Innovation Policy in/for ASEAN

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Introduction

It is widely acknowledged that innovation is a primary source of sustainable economic development and inclusive growth, not only through productivity improvements in firms, industries, and macro economies, but also through the expansion of consumption, investment, and exports stimulated by innovation. This recognition of the efficacy of innovation has, no doubt, been prevailing in developed countries, but there still seems to be some scepticism in developing countries (Fagerberg et al., 2010). That is, 'Is innovation a significant factor for economic development of developing countries?' or 'Is it beneficial to consider innovation as an important policy target for developing countries?' Such questions are frequently answered negatively on the grounds that high-tech firms and industries would emerge only in well-advanced economies. So far, Association of Southeast Asian Nations (ASEAN) Member States (AMS) have not on the whole been exceptions to this sceptical viewpoint.

This scepticism possibly stems from a high ideal of what innovation should be. The current popular definition of innovation is affected by Schumpeter (1934), who advocated the concept of 'new combination'.[1] Influenced by Schumpeter's work, the *Oslo Manual*, the guideline for data collection on and interpretation of innovation formulated by the Organisation for Economic Co-operation and Development (OECD, 2005), defines innovation as: 'the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation 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'.

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

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 there is much room for developing countries to advance their technologies through diverse activities: learning by doing, imitation, and technology transfer, not just through original inventions or innovations at the initial development stage.

Innovations diffuse from developed to developing countries as if water flowed from high to low places and, as a result, development levels would converge between these countries. But this discreet, passive 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 governments of developing countries, which could be conducive to innovation in contrast to 'laissez-faire' market approaches (Fagerberg et al., 2010). Successful examples of East Asian countries, such as Japan, Korea, China, and Singapore, which have somehow achieved their own innovation, to varying degrees, demonstrate that they systemically formulated and implemented innovation policies not only to carefully address market failure,[2] but also to aim to audaciously close innovation gaps with developed countries. From this viewpoint, it is therefore indispensable for AMS and ASEAN to develop their own effective innovation policies.

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 degree of innovative activities, the following measures provide some approximations.

Innovation Capability

How countries achieve innovation 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.

[2] Since innovators typically find it difficult to appropriate their innovation outcomes but for intellectual property rights such as patents, a free-ride problem caused by other innovators is inevitable (Arrow, 1962).

AMS need to enhance their innovation capability to achieve autonomous and sustainable economic development based on innovations so as not to be overdependent only on foreign direct investment (FDI) and official development aid. Innovation capability also matters for AMS to escape the so-called 'middle-income trap', meaning that developing countries that attain a certain middle income owing to given advantages such as abundant natural resources become stagnant and stay at that level. For ASEAN to be competitive, dynamic, and innovative, as well as maintain its centrality in the global economy, developing the innovation capability of AMS through effective policies is its key challenge.

To make the concept of innovation capability more concrete, Fagerberg and Srholec (2008) presented comprehensive measures in accordance with four different types of capabilities: innovation system, governance, political system, and openness. The innovation capability we now focus on mostly corresponds to their innovation system. According to the result of their factors analysis, an innovation system includes the United States Patent and Trademark Office (USTPO) patents, science and engineering articles, International Organization for Standardization (ISO) 9000 certification, fixed line and mobile phone subscribers, internet users, secondary and tertiary school enrolment, and so on. By employing scores for the innovation system evaluated by using these measures, Fagerberg and Srholec (2008) identified a clear-cut positive relationship between the innovation system and economic development evaluated by gross domestic product (GDP) per capita across countries. Based on a regression analysis on 115 countries from 1992 to 2004, the authors also found that the innovation system is positively associated with and of particular importance for economic development.

To summarise, we can see that having better innovation capability strengthened by various tangible and intangible factors is of significant importance for developing countries to move ahead with their economic development agendas. In what follows it is argued that most AMS are still in the midst of building their innovation capability, an assessment based on data relevant for innovative activities.

Data on Innovative Activities in ASEAN

R&D intensity

Let us take a look at data on innovative activities in ASEAN. In the first place, research and development (R&D) expenditure should be a main indicator of how innovation progresses in a country. Table 1 presents R&D intensity per GDP for AMS, China, India, Japan, and Korea. It shows that most AMS except Singapore have a quite low (and largely stagnant except for Malaysia) share of investments in R&D to GDP,

as compared with Japan and Korea, which have continued to record over 3% of R&D intensity in recent years.[3] The trend of R&D expenditure in Malaysia has been rapidly upward and the R&D intensity has reached over 1%, but it has not attained the level of Japan and Korea. China's R&D expenditure, on the other hand, has skyrocketed recently, in line with its strong economic development.

