Chapter 6
Industrial Technology Upgrading and Innovation Policies: A Comparison of Taiwan and Thailand

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The question of why some developing countries succeed in catching up technologically with developed countries while others fail to do so has attracted considerable interest among academics and policy makers. Since the notion of 'middle-income trap' emerged in the mid-2000s, the question has grown even more popular. This paper aims to contribute to knowledge of this issue by examining the cases of two East Asian countries, Taiwan and Thailand. Taiwan is now a high-income economy with GDP per capita of $22,000 in 2015, while Thailand has been trapped at middle-income country status, with GDP per capita of $5,400 in the same year. The two countries are selected here because although they differ in economic performance, their economic and political backgrounds are rather similar. Both started serious industrialization in the 1950s, and both faced serious security threats from communist regimes during the Cold War. Taiwan had major conflicts with Mainland China and Thailand was a front-line country in the fight against communism in Southeast Asia. Both countries are mid-sized in terms of population (sixty-five million and twenty-three million in Thailand and Taiwan, respectively). Both have sizable, quite successful agriculture sectors. Importantly, both countries joined global production networks of transnational corporations (TNCs), especially Japanese firms, after the Plaza Accord in 1980s.

While recognizing the significance of other economic, political and social factors of catching-up, such as human resources, macro-economic management, and various types of policy, this paper focuses primarily on the comparison of policy on technology, innovation, and industrial upgrading. Another main focus is the manufacturing sector, where technological upgrading and innovation are critical. The structure of the paper is as follows. We will provide an overview of the evolution

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of manufacturing industries and general industrial policy in Sect. 6.2. In Sect. 6.3 we will specifically examine the content and implementation of key policy instruments. Institutions underlying effective policy design and implementation will be investigated in Sect. 6.4. In the final section, conclusions will be drawn and policy implications will be provided.

6.1 Evolution of Manufacturing Industries in Taiwan and Thailand

This section provides an overview of the evolution of industrial development in Thailand and Taiwan.

6.1.1 Taiwan

Taiwan's technological catching-up record is quite impressive. In order to investigate the evolution of Taiwan's policies, we break its economic development history into four stages: (1) the "Import-substitution of labor intensive industry" period of 1950–62; (2) the "Export-orientation with import-substitution of intermediate-goods" period of 1962–1980, (3) the "Liberalization and technological orientation" period of 1980–2000, and (4) the "Economic globalization period" of 2000 onward (Li 1988; CEPD 2008). Prior to 1980, Taiwan's industrial development policies were designed to promote exports in order to develop downstream industries, in which many small and medium-sized enterprises (SMEs) were agglomerated. An import substitution policy was adopted at the same time to incubate the capital-intensive upstream industries dominated by large-sized firms. With respect to technology policies, the Taiwan government promulgated "Guidelines for the Long-range Development of Science" in 1959 and implemented the "National Science Development Plan (1969–1980)" in 1968. In order to commercialize technologies more effectively, the government launched implementation of the "Science and Technology Development Program" in 1979. The "Long-term National Science Development Program" passed by the Legislative Yuan (Taiwan's parliament) in 1959, was the first technological policy program initiated by the government since 1949. This program was aimed at the creation of a foundation for scientific development. The measures within such programs included personnel recruitment, encouragement of research, research facilities development, and the provision of dedicated funding for scientific purposes. At the same time, in order to promote the development of science related approaches, the cabinet (the Executive Yuan) created the "Long-term National Science Development Council," which was the predecessor of the National Science Council, which later expanded further into the "National Science Council, Executive Yuan" in 1969. More importantly, 1968, when the "National Science Development Plan" was established,

the country's science and technology (S&T) policy was already shifted from a focus on pure science and basic research to an emphasis on technological research to meet the needs of national development.

Furthermore, since the 1980s, Taiwan has undergone significant trade liberalization. In the early stages, under pressure from the United States, the country was forced to lower its tariffs and reduce its import restrictions. In the years following the announcement of the Section 301 of the US 1974 Trade Act, Taiwan hastened the implementation of import liberalization. The threat of retaliatory action spelled out in the 301 Bill provided the prime motivation for Taiwan's accelerated trade reforms from 1986 onward (Liu 2002).

Taiwan's industrial and technology policies are intended to cope with changes in the industrial environment, characterized by an ongoing increase in labor and land costs, and by intensive competition in the international market. In an effort to enhance the country's industrial technology capacities, the government adjusted its industrial and technology development strategies. In particular, the Ministry of Economic Affairs (MOEA) decided to let the private sector serve as the main actor in the conduct of R&D investment by providing enterprises with mutual funds for the execution of designated R&D projects. The private sector is expected to play the leading role in both developing and acquiring industrial technologies with the government's support and consultation.

In addition, in order to effectively support R&D by domestic industries, the Taiwanese government relies heavily on government-sponsored research institutes (GSRIs) to execute contracted research projects and subsequently transfer and diffuse the outcomes of those projects to the industry for commercialization. To that end, the government founded the Industrial Technology Research Institute (ITRI) in 1973. (In recent years ITRI has devoted the bulk of its research to electronics, computers and communications, opto-electronics, micro-electro-mechanical systems, mechanical systems, chemicals, biotechnology and medicine, materials, aviation and space, measurement standards, energy and resources, environmental protection, and industrial safety and health.) Drawing on the successful experience of ITRI, in 1979 the Taiwan government promoted the development of software-related technology industry by establishing another GSRI, the Institute for Information Industry (III), which differs from ITRI in that it focuses on hardware technologies.

The establishment of the Hsinchu Science-based Industrial Park in 1980 and the implementation of the "Program for Strengthening the Education, Training, and Recruitment of High-level Science and Technology Personnel" in 1983 were milestones in Taiwan's technological orientation period. A high proportion of Taiwan's university graduates, approximately 15%, went overseas for graduate degrees over the period of 1980s–2000s. A large number of experienced scientists and engineers have now returned to Taiwan to contribute to the development of domestic S&T. These returns were largely due to more favorable government policy, the improvement of the research environment, the increased number of university graduate departments, and the establishment of ITRI and the Hsinchu Science-Based Industrial Park (HSP).

Importantly, it has been estimated that more than half of the 203 firms in the Hsinchu Science-Based Industrial Park were founded by returnees, or relied on their investment and skills.

