Chapter 1

Best Policy Practices in Small and Medium-Sized Enterprise Innovation and Technology Transfers for ASEAN and East Asia

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CHAPTER 1

Best Policy Practices in Small and Medium-Sized Enterprise Innovation and Technology Transfers for ASEAN and East Asia

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Most small and medium-sized enterprises (SMEs) are latecomers facing two disadvantages: they are behind in research, development, and engineering capability, and they are dislocated from international markets, whose demands help stimulate technological advance and innovation. Policies to stimulate SMEs' technological development are thus divided into two groups: (i) supply-side policies that aim to increase incentives to invest in innovation by reducing costs, and (ii) demand-side policies that are public actions to induce innovation and/or speed up the diffusion of innovation.

Policies can be implemented through tax incentives, grants or direct subsidies, low-interest loans, and government direct equity participation—all of which have pros and cons. We summarize several lessons learnt from the experiences of Taiwan, Singapore, Malaysia, and Thailand. Different levels of technological and innovative capabilities of SMEs need different policy instruments. The more successful countries have greater flexibility and policy coordination and learning. The amount, duration, and continuity of government-supported schemes are crucial. Policymakers must have a deep understanding of what constitute innovations and innovation systems, and how these evolve. Successful innovation financing policies require corresponding policy initiatives. Lastly, institutional factors shape the choices and the effective implementation of these policies.

Keywords: SMEs, innovation, Asia, demand-side policies, supply-side policies

1. Introduction

East Asian countries are latecomers to industrialization. While they enjoy the advantage of utilizing the technological and institutional advances created by the forerunner countries (Gerschenkron, 1962), they also face two disadvantages in competing in the global market:

(i) They lack research, development, and engineering capability, and their poorly developed industrial and technological infrastructure operates in isolation from the world centres of science and innovation.

(ii) They are dislocated from international markets, whose demands help stimulate technological advance and innovation (Hobday, 1995).

Several latecomer firms, especially in Japan, Korea, Taiwan, and Singapore, have been able to exploit their advantages and overcome their disadvantages by increasing their technological capabilities. Some small and medium-sized enterprises (SMEs) became large, even global, firms, but most left the market or remained weak in technology and innovation. What factors determined these outcomes? While strategies and behaviours were decisive, policy content and implementation also mattered significantly.

This paper aims to shed light on how policies supported innovation in and technology transfer to SMEs by examining the experiences of Taiwan, Singapore, Malaysia, and Thailand. Two criteria were used to select them:

(i) SMEs should be economically significant. Although Japan and Korea are technologically successful, their economies are dominated by large firms.

(ii) Serious industrialization and technological development should have taken place around the same time. The four selected economies started in the 1960s.

Although the industrialization strategies of Singapore, Malaysia, and Thailand depend considerably on foreign direct investment, technological spillovers to local firms (especially SMEs) were significantly higher in Singapore. We will examine the extent to which these economies are influenced by different technology and innovation policy content and implementation. By adopting a history-friendly and longitudinal approach, the paper will trace any co-evolutions between government policies and the increase in technological capabilities and innovation in firms in the four economies and determine how they happened. This will shed light on the types of policies that will stimulate innovation in firms at each level of technological capability and economic development. The empirical results draw extensively on 'Towards Effective Policies for Innovation Financing in Asia', a study under my leadership for the International Development Centre of Canada in 2010–2011.

Section 2 describes the significance and process of and barriers to innovation and technology transfer for SMEs. Section 3 examines types of policy intervention, and the pros and cons of government instruments: tax incentives, grants, loans, and equity participation. Section 4 considers the four countries' policy experiences. Section 5 provides conclusions and recommends policies for countries at different levels of development and for regional cooperation.

2. Innovation in and Technology Transfer to Small and Medium-Sized Enterprises: Significance, Process, and Barriers

Latecomer firms' technological capability levels are classified in different ways. The most comprehensive and best-accepted classification is by Bell and Pavitt (1995), who developed their framework based on Westphal *et al*. (1985) and Lall (1992). They differentiate 'production capacity' from 'technological capabilities'. Production capacity incorporates resources used to operate existing technological systems (to produce goods at given levels of efficiency and given input combinations). Technological capabilities are resources needed to generate and manage technological change. These include skills, knowledge, and experience, as well as the institutional structures and linkages necessary to produce inputs for technical change. Bell and Pavitt also distinguish among 'depths' of technological capabilities. A basic level of capability permits only minor and incremental technical change, while intermediate and advanced technological capabilities may result in more substantial, novel, and ambitious change. Functionally, they classify capabilities into types: facility user's decision-making and control, project preparation and implementation, process and production organization, product —centre, linkage development, and capital-good supply (Table 1.1).

Alternatively, Amsden (2001) has simplified the classification of technological capabilities into production capabilities (the skills to transform inputs into outputs), project execution capabilities (the skills to expand capacity), and innovation capabilities (the skills to design entirely new products and processes).

Table 1.1. Bell and Pavitt's Industrial Technological Capabilities: An Illustrative Framework

	PRIMARY ACTIVITIES				SUPPORTING ACTIVITIES	
	INVESTMENT		PRODUCTION			
	Facility User's Decision Making and Control	**Project Preparation and Implementation**	**Process and Production Organization**	**Product Centred**	**Developing Linkages**	**Capital-Good Supply**
Basic Production Capabilities (capacities to use existing production techniques)	Engaging prime contractor. Securing and disbursing finance. Officiating at opening ceremony	Preparation of initial project outline. Construction of basic civil works. Simple plant erection	Routine operation and basic maintenance of given facilities. Efficiency improvement from experience in existing tasks	Replicating of fixed specification and design. Routine quality control to maintain existing standards and specifications	Procurement of available inputs from existing suppliers. Sale of 'given' products to existing and new customers	Replication of unchanging items of plants and machinery
TECHNOLOGY CAPABILITIES (CAPABILITIES TO GENERATE AND MANAGE TECHNICAL CHANGE)						
BASIC	Active monitoring and control of feasibility studies, technology choice and sourcing, and project scheduling	Feasibility studies. Outline planning. Standard equipment procurement. Simple ancillaries engineering	Commissioning and debugging. Improved layout, scheduling, and maintenance. Minor adaptation	Minor adaptations to market needs, and incremental improvement in product quality and mechanical properties	Searching and absorbing new information from suppliers, customers, and local institutions	Copying new types of plants and machinery. Simple adaptation of existing designs and specifications
INTERMEDIATE	Search, evaluation, and selection of technology and sources. Tender and negotiation. Overall project management	Detailed engineering. Plant procurement. Environment assessment. Project scheduling and management. Commissioning. Training and recruitment	Process improvement. Licensing new technology. Introducing organizational changes	Licensing new product technology and/or reverse engineering. Incremental new product design	Technology transfer to suppliers and customers to raise efficiency, quality, and local sourcing	Incrementally innovative reverse engineering and original design of plant and machinery
ADVANCED	Developing new production systems and components	Basic process design and related R&D	Process innovation and related R&D. Radical innovation in organization	Product innovation and related R&D	Collaboration in technology development	R&D for specifications and designs of new plant and machinery

Source: Bell and Pavitt (1995: 84).

