CHAPTER 1

Introduction to Innovation Policy in ASEAN

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1.1 | Is Innovation Indispensable for ASEAN?

Innovation is widely acknowledged as a primary source of sustainable economic development and inclusive growth, not only through improving productivity in firms, industries, and macro economies but also through stimulating the expansion of consumption, investment, and exports. Innovation, in addition to capital investments and human resources, is regarded as indispensable for propelling modern economies. It should also be noted that innovation frequently brings about spillover effects via research and development (R&D) activities and patents to other economic agents. In other words, the social returns of innovation could be much higher than the private ones because of positive externalities.[1]

Moreover, recently, the economic impacts of innovation have been emphasised in relation to the emergence of information and communication technology (ICT), especially the Internet, since the 1980s. ICT has affected the technology levels, business investments, and management systems of both manufacturing and service industries through computers and networks enabled by the Internet, the speed of which has been increasing rapidly. With respect to manufacturing industries, ICT facilitates production processes and systems in, for example, automobile industries. In the currently prevailing fragmented production system, factories and facilities (including goods, know-how, ideas, capital, investment, and workers) are unbundled within global value chains with the support of ICT by the trading of raw materials, final goods, and production services, which promotes new types of manufacturing innovation.[2]

1 Hall and Lerner (2010) conclude that the social returns of R&D activities, which they estimate as 20%–30% in developed countries, are higher than those of capital investments overall.

2 Baldwin (2011) represents this global division of production at the task level as the 'second unbundling', while the 'first unbundling' indicates the division of production based on the trade theory of comparative advantage.

Moreover, the latest technologies, such as the Internet of things or artificial intelligence, produce business opportunities for services companies that heavily depend on the Internet, such as Amazon, Alphabet (the holding company of Google), and Uber.

This recognition of the efficacy of innovation has, no doubt, been prevailing in developed countries for some time, but there still seems to be some scepticism in developing countries (Fagerberg et al., 2010). Questions such as 'Is innovation a significant factor for the economic development of developing countries?' or 'Is it beneficial to consider innovation as an important policy target for developing countries?' are frequently answered negatively on the grounds that high-tech firms and high-tech industries would emerge only in advanced economies. So far, the member states of the Association of Southeast Asian Nations (ASEAN) have not on the whole been exceptions to this sceptical point of view.

This scepticism may stem from a high ideal of what innovation should be. The current popular definition of innovation was affected by Schumpeter (1934), who advocated the concept of 'new combination'.[3] Influenced by Schumpeter's work, the *Oslo Manual* (OECD, 2005), which is the source of guidelines for the collection and interpretation of data on innovation, defines innovation as 'the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations'. Although this definition of innovation excessively emphasises the element of 'new', it is highly likely that most actual innovation steps start with imitation. For example, Japan and the Republic of Korea (henceforth, Korea), when they were less developed countries that possessed only infant technologies, were eager to imitate superior Western technologies through licensing and reverse engineering. This suggests that there is much room for developing countries to advance their technologies through diverse activities, including learning-by-doing, imitation, and technology transfer, and not just through original inventions or innovations at the initial development stage.

Innovations diffuse from developed to developing countries like water flowing from high to low places and, as a result, countries' development levels converge.

[3] Schumpeter (1934) employed the term 'new combination', rather than innovation, in his early writings. He categorises new combination into five types: (1) the launch of a new product or a new quality of an already known product, (2) the application of new methods of production or sales of a product, (3) the opening of a new market, (4) the acquisition of new sources of supply of raw materials or semi-finished goods, and (5) the formation of a new industry structure, such as the creation or destruction of a monopoly position. Thus, he stresses that innovation in the economy is not led by consumers but by producers.

But this discreet, passive, neoclassical view captures only one aspect of innovation in developing countries. Another more important aspect highlights innovation policies or systems for proactive, provocative technological development, undertaken or put in place by the governments of developing countries. This approach could be conducive to innovation in contrast to laissez-faire market approaches (Fagerberg et al., 2010). Successful examples are observed in East Asian countries, such as China, Japan, Korea, and Singapore, which have achieved their own innovation to varying degrees. It has been demonstrated that they systemically formulated and implemented innovation policies not only to carefully address market failure[4] but also to aim to audaciously close innovation gaps with developed countries. It is, therefore, indispensable for ASEAN Member States (AMS) and ASEAN to develop their own effective innovation policies.

1.2 | Innovative Activities in ASEAN

Before investigating in detail possible innovation policies for ASEAN, it is useful to review the current status of innovative activities conducted in the region. Although, in general, it is difficult to accurately evaluate the level of innovative activities, the following measures provide some approximations. Subsequent chapters in this book provide details of innovative activities in individual countries.

1.2.1 Innovation capability

How innovation is achieved by countries depends on their intrinsic capability, which is frequently referred to as 'innovation capability' in the literature. Intuitively, innovation capability provides a country with the foundation for creating innovation by itself, and thus, it can take on physical, intangible, and institutional characteristics.

AMS need to enhance their innovation capability to achieve autonomous and sustainable economic development based on innovations so as not to be over-dependent only on foreign direct investment (FDI) and official development assistance. Innovation capability also matters if AMS are to escape the so-called 'middle-income trap', where developing countries that attain middle-income status owing to given advantages, such as abundant natural resources, stagnate at that development level.