Table 1: R&D Intensity (per GDP, %)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Brunei Darussalam	n.a.	n.a.	0.02	0.02	0.04	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Cambodia	n.a.	n.a.	0.05	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Indonesia	0.07	0.05	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.08	n.a.	n.a.	n.a.	0.08	n.a.
Lao PDR	n.a.	n.a.	0.04	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Malaysia	0.47	n.a.	0.65	n.a.	0.60	n.a.	0.61	n.a.	0.79	1.01	1.04	1.03	1.09	n.a.	1.26
Myanmar	0.11	0.07	0.16	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Philippines	n.a.	n.a.	0.14	0.13	n.a.	0.11	n.a.	0.11	n.a.	0.11	n.a.	0.12	n.a.	0.14	n.a.
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	n.a.	0.23	n.a.	0.36	n.a.	n.a.	0.48
Viet Nam	n.a.	n.a.	0.18	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.19	n.a.	n.a.	n.a.
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	n.a.	n.a.	n.a.
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

GDP = Gross domestic product; Lao PDR = Lao People's Democratic Republic; n.a. = not available; R&D = research and development.

Source: UNESCO Institute for Statistics.

Patent applications

The same trend can be observed with regard to the number of patent applications in each country, as shown in Table 2. Patent applications are positively associated with inventions. Table 2 indicates that although the number of direct patent applications has tended to increase in all AMS, it is still smaller than in developed Asian countries.

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

Table 2: Direct Application of Patents (per million population)

	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	n.a.	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	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
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

Lao PDR = Lao People's Democratic Republic; n.a. = not available.

Source: WIPO Global Brand Database and World Bank Database.

Somewhat surprisingly, even Singapore does not produce sufficient patent applications. This suggests that AMS have much room to improve their patent systems as an indicator of innovation capability.[4]

Number of R&D researchers

Finally, Table 3 presents the number of R&D researchers per million population in major AMS. Educated human resources are without doubt a fundamental driving force of innovation. As of 2014, Malaysia had the highest number of the AMS (2,051.7) except for Singapore (6,658.5), but it is small compared with Japan (5,386.2) and Korea (6,899.0). Singapore is considered to be a dedicated country that has focused its limited human resources on R&D activities. These figures suggest that at least the quantity of R&D researchers is not sufficient in most AMS. Hence, the effort required to produce more talented R&D researchers who excel in science and technology (S&T) through a higher education system (e.g. universities, national research laboratories, etc.) is a pressing issue for AMS to achieve their own innovation.

[4] These tendencies of innovative activities concerning patents can also be reaffirmed by observing data on patent filling of AMS in the United States.

Table 3: Number of R&D Researchers (full-time equivalent; per 10,000 population)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Brunei Darussalam	n.a.	n.a.	288.3	280.4	286.5	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Cambodia	n.a.	n.a.	17.6	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Indonesia	212.6	199.2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	89.5	n.a.	n.a.	n.a.	n.a.	n.a.
Lao PDR	n.a.	n.a.	15.8	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Malaysia	274.2	n.a.	293.3	n.a.	500.1	n.a.	369.1	n.a.	601.0	1,070.4	1,467.1	1,653.4	1,793.5	n.a.	2,051.7
Myanmar	n.a.	11.9	17.2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Philippines	n.a.	n.a.	n.a.	70.6	n.a.	80.1	n.a.	78.2	n.a.	81.9	n.a.	85.1	n.a.	189.4	n.a.
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	5,740.8	6,149.0	6,306.5	6,496.0	6,442.3	6,665.2	6,658.5
Thailand	n.a.	279.3	n.a.	279.5	n.a.	311.3	n.a.	322.4	n.a.	330.6	n.a.	543.5	n.a.	n.a.	974.0
Viet Nam	n.a.	n.a.	113.9	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
China	547.3	581.5	631.1	667.5	713.3	856.8	932.3	1,078.6	1,200.3	863.9	903.0	977.7	1,035.9	1,089.2	1,113.1
India	110.1	n.a.	n.a.	n.a.	n.a.	135.3	n.a.	n.a.	n.a.	n.a.	156.6	n.a.	n.a.	n.a.	n.a.
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	5,157.8	5,147.8	5,152.6	5,160.2	5,083.7	5,201.3	5,386.2
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	4,867.8	5,000.9	5,380.3	5,853.3	6,361.6	6,456.6	6,899.0

Lao PDR = Lao People's Democratic Republic; n.a. = not available; R&D = research and development.