‘Learning by interacting’ with other actors is more important than ever as it is difficult for firms to innovate without relying on external knowledge. To leverage external knowledge, firms have to go beyond the conventional ‘technology or knowledge transfer’, which implies simple and one-way transfer from knowledge providers to recipients. ‘Knowledge diffusion’ is a two-way process. Its success depends on the recipients’ capacity to absorb and assimilate that technology. As pointed out by Cohen and Levinthal (1990) and Leonard-Barton (1995), a firm’s absorptive capacity enables it to search and access external technological knowledge, and to identify suitable technological choices. A few case studies show that when technology was imported by recipient firms to complement in-house technological effort rather than only to produce new products, diffusion was more likely to succeed in upgrading their technological capability (Katrak, 1990).

Many firms, especially SMEs, face difficult barriers to increasing their technological capability to upgrade and innovate. They are passive learners with limited absorptive capacity to select, acquire, absorb, and upgrade external knowledge. The innovation system concept stresses that the flow of technology and information among people, enterprises, and institutions is key to an innovative process. The concept includes the interaction among the actors needed to turn an idea into a process, product, or service on the market (Lundvall, 1985, 1988, 1992). Some barriers are internal to the firms while some are external (the unfavourable innovation systems in which firms are located), contributing to the following (Chaminade and Edquist, 2006; Woolthuis, *et al*., 2005):

(i) Infrastructure provision and investment failures.

(ii) Transitional failures. Firms are less capable of foreseeing the emergence of new technological paradigms.

(iii) Lock-in failures. Firms are locked into acquired existing technologies and technology systems.

(iv) Formal and informal institutional failures. Laws, regulations, norms, and routines hamper innovation and capability building.

(v) Network failures. Knowledge intensity of exchange is too weak, or linkages are too strong, leading to blindness to what happens outside the network.

(vi) Capability and learning failures. Firms have insufficient competencies, limiting their capacity to learn, adopt, or produce new technologies over time.

(vii) Unbalanced exploration–exploitation mechanisms. The system might be capable of generating diversity but lacks the mechanisms to make adequate selections, or it may have refined selection procedures but not the capability to generate diversity.

(viii) Complementarity failures. The systems' competencies might not complement each other.

An important aim of technology and innovation policies in developing countries is to eliminate or mitigate these failures and barriers, i.e., changing firms' learning behaviour from 'passive' to 'active'.

3. Types and Instruments of Government Policies Stimulating Innovation and Technology Transfer

Policies to overcome systemic failures that prevent firms, especially SMEs, from increasing their technological capabilities and ability to leverage external knowledge can be classified into supply side and demand side.

The aim of supply-side policies for innovation in firms is to increase incentives to invest in innovation by reducing costs. These incentives include direct funding of firms' research and development (R&D), fiscal measures, debt- and risk-sharing schemes, and technology extension services. Supply-side instruments encourage investments that otherwise might not be undertaken as liquidity constraints caused by capital market imperfections can be substantial when it comes to innovation.

Demand-side policies are public actions to induce innovation and/or speed up the diffusion of innovation by (i) increasing demand for innovation, (ii) defining new functional requirements for products and services, and/or (iii) improving user involvement in innovation (Edler, 2009). For SMEs, in particular, demand for their innovation (new or significantly improved products or processes) is insufficient or unarticulated. Policies to increase new public and private demand and/or to articulate existing demand are much needed.

Both supply- and demand-side policies can be deployed by several instruments such as tax incentives, grants or direct subsidies, low-interest loans, and government direct equity participation. An R&D tax incentive has been adopted in many countries since it is generic and applies equally to all R&D-performing firms. The government can, therefore, avoid criticism for picking the winners. Nonetheless, the incentives might be viewed as less effective than direct government subsidies, which can target particular activities, clusters, or sectors. The effectiveness of tax incentives also depends largely on the definition of R&D, administration of incentives, eligibility of firms, and form of incentives (OECD, 2002).

Grants can be more effective than tax incentives in encouraging specific activities, sectors, clusters, or firms, but they require higher government capabilities to select and meet targets. The selection and management processes are also complicated and can be subject to political interventions as well as opportunities for corruption, cronyism, and nepotism. Loan programs are more popular in countries with problems giving direct grants to the private sector for innovative projects, simply because loans have to be paid and need collateral guarantees. Equity financing can be used selectively, like grants. Recipients can also get the money up front, which means investment risk can be substantially reduced. Having government co-invest in a project can increase its creditability. Still, writing off bad projects financed by public funds is problematic. Table 1.2 summarizes the advantages and disadvantages of these instruments.

Table 1.2: Innovation Policy Instruments: Advantages and Disadvantages

Type	Advantages	Disadvantages
Tax Concession	- Non-discriminatory, open to all - 'Arm's length' instrument; activities chosen by industry - Maintenance of firm's confidentiality - Speedy processing (where approval is 'automatic')	- Of no benefit to unprofitable or start-up firms - Subsidizes 'existing' activity that would have occurred anyway (unless based on incremental performance, which is hard to police)
Repayable Loan	- Can be targeted widely or focused - Priorities or scope (type, timing, size) set by government - Specific proposals can be made by firms	- Requirements (e.g., collateral) work against small and medium-sized enterprises and start-ups - Procedures are long and cumbersome.
Grant	- Benefits focused activities, sectors, clusters, some types of firms - Allows prioritization and, therefore, are appropriate for innovative projects - No need to write it off	- May be subject to criticism for being unfair - Government must have the ability to *select* recipient.
Equity Participation	- Benefits focused activities - Firms get investment money up front, reducing risks and uncertainty and increasing creditability.	- May be subject to criticism for being unfair - Government must have the ability to *select* recipient. - Must write off *bad* projects

Source: Author.