[4] It is typically difficult for innovators to appropriate their innovation outcomes except for intellectual property rights, such as patents, because of externalities (spillovers). Hence, market failure caused by the free rider problem is inevitable (Arrow, 1962).

For ASEAN to be competitive, dynamic, and innovative, and for it to maintain its centrality in the global economy, developing AMS' innovation capability through effective policies is its key challenge.

To make the concept of innovation capability more concrete, Fagerberg and Srholec (2008) presented comprehensive measures that can be categorised into four types of capabilities: innovation system, governance, political system, and openness. The innovation capability we now discuss mostly corresponds to the innovation system they proposed. According to the results of the factor analysis they undertook to identify effective measures for innovation achievement, innovation systems include measures such as the United States Patent and Trademark Office patents, science and engineering articles, the International Organization for Standardization (ISO) 9000 certification, fixed line and mobile phone subscribers, Internet users, and secondary and tertiary school enrolment. Using the score of the innovation system specifically calculated by the above-mentioned innovation-related measures, the authors observe a clear positive relationship between the innovation system and the level of economic development expressed as gross domestic product (GDP) per capita across countries. Based upon a regression analysis of 115 countries from 1992 to 2004, the authors also find that the degree of sophistication of innovation systems is positively associated with and of particular importance for economic development.

From this finding, clearly, having better innovation capability, strengthened by various tangible and intangible factors, is of significant importance in enabling developing countries to move ahead with their economic development agendas. The following sections consider data on innovative activities in ASEAN and provide an assessment of AMS' innovation capability. They argue that most AMS are still building their innovation capability.

1.2.2 Data on innovative activities in ASEAN

Research and development intensity. R&D expenditure should be a main indicator of innovation progress in a country. Table 1.1 presents R&D intensity per GDP for AMS, China, India, Japan, and Korea. It shows that most AMS, except Singapore, have maintained quite low investments in R&D compared with Japan and Korea, which have recorded an R&D intensity in excess of 3% since 2000 (Japan) and 2008 (Korea).[5]

[5] In 2000, the European Union formulated the Lisbon Strategy, which aimed to leverage R&D investments to boost its economies. This strategy was followed in 2003 by an action plan, 'Investing in Research', which laid out an ambitious goal of investing 3% of GDP in R&D by 2010 (the so-called '3% objective', set in Barcelona). This goal is regarded as a numerical criterion that developed countries are encouraged to achieve.

Table 1.1: Research and Development Intensity
(% of gross domestic product)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Brunei Darussalam	...	...	0.02	0.02	0.04	...	...	...	...	...	...	...	...	...	...
Cambodia	...	...	0.05	...	...	...	...	...	...	...	...	...	...	...	...
Indonesia	0.07	0.05	...	...	...	...	...	...	...	0.08	...	...	...	0.08	...
Lao PDR	...	...	0.04	...	...	...	...	...	...	...	...	...	...	...	...
Malaysia	0.47	...	0.65	...	0.60	...	0.61	...	0.79	1.01	1.04	1.03	1.09	...	1.26
Myanmar	0.11	0.07	0.16	...	...	...	...	...	...	...	...	...	...	...	...
Philippines	...	...	0.14	0.13	...	0.11	...	0.11	...	0.11	...	0.12	...	0.14	...
Singapore	1.82	2.02	2.07	2.03	2.10	2.16	2.13	2.34	2.62	2.16	2.01	2.15	2.00	2.00	2.19
Thailand	0.24	0.25	0.23	0.25	0.24	0.22	0.23	0.20	...	0.23	...	0.36	...	...	0.48
Viet Nam	...	...	0.18	...	...	...	...	...	...	...	...	0.19	...	...	...
China	0.90	0.95	1.06	1.13	1.22	1.32	1.38	1.38	1.46	1.68	1.73	1.79	1.93	2.01	2.05
India	0.74	0.72	0.71	0.71	0.74	0.81	0.80	0.79	0.84	0.82	0.80	0.82	...	...	...
Japan	3.00	3.07	3.12	3.14	3.13	3.31	3.41	3.46	3.47	3.36	3.25	3.38	3.34	3.47	3.58
Republic of Korea	2.18	2.34	2.27	2.35	2.53	2.63	2.83	3.00	3.12	3.29	3.47	3.74	4.03	4.15	4.29

... = no data, Lao PDR = Lao People's Democratic Republic.

Sources: United Nations Educational, Scientific and Cultural Organization Institute for Statistics, dataset obtained from Science, Technology & Innovation: Research and Development.

Malaysia's R&D expenditure has been rising rapidly and has exceeded 1% since 2009. Thailand's has been low at 0.2%–0.5% despite a recent upward trend, while the 'CLMV' countries (Cambodia, Lao PDR, Myanmar, and Viet Nam) have made minuscule investments in R&D. China's R&D expenditure, on the other hand, has skyrocketed since the 2000s, in line with its strong economic development. In 2014, it reached 2.05%, which is comparable to Singapore's 2.19%. (Note that the absolute amount of R&D in China is far greater than that of Singapore given the relative sizes of their economies.)