Trade liberalization took place in Taiwan in the 1990s. In order to avoid trade discrimination, diplomatic isolation, and a disadvantageous position in bilateral trade talks with its trade partners, Taiwan energetically pursued membership in the World Trade Organization (WTO). The motivation behind Taiwan's bid to join the WTO was its desire to have an international forum through which it could resolve trade conflicts while at the same time escaping from trade protectionism and diplomatic isolation (Liu 2002).

In that environment of trade liberalization, improvements in the scientific and technological environment drove swift growth of high-tech industries from 1986 onward. The vigorous expansion of Taiwan's high-tech industries transformed the nation's industrial structure. In 1986 the output of technology-intensive industries constituted just 24% of all manufacturing output; this rose to 37.5% by 1996. The growth of the HSP is a good illustration of this trend. In 1986 the HSP housed fifty-eight companies with a combined turnover of $0.45 billion ($17 billion TWD); by 1996, there were 203 companies in the park, with an annual turnover of $11.59 billion ($318.2 billion TWD)—18-fold growth. The HSP's success in attracting high-tech firms is certainly an achievement worthy of emulation. The output of Taiwan's information industry accounted for a volume of $16.4 billion in 1996, making Taiwan the world's third largest manufacturer of ICT products, behind only America and Japan. Taiwan was one of the market leaders in eleven information product categories during that year.

In order to overcome space limitations in Hsinchu, the HSP has been creating new science park bases since 1990, at five locations at the time of writing: Jhunan Science base in Miaoli in 1999; Longtan Science base in Taoyuan in 1990; Tongluo Science base in Miaoli in 2007; Yilan Science base in Yilan in 2005; and Biomedical Science Park in Zhubei in 2003.

Although Taiwan has already become a leading center for the development and manufacture of personal computers, it still relies heavily on imports of many key components for its ICT products. For example, in 1996 CRT and LCD imports were valued at $1.26 billion ($34.57 billion TWD) and $1.0 billion ($27.57 billion TWD) respectively. Clearly there is an urgent need to establish domestic key component industries to serve the country's IC sector. Moreover, in 1996 Taiwan was the world's fourth largest IC producer, but its IC output accounted for just $4.5 billion, only 3% of the world market. This shows that Taiwan's local IC industry still has much room for growth. Taiwan's communications products were worth $3.2 billion during 1996, making it the world's eleventh largest producer at that time. Since most of those products were mid- or low-grade items, it was necessary for Taiwan to strengthen R&D and introduce more value-added products.

From the 2000s onward, Taiwan has aimed at becoming a location for offshore R&D by multinational corporations (MNCs). In terms of R&D, local firms generally appear to lack systems integration capabilities and the ability to take the initiative in product and technology development; however, some of the current industrial players may be positioned to become first-tier suppliers possessing innovation capabilities

in certain areas and industrial segments. This could be considered as Taiwan's main geographic advantage in offshore R&D (Liu and Chen 2005). A notable example is Intel's creation of an R&D and innovation center in Taiwan dedicated to product innovation in wireless local area networks (WLANs), motivated partly by Taiwan's position as a major global supplier of WLAN sets. Sony and Hewlett Packard (HP) have also set up R&D centers in Taiwan, largely because Taiwanese IT firms have evolved from pure manufacturing toward integrated service provision, giving rise to intensified interdependence between the network flagships and their Taiwanese subcontractors.

More specifically, the MOEA initiated the "Multinational Innovative R&D Centers in Taiwan (DoIT Taiwan)" program in 2002. Taiwan, taking advantage of its outstanding production capacity (achieved thanks to its accumulated OEM/ODM experience, cheaper and superior manpower, governmental R&D sponsorship of technology acquisition, and flexible business cooperation sustained by entrepreneurship), aimed to establish itself as a global center for industrial innovation by cooperating with MNCs to set up their regional R&D centers in Taiwan. There were four incentives for the MNCs to establish the centers: human resource support, funding, tax exemption and a one-stop service window. The DoIT Taiwan program has received a very strong positive response: over the period from 2002 to January 2017, forty-seven MNCs, including several leading ones, (e.g., HP, Sony, Dell, IBM, and Intel) have established sixty-five R&D centers in Taiwan.

To cope with the new economic environment that arose after the 2008 global financial crisis, the new innovation financing policies promise to relieve income inequality and enhance job creation. Specifically, to provide the traditional sectors with some relief from the difficulties that they face from import competition; and to further reinforce local industrial clusters, in 2008 the DoIT, under Taiwan's MOEA, launched a scheme, the "Local Industry Innovation Engine Program" (LIIEP) to increase industrial value-added and achieve regional prosperity by reinforcing industrial clusters. The LIIEP is aimed at enhancing the capacity of research institutes so as to assist partner firms by means of various R&D grants and by organizing local R&D alliances in designated regions. Under this program, research institutes are assigned the task of organizing R&D alliances with local firms, especially in regions with less cutting-edge technology, in order to support them in accessing the government's various R&D resources embedded in various R&D grant programs. Those R&D programs are created under Taiwan's national innovation system, which can be described as an SME-public research institute innovation network model (Wong 1995). The GSRIs support firms by facilitating technology assimilation and/or transfer and cooperative R&D promotion. Taiwan's successful use of GSRIs to promote the diffusion of industrially-relevant technologies is widely recognized.

In addition to job-creation in the post-global financial crisis era, Taiwan's innovation financing policies have been swinging toward "manufacturing servitization"[1]

[1] As argued by Baines et al. (2009), from the output side of perspective, manufacturing servitization can be regarded as the innovation of an organization's capabilities and processes so as to shift from selling products to selling integrated products and services that deliver value in use.

as a means of improving industrial value-added (Liu 2015). Taiwan's manufacturing has been lost to the emerging economies, especially those of China and Southeast Asia. It is advocated by theorists and policy makers that manufacturing firms should move up the value chain by innovating and creating more sophisticated products and services and thus avoiding competition on the basis of cost alone (Porter and Ketels 2003). In response to manufacturing servitization in the advanced world, Taiwan has been moving forward to manufacturing servitization by reframing its industrial innovation policy. The interaction between manufacturing and services has increased rapidly (Vandermerwe and Rada 1989; Pilat and Woelfl 2005; Francois and Woerz 2008). Following that trend, Taiwan has adjusted the implementation of its industrial technology policy to encompass more manufacturing servitization. More specifically, Taiwan has adjusted its industrial innovation policy in pursuit of manufacturing servitization in order to change the mind-set of manufacturing firms, towards: rapid provision of customized services; transformation of sales from products to service; seizing the initiative to provide value-added services; and encouragement of firms to organize demand-oriented alliances so as to move toward synergy-creation.