Source: UNESCO Institute for Statistics.

Efforts towards Innovation in ASEAN

ASEAN has recognised the importance of improving the capability for developing S&T. It has made many efforts to produce innovation and address the challenges on the way to an 'Innovative ASEAN' (ASEAN Secretariat, 2015). Science and technology cooperation in ASEAN in fact started in 1971 with the establishment of the ASEAN Permanent Committee on Science and Technology (PCOST), which was followed in 1978 by the ASEAN Committee on Science and Technology (ASEAN COST) with the objective of cooperating to develop S&T and related human resources and encouraging technology transfers within and outside ASEAN.

ASEAN considers Science, Technology, and Innovation (STI) as a major foundation for attaining the ASEAN Vision 2020 set out in 1997.[5] 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

[5] The ASEAN Vision 2020 was issued during the 2nd ASEAN Informal Summit in Kuala Lumpur on 15 December 1997. It is available at http://asean.org/?static post=asean-vision-2020

of excellence'. In October 2016, the 'ASEAN Plan of Action on Science, Technology and Innovation (APASTI): 2016–2025' was formulated together with the vision, goals, and thrusts after the launch of the ASEAN Economic Community (AEC) 2015.[6] 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. In other words, the goals stress the active involvement with collaboration between the public and private sectors (especially small and medium-sized enterprises [SMEs]), mobility of talents, deep awareness of STI, an innovation-driven economy, active R&D collaboration, technology commercialisation, entrepreneurship, and so on. In response to concern about how to implement the strategic thrusts, the APASTI also puts forward detailed actions to be taken in each thrust.

Typology for Innovation Policy in ASEAN

There exists a large discrepancy in the levels of innovative activities amongst AMS, so innovation policies for individual AMS should vary. The wide discrepancy can be seen in the Global Innovation Index (GII) published by Cornell University, INSEAD, and the World Intellectual Property Organization. According to the latest results of the GII in 2016 (Dutta et al., 2016), the rankings of AMS range from Singapore's 6th rank to Cambodia's 95th rank.[7]

Similarly, the Technology Achievement Index (TAI) of the Asian Development Bank (2014) also assesses a country's technological development level. The TAI provides an indication of how well a country can create and use technology, rather than simply reflect the value of inputs such as the number of scientists and R&D expenditure. The TAIs of Asian countries including AMS from 1999 to 2008 suggest 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); nonetheless, they significantly improved their levels of technological development and innovation during 1999–2008, especially Viet Nam and China (Figure 3.7, p. 116). And yet, looking at ASEAN as a whole, technological development, innovation capability, and resulting innovation achievements have not progressed as rapidly as economic growth.

6 The APASTI has been officially published by the ASEAN Secretariat on the website available at http://aseanstiforum.net/wp-content/uploads/2016/09/APASTI2016-2025.pdf

7 Other than these two countries, the AMS rankings of GII in 2016 are: Malaysia, 35th; Thailand, 52th; Viet Nam, 59th; the Philippines, 74th; and Indonesia, 88th. The results of Brunei Darussalam, the Lao PDR, and Myanmar are not available.

Hence, when it comes to drawing up innovation policies for each AMS, a certain typology of technology and innovation is useful as a compass to guide individual AMS given that AMS are at very different stages of innovation. Following the analyses of Intal et al. (2014) and the Japan Science and Technology Agency (2015), we can divide the AMS into several 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, Thailand, the Philippines, and Viet Nam are in the 'Learning' phase, which is characterised by the acquisition process of innovation capability. These countries are assumed to have significant potential to improve their innovation capability as their economies grow in the future. In particular, 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, the Lao PDR, and Myanmar are in the 'Initial Condition' phase, which means they still need to establish nation building infrastructures and relevant institutions to set up their innovation capability.
- Brunei Darussalam is difficult to place in any of these categories because the country has been depending on its particular economic model driven by natural resources. But the country is now aware of the necessity for industrialisation through innovation.