Patent applications. The same trend can be observed with respect to the number of patent applications in each country (Table 1.2). As research has generally affirmed, most patent applications are associated with innovative activities, especially inventions. Table 1.2 indicates that although the number of direct patent applications has tended to increase in all AMS, it is still smaller than in the developed

Table 1.2: Direct Patent Applications
(number per million population)

Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Brunei Darussalam	5.53	0.00	26.71	5.25	5.17	83.90	25.03	64.12	75.33	88.65
Cambodia	0.00	0.00	0.00	0.00	0.07	0.07	0.07	0.00	0.07	0.33
Indonesia	1.12	1.32	1.31	1.67	1.83	2.21	2.31	...	2.77	2.92
Lao PDR	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Malaysia	34.11	36.40	40.29	42.61	58.46	59.92	50.33	51.62	56.91	66.28
Myanmar	...	...	...	...	...	...	...	...	...	...
Philippines	3.09	3.19	3.53	3.24	2.48	2.72	2.95	2.87	3.16	4.91
Singapore	326.55	372.84	490.35	471.75	412.63	469.59	501.19	524.05	548.23	609.17
Thailand	15.11	17.18	16.68	16.12	17.37	20.06	15.96	17.26	18.16	17.70
Viet Nam	2.21	2.42	2.72	2.50	3.06	3.61	3.49	4.41	5.14	5.71
China	73.55	96.66	119.45	150.72	177.40	224.51	314.65	402.86	526.96	597.39
India	5.30	6.24	7.12	7.49	8.12	9.81	10.21	11.60	12.97	14.40
Japan	3,721.06	3,541.24	3,423.09	3,388.88	2,997.56	2,936.34	2,954.83	2,950.25	2,758.97	2,685.61
Republic of Korea	3,244.67	3,410.01	3,415.54	3,296.41	3,203.18	3,339.24	3,484.29	3,728.97	4,068.01	4,152.37

... = no data, Lao PDR = Lao People's Democratic Republic.

Sources: World Intellectual Property Organization Global Brand Database and World Bank Database.

Asian countries. Even Singapore does not produce sufficient patent applications compared to other developed Asian countries. This suggests that AMS have much room to increase their patents as facilitators of innovation capability.

Number of researchers. Table 1.3 presents the number of R&D researchers per million people in major AMS. Educated human resources, especially engineers and scientists, are without doubt a fundamental driving force of innovation. Excluding Singapore, which has focused its limited human resources on R&D and had 6,658.5 researchers per 10,000 population in 2014, Malaysia had the highest number of the AMS (2,051.7) in the same year, although the number is small relative to Japan's 5,386.2 and Korea's 6,899.0. The figures suggest that the quantity of R&D researchers is not sufficient in most AMS. Hence, countries need to exert greater efforts to produce more R&D researchers who excel in science and technology (S&T) through their higher education systems (e.g. universities and national research laboratories) to achieve higher levels of home-grown innovation.

Table 1.3: Number of Research and Development Researchers
(full-time equivalent per 10,000 population)

Country	2000	2001	2002	2003	2004	2005	2006	2007
Brunei Darussalam	...	...	288.3	280.4	286.5	...	...	...
Cambodia	...	...	17.6	...	...	...	...	...
Indonesia	212.6	199.2	...	...	...	...	...	...
Lao PDR	...	...	15.8	...	...	...	...	...
Malaysia	274.2	...	293.3	...	500.1	...	369.1	...
Myanmar	...	11.9	17.2	...	...	...	...	...
Philippines	...	...	...	70.6	...	80.1	...	78.2
Singapore	4,245.0	4,160.9	4,381.0	4,706.5	4,881.9	5,291.8	5,424.8	5,768.6
Thailand	...	279.3	...	279.5	...	311.3	...	322.4
Viet Nam	...	...	113.9	...	...	...	...	...
China	547.3	581.5	631.1	667.5	713.3	856.8	932.3	1,078.6
India	110.1	...	...	...	...	135.3	...	...
Japan	5,151.1	5,183.8	4,934.9	5,156.1	5,156.8	5,360.2	5,387.0	5,377.7
Republic of Korea	2,345.4	2,932.5	3,034.4	3,215.2	3,301.3	3,777.1	4,175.0	4,603.8

Country	2008	2009	2010	2011	2012	2013	2014
Brunei Darussalam	...	...	...	...	...	...	...
Cambodia	...	...	...	...	...	...	...
Indonesia	...	89.5	...	...	...	...	...
Lao PDR	...	...	...	...	...	...	...
Malaysia	601.0	1,070.4	1,467.1	1,653.4	1,793.5	...	2,051.7
Myanmar	...	...	...	...	...	...	...
Philippines	...	81.9	...	85.1	...	189.4	...
Singapore	5,740.8	6,149.0	6,306.5	6,496.0	6,442.3	6,665.2	6,658.5
Thailand	...	330.6	...	543.5	...	...	974.0
Viet Nam	...	...	...	...	...	...	...
China	1,200.3	863.9	903.0	977.7	1,035.9	1,089.2	1,113.1
India	...	...	156.6	...	...	...	...
Japan	5,157.8	5,147.8	5,152.6	5,160.2	5,083.7	5,201.3	5,386.2
Republic of Korea	4,867.8	5,000.9	5,380.3	5,853.3	6,361.6	6,456.6	6,899.0

... = no data, Lao PDR = Lao People's Democratic Republic.

Sources: United Nations Educational, Scientific and Cultural Organization Institute for Statistics.