6.1.2 Thailand

In the past 50 years, Thailand has achieved both consistently high GDP growth rates (approximately 7% per annum) and significant diversification of its economy. The contribution of the aquaculture sector to GDP has fallen, while the share of manufacturing and services has increased markedly. Similar to Taiwan, Thailand embarked on industrialization with import-substitution in the 1950s, and shifted to export promotion in 1980s. However, different from the case of Taiwan, Thailand's industrialization depended much more on foreign direct investment, which has been promoted since the 1960s. Also different from Taiwan, where local firms demonstrated the ability to catch up technologically, Thai firms have grown without long-term deepening of their technological capabilities, and their technological learning has been very slow and passive (Bell and Scott-Kemmis 1985; Chantramonklasri 1985; Thailand Development Research Institute 1989; Tiralap 1990; Mukdapitak 1994; Lall 1998). A recent World Bank study (Arnold et al. 2000) confirms this long-standing feature of Thai firms. Only a small minority of large subsidiaries of transnational corporations (TNCs), large domestic firms and SMEs have R&D capability, while the majority are still struggling to increase their design and engineering capability.

Until the administration of Prime Minister Thaksin Shinawatra (January 2001–September 2006), the scope of S&T policy in Thailand was rather narrow, covering only four conventional functions: research and development; human resource development; technology transfer; and S&T infrastructure development. This narrow scope of S&T was very much based on the perception of policy makers that private firms were "users" of S&T knowledge produced mainly by government agencies and universities (see Arnold et al. 2000). There was no articulated national innovation policy. Though the word "innovation" was mentioned in several national plans, the

concept was not whole-heartedly incorporated into the scope of Thai S&T policies (see Lauridsen 2002). Unlike Taiwan, in Thailand S&T elements were not part of broader economic policy governing areas such as industrial policy, investment policy and trade policy and, to some extent, education policy.

Thai industrial policy did not pay enough attention to the development of indigenous technological capability as an integral factor of the process of industrialisation (Sripaipan et al. 1999, p. 37). Thai investment policy, especially the promotion of foreign direct investment (FDI), was aimed primarily at generating inward capital flow and employment. There was no explicit or pro-active link between promoting FDI and the upgrading of local technological capability in Thailand.

Moreover, industrial policy in Thailand was limited to the so-called 'functional' interventions such as the promotion of infrastructure building, general education, and export push in general. There were virtually no selective policy measures such as special credit allocation and special tariff protection targeting particular industries or clusters. The exception was the local content requirement in the automobile industry, which was rather successful in raising the local content of passenger vehicles to 54% in 1986 (see Doner 1992). Interestingly, with the exception of the automotive industry, there were no reciprocal performance-based criteria (such as export and local value added and technological upgrading targets) set for providing state incentives as was the case in Korea and Japan (Johnson 1982; Amsden 1989; Evans 1989, 1998; Chang 1994; Lall 1996). In Thailand, investment promotion privileges, for example, were given away once approved. The desire to attract foreign direct investment and promote exports overshadowed the need to develop local initiatives and indigenous technological capabilities. As a result, linkages between multinational corporations and local firms were weak. Unlike the case of Taiwan, Thai governmental protection and promotion failed to strengthen the absorptive capabilities of Thai suppliers and had a profound harmful impact on the already weak technology and suppliers' network of industries (Vongpivat 2003).

The major change in Thai government policy came under the Thaksin government (2001–2006), whose new policy made dual track policy the main thrust. The government tried to enhance the nation's international competitiveness by strengthening the 'external' side of the Thai economy, i.e., export, foreign direct investment and tourism. At the same time, it attempted to increase the capability of domestic and grass-roots economies by implementing projects like the Village Fund (one million baht to increase the local management capabilities of each village), a three-year debt moratorium on farmers' debt, the One Tambon One Product Project (supporting each tambon (local administrative unit) in the promotion of one champion local product), and the People Bank, giving underprivileged people loans with no collateral requirement. Some academics and politicians from opposition parties branded these new grass-roots support policies as 'populist policies' aimed at winning votes from among the rural poor.

The Thaksin government, unlike its predecessors, whose main focus was macroeconomic stability, focused more on enhancing meso- and micro-level foundations for international competitiveness. The high priority on the 'competitiveness' issue in the government's agenda was illustrated by the establishment of the National Com-

petitiveness Committee chaired by the Prime Minister. That was the first time that the Thai government had serious "selective" policies addressing specific sectors and clusters. The government identified five strategic sectors that Thailand should pursue: automotive, food, tourism, fashion, and software, and conceived clear visions for them: Detroit of Asia; Kitchen of the World; Asia Tourism Capital; Asia Tropical Fashion; and World Graphic Design and Animation Centre, respectively. Building the nation's innovative capabilities was widely regarded as a very important action towards increasing and sustaining Thailand's international competitiveness. "Innovative nation with wisdom and learning base" was one of the seven "Thailand's Dreams" promoted by the government. To make that innovation-related dream come true, several strategies were devised. The National Economic and Social Development Board (NESDB) was made implicitly responsible for the overall cluster policy of the country. It made substantial efforts to disseminate the concept to various government and private-sector agencies by organizing cluster seminars and workshops in the main regions of Thailand. It also commissioned a study to create a 'cluster mapping' of Thailand, which identified significant agglomerations of firms that function or have the potential to function as clusters in various geographical locations throughout the country. Under the 2006 Intellectual Property Institute, several implementing government agencies, including (1) the Department of Industrial Promotion; (2) a number of sectoral-specific institutes under the Ministry of Industry (including the Thai Automotive Institute, the Thailand Textile Institute, the National Food Institute, and the Electrical and Electronics Institute); (3) the National Science and Technology Development Agency under the Ministry of Science and Technology; and (4) the Office of SME Promotion worked to develop their own cluster projects in the areas under their direction. Nonetheless, the implementation and coordination of those policies during the Thaksin era was far from successful in the long-range industrial upgrading of the country. The Thaksin government largely failed to create policy consistency and continuity, and did not set up mechanisms to enforce, monitor and evaluate the outcomes of those policies. On the one hand, strong centralized power and a CEO style of management enabled the Thaksin government to push harder for implementation of policies for industrial upgrading. On the other hand, the discretionary power of the government, and especially of Thaksin himself, led to policies being controlled by particularistic interests; policy unpredictability; ad hoc decision making that favored politicians' pet projects; and policy rhetoric rather than real actions (Lauridsen 2008). An additional policy focus emerging when the Abhisit government came to power in 2009 emphasized means of making Thailand a 'creative economy,' i.e., an economy based on creativity, talent and the unique culture of the Thai people (the so-called 'Thainess'). As a result, policy makers paid strong attention to 'creative industries' such as Thai food, Thai craft, Thai massage and spas, Thai films, and Thai multimedia software. The major question remaining was how to link science, technology and technological innovation on one hand, and those creative industries on the other. So far, this has not been so successful. The current government at the time of writing, in the wake of the military coup in 2014, reintroduced the cluster policy. Then in 2015, Board of Investment (BOI)'s 'Super Cluster' incentive scheme was introduced. The government currently aims to pro-