4. Supporting Firms' Innovation and Technology Transfer: Policy Experiences of Selected East Asian Economies

The East Asian economies discussed here started serious industrialization in the 1960s and achieved remarkable growth rates. Singapore saw one of the most impressive economic growth records in the last four decades, with 7.6 percent gross domestic product (GDP) growth per annum over 1960–2009. Singapore's per capita GDP of US$72,724 in 2012 (on purchasing power parity basis) stands as one of the highest in Asia. Singapore's national innovation system was transformed from one with primary emphasis on technology adoption—particularly the assimilation and diffusion of technology by leveraging inward investments by transnational corporations (TNCs)—to one with a more balanced approach that significantly encourages indigenous innovation capability, including basic and strategic R&D, and the creation of local high-tech firms (Wong and Singh, 2012). Singapore's innovation financing schemes co-evolved with the development of its national innovation system. Its earliest schemes targeted innovation diffusion and capability development to transfer technology, particularly from TNCs. These schemes remain the most common innovation assistance program. From the late 1980s, the government also focused on developing applied, and then basic, R&D capabilities, particularly through the use of grants and tax incentives. Start-up support schemes were first implemented in response to the policy focus on high-tech entrepreneurship during the late 1990s. Technology commercialization schemes, which began in the mid-2000s, are the more recent development in innovation policies (Wong and Singh, 2012).

Similarly, Taiwan's average annual growth rate has been an impressive 8 percent in the past three decades. Taiwan is now a high-income economy with GDP per capita (on purchasing power parity basis) of US$39,059 in 2012. It adopted the 'second mover' strategy of entering the global high-tech market only after the product matured and exploiting manufacturing and project execution capabilities (Amsden and Chu, 2003). The government-sponsored research institutes were important in implementing the strategy. They assimilated advanced technology from overseas, then rapidly diffused the technology to local firms. The institutes have also increasingly served as the coordinating platform nodes for promoting the creation of indigenous technology via innovation networks and strategic R&D programs (Wong, 1999). As a result, although not yet technologically on a par with their Western counterparts, many Taiwan firms, which started as SMEs, have enhanced their technological and innovative capabilities and climbed up the global value chain. Like Singapore's, Taiwan's innovation financing policies, together with other government interventions (especially the intermediary role of government research institutes), have been significant in the learning processes of Taiwan's firms. These programs also co-evolved with the development of Taiwan's firms' technological capabilities and innovation system. The schemes of the 1960s–1980s focused on developing absorptive capacity to take advantage of foreign technologies. During the 1990s, the schemes began to focus more on helping firms develop new products, enhancing R&D capabilities, and encouraging the emergence of start-up companies in emerging sectors such as biotechnology (Liu and Wen, 2012).

The experiences of Malaysia and Thailand have been significantly different from those of Singapore and Taiwan. Although Malaysia and Thailand have made remarkable socio-economic progress over the past four decades (with average annual GDP growth rates of more than seven percent) and attained middle-income status, both are stuck in the 'middle-income' trap: the inability to produce differentiated and sophisticated products and climb up the global value chain. The national innovation systems of Malaysia and Thailand are weaker and more fragmented than those of Singapore and Taiwan (Thiruchelvam, *et al*., 2012; Intarakumnerd, *et al*. 2002). Likewise, firms in Malaysia and Thailand have lower technological capabilities and exhibit more 'passive' learning patterns. The innovation financing schemes of these two countries have not co-evolved as much with the development of technological capabilities of firms and national innovation systems. Thailand, in particular, has been unable to quickly modify its schemes. Most policy instruments in Thailand are limited to tax incentives and only for R&D. In Malaysia, however, several grant schemes target firms' different development stages. Such schemes in both countries have been hindered by fragmented policies and government agencies' inability to monitor, evaluate, and learn from policy implementation.

We will now examine in detail the four economies' policy instruments to find similarities and differences in content and execution.

4.1. Tax Incentives

Table 1.3: Comparison of Tax Incentives in Thailand, Malaysia, Singapore, and Taiwan

	Thailand	**Malaysia**	**Singapore**	**Taiwan**
Year of Operation	**1996**	**1982**	**1960s**	**1991**
Type	Tax incentives on expenditures	Tax incentives on expenditures	Tax incentives on expenditures	Tax credits
Coverage	R&D (strict definition), training, collaboration with universities	R&D, commercialization of R&D	Pioneer activities, R&D, R&D hub (covering R&D outside Singapore), design, acquisition of intellectual property right and automation equipment	R&D, training, using certain technologies
Focus (sector, cluster, technology, type of firm)	General	General, specific (biotechnology, information and communications technology, East Coast Development Region), and firm-specific (pre-packaged incentives)	Pioneer status (strategic activities and sectors) - Convertible to grants for start-ups	General and specific (automation, energy saving, pollution control, digital technologies)
Project-by-Project Approval	Yes	No	No	No
Effectiveness	Number of approved	Increase in number of	Increase in number of firms	Number of approved tax

	projects increased but still from limited number of firms	projects but decline in number of applying firms	doing R&D in Singapore, especially transnational corporations	deductions in Taiwan new dollar has increased but no significant changes in number of applying firms. Increase in employment, GDP, and net tax revenues

Singapore, Thailand, and Malaysia have R&D tax incentives based on R&D expenditure (double deduction) while Taiwan has adopted R&D tax credits. Singapore's tax incentive system, like other financial incentives, has evolved according to the country's strategy and level of technological capability, unlike in Thailand and Malaysia. When Singapore wanted to attract the labour-intensive electronics industry from the US and Japan, its government offered 'pioneer status,' with attendant tax holidays of up to 15 years and other benefits, to TNCs to invest in *strategic* projects in Singapore. From the late 1980s to the late 1990s, when the strategy shifted to position Singapore as an R&D hub of TNCs, the government launched the Research and Development Tax Deductions Program. Unlike in other countries, this deduction included R&D activities that took place outside Singapore (but were related to and benefited those in Singapore), although the deduction rate was lower than for those of local activities. It seems that Singapore's government officials have an understanding of how global R&D networks of TNCs operate and what constitutes an R&D hub. Beginning in the late 1990s, when Singapore emphasized indigenous innovation by high-tech entrepreneurs, the government initiated the R&D Incentive for Start-Up Enterprises. It was designed to meet the needs of R&D-intensive start-ups, which usually spend the first few years developing products and incurring losses. Tax exemption is therefore not useful to them. It also allowed these start-ups to convert their tax losses to cash grants during the initial years. Since 2010, firms have been able to deduct 400 percent of their expenditure from their income, subject to a cap of SGD800,000, from innovation activities, including not only R&D but also design, registration and acquisition of intellectual property rights and acquisition of automation equipment. The government realizes that successful innovation needs more than R&D: it needs the support of a combination of several activities.