1.2.3 Empirical observations of existing studies

Several empirical studies examine how innovation in ASEAN has progressed and what impact innovation has had on the economic environment. Hahn and Narjoko (2010) published a pioneering study with the Economic Research Institute for ASEAN and East Asia (ERIA) that investigated innovation issues based on unique micro firm- and establishment-level data across East Asian countries.

As part of the research project, a prominent study by Kuncoro (2010) examined the relationship between globalisation and innovation through a study of Indonesian medium and large manufacturing firms. Somewhat surprisingly, no clear-cut upward trends in the percentage of Indonesian firms that conducted R&D investments could be observed in his dataset during 1995–2006 (7.4%–8.8%). Furthermore, the R&D intensity of firms (R&D expenditure as a share of the value of total inputs), regardless of their enterprise characteristics, decreased during 2000–2006 (from 1.1% to 0.5% for all firms). Although these data should be interpreted carefully, Ito (2013) develops an insightful argument that Indonesian firms may have changed their production from high-end (R&D intensive) products to low-end (primary, such as mining and mineral) products. As for other AMS, there do not seem to be any robust findings to suggest that the R&D intensity of domestic firms greatly increases through investing more in R&D and innovative activities, in tandem with increasing globalisation.

These empirical observations may indicate that AMS are caught in the middle-income trap (Griffith, 2011). This may be because of the absence of industrial competitiveness, particularly in manufacturing. As these studies suggest, domestic firms in AMS are likely to have transformed their business structures to improve their comparative advantage in low-end products in primary industries rather than concentrating on high-end products that require greater innovative activities (Ito, 2013). The resource boom that has occurred since the beginning of the 21st century, as observed in the price hikes of oil, gas, and commodities, induced many AMS to invest in these products. This raises a serious concern that such biased investments in and orientation towards primary industries and products and away from innovative activities could cause the so-called 'Dutch disease' in some AMS.[6]

[6] Dutch disease suggests the causal relationship in which an expansion in the resource sector weakens the manufacturing sector. This occurs because as the resource sector grows, the national currency appreciates, and the domestic wage of the workforce rises, reducing the competitiveness of manufacturing industries.

This suggests that exports of resources and resource-related products may further weaken the competitiveness and innovativeness of AMS manufacturing industries in international markets.

The industry shift to less-innovative activities seems to be simply firms optimising their behaviour. More precisely, firms seek to short-sightedly accommodate their businesses activities to given market environments (the resource boom in this case) by producing and exporting more low-end primary products based on the free trade mechanism (that is, specialisation of production based on the principle of comparative advantage). However, an overdependence on resources is likely to unintentionally undermine the foundation of firms in AMS for producing innovation in the long run (Ito, 2013). Strenuous efforts to nurture innovation capability are, therefore, of paramount importance for AMS to avoid the middle-income trap and Dutch disease. To this end, it would be sensible to allocate government financial surplus obtained from exporting primary products to the budgets for innovation policies to support public and private innovative activities.

1.3 | Efforts towards Innovation in ASEAN

Despite a prolonged stagnation in innovative activities, ASEAN has recognised the importance of improving its members' ability to develop S&T. The organisation has made many efforts to produce innovation and address the challenges on the way to becoming an 'innovative ASEAN' (ASEAN Secretariat, 2015). The following paragraphs review ASEAN's efforts to promote innovation.

Science, technology, and innovation (STI) policies in ASEAN have progressed along with a set of frameworks developed within ASEAN. In 1971, the ASEAN Permanent Committee on Science and Technology was reorganised to enhance the work of promoting and intensifying cooperation in S&T activities. Subsequently, in 1978, the ASEAN Committee on Science and Technology (ASEAN COST) was officially established as a primary headquarters of ASEAN S&T policies, guided by the ASEAN Summits and the ASEAN Ministerial Meetings on Science and Technology. Roughly speaking, the objective of ASEAN COST is to promote cooperation towards developing S&T and related human resources and to encourage technology transfer within and outside ASEAN. In addition, ASEAN COST organises nine sub-committees, including food S&T, biotechnology, and space technology and applications. Since the establishment of ASEAN COST, ASEAN has reinforced its ability to develop STI.

For example, the ASEAN Ministerial Meetings on Science and Technology and ASEAN COST have been held once and twice a year, respectively, to discuss STI-related issues. One of the achievements of ASEAN COST has been the design of the first ASEAN Plan of Action on Science and Technology, which was adopted in 1985. ASEAN COST holds periodic meetings with China, the European Union, Japan, Korea, the United States, and others, and discusses cooperation issues on STI through a multinational interlocutory framework of Japan–China–Korea.

STI has recently been positioned as a major foundation for attaining the ASEAN Vision 2020 that was set out in 1997.[7] The goal is to transform ASEAN into 'a technologically competitive ASEAN, competent in strategic and enabling technologies, with an adequate pool of technologically qualified and trained manpower, and strong networks of scientific and technological institutions and centres of excellence'. In October 2016, the ASEAN Plan of Action on Science, Technology and Innovation (2016–2025) was formulated, together with vision, goals, and thrusts, after the launch of the ASEAN Economic Community (AEC) in 2015.[8] This new comprehensive action plan aims to promote 'a science, technology and innovation-enabled ASEAN, which is innovative, competitive, vibrant, sustainable and economically integrated' towards 2025. The goals underline the active involvement of and collaboration between the public and private sectors (especially small and medium-sized enterprises), mobility of talent, deep awareness of STI, an innovation-driven economy, active R&D collaboration, technology commercialisation, entrepreneurship, and so on. In response to concerns about how to implement a designated vision, goals, and thrusts, the plan puts forward detailed strategic actions.