mote the Eastern Economic Corridor (EEC), consisting of the three eastern provinces, Rayong, Chonburi, and Chachoengsao. The EEC is intended to accommodate investment in ten targeted industries that have significant promise for Thailand's future: next-generation cars; smart electronics; affluent medical and wellness tourism; agriculture and biotechnology; food; robotics for industry; logistics; aviation; biofuels and biochemical; and digital and medical services. However, at present it is too soon to evaluate the results of this new initiative.

6.2 A Comparison of Taiwanese and Thai Policy Instruments Supporting Technology Upgrading and Innovation

After presenting an overview of industrial development of the two countries, we will examine in detail five specific policy instruments (tax incentives, grants, loans, government equity participation, and capital markets for innovation) aimed at promoting technology upgrading and innovation in the two countries.

6.2.1 Tax Incentives

R&D tax incentives, a rather common policy instrument, have been adopted in many countries since that type of incentives is generic in nature and can be applied equally to all R&D-performing firms in all sectors, allowing governments to avoid criticism for picking winners. Nonetheless, those incentives tend to be seen as less effective than direct subsidies from the government, which can *target* particular activities, clusters, or sectors. The effectiveness of tax incentives also depends largely on the definition of R&D, the administration of incentives, the eligibility of firms, and the form of incentives (OECD 2002) (Table 6.1).

Thailand gives R&D tax incentives based on R&D expenditure (double deduction), while Taiwan has adopted R&D tax credits. The definition of R&D is very rigid, so many firms engaged in technological upgrading activities such as design, engineering, and product development do not qualify. Apart from double deduction of R&D expenditure, in 2003 the Thailand BOI initiated a scheme to promote 'Skill, Technology and Innovation' (STI) by offering an additional 1–3 years' tax exemptions to companies already receiving tax privileges for investment in production, assuming that those companies met the requirements for in-house R&D, in-house training, and R&D collaboration with local universities. Changes have been made as recently as 2017, when the BOI's new 'merit-based' investment promotion scheme started to cover non-R&D technological upgrading activities such as product design, packaging design, advance technology training, licensing fees of intellectual property rights, collaboration with universities, and development of local suppliers.

Table 6.1 Comparison of tax incentives in Thailand and Taiwan

	Thailand	Taiwan
Year of operation	1996	1991
Type	Tax incentives on expenditures	Tax credits
Coverage	R&D (strict definition), training, and collaboration with universities. Coverage of other innovation activities and merit-based approach began as late as 2015 and 2017, respectively	R&D, training, implementation of specific technologies (R&D, training, establishment of R&D centres, encouragement of collaboration between industry and research institutions, and promotion of local industries' innovation)
Focus (sector, cluster, technology, type of firms)	General	General and specific technological fields, such as automation, energy saving, and pollution control, and digital technologies
Project-by-project approval	Yes	No
Effectiveness	Increased number of approved projects, but number of firms still limited	Number of approved tax deductions in TWD has increased but no significant change in number of firms applying. Increase in employment, GDP and net tax revenues

Note Taiwan adjusted the scope of its tax incentive in 2010
Source Constructed by authors

Taiwan's tax credit program covers not only direct R&D activities, but also expenditures on activities *critical* to the upgrading of firms' activities, specifically automation of production, reclamation of resources, pollution control, use of clean and energy-saving technologies, and the enhancement of efficiency of use of digital information technologies. The experiences of Taiwan illustrate the country's ability to implement government incentives to effectively tackle the technological upgrading problems faced by Taiwanese companies.

Regarding the efficiency of tax incentives, Thailand scrutinizes companies wanting to apply for R&D tax incentives *project by project*, though since 2015 approved firms with reliable track records have been exempted from scrutiny, which makes the application process very cumbersome. The level of trust in Thai society is very low, as the Thai government has been strongly concerned about false claims. As a result, the Thai Revenue Department (the agency responsible for the scheme of double deduction of R&D expenses) authorized another government agency, the National Science and Development Agency (the country's largest public research institute) to judge whether submitted projects were really R&D projects and whether proposed R&D expenses were appropriate. A large number of projects were submitted, so on average

the approval process could take as long as 5–6 months. Similarly, project-to-project approval is required for firms wishing to take advantage of the BOI's STI program. Nevertheless, the number of approved projects has increased in recent years. In the case of Taiwan, since 2000, the number of approved tax deductions (in TWD) has increased year by year, but the number of companies applying for such incentives has not changed significantly.

Of the two countries, only Taiwan conducted a formal study on the impact of its tax incentives. Tax credits for encouraging R&D, training, and green energy induced further R&D investment, with significant *positive* net effects on tax revenue (Liu and Wen 2011). In the case of Thailand, though one cannot claim direct causation, the results of community innovation surveys illustrate that innovating firms take advantage of R&D tax incentives more frequently than non-innovating firms.

A major industrial development policy reform that took place in Taiwan during the period of this review was seen when the Statute for Upgrading Industries (SUI) expired in 2009, and its successor, the Statute for Industrial Innovation (SII), was introduced in 2010. SII provisions include the following six targets: the encouragement of innovation efforts; the distribution and utilization of intangible assets; human resource development for industry; funding assistance; investment in the sustainable development of industry; and land supply. In comparison with the now abolished SUI, one critical change in the SII was the amendment of the tax incentive scheme. Different from the SUI, which covered a wide range of tax incentive schemes, under the SII the only remaining tax incentive to encourage innovation is the 15% tax credit against payable business income tax for R&D expenditures (provided that the tax credit does not exceed 30% of business income tax payable in the relevant year). The tax incentive is also time-limited, with a sunset clause set for December 31, 2019.