Taiwan's tax credit program covers not only direct R&D activities but also expenditures on critical activities to upgrade firms' activities: automating production, reclaiming resources, controlling pollution, using clean and energy-saving technologies, and using digital information technologies more efficiently. The experience of Taiwan illustrates that, like Singapore, it understands how to implement government incentives to tackle companies' technological upgrading problems.

Malaysia implemented its double deduction program more than 10 years earlier than Thailand. Malaysia's R&D tax incentive schemes are also much wider in scope than Thailand's, dealing not only with R&D activities but also the commercialization of R&D findings. Apart from double deduction of R&D expenditure, Thailand's Board of Investment initiated a scheme in 2003 to promote 'Skill, Technology and Innovation' by offering one to three more years' tax exemptions for companies already receiving tax privileges for investing in production so they could meet the requirements for in-house R&D, in-house training, and R&D collaboration with local universities. Malaysia's tax incentive system is more selective than Thailand's. It has tax incentives for targeted industries such as information and communications technology (ICT) and biotechnology, activities such as medical device testing, and geographical clusters such as the East Coast Economic Development Region. Incentives customized on the merit of each case—the 'pre-packaged incentives'—have also been introduced recently. Unlike Thailand, therefore, Malaysia has both generic and selective tax incentives.

Regarding the efficiency of tax incentives, only Thailand scrutinizes companies wanting to apply for R&D tax incentives and on a project-by-project basis. This makes the application process cumbersome. The level of trust in Thailand's society is low and its government has been worried about false claims. Thus, the Department of Revenues (responsible for double deduction of R&D expenses) authorizes the National Science and Development Agency (the largest public research institute) to verify whether submitted applications are R&D projects and whether their proposed expenses are appropriate. Since many proposals are submitted, the average approval period is as long as five to six months. Similarly, project-to-project approval is required for firms wanting to take advantage of the Board of Investment's 'Skill, Technology and Innovation' program. The number of approved projects, however, has increased over the years. Likewise, in Taiwan, after 2000, the number of approved Taiwan new dollar tax deductions has increased year by year, but the number of companies applying for such incentives has not significantly changed. Large firms in Malaysia and SMEs in Thailand mainly benefit from R&D tax incentives.

Only Taiwan has conducted a formal study on the impacts of its tax incentives. It found that tax credits for encouraging R&D, training, and automation have induced further R&D investment, leading to more jobs and higher GDP. As a result, there have been significant positive net effects on tax revenue (Liu and Wen, 2012). In Thailand, however, although one cannot observe direct causation, results from community innovation surveys illustrate that innovative firms used R&D tax incentives more than non-innovative firms.

4.2. Grants

Table 1.4: Comparison of Grant Schemes in Thailand, Malaysia, Singapore, and Taiwan

	Thailand	**Malaysia**	**Singapore**	**Taiwan**
Year of Operation	1990s	2000s (becoming more unified)	1970s	1980s
Level of Significance Compared with Other Mechanisms	Not significant	Very significant	Very significant	Very significant
Coverage	R&D, prototyping, pilot scale	The whole spectrum (pre-R&D, R&D, commercialization, acquisition of other firms' intellectual property right	Wide-ranging and evolving according to the needs and capabilities of firms	Wide-ranging and evolving according to the needs and capabilities of firms
Focus (sector, cluster,	General	Both general and specific (technologies,	Both general and specific (sectors,	Both general and specific (sectors,

technology, type of firm)		sectors, clusters, products)	technologies, types of firms)	technologies, products)
Effectiveness	Too small to have critical success	Criticism of lengthy approval processes and duplication of schemes	Effective older policies, e.g., Local Industry Upgrading Program, enhancing linkages between transnational corporations and local firms, but only moderate success with recent policy on promoting high-tech start-ups	Inducing substantial R&D investment from recipient firms, supporting creation of new industries or products. Small and medium-sized enterprises benefited significantly.

In Singapore, grants are the key instruments for financing technological capability development and innovation. Singapore has also had a greater variety of grant schemes targeting all activities in the value chains, and evolving according to the country's level of development and the technological capabilities and needs of firms. In the 1970s and 1980s, Singapore initiated schemes such as the Local Industry Upgrading Program to promote technological diffusion from TNCs to local enterprises. The Economic Development Board subsidized for two years a percentage of the salary of a manager sent by a TNC to work in a local enterprise. As of 2010, more than 200 TNCs and 1,000 local suppliers had been involved in the program. Grant schemes were also given to individuals and companies to promote critical skills such as ICT. In the 1990s, when firms in the country needed to increase their R&D capability, the government initiated a grant scheme to leverage Israel's R&D capability by funding feasible R&D collaborative projects of firms in the two countries. Since the late 1990s, whenever the government has wanted to promote high-tech entrepreneurship and basic R&D, it has initiated grant schemes. For example, the Technology Innovation Program covers 50–70 percent of equipment, materials, labour, software, and IP costs of projects operated by individual SMEs and consortiums. The Innovation Voucher

Scheme provides SMEs with grants to pay for consultancy and technical services provided by reputable local and overseas universities and research institutes. The government also uses this scheme to promote inter-firm collaboration by allowing up to 10 SMEs to pool their vouchers. Singapore astutely uses government schemes to tackle systemic failures of its national innovation systems, i.e., linkages among local SMEs, and between local SMEs and public research institutes and universities.

The Technology Enterprise Commercialisation Scheme, a competitive grant scheme, was launched in 2008 to support locally owned technology-oriented start-ups and SMEs at the proof-of-concept stage (to conceptualize ideas) and the proof-of-value stage (to carry out further R&D and develop a prototype). Specific grant schemes commercialize technologies developed by universities, encourage polytechnic institutes to conduct translational research on R&D outputs from universities and research institutes, and bridge the gap between universities' seeds and firms' needs by allowing collaborating firms to license technology once proven, but to be under no obligation if the project fails. Some grant schemes are aimed at strategic service sectors (e.g., aviation and animation) and strategic and future-oriented technologies and capabilities (e.g., logistics capability, environmental technology capability, medical technology capability, marine capability, and tourism technology). These schemes are under the management of responsible sector-specific development agencies. Some grant schemes have been provided by universities to their students to start their own businesses. These recent government schemes targeting early-stage companies, however, have had only moderate success. For example, only one-fifth of surveyed firms were aware of the Innovation Voucher Scheme. Start-ups that have taken part in the recent schemes gave an average rating of 3 on the 5-point Likert scale on three criteria: meeting firms' immediate objectives, improving their long-term growth prospects, and helping them move to the next growth stage. The bureaucracy involved in the application processes must be lessened and awareness of the various schemes raised.