Another remarkable thing about the framework of STI policy in ASEAN is that the institutional position of ASEAN COST moved from the ASEAN Socio-cultural Community to the AEC, as indicated by the AEC Blueprint 2025. Since ASEAN COST is under the supervision of the AEC, it has been designed to address the economic issues specified by the AEC Blueprint 2025 – 'productivity-driven growth, innovation, R&D, and technology commercialisation' (Subsection B.4). This institutional change not only streamlines the organisation of the ASEAN Secretariat but also indicates

7 The ASEAN Vision 2020 was issued during the Second ASEAN Informal Summit in Kuala Lumpur on 15 December 1997. It is available at http://asean.org/?static post=asean-vision-2020

8 The ASEAN Plan of Action on Science, Technology and Innovation was published by the ASEAN Secretariat and is available at http://aseanstiforum.net/wp-content/uploads/2016/09/APASTI2016-2025.pdf

ASEAN's keen interest in improving productivity and reinforcing global industrial competitiveness through innovation, and thereby producing more economic value. In this sense, the development of STI should be further promoted with a particular focus on R&D investment relevant to industries and firms that directly contribute to the aforementioned economic objectives.

Although the discussion so far has stressed innovation policy in the framework of the AEC, the impact of innovation on sociocultural aspects should not be overlooked. Indeed, the ASEAN Socio-cultural Community Blueprint 2025 still refers to S&T in terms of education systems under the common goal of 'a creative, innovative and responsive ASEAN'. Aside from economic impacts, the sociocultural impacts (e.g. the digital divide) that innovation entails remain an important issue in ASEAN.

1.4 | Typology for Innovation Policy in ASEAN

The large discrepancy in the levels of innovative activities among AMS means that innovation policies for individual AMS will also vary. The discrepancy can be seen in the Global Innovation Index published by Cornell University, INSEAD, and the World Intellectual Property Organization. According to the 2016 Global Innovation Index (Dutta et al., 2016), the rankings of AMS range from Singapore's rank of 6th to Cambodia's rank of 95th.[9] Hence, in drawing up innovation policies for each AMS, a typology of technology and innovation is useful to guide individual AMS.

The Technology Achievement Index (TAI), developed by the United Nations Development Programme, also assesses countries' technological development levels. The TAI provides an indication of how well a country can create and use technology, rather than simply reflecting the value of inputs, such as the number of scientists and R&D expenditure. An analysis by the Asian Development Bank Institute (2014) of the scores of Asian countries, including AMS, from 1999 to 2008 suggests that, in terms of technology and innovation, AMS can be roughly classified into two categories: Singapore (which is comparable to Japan and Korea) and the rest of ASEAN (along with China and India).[10] Another interesting finding of the study is that

[9] Other AMS rankings in the 2016 Global Innovation Index are as follows: Malaysia, 35th; Thailand, 52th; Viet Nam, 59th; the Philippines, 74th; and Indonesia, 88th. The results for Brunei Darussalam, Lao PDR, and Myanmar are not available.

[10] See Asian Development Bank Institute (2014, p. 116, Figure 3.7).

some AMS, such as Brunei Darussalam, Malaysia, Singapore, Thailand, and Viet Nam increased their TAI scores between 1999 and 2008, meaning that they significantly improved their levels of technological development and innovation during the period. The biggest improvement can be seen for Viet Nam.

Looking at ASEAN as a whole, however, technological development, innovation capability, and the resulting innovation achievements have lagged economic growth. Moreover, AMS are at very different stages of innovation. Following the analyses of Intal et al. (2014) and the Japan Science and Technology Agency (2015), AMS can be roughly divided into the following five groups:

- Singapore is the only ASEAN member in the 'frontier' phase of innovation, and its innovation capability, based on solid domestic R&D, is almost at the same level as that of developed Western countries.
- Malaysia is in the 'catch-up' phase, and its innovation capability is relatively high, just behind that of Singapore.
- Indonesia, the Philippines, Thailand, and Viet Nam are in the 'Learning' phase, which is characterised by the acquisition of innovation capability. These countries are assumed to have significant potential to improve their innovation capability as their economies grow in the future. Thailand is the most likely to catch up with Singapore and Malaysia, which are in the upper development stage. In this regard, Thailand could well be in the 'catch-up' phase, like Malaysia.
- Cambodia, Lao PDR, and Myanmar are in the 'initial condition' phase, which means they still need to establish nation-building infrastructure and institutions to set up their innovation capability.
- Brunei is difficult to place in any of these categories because the country depends on its natural-resources-driven economic model. But the country is now aware of the necessity for industrialisation through innovation.