6.2.2 Grants

Compared to tax incentives, grants can be used more effectively as instruments targeting the encouragement of specific activities, sectors, clusters or firms. However, those incentives require greater government capability in the selection and implementation of those targets. Also, the selection and management processes are complicated and can be subject to political intervention and allegations of corruption, cronyism and nepotism (Table 6.2).

Taiwan has for many years been using grants in various programs as financial instruments to encourage firms to enhance their technological and innovative capabilities. Programs did co-evolve with the development of the capabilities of firms. Several programs are sector- or even product-specific. For example, in 1991 when Taiwanese firms had already gained production capabilities as subcontractors of TNCs and wanted to move up global value chains by acquiring product development capability, the Program for Leading Product Development (LPD) was implemented to subsidize costs of R&D for high-tech products and technologies such as those for ICT, aerospace, pharmaceuticals, and semiconductors. Approximately 800 out

Table 6.2 Comparison of grants schemes in Thailand and Taiwan

	Thailand	Taiwan
Year of operation	1990s	Since 1980s
Level of significance compared to other mechanisms	Not significant	Very significant
Coverage	R&D, prototyping, pilot scale	Wide-ranging and evolving, according to the needs and capabilities of firms
Focus (sector, cluster, technology, type of firm)	General, more sector-specific as late as 2016	Both general and specific (sectors, technologies, products)
Effectiveness	Too small to have critical success	Inducing substantial R&D investment by recipient firms, supporting creation of new industries/products. SMEs benefited significantly

Source Constructed by authors

of 1,600 submissions were approved. The share of approved projects between SMEs and large firms was roughly fifty-fifty. Results of the LPD program were quite impressive: $1 TWD of grant induced an additional investment of approximately $10 TWD for R&D, $21 TWD investment for production, and $42 TWD for sales. On average, one project generated 3.7 patents and 2.9 derivative products (Liu and Wen 2011).

Similarly, in 1998 when the government desired to promote the emergence of local startups, it adopted the US Small Business Innovation Research (SBIR) model which provided grants to firms in three phases: feasibility studies, R&D, and commercialization. A more generic grant scheme, the Industrial Technology Development Program (ITDP), was initiated in 1999 to fund both the preliminary study and R&D phases of firms aiming to develop forward-looking industrial technologies. $1 of grant induced $2.46 and $4.89 of R&D and capital investment respectively (Liu and Wen 2011). In the 2000s, grants were given specifically to strategic technologies and industries such as conventional technology development, commercialization of biotechnology, and the knowledge-based service industry.

In Thailand, grant schemes are limited, both in terms of variety and grant size. The country relies more on indirect support to private firms through such means as tax incentives. However, there are serious problems with giving 'public money' to private firms, as it often gives rise to allegations of cronyism and corruption. In addition, the neoclassical economists who have authority in the national economic policy agencies (and in academia) do not like the idea of selective government intervention in specific industrial sectors, activities, clusters and firms, as such interventions appear to work against the market mechanism. The prospect of loss of public money resulting from grant project failure is also not acceptable to government authorities, especially those in charge of government budgets. As a result, grants have mostly been

awarded to public research institutes and universities. Recently R&D grants like those awarded by the National Science & Technology Development Agency (NSTDA) to private firms have been significantly reduced in number or almost stopped. The most successful granting program has been the Industrial Technology Assistant Program (ITAP), started in 1992, which provides up to 50% financial support for the hiring of external experts (freelance or university faculty) to provide small and medium enterprises with consultation on technological problems. More than 1,000 firms have received financial support from ITAP, with mixed results. The factors most strongly correlated with success appear to be active involvement of firm executives, clarity of project goals, finding 'right' and dedicated experts, and, importantly, the involvement of NSTDA employees (Industrial Technology Assistants [ITAs]) who act as intermediaries between firms and experts.

Another noteworthy grant scheme, offered by the National Innovation Agency (NIA), supports firms with up to 75% of expenses for prototyping and pilot-scale activities. Nonetheless, compared to grants in other countries, NIA grants are rather small (around $160,000 for 3 years), and only fifty-six projects were granted during 2003–2007. Since 2009, NIA support has become more focused on the strategic sectors of bio business, design and solutions, and energy and environment. In 2011, the idea of an 'innovation coupon' was adopted. The NIA gives grants of up to 90% of the cost of projects to private firms for the hiring of listed innovation service providers for either feasibility studies or pilot project implementation. The Federation of Thai Industries (FTI), the largest manufacturers association, is a partner in the scheme, assisting the NIA to select the most appropriate projects. In 2016, the Fund for Enhancement of Competitiveness for Targeted Industries was established with $285 million in government seed money for investment projects targeting research and development or human resource development in specific areas. The results are yet to be seen.

6.2.3 Loans

Loan programs are more popular among countries having problems giving direct grants to the private sector for innovative projects, simply because loans have to be returned and collateral guarantees are required. Not surprisingly the use of loans is a relatively prominent financing innovation mechanism for countries like Thailand. The NSTDA's Company Directed Technology Development Program has been providing soft loans of up to 75% of total project cost and less than $1 million per project for R&D, product and process upgrading, and building or refurbishing laboratories. Nonetheless, the number of projects approved each year has been quite small (fewer than twenty) and has fallen recently, largely because selection criteria have become more stringent. Firm activities must be R&D related and must employ technologies new to the industry. Acquisitions of machinery not related to R&D are unlikely to be awarded loans. Therefore, most Thai SMEs do not qualify, since they do not have R&D capability and the problems that they are facing are more production related.

Table 6.3 Comparison of loan schemes in Thailand and Taiwan

	Thailand	Taiwan
Year of operation	1990s	Since 1980s
Level of significance compared to other mechanisms	Significant	Significant
Coverage	Increasingly focused on R&D	Wide-ranging and evolving according to needs and capabilities of firms
Focus (sector, cluster, technology, type of firms)	Rather general	Both general and specific (sectors, technologies, activities)
Facilities supporting access to loans	SME credit guarantee	SME credit guarantee
Effectiveness	Number of applications in some programs has dropped significantly	Number of approved projects has increased

Source Constructed by authors

On the other hand, the NIA has provided a zero-interest loan of up to 5 million baht for the first three years of an innovation project. Nevertheless, the setting up of the scheme is problematic, as loans have to be channelled through commercial banks, whose usual selection requirements do not favor the financing of risky innovative projects. As a result, only thirty-eight projects were approved during 2003–2007 (Table 6.3).

