected from the productive sphere. At the same time, the private sector is itself unwilling and incapable of investing in the process of technological upgrading. The role of TLAs is to overcome this gap by intervening as a pre-competitive catalyst. Pre-competitive research generates knowledge and capabilities that are applicable across firms in a sector, that no single firm could justify funding alone, and whose spillovers are sufficiently diffuse not to be completely appropriated by one actor. In pre-competitive R&D consortia, firms work together, sharing the resulting intellectual property from which they can develop into differentiated downstream products. A*STAR operationalises this principle through its Industry Alignment Fund, which co-funds pre-competitive research consortia in which competing firms from the same sector share the outputs while preserving product competition.

Principle 7: TLAs should rely on clear exit mechanisms

Critically, TLAs should possess endogenous commercialisation imperatives. Concretely, this means that each publicly funded research programme should be subject to a defined timeline after which the programme must demonstrate either that its outputs are commercially viable and capable of acquisition by private firms, or that they can be structured for institutional spinout. Programmes that demonstrate neither within the prescribed period should be discontinued. In doing so, TLAs would need to establish ex ante assessment frameworks involving independent technical review panels with both sectoral expertise and commercialisation experience. At the same time, it is important for the TLAs to possess substantial financial support and institutional capacity (i.e., legal, managerial) to facilitate the spinout process. Ideally this can be provided by the institution itself. In a second-best scenario, it could be supported by other public institutions or financial intermediaries.

Principle 8: TLAs should function as active intermediaries between foreign investment and domestic firms

Beyond autonomous efforts at technology absorption, as in the case of ITRI's semiconductor success story, TLAs should also serve as a key negotiating actor in the dialogue between the state and foreign firms desiring to invest locally. Here, it is possible to take inspiration from Singapore's development model. In particular, the Lab-in-Fab model pioneered by A*STAR, which involves physically embedding the public research capacity inside MNCs' production facilities, can offer an important source of inspiration for countries that possess extensive FDI investment yet limited technology spillovers.

Principle 9: TLAs should foster a holistic approach to technology learning, not solely focusing on the technological frontier

TLAs' research ambitions should not be confined to narrow processes or technologies. Instead, they should adopt a broad approach to the technology learning process comprising a full range of activities, from design, materials, equipment, manufacturing, testing or packaging. Indeed, this has also been one of the distinctive features of ITRI. Such an approach could enable TLAs to maximise the transfer of knowledge to a diverse set of domestic industrial players. TLAs should also support sectors capable of simultaneously advancing productive upgrading, environmental sustainability and social inclusion. Strategic opportunities for Mexico exist in areas where industrial development and ecological transition overlap, including electromobility, low-carbon manufacturing, sustainable agroindustry, biotechnology, circular economy applications and renewable energy.

Principle 10: TLAs should promote technological diffusion through open forms of intellectual property rights

As we have seen, for a follower country, one important objective is to maximise technology diffusion across the domestic industrial base. For this end, TLAs should rely on property right regimes that maximise the accessibility and transferability of the knowledge produced to the external industrial ecosystem. Part of this is allowed by the pre-competitive research focus described under Principle 6, but it should also be actively promoted through the use and establishment of open and flexible forms of intellectual property right regimes. More concretely, this could take various forms such as conditioned and milestone-based licensing that could allow TLAs to retain disciplinary power while incentivising commercialisation; or subsidised licensing frameworks to allow a broad range of domestic actors to create competitive commercial exits from the knowledge produced within TLAs.

It is not the aim of this research brief to propose a specific and concrete institutional arrangement to build one or several TLAs in Mexico. Still, when thinking about broad potential implementation pathways, three options deserve consideration, each involving different degrees of institutional complexity and political ambition. An incremental route would involve transforming selected public research centres into sector-specific TLAs, building upon existing capacities while gradually reshaping their mandates and organisational structures. A 'pilot' route could establish two or three experimental TLAs in sectors prioritised under Plan Mexico, allowing institutional experimentation and learning before deciding whether to broaden the scope of TLAs. A more ambitious route would involve creating a dedicated national technological learning institution that could be jointly coordinated by the Ministry of Economy, SECIHTI and domestic development finance institutions (e.g., NAFIN S.A., BANCOMEXT).[4]

[4] Beyond the national level, the territorial dimension of Mexico's productive landscape also warrants attention. Regions such as Nuevo León, Querétaro, Jalisco, Guanajuato and Aguascalientes have accumulated differentiated productive capabilities and developed distinctive industrial ecosystems around sectors such as aerospace, automotive manufacturing, electronics, software, and advanced services. Rather than conceiving TLAs exclusively as centralised national institutions, an alternative model would involve the development of regional technological learning nodes embedded within local productive ecosystems and linked to public research centres, universities, firms and state governments. Such regional TLAs could function as distributed platforms for technological learning, experimentation and industrial coordination.

Together, national and regional TLAs could form a distributed architecture of technological learning capable of matching the geographic and sectoral diversity of Mexico's productive base.

6. Conclusion

The case for Technological Learning Accelerators emerges from a diagnosis of Mexico's productive and technological challenges and draws on institutional lessons from the history of economic development.

More specifically, the concept of Technological Learning Accelerator embodies what Cherif et al. (2026) have described as the four institutional features of East Asian Miracle pilot agencies: Ambition, Autonomy, Accountability, and Adaptability. Indeed, although TLAs' function is narrower than institutions such as Japan's Ministry of International Trade and Industry (MITI), Korea's Economic Planning Board (EPB), or Singapore's Economic Development Board (EDB), it still is the case that TLAs would be in charge of a key part of the more general process of fostering new sophisticated industries.

The TLA proposal is ambitious in that it possesses a clear and bounded purpose—i.e., that of serving as a key institutional anchor in the development of technologically advanced sectors in which Mexico targets national and global competitiveness—and is structured to attract and retain the best available talent in its chosen domain. It is autonomous, accountable, and adaptable by design: (i) strategically autonomous yet responsive to the government's broader development agenda; (ii) it functions as a key node connecting the research system to the productive sector without being subordinated to the priorities of either; and ultimately (iii) it is guided by deeply informed technological bets and the imperative of commercial viability.

Mexico has long had the conditions for industrial transformation. What it has lacked, and what this brief has argued it can build, is the institutional infrastructure to convert these conditions and potential into genuine structural change and competitiveness.

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