For many years and in various programs, Taiwan has been using grants as financial instruments to encourage firms to enhance their technological and innovative capabilities. As in Singapore, programs in Taiwan have co-evolved with the development of firms' capabilities. Several programs are sector or even product specific. For example, when Taiwan firms gained production capabilities as subcontractors of TNCs and wanted to move up the global value chain by attaining product development capabilities, Leading Product

Development was implemented in 1991 to subsidize costs in R&D for high-tech products and know-how such as those produced by the ICT, aerospace, pharmaceutical, and semiconductor industries. About 800 of 1,600 cases were approved, about evenly divided between SMEs and large firms. The results of the Leading Product Development were impressive, as TWD1 of grant induced about TWD10 investment in R&D, TWD21 investment in production, and TWD42 in sales. On average, one project generated 3.7 patents and 2.9 derivative products (Liu and Wen, 2012). Similarly, when the government wanted to promote local start-ups, it adopted as a model in 1998 the US Small Business Innovation Research Program, which provided grants to firms in three phases: feasibility studies, R&D, and commercialization. A more generic grant scheme, the Industrial Technology Development Program, was initiated in 1999 to fund the preliminary study and R&D phases of firms aiming to develop forward-looking industrial technologies. TWD1 of grant induced TWD2.46 of R&D and TWD4.89 of capital investment (Liu and Wen, 2012). 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.

Similarly, Malaysia's Ministry of Science, Technology and Innovation has been providing various types of grants that cover the whole spectrum, from basic and applied research and prototype development (Science Fund) to development of technology for commercialization (TechnoFund) and innovation (InnoFund). The TechnoFund supports the development of pilot plant and upscaling of laboratory prototypes, and field trials and testing. It also has provisions for the acquisition of IP rights from local and overseas entities to be further developed locally during the pre-commercialization stage. The InnoFund has two categories of grants. The first is allocated to assist individuals and sole-proprietors, micro, and small enterprises in developing new or improving existing products, processes, or services with elements of innovation for commercialization (Enterprise Innovation Fund). The second grant type is used to assist community groups in converting knowledge and ideas into products, processes, and services that improve the groups' quality of life (Community Innovation Fund). This kind of support is for innovation at the bottom of the pyramid. In addition, the Cradle Fund provides support at the pre-R&D phase.

On another front, the Ministry of International Trade and Industry also provides several matching grant schemes to SMEs for business start-ups, product and process improvement, productivity and quality improvement, and the enhancement of *targeted* capabilities in design, labelling, product packaging, and market development and brand promotion (including their activities abroad). Apart from these general grant schemes, some schemes promote *strategic* technologies, industry clusters, and products. The Multimedia Super Corridor R&D Grant Scheme was set up to assist local companies and joint ventures in developing multimedia technologies and applications that would contribute to the overall development of Multimedia Super Corridor. The Biotechnology R&D Grant Scheme was established in 2001 under the National Biotechnology Directorate to support biotechnology R&D activities and the commercialization of research findings in specific areas of national importance to the biotechnology industry. Matching grants for developing halal products are also available. All these schemes can be seen as attempts to promote technological and innovative capabilities in the private sector and to forge relations between industry, universities, and public research organizations. Most funds are devoted to applied and problem-solving research projects under the TechnoFund. Although the administration of these schemes has not been formally assessed, it is problematic because project approval takes a long time.

In administering grant programs, Thailand is an exception. Grant schemes are limited in variety and size. The country relies more on indirect support to private firms through such means as tax incentives. Giving *public money*' to private firms gives rise to allegations of cronyism and corruption. Neoclassical economists, who dominate national economic policy agencies (and academia), do not like the idea of selective government interventions in particular industrial sectors, activities, clusters, and firms as these appear to be working against the market mechanism. The prospect of loss of public money, if grant projects were to fail, is not acceptable to government authorities, especially those in charge of the budget. As a result, grants are given mostly to public research institutes and universities. R&D grants such as those awarded by the National Science and Technology Development Agency to private firms have recently been significantly reduced, even practically stopped. The most successful grant giver has been the Industrial Technology Assistant Program, started in 1992, which provides up to 50 percent financial support for hiring consultants (freelancers or university professors) to help solve SMEs' technological problems. More than 1,000 firms have received financial support from this program. Results, however, have been mixed. The factors correlated with success appear to be active involvement of executives of firms, clarity of project goals, finding the 'right' and devoted experts, and, importantly, the

National Science and Technology Development Agency's industrial technology assistants, who act as intermediaries between firms and experts.

Thailand's National Innovation Agency (NIA) also offers a grant scheme to support up to 75 percent of expenses for prototyping and pilot-scale activities of firms. It gives smaller grants than agencies in other countries (about US$160,000 for three years) and gave grants to only 56 projects during 2003–2007. Recently, the NIA has focused more on the strategic sectors of bio businesses, design and solutions, and energy and environment. In 2011, the NIA adopted the idea of an 'innovation coupon': it gives grants to private firms equal to 90 percent of the project cost to hire listed innovation service providers either for feasibility studies or pilot project implementation. The Federation of Thai Industries, the largest association of manufacturers, is a partner in the scheme to help the NIA select the right projects. The results are yet to be seen.