Intal et al. (2014) provided a useful matrix table to illustrate the development stages of each AMS and the necessary policies in accordance with the above-mentioned innovation phases (Figure 4.5, p. 199),[8] which is reproduced in Table 4. 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 (Figure 1.1, p. 4). In ERIA (2015), it is suggested that developing AMS should steadily advance their development stages at the country, city, and regional levels. In this regard, the implication of Table 4 for AMS is the same as ERIA (2015) – it is important to understand at what innovation stages AMS are (i.e. what their level of innovation capability is), and to move up this 'technology ladder' accordingly, step by step, based on effective strategic and systemic 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

[8] This table is substantively built on the idea of Rasiah (2013).

Table 4: Typology of Policy Framework for ASEAN

Phase	Basic Infrastructure	High-tech Infrastructure	Network Cohesion	Global Integration
Initial Conditions (1) 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
Learning (2) 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 FDI inflows. Integration in global value chain
Catch-up (3) Malaysia	Smooth links between economic agents	Creative destruction activities start here 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
Advanced (4)	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 here	Strong participation of intermediary and government organisation in coordinating technology inflows, initiation of commercially viable R&D	Access to foreign human capital, knowledge linkages, and competitiveness in high-tech products and collaboration with R&D institutions
Frontier (5) 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 here	Participation of intermediary organisation in two-way flows of knowledge between producers and users	Connecting to frontier nodes of knowledge, and competitive export of high-tech products

ASEAN = Association of Southeast Asian Nations; FDI = foreign direct investment; R&D = research and development; US = United States.

Sources: Intal (2015) and Rasiah (2013).

at every stage, to achieve basic innovation from the ground up, and to realise steady industrial development through the innovations.[9]

Table 4 also suggests a typology of policy frameworks required for AMS in terms of basic and high-tech infrastructures, 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. We need to note that this angle of policies for AMS is merely a typical framework, which signifies that policymakers should formulate actionable innovation policies.

National and Region-wide Innovation Policies

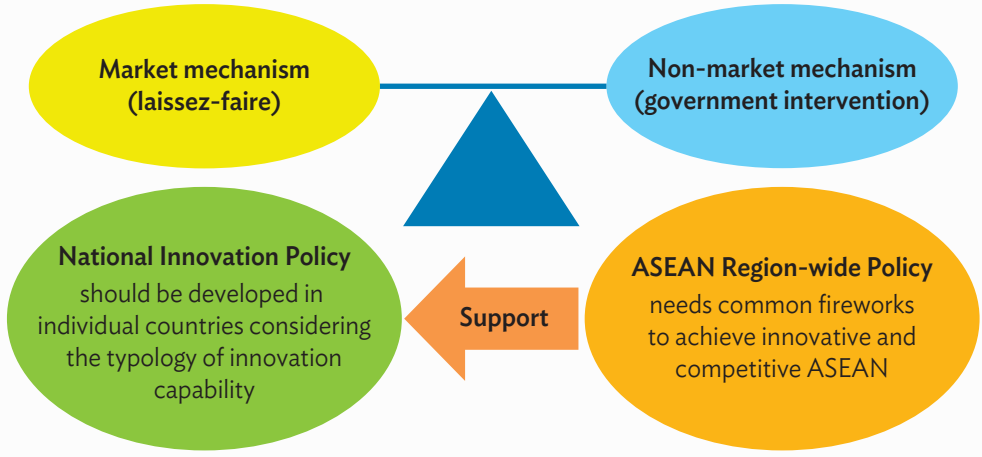
From the discussion so far, it seems clear that AMS need to develop their national innovation policies in various dimensions, such as R&D incentives, human resource development, and industrial and trade policies. Policymakers need to find a balance between market-oriented and government intervention approaches depending on their country's specific situation. This is particularly important for AMS that have just started industrialisation on the basis of 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 AMS. This relationship between national and region-wide innovation policy is conceptually described in Figure 1.

National Innovation System (NIS)

How did leading Asian countries succeed in building their innovation capability? In retrospect, these countries formulated 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 the stages of innovation (Table 4). The experience of leading Asian countries offers valuable lessons for AMS that aspire to achieve innovation on their own.