Taiwan has several loan schemes for purposes including the purchase of automated machinery for manufacturing and agriculture enterprises, the revitalization of traditional industries, the purchase of energy-saving equipment, the promotion of industrial R&D, and the purchase of computer hardware and software. Firms in service industries, such as Internet and technical service providers, are also eligible. The amount of loan per company is some $2–3 million. More than 50,000 cases have been approved. Both loan size and number of approved projects are on a much greater scale than those of Thailand. The SME Credit Guarantee Fund (SMEG) is also available to help SMEs secure loans from government programs.

6.2.4 Equity Financing

The aim of venture capital is to finance firms at the early stages of starting up or during early growth. During those phases, financing the companies is too risky and uncertain for ordinary commercial banks (Table 6.4).

In Thailand, the genesis of the venture capital (VC) industry was initiated by some foreign VC funds in 1987. Those VC investments are generally targeted at

Table 6.4 Comparison of equity financing schemes in Thailand and Taiwan

	Thailand	Taiwan
Year of equity financing operation	1987	1983
Stages of VC investment	Expansion and mezzanine stages	Established, mass production and expansion stages
Specialized funds to support innovative firms through VCs	SME VC Fund, MAI Matching Fund, Startup Fund	Development Fund and SME Development Fund
Sectors of VC investment	Food and drinks, machinery and equipment, household furnishings, wood products, costumes	Optoelectronics, semiconductor, biotechnology, information services, electrical machinery, electronic components
Formal VC association	Thai Venture Capital Association (TVCA) established in 1994	Taiwan Private Equity and Venture Capital Association (TVCA) established in 1999
Business angel financing	Not active	Has formal business angel network (TWBAN)
Government's direct equity financing	None	Very large government funds (Development Fund and SME Development Fund)
Effectiveness	Low uptake in government VCs; private VCs are risk averse; fund of funds initiative failed because of insufficient demand. Lack of mentoring services	Helped to increase high-tech start-ups but not so significantly, as only 11.34% of VC funds went to early stages, according to a TVCA statistical summary for 2010

Source Constructed by authors

the growth and expansion stages of the venture life cycle. In Thailand the major organizations providing VC funds to support entrepreneurial development are the Office of Small and Medium Enterprises Promotion (OSMEP), the National Innovation Agency (NIA), One Asset Management Ltd., Stang Holding Co., Ltd., and MAI Matching Fund. The MAI Matching Fund, a fund of funds with assets of 2,000 million baht, was set up to increase the number of newly-listed companies (including VC-backed companies) on the MAI. However, the fund has recently ceased operation. The Revenue Department also provides taxation schemes to support VC fund investments. These schemes assist both VC funds and investors through corporate and personal tax exemption policies. VC funding in Thailand totals 720 million baht on average with a duration of approximately ten years. Most VC funds invest 30% in the early stage and 70% in the growth and mature stages. The leading business angel in Thailand is the Thai-Chinese Business Association. The fund size of business angel investing is approximately 90 million baht. The average deal ranges between 4 and 50 million baht with no exit strategies (Scheela and Jittrapanun 2012). In 2016, the Ministry of Science and Technology tried to launch a 500 million baht ($14.2 mil-

lion) fund of funds for Thai startups in ten targeted industries under the umbrella of 'Startup Thailand,' but that has not yet materialised. Providing funds to the private sector through VCs, let alone direct financing, is very problematic in Thailand.

In Taiwan, on the other hand, venture capital financing began in 1983 with the launch of the Regulation Governing Venture Capital Business Management to stimulate the development of the venture capital industry. VC investing is mostly done at the established mass production and expansion stages with the government playing a major role in financing firms at those stages. The Taiwan Private Equity and Venture Capital Association (TVCA) was established in 1999 to create an environment conducive to the development of Taiwan's economy. At present, the management of VC funds is under the supervision of the Ministry of Economic Affairs (MOEA). The success of VC development in Taiwan can be tied to its active network linkages with Silicon Valley in the US (the success of VC development there is the result of a social and economic bridge linking the US Silicon Valley and Taiwan's high-tech industry). In addition to venture capital enterprises, Taiwan also has government 'direct' financing schemes. In 1973, the Development Fund was set up to invest directly in innovative companies and indirectly through VC firms. Priority was given to strategic sectors such as biotechnology, aerospace and optoelectronics. Also, to stimulate the technological development of SMEs, the SMEs Development Fund was established in 1994 to invest directly and indirectly through government and private VCs. These two large government funds are the government's main investment arms for promotion of innovative firms and stimulation of the growth of Taiwan's VC industry.

With regard to the efficiency and effectiveness of the implementation of VC financing policy, the number of VC funds in Thailand remains small despite government policy of promoting the VC industry. In 2010, only two VC funds applied for VC licenses. The total funds raised in the Thai VC industry accounted for 0.15% of GDP. In the case of Taiwan, the number of new VC investments grew as a result of government tax credit policies aimed at supporting VC companies (the number of new investments grew from 1,155 cases to 1,850 cases between 1998 and 2000). However, the number of investments decreased after the cessation of tax credit. In comparison, as a result of more effective government intervention in Taiwan, firms at the start-up phase or early-growth phase received more financing in Taiwan than was the case in Thailand, where firm financing is more at the later phases, when firms can also get financial support from ordinary financial institutions such as commercial banks.

6.2.5 Capital Market Funding

Establishment of a capital market provides an investment exit through initial public offering (IPO) listings, including IPO exits for VC-backed firms. In Taiwan, there are two stock markets: the Taiwan Stock Exchange (TWSE) and the Over-the Counter Securities Exchange (OTC, also called Gre Tai Securities Market or GTSM). The

Table 6.5 Comparison of capital market funding in Thailand and Taiwan

	Thailand	Taiwan
Main stock markets	SET, MAI	TWSE and GTSM
Stock market for technology-based firms	No	Yes (TWSE and OTC)
Major sector of listing securities	Production, consulting, trading, services	Electronic parts and components, semiconductors, optoelectronics, computer and peripheral equipment
Listing platform to support technology-based firms	No particular rules for technology-based firms	Flexible listing rules for technology-based firms
Effectiveness	No significant impact in terms of increasing number of 'innovative' SMEs	Number of listed companies has increased rather significantly in recent years