4.3. Loans

Table 1.5: Loan Schemes in Thailand, Malaysia, Singapore, and Taiwan: A Comparison

	Thailand	**Malaysia**	**Singapore**	**Taiwan**
Year of Operation	1990s	1970s	1970s	1980s
Level of Significance Compared with Other Mechanisms	Significant	Significant	Not significant	Significant
Coverage	Increasingly focused on research and development	The whole spectrum	Evolving according to needs and capabilities of firms	Wide-ranging and evolving according to needs and capabilities of firms
Focus (sector, cluster,	General	General and specific technologies,	General and specific activities	General and specific sectors,

technology, type of firm)		sectors, and activities		technologies, activities
Facilities Supporting Access to Loans	SME credit guarantee	SME credit guarantee SME credit rating agency	SME credit guarantee	SME credit guarantee
Effectiveness	Number of applications in some programs has dropped significantly.	Applications increased significantly, especially from SMEs, but 90% of recipient firms are bumiputra (Malay ethic).	Not significant	Number of approved projects increased

Loans are a more prominent innovation financing mechanism in countries such as Thailand. The National Science and Technology Development Agency's Company Directed Technology Development Program has been providing soft loans of up to 75 percent of total project cost and less than US$1 million per project for R&D, product and process upgrading and building, or refurbishing laboratories. The number of approved projects each year has been small (fewer than 20), however, and recently even smaller as selection criteria have become more stringent: activities of firms must be R&D related and employ technologies new to the industry. For example, acquisition of machinery not related to R&D is unlikely to receive a loan. Most Thailand SMEs, therefore, are not qualified since they do not have R&D capabilities, and the problems they face are more production related. Although the NIA provides zero-interest loans of up to TBH5 million for innovation projects for the first three years, setting up the scheme is problematic as loans have to be channelled through commercial banks whose usual selection requirements are not favourable to financing risky innovative projects. As a result, only 38 projects were approved during 2003–2007.

In Singapore, loan programs are a much less prominent government financing mechanism than grants and equity. As early as 1976, when Singapore was still trying to exploit technologies generated elsewhere. SPRING's Local Enterprise Finance Scheme was initiated to provide low-interest loans to automate and upgrade factories and equipment, and to purchase factories. More recently, a program was set up to help SMEs acquire working capital and machinery. A loan insurance scheme to help SMEs secure loans by providing insurance against default has become available, as well.

Taiwan has several loan schemes, including for purchasing automating machinery for manufacturing and agriculture enterprises, revitalizing traditional industries, purchasing energy-saving equipment, promoting industrial R&D, and purchasing computer hardware and software. Firms in service industries such as the Internet and technical service providers are also eligible. The loan per company is about US$2 million to US$3 million. As of 30 April 2010, more than 50,000 cases had been approved. Both loans and approved projects are on a much greater scale than in Thailand. The SME Credit Guarantee Fund is also available to help SMEs secure loans from these government programs.

Malaysia has used loans as financial instruments since the 1970s and implemented many schemes for different purposes. Specific low-interest loan schemes for high-tech enterprises and entrepreneurs have been used to stimulate technology development and innovation. Loans for particular groups such as university graduates are also available. Schemes for strategic sectors (e.g., automotive, food), technology (e.g., adoption of automation technology, ICT), and activities (e.g., international branding) are also in place, as well as more generic schemes. Credit Bureau Malaysia (formerly known as SME Credit Bureau) was incorporated in 2008 to give independent credit ratings to SMEs, which usually lack ‘reputational collateral’ for access to finance. The ratings are based on information from the Central Bank and financial institutions. The bureau is popular and trusted, with a membership of 27,000 SMEs and 38 financial institutions.

4.4. Equity Financing

Table 1.6: Equity Financing Schemes in Thailand, Malaysia, Singapore, and Taiwan: A Comparison

	Thailand	**Malaysia**	**Singapore**	**Taiwan**
Year of Equity Financing Operation	**1987**	**1984**	**1983**	**1983**
Stages of VC Investment	Expansion and mezzanine	Growth and expansion	Early, growth, and expansion	Established, mass production, and expansion
Specialized Funds to Support Innovative Firms through VCs	SME VC Fund, MAI Matching Fund	MTDC, MAVCAP	TRIDENT Platform	Development Fund and SME Development Fund
Sector of VC Investment	Food and drink, machinery and equipment, household furnishings, wood products, costumes	Manufacturing, ICT, biotechnology	ICT, Biotechnology, medicine, genetic engineering, software and technology-enabled business services	Optoelectronics, biotechnology, electronics
Formal VC Association	Thai VCA established in 1994	MVCA established in 1995	SVCA established in 1992	Taiwan VCA established in 1999
Business Angel Financing	Infancy stage of business angel clubs and networks	Infancy stage of business angel clubs and networks	Has formal business angel network (SPRING)	Has formal business angel network (TWBAN)

Government's Direct Equity Financing	None	None	Several schemes both by government alone and co-investment with private VC	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 sustain private sector R&D but not yet effective in creating new start-ups.	Surveys show moderate success of new programs but the overall number of high-tech start-ups increased significantly, especially in the past few years.	Helped increase high-tech start-ups but not significantly as only 28% of VC funds went to early stages.

In Thailand, the venture capital (VC) industry was first set out by foreign VC funds in 1987. VC investments generally target growth and expansion in the venture life cycle. The major organizations providing VC funds to support entrepreneurial development are the Office of Small and Medium Enterprises Promotion, NIA, One Asset Management, Stang Holding, and (MAI) Matching Fund. The MAI Matching Fund, a fund of funds with assets of THB2,000 million, was set up to increase the number of newly listed companies (including VC-backed companies) on the MAI. However, the fund recently ceased operation. The Revenue Department also provides taxation schemes to support VC fund investments. These schemes assist VC funds and investors through corporate and personal tax exemption policies. VC funding in Thailand is THB720 million on average for about 10 years. Most VC funds invest 30 percent in the early stage and 70 percent in the growth and mature stages. The leading business angel in Thailand is the Thai-Chinese Business Association. The size of business angel investing is about THB90 million. The average deal ranges from THB4 million to THB50 million, with no exit strategies (Scheela and Jittrapanun, 2010).

In Malaysia, the VC industry began in the early 1980s with the establishment of Malaysian Ventures, whose primary aim was to invest in high-tech industries. The Malaysia Venture Capital Association was established in 1995 to develop a VC industry to further support technological innovations. The government is a major source of VC financing: most VC funds are channelled to Bumiputra-owned and government-linked firms. The major organizations providing VC investment funds to support entrepreneurial activities are Malaysia Technology Development Corporation, established in 1992 to provide financial support for multinational subsidiaries, and Malaysia Venture Capital Management Fund, established in 2001 to support entrepreneurial activities of local high-tech firms. Only seven percent of total VC funds in 2004, however, were invested in the start-up phase.