Intal et al. (2014) provide a useful matrix table, reproduced in Table 1.4 of this chapter, to illustrate the development stages of each AMS and the policies needed at each innovation phase.[11] This kind of typology is quite analogous to ERIA (2015), which proposes development strategies, mainly for manufacturing industries, in relation to the quality of infrastructure and participation in production networks in East Asia.[12]

[11] Intal et al.'s Figure 4.5 (p. 199) is substantively built on the idea of Rasiah (2013).
[12] See ERIA (2015, p. 4, Figure 1.1).

ERIA (2015) suggests that developing AMS should steadily advance their development stages at the country, city, and regional levels. The implication of Table 1.4 for AMS is dependent on the same idea as that proposed by ERIA (2015) – that it is important to understand which innovation stages AMS have reached (i.e. what their level of innovation capability is) and to move up the 'technology ladder' accordingly, step by step, based on effective strategic and systemic economic policies. In other words, the best way for developing AMS to grow out of conventional industrial structures that depend on low-end products is to nurture their innovation capability at every stage, to achieve basic innovation from the ground up, and to realise steady industrial development through the innovations.[13]

Table 1.4 also suggests a typology of policy frameworks required for AMS in terms of basic and high-tech infrastructure, network cohesion, and global integration. For example, the 'learning' phase, where most AMS are situated, emphasises basic approaches to innovation, such as learning-by-doing and imitation, social institutions connected to formal intermediary organisations, and access to foreign sources of knowledge and FDI inflows. It should be noted that the table merely presents a typical framework, and policymakers should formulate actionable and implementable innovation policies. In view of this, it is desirable to add policy recommendations that include concrete elements to Table 1.4 to link academic studies with policies. Rasiah (2013) addresses the problem of intellectual property rights in ASEAN in an interesting case study. But the study needs to be expanded to areas such as competition policies, R&D incentive measures, and university–industry links, all of which are likely to promote innovative activities in ASEAN.[14]

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[13] Schumpeter (1942) advocated a concept of 'creative destruction' that induces industry dynamics, exemplified by the entry and exit of firms through lively innovative activities. Although activating industries is indispensable for AMS as well, this concept seems more applicable to developed countries. It is open to discussion whether developing AMS can 'leapfrog' development stages through revolutionary innovation in the era of ICT.

[14] Intarakumnerd (2013) depicts a very similar conceptual framework to Table 1.4 while proposing policy measures from the perspective of small and medium-sized enterprise innovation and technology transfer according to countries' development levels. He discusses issues such as grants for targeted activities, R&D tax incentives, and innovation coupons that provide small and medium-sized enterprises with services offered by universities.

Table 1.4: Policy Framework Typology for ASEAN

Phase	Basic Infrastructure	High-tech Infrastructure	Network Cohesion	Global Integration
(1) Initial conditions Cambodia, Lao PDR, Myanmar	Political stability and efficient basic structure	Emergence of demand for technology	Social bonds driven by the spirit to compete and achieve	Linking with regional and global markets
(2) Learning Thailand, Philippines, Indonesia, Viet Nam	Strengthening of basic infrastructure with better customs and bureaucratic coordination	Learning-by-doing and imitation	Expansion of tacitly occurring social institutions to formal intermediary organisations to stimulate connections and coordination between economic agents	Access to foreign sources of knowledge, imports of material and capital goods, and inflows of foreign direct investment Integration in global value chain
(3) Catch-up Malaysia	Smooth links between economic agents	Creative destruction activities start through imports of machinery and equipment, licensing, and creative duplication	Participation of intermediary and government organisations in coordinating technology inflows, initiation of commercially viable R&D	Licensing and acquisition of foreign capabilities Upgrading synergies through technology imports Emergence of strong technology-based exports
(4) Advanced	Advanced infrastructure to support meeting demands of economic agents	Developmental research to accelerate creative destruction activities Frequent filing of patents in the United States starts	Strong participation of intermediary and government organisations in coordinating technology inflows, initiation of commercially viable R&D	Access to foreign human capital, knowledge links, and competitiveness in high-tech products and collaboration with R&D institutions
(5) Frontier Singapore	Novel infrastructure developed to save resource costs and stimulate short lead times	Basic research R&D labs to support creative accumulation activities Generating knowledge Technology shapers generate invention and design patents extensively	Participation of intermediary organisations in two-way flows of knowledge between producers and users	Connecting to frontier nodes of knowledge, and competitive exports of high-tech products

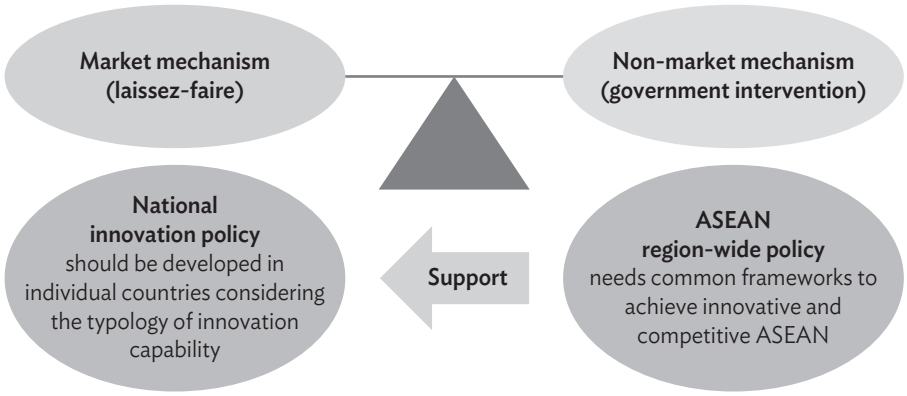
Lao PDR = Lao People's Democratic Republic, R&D = research and development.