Source Constructed by authors

listing rules of the TWSE market are more restrictive than those of GTSM. However, both markets provide flexible market-entry regulations for high-tech industries (assisting high-tech companies to receive sufficient funds for development). TWSE listing rules require that companies receive an appraisal opinion from the central authority, i.e., the Industrial Development Bureau of Ministry of Economic Affairs (MOEA), to demonstrate their capacity to deal with developing technologies. The OTC market, the equivalent of the US NASDAQ, supports high-tech start-ups in particular. It has a flexible listing process for high-tech companies. However, the listing rules of the OTC also require that MOEA provide its professional opinion regarding the ability of the issuing company to innovate. As of 2017, there were 894 companies listed on TWSE and 732 companies listed on the OTC market, which illustrates the policy coordination between listing regulations and overall industrial technology development policy under the supervision of a single agency, the powerful MOEA. It is interesting to see that the creation of a vibrant stock market in the case of Taiwan has led to improved VC performance as the equity capital markets provide jump-start financing for SMEs and new technology-based firms. It is noteworthy that the high-tech industry reaps the largest net profits among all industries (Table 6.5).

In Thailand, the main capital markets are the Stock Exchange of Thailand (SET) and the Market for Alternative Investment (MAI). There is no special capital market set up to finance technology-based firms as is the case in the OTC market in Taiwan. However, it is interesting to see that the MAI attempts to support innovative businesses, including firms with high growth potential in the technology industry. The capital market in Thailand seems to be focused on promoting SMEs rather than driving technology- and innovation-based firms. At present, the MAI market has 64 listed companies with a market capitalization of 12,025 billion baht. Data from interviews of listed firms illustrates that the MAI does not encourage or support listed firms to become more innovative or to conduct sophisticated technological activities. By listing in the MAI, firms gain prestige, which is quite helpful in terms of mar-

Table 6.6 Innovation performance of Taiwan and Thailand

	Thailand	Taiwan
Innovating firms (% of total number of firms) in 2011	20.7	50.2
Number of patents granted by US Patent Office (USPTO) in 2014	125	12,254

Note The data on Thailand's R&D performing and innovating firms is for 2011. The data on Taiwan's R&D performing and innovating firms is for 2000
Sources National Science and Technology Development Agency (NSTDA), Thailand; National Science Council, Taiwan; United States Patent Office (http://www.uspto.gov)

keting, raising more capital, and dealing with government authorities, but there are no tangible gains in terms of either product or process development or management practice enhancement.

Differences between Taiwan and Thailand in terms of government policies for the support of innovation have led to different results. In Taiwan there are significantly more innovating firms and more patents registered in the US by Taiwanese firms and entities than is the case in Thailand (see Table 6.6). Interestingly, in 2014 the number of Taiwanese patents granted by the US Patent Office was almost a hundred times that of Thai patents.

6.3 Institutions Affecting Policy Formulation and Implementation

Different institutions in the two countries shape both policy content and policy processes, and, thereby, the policy results of each country. Both countries have managed to use policy instruments to mitigate institutional shortcomings (Table 6.7).

6.3.1 Unity and Capability of Government Bureaucracy

There are also bureaucratic differences between Taiwan and Thailand. In Taiwan, most incentives, regardless of types, have been awarded by a single agency, the Ministry of Economic Affairs (MOEA). As a result, there have been no significant problems with policy coordination or turf wars between different agencies. Moreover, MOEA has established and reformed sixteen GSRIs that cover most fields of industrial technology, including agricultural technology. The most famous GSRI is ITRI, that serves as MOEA's 'industrial technology development arm' and as an 'intermediary' for resolving conflicts between concerned actors and leading various types of vertical, horizontal and industry-academia cooperation (e.g., R&D consor-

Table 6.7 Comparison of institutions in Thailand and Taiwan

	Thailand	Taiwan
Unity and capability of government bureaucracy	Fragmented: MOST is not an economic ministry, MOI has little role in technology development	Under one strong agency (MOEA)
Perception of roles of government in strengthening private firms	Limited to HR and infrastructure (neoclassical economics and linear model of innovation)	To solve both market and systemic failures; strong 'selective' intervention
Corruption and attitudes on corruption	Strong concerns preventing grants/public equity participation, and 'selective' policies	Not a significant factor as grants/public equity participation, and 'selective' policies are normal practices
Laws, regulations and norms	'Public money must be recovered' attitude preventing grants/public equity participation in risky 'innovation'	No similar concept of public money
Entrepreneurship	Many 'necessity-based' entrepreneurs but few 'opportunity-based' or Schumpeterian ones. Positive changes in the younger generation	Large number of high-tech startups, especially in ICT, enhanced by attracting Taiwanese entrepreneurs, engineers and managers who used to work in advanced countries
Trust	Limited inter-firm collaboration and university-industry links	Strengthened by intermediaries such as public research institutes (e.g., ITRI)

Source Constructed by authors

tiums). However, the status of MOEA has been weaker since the abolition of martial law in the late 1980s and as a result of recently rising public financial deficit problems (Liu and Wen 2011).

The situation is very different in Thailand, where the Ministry of Science and Technology had not been considered as an 'economic' ministry until the present government took power in 2014. The Ministry of Industry, on the other hand, pays little attention to the development of indigenous capability of firms. Innovation financing schemes executed by the ministry are very limited. Also different from the case of Taiwan, in Thailand there are Research and Technology Organizations (RTOs) under the ministry which can function as industrial technology development arms and as intermediaries in sectoral and regional innovation systems.

6.3.2 Perception of the Role of Government in Strengthening Private Firms

Government officials in Taiwan are keenly aware that both market failures and systemic failures prevent firms from developing technological and innovative capabilities and innovation systems from functioning successfully. There are many schemes for overcoming such failures, including direct grants and public equity participation. These schemes are almost non-existent in Thailand, in terms of both variety and amount of support, largely because there is a long-standing reliance on neoclassical economic thinking among Thai bureaucrats, who believe that the market mechanism is the best for allocation of resources. For that reason, it is widely held that government intervention should be limited; firms should be able to help themselves, and government roles should be limited to providing adequate infrastructure and a favorable business environment with transparent and stable rules. Selective financing innovation policies aimed at supporting particular sectors, cluster, types of firms, or activities are viewed as market distortions. Given that atmosphere, there are few grant and public equity participation schemes, and even fewer selective ones, in Thailand. On the other hand, S&T policy making has largely been in the hands of scientists who believe in a 'linear model of innovation.' As a result most schemes focus on R&D and neglect other aspects of capability development including production, engineering, design, problem solving, and utilization of other firms' knowledge and intellectual property rights,. Since innovation is often narrowly viewed as 'commercialization of R&D,' other types of innovation which are not R&D-led, such as new services, new business models, new applications and solutions are widely ignored, unlike the situation in Taiwan.