In Singapore, the government launches innovation financing schemes and programs to support innovative firms, as most VC funds are set up with government co-funding (such as Temasek Holdings and Technopreneurship Investment Fund Ventures, which act as funds of funds), and are managed directly by government agencies or government-linked companies (e.g., Economic Development Board Investments, Vertex Management, Economic Development Board Life Science Investment). These government VC funds invest in various sectors but mainly in government strategic areas of ICT and, subsequently, biomedical sciences, clean technology, and digital media. To fill the gap of early-stage funding left by private VCs, a government VC firm called TDF Management was formed in early 1995. It provides seed funding to entrepreneurs and high-tech start-ups. Apart from funding through VC, the government provides 'direct' financing, especially to new entrepreneurs and start-ups. For example, the Economic Development Board launched the Startup Enterprise Development Scheme, a co-financing scheme to take dollar-for-dollar equity stakes in promising start-ups backed by third-party private sector investors in order to fill a market gap in seed-stage funding (Mani, 2004). In 2008, the Early-Stage Venture Funding Scheme was founded to match SGD1 investments in early-stage technology start-ups with another SGD1 invested by selected VC firms. Singapore has also tried to groom its angel investment network, as business angel investors often provide seed funding to support the early stages of new venture development. Business Angel Funds, managed by SPRING, co-funds pre-approved business angel groups. Business Angel Funds and Startup Enterprise Development Scheme complement each other. A start-up that has already received funding from Startup Enterprise Development Scheme can still apply under Business Angels Funds for a follow-up investment up to SGD1.5 million. This is an example of how well financing innovation schemes in Singapore are coordinated, which is not usually the case in other countries. Schemes for promoting start-ups by particular groups of people, such as entrepreneurs under 26 years old, have also been made available. The effectiveness of these recent schemes is moderate. Results of surveys from around 300 start-ups revealed that about one-fifth of start-ups have participated in such government assistance schemes, with those in the very early stages of growth (i.e., pre-revenue firms) having a higher propensity to participate than those in later-growth stages. Still, since 2006, close to 5,000 new high-tech enterprises have been registered each year, and the growth rate of firm formation of high-tech enterprises has increased in recent years, partly because of government financing policy measures.

In Taiwan, VC financing began as early as 1983 with the implementation of the Regulation Governing Venture Capital Business Management to stimulate the development of the VC industry. VC investing is mostly done in the established, mass production, and expansion stages, where the government plays a major role. The Taiwan Private Equity and Venture Capital Association was established in 1999 to encourage economic development. The Ministry of Economic Affairs supervises the management of VC funds. The success of VC development in Taiwan can be tied to the social and economic bridge linking its high-tech industry with the US Silicon Valley. In addition to VC enterprises, Taiwan, like Singapore, also has government *direct* financing schemes. As early as 1973, the Development Fund was set up to directly invest in innovative companies and invest indirectly through VC firms. Strategic sectors such as biotechnology, aerospace, and optoelectronics were the priorities. To stimulate the technological development of SMEs, the SME Development Fund was established in 1994 to invest directly and indirectly through government and private VCs. These two large funds are the government's main investment arms to promote innovative firms as well as stimulate the growth of the VC industry.

The governments of Thailand, Malaysia, Singapore, and Taiwan play a major role in promoting innovation through VC financing schemes that support companies with high growth potential (public sector interventions). Although the VC mechanism aims to provide risk capital to firms operating in high-risk environments, VC financing programs are not effective in the early stage of entrepreneurial development. VC investment in these four countries tends to come in at the less risky, later stages (expansion), reflecting the funding institutions' aversion to high risk. The angel investment network is not fully developed except in Singapore, where it is a significant source of capital during the early stages of high-tech development. To overcome difficulties in early-stage financing, the governments in Singapore and Taiwan have initiated 'direct' equity financing programs.

Only a small number of VC funds operate in Thailand despite the government policy to promote the VC industry. In 2010, only two VC funds applied for a VC license. The total funds raised by Thailand's VC industry represent 0.15 percent of GDP. In Malaysia, although the government is the main investor in developing technology-based start-ups, the VC market's growth is slow because of the lack of human capital and the risk-averse behaviour of local VC firms. In Singapore, local high-tech companies have effectively used a variety of assistance schemes such as Growing Enterprises through Technology Upgrade, Economic Development Board, SPRING Singapore, International Enterprise Singapore, and Political Risk Insurance Scheme. The effectiveness of more recent programs targeting start-ups, however, seems to be moderate. In Taiwan, new VC investments have grown as a result of the government tax credit policies to support VC companies (new investments grew from 1,155 cases to 1,850 cases between 1998 and 2000). The number of investments, however, decreased after the tax credits stopped.

5. Conclusion and Policy Recommendations

This section elucidates key findings from the case studies of the four countries and proposes policy recommendations for other countries in the Association of Southeast Asian Nations (ASEAN) and East Asia.

5.1. Summary of Key Findings and Lessons Learnt

The factors underlying successful government innovation financing programs can be summarized as follows:

(i) In the more successful countries—Singapore and Taiwan—innovation financing policy instruments co-evolved with levels of technological and innovative capabilities of firms. Different levels of technological and innovative capabilities of firms need different policy instruments. The ability to initiate and implement new policy instruments to fit the changing needs of firms at different levels of capability over time is critical. Policymakers must understand the current needs and technological barriers facing firms in the countries under study. Strategies based on copying other countries—which no doubt have different needs and challenges—will not be effective.

(ii) Singapore, Taiwan, and, to a lesser extent, Malaysia have a higher level of flexibility and policy coordination and learning. They offer a much greater variety of policy instruments and cater them 'selectively' to the particular needs of industrial sectors, clusters, technologies, types of firms, or even individual firm demands (the so-called 'firm-specific' or 'pre-packaged' incentives). Incentives should be formulated and executed so that they complement each other and contribute to overall industrial technology development strategy, as illustrated in the cases of VC and business angel financing in Singapore, and the mandate of the Ministry of Economic Affairs in giving opinions on the prospects of newly listed firms in Taiwan's stock markets. When incentives do not work for some types of firms, they can be adjusted to fit those firms' demands. For example, Singapore's R&D tax incentives for start-ups can be converted to grants, since those firms do not make a profit in their initial years.

(iii) Developing firms' technological and innovative capabilities takes a long time. The amount, duration, and continuity of government-supported schemes are crucial as they reflect policy priorities and the commitment of governments. The case studies show that the governments of Singapore and Taiwan are highly committed to fostering firms' capabilities.