Sources: Intal et al. (2014) and Rasiah (2013).

1.5 | National and Region-wide Innovation Policies

From the discussion so far, it seems clear that AMS need to develop their national innovation policies from multifaceted dimensions, such as R&D incentives, human resources development, and industrial and trade policies. Policymakers need to find a balance between market-oriented and government intervention approaches depending on their country's specific situation. This is particularly important for AMS that have just started industrialisation based on innovation. As a regional institution, ASEAN also needs to consider what region-wide policies to implement and how to synergise them with national innovation policies in each member state. This relationship between national and region-wide innovation policy is described conceptually in Figure 1.1.

Figure 1.1: National and Region-wide Innovation Policy



Source: Author.

1.5.1 National innovation system

How did leading Asian countries succeed in building their innovation capability? They did so by formulating effective national innovation policies with the strategic use of foreign technologies and knowledge as a driving force for domestic innovation supported by industrial and trade policies, and thus achieved dramatic economic development. To avoid the middle-income trap and become competitive in the global market, as leading Asian countries did, AMS need to have in place systematic innovation policies to move up through the stages of innovation (Table 1.4).

The experiences of leading Asian countries offer valuable lessons for AMS that aspire to achieve innovation on their own.

One thing leading Asian countries have in common is that they each successfully established their own effective and functional national innovation system (NIS), and their governments functioned as active agents in coordinating these systems to make them work well. According to Soete et al. (2010), an NIS can be defined as a continuous government-controlled process where institutions, learning processes, and networks play a central role in generating technological change and innovation via intentional, systemic interactions between various components.[15] The key point of an NIS is that it is a government-coordinated institutional system that incorporates well-organised interactions among many agents (e.g. public and private institutions and universities) that engage in innovative activities. The NIS approach has a more general purpose than being just a localised market-failure approach, and, hence, a government can be an endogenous positive actor that controls innovative activities within the economy.

Two prominent types of NISs have been used by leading Asian countries as a strategic way to catch up with Western developed countries. One emphasises domestic industrial resources to be utilised for innovation; the other relies on technologies and skills transferred from foreign countries, including through FDI. The first type of NIS was adopted by Japan and Korea, and the second by China and Singapore (Figure 1.2) as well as many AMS more recently. Although space constraints prevent detailed explanations, the following paragraphs describe the prominent characteristics of NISs in these countries with reference to other studies, such as Fagerberg et al. (2010).[16]

Japan. Japan, the leading country of the 'flying-geese'[17] pattern of economic development in Asia, was the first Asian country to catch up with Western developed countries. Just after World War II, the Government of Japan and Japanese firms formed implicit strategies of importing technologies and knowledge via licensing

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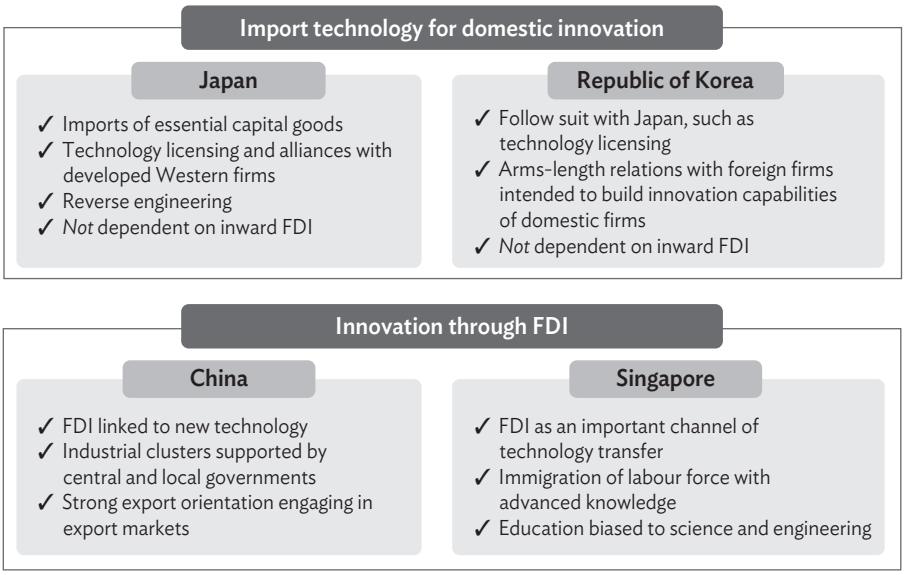
15 In addition to the comprehensive explanation by Soete et al. (2010), a variety of definitions of an NIS have been presented by other authors, such as Nelson (1993). Yet, all these authors stress that the core of a functional NIS is the active and effective involvement of government.

16 For details of the analyses of innovation in China and Singapore, see Chapter 3 and Chapter 7, respectively.

17 Akamatsu (1962) argued that a long-term industrial development pattern from imports to exports after import substitution is observed in the industrial dynamics of developing countries that follow developed countries. He likened this to the arrangement of a group of flying geese, where the lead goose is the technologically more advanced developed country.

Figure 1.2: National Innovation Systems of Leading Asian Countries



FDI = foreign direct investment.