[9] Schumpeter (1942) advocated a concept of 'creative destruction' that induces industry dynamics, exemplified by 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 it is possible for developing AMS to 'leapfrog' development stages through revolutionary innovation in the modern era of information and communication technologies.

Figure 1: National and Region-wide Innovation Policy



Source: Author.

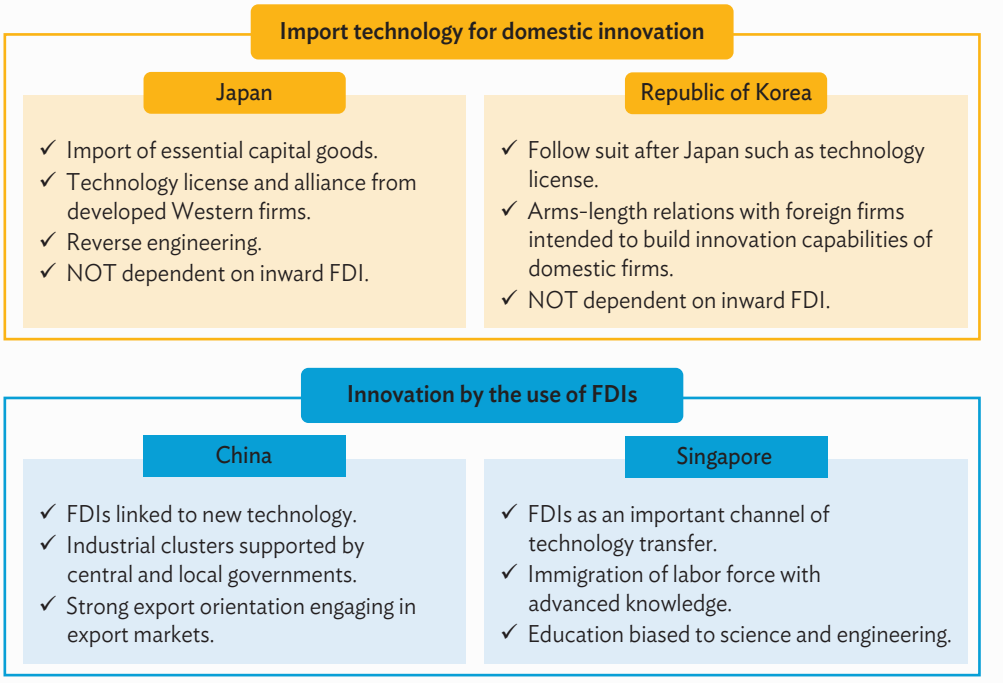
What leading Asian countries have in common is that they successfully established their own effective and functional national innovation systems (NISs) and their governments functioned as active agents in coordinating these systems to make them work well. According to Soete et al. (2010), an NIS can be defined as a continuous process controlled by a government, where institutions, learning processes, and networks play a central role in generating technological change and innovation via the intentional, systemic interactions between various components.

There seem to be two prominent types of NISs that 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 through FDIs. Specifically, the former type of NIS was adopted by Japan and Korea, the latter by China and Singapore as well as by many AMSs more recently (Figure 2).

Japan

With regard to the first type of NIS, Japan was the first Asian country that caught up with Western developed countries, as the leading country of the 'flying-geese-pattern' of economic development in the Asian region. Just after World War II, the Japanese government and firms formed implicit strategies of importing technologies and knowledge via licensing agreements and alliances concluded with Western firms, and inventing through reverse engineering. Japanese firms imitated Western products and made new, but not always unique, products around them.

Figure 2: National Innovation Systems of Leading Asian Countries



FDI = foreign direct investment.

Source: The author in reference to Fagerberg et al. (2010).

This type of innovation, which was combined with relatively highly educated low-wage human capital, generated highly competitive products. In contrast to the second type of NIS, the Japanese government did not depend on FDI for technologies and knowledge; instead, it implemented a number of industrial policies such as domestic industrial promotion, export-incentive schemes, and R&D incentives.