(iii) Policymakers must have a deep understanding of innovations and innovation systems and how they evolve. While Thailand narrowly focused on R&D-led innovation, Singapore and Taiwan broadened their incentives to other activities important in innovation, both inside and outside a single firm, such as services, business models, and solutions, among others. The difference between incentives to promote Thailand and Singapore as R&D hubs is a good example of how their government officials understand the global R&D processes of TNCs.

(v) Innovation financing policies require corresponding policy initiatives that produce qualified human resources, attract foreign talent, and help organizations work together. Examples of this synergy are public research institutes in Taiwan and entrepreneurial universities in Singapore.

(vi) Institutional factors shape choices and policy implementation. They include laws and regulations, unity and capability of government bureaucracy, trust, entrepreneurship, attitudes towards corruption, and the government's role in supporting private firms. Institutional shortcomings can, to some extent, be corrected. Successful countries can use financing innovation incentives as well as other government mechanisms (such as using public research institutes as intermediaries in innovation systems as in Taiwan) and initiatives (such as Malaysia's credit-rating agencies for SMEs and Singapore's promotion of business angel networks) to overcome or mitigate these shortcomings.

5.2. Policy Recommendations

We propose two sets of policy recommendations: one for ASEAN governments and the other for regional collaboration among ASEAN Plus Six countries.

5.2.1. Policy Recommendations for Individual Countries of ASEAN

Objective of Policies

The overall objective of policies encouraging innovation and technology transfer in ASEAN members is to change behaviours of firms, especially SMEs—'passive' learners must become 'active' ones—and to mitigate 'systemic failure' in innovation systems that hinder firms from changing their behaviour. An important systemic failure is knowledge transfer from TNCs and large domestic firms to local SMEs.

Changing Policymakers' Mindsets and Upgrading Government Agencies' Capacity

Government officials should understand innovation, innovation systems, and the long-term benefits of government intervention in helping firms increase their innovative capabilities. Policies targeting specific industrial sectors, technologies, activities, and types of firms are desirable if the government has the capacity to formulate, implement, monitor, and evaluate policies effectively. Such capacity should be built and enhanced.

Choice of Policy Instruments

Policymakers must understand the pros and cons of each instrument and select them in accordance with their targets and bureaucratic capacity (which, of course, can be enhanced). Grants and equity participation are more effective for selective targets and in line with the nature of innovative projects (high risk, high uncertainty and not well defined). However, policymakers must be able to objectively select the right targets, take risks, and periodically monitor project performance.

Sectoral Priorities

Priorities should not be limited to high-tech companies. Attention should also be paid to companies in traditional, resource-based, mid-tech, and service sectors (such as garments, wood furniture, food, agriculture related and agribusiness, automotive parts, tourism, and knowledge-intensive business services), where the countries under study have a competitive edge, and to companies that innovate products, processes, services, and business models, among others. Innovation should be defined broadly, including even new-to-the-firm incremental or problem-solving advances.

Typology of Policies for Different Firms' Level of Capabilities and Countries' Level of Development

The case studies vividly illustrate that effective policies need to co-evolve with the level of firms' capabilities and countries' development level. We propose a policy matrix outlining different policy targets and instruments for different levels of firms' capabilities and countries' development. In reality, firms may not linearly progress from one stage to another.

Table 1.7: Recommended Typology of Policy Measures

Level of Countries' Development	Targeted Firms' Capabilities	Policy Measures
Low Income	- Production capability - Quality control - Absorptive capacity to select, acquire, evaluate, and upgrade external knowledge - Basic engineering capabilities	- Grants targeting activities and capabilities - Grants for hiring TNCs' engineers and technicians to work for two years in local SMEs on targeted activities - Innovation coupons for SMEs for services offered by universities, PRIs, and private consultancies
Lower-Middle Income	- Absorptive capacity - Automation - Advanced engineering and testing capabilities - Design for manufacturing -Detailed product design	- Grants targeting activities and capabilities - Grants for hiring TNC engineers and technicians to work for two years in local SMEs on targeted activities - Innovation coupons to SMEs for services offered by universities, PRIs, and private consultancies - Tax incentives for targeted activities (with convertibility to cash subsidy for loss-making SMEs)
Higher-Middle Income	- Basic product design (changing main features) - Applied and translational research - Branding - International distribution network building - IP management - Innovative start-ups (not only in high-tech sector)	- Grants targeting activities and capabilities - Grants for hiring TNC engineers and technicians to work for two years in local SMEs on targeted activities - Innovation coupons to SMEs for services offered by universities, PRIs, and private consultancies - Tax incentives for targeted activities (with convertibility to cash subsidy for loss-making SMEs) - Direct equity participation and government-owned and -sponsored VCs targeting early-stage activities - Government procurement of innovative products and services
High Income	- Fundamental research - Global branding and marketing - Creativity - Innovative start-ups (not only in high-tech sector)	- R&D tax incentives - Direct equity participation and government-owned and -sponsored VCs targeting early-stage activities - Government procurement of innovative products and services

5.2.2. Policy Recommendations for Regional Collaboration among ASEAN Plus Six

- Set up an intelligence centre for ASEAN Plus Six to collect information on incentive schemes provided by agencies in member countries and to disseminate information to firms across the region.

- Conduct region-wide training and brainstorming workshops among policymakers in charge of agencies providing incentives for innovation and technology transfer.

- Study the coordination of existing tax and financial incentives and the possibility of joint incentives across these countries.

- Include in the study the possibility of non-discriminatory or open incentives, i.e., firms registered in one member country would be eligible for incentives provided by government agencies in other countries.

- Encourage region-wide funding mechanisms to support innovation and technology upgrading for SMEs. The initiative may be carried out in two phases:

    - In the short and medium term, develop or expand networks among existing funding institutions to seamlessly support regional collaborative research and technology-upgrading projects that will lead to innovation and/or technological upgrading of SMEs. The following institutions have funding mechanisms for regional collaborative research: ASEAN Foundation, TEMASEK Foundation, Human Frontier Science Program, JST (SATREPS, e-ASIA JRP), Asian Development Bank, as well as private foundations including the Bill & Melinda Gates Foundation and the Mizutani Foundation for Glycoscience. These institutions should be convinced to fund not only research but also SME upgrading.

    - In the long term, establish a regional foundation to support regional collaborative research and technology upgrading of SMEs. The foundation can raise funds from the public and private sectors within and outside the region. It should be independent—not too close to a specific country or interest. It is essential to develop flexible funding programs that can be shaped as they grow. The new funding programs should support various levels of SME technological upgrading, including production, engineering, testing, design, development, and applied and basic research.

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