Source: Author, with reference to Fagerberg et al. (2010).

agreements and alliances concluded with Western firms, and inventing through reverse engineering. Japanese firms imitated Western products and invented new, but not always unique, products around them. This type of innovation, which was combined with relatively highly educated, low-wage human capital, generated very competitive products. The government did not depend on FDI for technology and knowledge; rather, it implemented several industrial policies, such as domestic industrial promotion, export-incentive schemes, and R&D incentives.

Korea. Korea formulated a catch-up policy as that of Japan. It did not depend too heavily on FDI or multinational foreign firms, but used industrial policies that aimed to accelerate innovation conducted by large domestic firms (home-grown conglomerates, or *zaibatsu*). Like Japan, Korea also succeeded in achieving its own innovation mainly by utilising domestic resources but also by purchasing technologies from developed countries.[18]

[18] Fagerberg et al. (2010) pointed out that Taiwan adopted the first type of NSI, which succeeded in changing a main engine of the economy from labour-intensive industries to high-tech ones, such as electric and electronics, based on export-oriented industrial policies.

China. After lengthy isolation from the global economy, China started to transform its economic system into a socialist market economy in the 1970s. Above all, the 'openness policy', initiated in 1978, encouraged FDI, and special economic zones and national economic and technological development zones were established with the aim of assimilating foreign technologies.[19] Meanwhile, China made efforts to expand exports of domestic products by prioritising growth and development through a variety of industrial promotion policies. Intal et al. (2014) argue that both central and local governments provided strong support for the formation of industrial clusters that enabled China's rapid export-led growth. They conclude that the success of Chinese industrial clusters was due in large part to local governments' institutional, comprehensive, and responsive support systems, which addressed market failures, instituted regulatory reforms, provided monetary incentives for R&D and financial assistance to small and medium-sized enterprises, and promoted innovation research centres in collaboration with local universities and research institutes.

Singapore. Singapore is a distinctive country that has aggressively engaged in the second type of NIS, and FDI has played a critical role as an important channel of technology and knowledge transfer. The country has made a great deal of effort to set up industrial estates and clusters in association with both FDI and innovation-friendly domestic policies. One remarkable example is the Johor electronics cluster, which started in the 1960s as a semiconductor assembly plant and greatly contributed to Singapore's modern industrialisation (Intal et al., 2014). Another is modern research parks that are represented by biotechnology clusters, where the Government of Singapore, domestic and multinational firms, and universities cooperate to encourage high-value-added innovation in the field of biotechnology (Asian Development Bank Institute, 2014). Moreover, Singapore has willingly accepted high-quality immigrants with a view to profiting from their high skill levels and advanced knowledge. Singapore's superior higher education system, with its bias towards attracting more domestic and foreign students into science and engineering, also complements its NIS.

1.5.2 Region-wide innovation policies for ASEAN

There is a great need for region-wide innovation policies to enhance ASEAN's presence and create a competitive and dynamic ASEAN in the global economy, notwithstanding the existing projects of developing STI policies discussed under ASEAN COST.

[19] China was admitted as a member of the World Trade Organization in December 2011. This accelerated the reform and opening-up of its economy, providing access to the global market and attracting more investment.

Chapter 10 of this book investigates in-depth, current innovative activities and the necessary innovation policies to be developed in ASEAN. In addition, Chapter 11 provides policy recommendations from the perspective of (i) initiatives for promoting innovation with more cross-regional synergies and positive feedback across AMS; (ii) goods, investment, and service trade liberalisation and deregulation; and (iii) the freer movement of natural persons, especially of highly skilled immigrants. The final chapter also briefly touches upon the policy requirements of addressing the innovation gaps among AMS.

1.6 | Concluding Remarks

The objective of this chapter is to discuss the innovation policies that are needed for each AMS and for ASEAN. While existing studies point to the importance of enhancing innovation capability of each country to achieve its own innovations, most AMS have made little progress in terms of R&D intensity, patent applications, and the number of science researchers. This heightens concerns that some AMS may be stuck in the middle-income trap. It is important for them to steadily move up through the stages of innovation and to formulate appropriate policies in accordance with the typology of stages. To this end, NISs employed by countries can be an effective policy tool to achieve home-made innovation as such systems organise innovation policy in a systematic manner, emphasising an active coordinating role for governments. Finally, it is also important to examine ASEAN region-wide innovation policies that enhance ASEAN's presence and competitiveness in the global economy.

Economic growth in most AMS has been driven by manufacturing industries in conjunction with a low-wage labour force, and labour-intensive manufacturing remains the basis for economic development in ASEAN. However, if AMS remain dependent on this model in the long term, their economic management will run into obstacles. Wage levels in some AMS, such as Malaysia and Thailand, have been rising sharply and other AMS will also witness wage increases in the near future. This will harm the competitiveness of ASEAN manufacturing industries compared with other emerging countries. In response to this challenge, innovation can help ASEAN take a step forward and improve the sophistication of its economies as it enhances the attractiveness of its single market and production basis. Although it will not necessarily be easy for AMS to immediately achieve a significant level of innovation capability, they have much potential to enhance it in future years. It is not until ASEAN produces its own innovation that it will be able to reach the position in the world that it aspires to, as embodied by the concept of 'ASEAN centrality'.

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