Republic of Korea

This kind of NIS was also adopted by Korea. In a similar vein, the country formulated a catch-up policy in reference to Japan's experience. It did not depend too much on FDI or multinational foreign firms, but used industrial policies that aimed to accelerate innovation conducted by large domestic firms (i.e. home-grown conglomerates). Like Japan, Korea also succeeded in achieving its own innovation mainly by utilising domestic resources, but also by purchasing technologies from developed countries.[10]

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

China

After its long-time isolation from the global economy, China started transforming its economic system into a socialist market economy in the 1970s. Above all, the 'openness policy', initiated in 1978, aggressively courted FDI. Special Economic Zones and National Economic and Technological Development Zones were established with the aim of assimilating foreign technologies. China was admitted as a member of the World Trade Organization (WTO) in December 2001. This accelerated the reform and opening up of the Chinese economy, providing access to the global market and attracting more investment. Intal et al. (2014) argued that both central and local governments provided strong support to form industrial clusters that enabled China's rapid growth led by exports. They concluded that the success of Chinese industrial clusters was due in large part to local governments' institutional, comprehensive, responsive, and dedicated support systems through addressing market failure, regulatory reforms, monetary incentives for R&D, financial assistance to SMEs, and innovation research centres in collaboration with local universities and research institutes.

Singapore

Singapore aggressively engaged in the second type of NIS, where FDI played a critical role as an important channel of technology and knowledge transfer. Singapore has made a great deal of efforts to set up industrial estates and clusters in association with both FDI and innovation-friendly domestic policies. For example, Singapore established modern research parks that are represented by biotechnology clusters, where the Singapore government, industries made up of domestic and multinational firms, and universities cooperate to encourage high-value added innovation in the field of biotechnology (Asian Development Bank, 2014). Moreover, Singapore has willingly accepted high-quality immigrants with a view to profiting from their high skills and advanced knowledge. Singapore's superior higher education system also complements its NIS, being biased towards attracting more domestic and foreign students into science and engineering.

Possible directions of NISs for AMS

For AMS, the second type of NISs adopted by China and Singapore that have actively courted FDI seems to be more plausible than the first type of NISs in the current free trade system based on rules agreed amongst countries. This is because countries have found it more difficult to use restrictive trade and investment policies under the current WTO system, which is totally different from the rules in the past (for instance, the Agreement of Trade-Related Aspects of Intellectual Property Rights under the WTO specifies strict rules of intellectual property right issues). Alternatively, FDI can be a key to innovation creation because it is a major channel of technology spillovers into AMS from other developed countries. However, excessive reliance on FDI may not

necessarily stimulate innovation. This is confirmed by the experiences of China and Singapore, which effectively combined their domestic industrial promotion policies with openness policies to reap the benefits of FDI.[11] Some AMS have also tried to establish their own NISs based on industrial clusters in conjunction with FDI. For example, Thailand's automobile cluster around Bangkok and Malaysia's Penang electronic cluster are considered successful cases where technologies and knowledge are successfully transferred from multinational firms (Intal et al., 2015; Nishimura et al., 2016). It is essential for AMS, including the CLMV countries (Cambodia, the Lao PDR, Myanmar, and Viet Nam), to promote cluster formation that builds a foundation for moving to the next stage of innovation through technology and knowledge spillovers.

A broad range of 'systemic' policies are required in AMSs to nurture innovation capability and boost innovation. To achieve this objective, it is necessary to create stable microeconomic and macroeconomic conditions, improve business climates, construct hard and soft infrastructures, develop human capital (especially R&D and science researchers), secure financial accessibility for entrepreneurs, maintain good governance, and arrange systematic university–industry institutions (Asian Development Bank, 2014).