6.3.3 Corruption and Attitudes Toward Corruption

Corruption brings extra costs to doing business. It is a greater concern in Thailand than in Taiwan. In societies where corruption is rampant and people are afraid of corruption, new policy initiatives are often viewed with skepticism, reflecting concerns that these policies will favour particular parties. This is one of the main reasons why grants and, to a lesser extent, direct equity participation from government, are very few, and why R&D tax incentives require project by project scrutiny in Thailand, where there are serious concerns about nepotism and cronyism. Similarly, selective policies targeting particular industrial sectors, types of companies, products, and activities are also subject to this negative view. As a result, selective policies are very difficult to realize in Thailand.

6.3.4 Laws, Regulations and Norms

Laws, regulation and norms can limit the policy makers' choices of incentive schemes. They also can reduce the effectiveness of those schemes. In Thailand, there is a widely accepted notion of how 'public money' should be used: public money must be recoverable; it should not be spent in ways that do not generate returns, even if such spending is done with good intentions; and the government officials who authorize such spending should be individually accountable for mistakes that arise. Therefore, grants, and even direct equity participation by government in risky corporate activities or in particularly risky types of firms such as startups, are quite rare in Thailand.

6.3.5 Entrepreneurship

The effectiveness of public innovation schemes is heavily contingent on the firms' contribution to innovation processes through their culture and management practices. Government support will only have a positive influence on firms' innovation performance if those firms have good entrepreneurial management practices. More and more entrepreneurs are able to see business opportunities in high-tech industries in Taiwan. Also, Taiwan has been successful in bringing entrepreneurs and professionals back to Taiwan to work in TNCs, Taiwanese firms, and government agencies, and to start new businesses, especially in the electronics industry. Though foreign direct investment and the global production networks of transnational corporations have played important roles in providing business opportunities to local Taiwanese companies, technology transfer and technological upgrading of local Taiwanese firms in the electronics, machinery, automotive parts and components sectors did not occur automatically. Taiwanese firms attained 'second mover advantage' by entering markets faster than other latecomer firms, ramping-up their production, achieving economies of scale, and continuously upgrading their technological and managerial capabilities (Amsden and Chu 2003). In Thailand, however, Thai firms were much slower to enter markets and develop their own capabilities. Attempts to encourage innovative startups have not been very successful either, as there is a lack of 'opportunity-based' entrepreneurship (where entrepreneurs seize and execute risky opportunities through innovation). On the other hand, there is plenty of 'necessity-based' entrepreneurship (i.e., people become entrepreneurs because they need to do so to survive economically) as in the case of street vendors.

6.3.6 Trust

The effectiveness of the financing of innovation schemes depends on societal trust. In Thailand, inter-firm collaborations are relatively few because of a lack of trust among firms. Policy instruments might help to overcome that obstacle, but they pose a considerable challenge. In Taiwan, GSRIs such as ITRI acted as intermediaries linking competing firms through mechanisms such as R&D consortia, where participating firms and GSRIs cooperate in costly and risky 'pre-competitive' stage R&D before the individual participating companies set out to develop their own branded versions of products based on the outputs (such as prototypes) of the R&D consortia. This practice is not seen in Thailand.

6.4 Conclusion

The results of this comparative study of Taiwan and Thailand are summarized below in terms of lessons learned and policy implications for technological upgrading and innovation in the manufacturing sector.

Firstly, in Taiwan the more successful of the two countries, there is co-evolution of policy instruments and levels of technological and innovative capability of firms. The enhancement of various technological and innovative capabilities does require different policy instruments. The ability to initiate and implement new policy instruments to suit the changing needs of firms at different levels of capability over time is critical. Policy makers in both countries must understand the current needs of firms and the technological barriers they face. 'Me-too' strategies based on copying other countries (countries which no doubt have different needs and face different challenges) are extremely unlikely to be effective.

Secondly, more successful countries such as Taiwan have a greater flexibility and stronger policy coordination and learning capacity. Their governments offer a much greater variety of policy instruments and cater to them 'selectively' to meet the particular needs of industrial sectors, clusters, technologies, types of firms and even individual firm demands. Incentives should be formulated and executed so that they are mutually complementary and should contribute to overall industrial technology development strategy, as was the case in the mandate of MOEA to evaluate the prospects of newly listed firms in Taiwan's stock markets. In addition, when incentives do not work for some particular types of firms, it should be possible to adjust them to meet the demands of those firms.

Thirdly, developing the technological and innovative capabilities of firms takes considerable time. The size, duration and continuity of government support schemes are crucial. Those schemes should reflect policy priorities and government commitment. The policies and practices of Taiwanese government illustrate its commitment to offering such schemes.

Fourthly, policy makers must have a deep understanding of the nature of innovations and innovation systems, and how they evolve over time. This is an important prerequisite for formulating effective policies. There is a sharp contrast between Thailand and Taiwan regarding the formulation of policy measures. While Thailand has focused narrowly on R&D-led innovation, Taiwan broadened its incentives to other types of activities important to innovation processes, both in-house and beyond the boundaries of the individual firm. Incentives can also be provided to cover innovation types including services, business models and solutions.

Fifthly, technology upgrading and innovation policy formulation require corresponding policy initiatives if they are to work successfully. Also very necessary are government initiatives that produce qualified human resources, attract foreign talent, and help organizations to work together. An example of the needed synergy is Taiwanese government's success in educating technicians, engineers and researchers. The density of researchers in Taiwan has increased from 311 per one million population in 2009 to 5,200 in 2014. Also, Taiwan, unlike Thailand, has succeeded in bringing back talented Taiwanese who had been studying and working in advanced countries.

Last but not least, the choices related to and the effectiveness of implementation of these policies are shaped by institutional factors including laws and regulations, unity and capability of government bureaucracy, trust, entrepreneurship, attitudes toward corruption and the role of government in supporting private firms. It is important to bear in mind that to some extent institutional shortcomings can be corrected. Successful countries can use incentives and other government mechanisms (e.g., GSRIs as intermediaries in innovation systems in Taiwan) and initiatives to overcome these shortcomings or at least mitigate their impact.

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