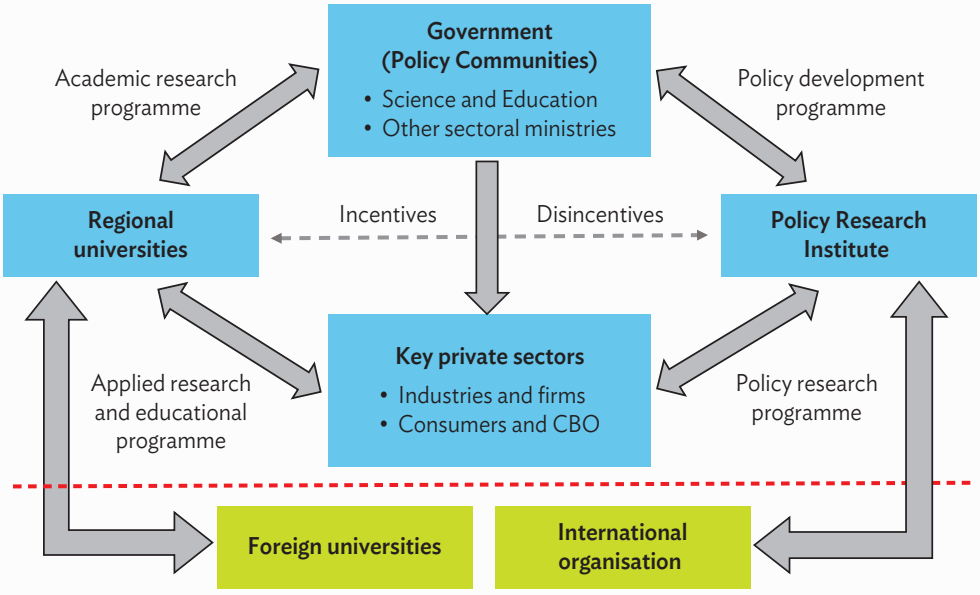
As one of the characteristics of NISs, innovation policy should be closely coordinated with human capital development policies, especially for scientists who are essential for conducting R&D in both public and private organisations. Moreover, according to the systemic notion of the NIS focusing on the linkage between universities and industries, universities should be given a more important role as a major source of innovation. This is because they can sow the seeds for unique innovations that may be used by commercial industrial sectors. All in all, infrastructures, human capital, education systems, industrial policies, and the ability to assimilate innovations should be promoted in an integrated manner. Figure 3 illustrates that this systemic innovation framework involving all actors is likely to transform individual small steps into great achievements, which could be a strategy undertaken by AMS that seek to create a new innovation dynamic.[12]

It should be noted, however, that NISs also have a limitation. Government interventions can sometimes lead to 'government failure', which may cause a more serious problem than market failure. Therefore, it is desirable to utilise market mechanisms to promote

[11] 'Absorptive capacity' is regarded as indispensable for effectively assimilating positive economic impacts of FDI. Cohen and Levinthal (1990) interpreted absorptive capacity as an ability of firms to recognise the value of new, external information, assimilate it, and apply it commercially. Hence, this absorptive capacity to receive FDI critically affects the innovation capability.

[12] I would like to thank Dr. Anbumozhi Venkatachalam (Senior Energy Economist of ERIA) for kindly providing the original material for Figure 3.

Figure 3: Framework for Innovations by the Use of University–Industry Linkage



CBO = Consumer Business Organisation.

Source: Author.

innovations if appropriate, whereas governments would best concentrate on issues that cannot be resolved by market mechanisms alone, and enhance complementarity with the market. In addition, when learning from successful cases of NISs adopted by other countries, AMS need to recognise the differences in environments, times, and histories from those of others. Hence, since institutions and systems including NISs are strongly affected by the 'path dependency' of the country (David, 1985; David, 1994), AMS would be wise to investigate what elements of NISs can still be effective for establishing their own NISs.

ASEAN Region-wide Innovation Supporting Policies

It might not be sufficient for us to consider innovation policy solely inside the framework of NISs in the globalisation era. ASEAN region-wide innovation policies are very much needed to enhance the presence of ASEAN in the world, to create a 'competitive and dynamic ASEAN' in the global economy. Aside from the existing project of developing STI policies discussed under the ASEAN COST (see Section 3), I would like to provide the following policy recommendations from another perspective.

Reinforce trade, investment, and service liberalisation

Strengthening market competition in both domestic and foreign markets is expected to make ASEAN local firms more productive and innovative. As for the competition effect on innovation, a project undertaken by ERIA (Hahn and Narjoko, 2010) found some results regarding the relationship between competition and innovation in AMS. Anh et al. (2010) empirically demonstrated that innovation such as new products and new production processes in Vietnamese SMEs are strongly associated with competition with foreign firms generated by trade liberalisation. Also, with regard to Philippines manufacturing firms, Aldaba (2010) maintained that trade liberalisation led by a reduction in tariff rates has a significant positive impact on innovation through fierce competition that promotes industrial 'refreshment'. In this way, trade liberalisation, such as a reduction in tariffs and non-tariff barriers, exposes local firms to fiercer market competition, which in turn inspires them to improve their productivity through innovation to survive the competition.

The aforementioned studies make a reference to goods trade liberalisation, but investment and service liberalisation within ASEAN also has a significant potential to spur innovation in the region. In reality, service industries account for more or less 50% of GDP in most AMS (Table 5). According to a recent study by Duarte and Restuccia (2010), the productivity difference across sectors in service industries is larger than in manufacturing industries, which suggests that innovation leading to productivity improvement in services industries will enhance the economic performance of AMS that seem to be suffering from a low-productivity problem. In spite of its considerable potential, services trade liberalisation encounters many challenges in contrast to goods trade liberalisation in ASEAN; hence, there still is much leeway for international services trade liberalisation through negotiation in the AEC and ASEAN-plus-one FTAs.

Promote movement of natural persons

The free movement of natural persons (Mode 4 of the General Agreement on Trade in Services) is also significant in terms of creating innovations. According to surveys, technology and knowledge spillovers are brought about by people, especially scientists, who are related to R&D investments (Almeida and Kogut, 1999; Appleyard, 1996). It is also revealed that the introduction of immigrants is positively associated with labour productivity of domestic workers (Lewis and Peri, 2015); therefore, highly skilled immigrants are more likely to have positive economic impacts especially on developing countries because, in most cases, immigrants and domestic workers complement each other.

Table 5: Industrial Structures of ASEAN Members in 2014

Country	Agriculture (%)	Manufacturing (%)	Service (%)
Brunei Darussalam	0.8	15.9	32.4
Cambodia	30.5	16.3	42.4
Indonesia	13.7	21.6	43.3
Lao PDR	23.9	8.1	42.5
Malaysia	9.2	24.2	49.8
Myanmar	27.9	19.9	37.7
Philippines	11.3	20.5	57.5
Singapore	0.0	18.4	75.0
Thailand	10.5	27.7	52.7
Viet Nam	18.1	17.5	43.4

ASEAN = Association of Southeast Asian Nations; Lao PDR = Lao People's Democratic Republic.
Source: United Nations statistical database.

The movement of human resources in higher education is also an important challenge. Human capital development is an indispensable component of operationalising an innovation-friendly system centred on universities. While AMS have traditionally sent their students to Western (e.g. US, United Kingdom, and Australian), Japanese, and Korean higher education institutions, they have also increased exchange students within ASEAN in recent years. ASEAN needs to reinforce the existing ASEAN University Network (AUN), designed to promote the movement of students and researchers amongst affiliated universities, as it could create new university-originated innovations that transcend countries' boundaries.[13] In addition to intra-ASEAN human movement, interaction between and exchange of academic researchers and students is necessary between ASEAN and outside universities. For these reasons, ASEAN should make greater efforts to improve entrance mechanisms and educational environments for students and researchers.

[13] The AUN was established in 1995 with as its objective to 'hasten the solidarity and development of a regional identity through the promotion of human resource development so as to further strengthen the existing network of leading universities and institutions of higher learning in the region' (the 4th ASEAN Summit in 1992). The ASEAN Charter signed in 2007 delegated a task to the AUN – to be a key implementing agency of ASEAN in the socio-cultural pillar. For more details, see the website of the AUN, available at http://www.aunsec.org/index.php

Introduce a peer review system of innovation capability

Comparison amongst AMS' innovation policies by introducing a peer review system is worth considering to be able to assess at what innovation stages countries find themselves and how fast their innovation capability is advancing. It is likely that the peer review would motivate each AMS to accelerate the establishment of its own NISs. In formulating the system amongst AMS, it is also important to take into account at what innovation stage each AMS is, as discussed in Section 4. Furthermore, the peer review system would allow AMS to learn best practices from innovation policies of other countries.

Concluding Remarks

The objective of this chapter is to discuss what innovation policy is needed in each AMS and for ASEAN as a whole. While existing studies point to the importance of enhancing innovation capability in each country to achieve its own innovations, AMS have not made much progress in terms of R&D intensity, patent applications, and the number of science researchers, which heightens concerns that some AMS may be stuck in the middle-income trap. It is important for them to steadily move up 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. Furthermore, it is important to encourage ASEAN region-wide policies to promote innovation that push individual AMSs through, for example, service trade liberalisation, freer movement of natural persons, and the establishment of a peer review system of innovation policy.

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