Chapter 4

Competitive and Dynamic ASEAN

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Chapter 4

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Introduction

In addition to deeper economic integration within ASEAN and with rest of East Asia and the world, ASEAN Rising post 2015 demands engendering a globally competitive and dynamic ASEAN. This chapter emphasises that plugging ASEAN deeply into the networked and innovation world future is the core of ASEAN's drive to be competitive and dynamic. In the process, ASEAN Rising is embodied in an "ASEAN Miracle" albeit not spectacular as the "China Miracle" but nonetheless still a remarkable one.

To a large extent, some ASEAN member states are already plugged in the networked world future embodied in production networks or supply chains or vertical trade unleashed by the *2nd unbundling*. ASEAN, along with China, is right in there in the *2nd unbundling* wave, involved in what is the world's most elaborate regional production networks in contrast to the more hub-and-spoke pattern of trade linkages in NAFTA [around the United States (US)]. The *2nd unbundling* has transformed the process of industrialisation in the world, arguably best exemplified by China, but also illustrated by the unfolding "Rising ASEAN" where economic policy is increasingly shaped significantly by the demands of and the opportunities provided by the *2nd unbundling*. This chapter highlights that the key to greater competitiveness of ASEAN is to push the production networks forward, both outward through deeper engagement in regional production networks in East Asia and the world as well as inward domestically and regionally through industrial clusters. It is this outward and inward push that would plug ASEAN firmly and deeply in the networked and *"2nd unbundling"* world.

In order for ASEAN to be fully engaged in the virtuous dynamic of deepening regional production networks and rising market demand within East Asia that becomes an important pillar of ASEAN's further industrialisation and economic transformation, ASEAN needs to be more competitive that is anchored on sustained robust productivity growth over time. Indeed, it is robust productivity growth that is the central determinant of competitiveness of ASEAN and each AMS. However, as the recent Conference Board (2013) estimates of total factor productivity growth show, the productivity growth performance of many AMSs falls far short of those of China, Korea and Taiwan during the past decade.

However, ASEAN is not firmly, and therefore not deeply, plugged into the innovation world future, except for Singapore. Yet technology diffusion and innovation are the major engines of productivity growth and therefore of long term competitiveness. Indeed, what would allow AMSs to move up the value chain, prevent the occurrence of "enclave industrialisation", and avoid the middle income trap is for AMSs to invest for improved policy and institutional environment and capacity for enhanced technology diffusion and innovation. The good news is that most AMSs included in the Global Innovation Index are among the top ranking in their income groupings, best exemplified by Malaysia leading the upper middle income countries, Singapore being the 8th best globally, and even Cambodia ranking fifth among the low income economies (see Dutta and Lanvin, 2013--Global Innovation Index 2013, pp. 19-39). The challenge is to push the process further towards a more innovative ASEAN in terms of investments in research and development, investments in human capital, and the strengthening of the policy and institutional environment (e.g., IPR regime) for quality assurance, technology diffusion and innovation.

Innovation does not exist in a vacuum; instead, innovative activities tend to occur in industrial clusters that are likely plugged to regional and global production networks. Additionally, effective innovation needs appropriate financing, availability of specialised skills and services, and large integrated markets; conditions that are the purview of the ASEAN Economic Community Blueprint. Technology diffusion and innovation benefit from investments and from the trade-investment-technology nexus of production networks. There is thus a substantial complementarity among the components of an integrated and highly contestable ASEAN (discussed in previous chapter) and a competitive and dynamic ASEAN (discussed in this chapter).

As ASEAN strengthens its linkages in regional (and global) production networks and supply chains, deepens its industrial base through clusters that are increasingly innovative, invests strongly in human capital and R & D, becomes more deeply integrated, highly contestable, and more welcoming to foreign (including from other AMSs) investors and expertise, and strengthens cooperation towards greater resiliency and regulatory coherence, then during the next decade and a half, the unfolding ***ASEAN Rising*** is best exemplified by an ***ASEAN Miracle*** . As such, ASEAN becomes the poster region of the new model of regional integration and development, deeply shaped by the *2nd unbundling and production networks*, as discussed earlier in Chapter 2 of this report.

2nd Unbundling, Production Networks and ASEAN

2nd unbundling and industrialisation. Richard Baldwin (2011) most cogently described globalisation as two unbundlings that were the product of two of the most important connective technological revolutions ever; i.e., transport revolution that ushered the *1st unbundling* and the ICT revolution which ushered the *2nd unbundling.*

The *1st unbundling* is the spatial separation of production and consumption, brought about initially by steamships and railroads that reduced substantially transport and trade costs and allowed economies of scale in production and the benefits of comparative advantage; this transport revolution in tandem with lowered trade barriers gave rise to the global economy. In the *1st unbundling*, the production processes or tasks needed to produce a commodity are done within factories or production areas (or industrial districts) situated in various parts of a country. International trade consisted mainly of exchanging products of one industry in one country with the products of another industry in another country or among differentiated products of a given industry in two or more countries. Thus, the 20th century international trade that was shaped by the *1st unbundling* is essentially about selling things. That production is mainly in industrial districts and not spread out randomly in a country reflects the fact that cheap transport enables large scale production, large scale industrial production is complex, and proximity lowers the cost of coordinating complexity. Coordination is a continuing two-way flow of goods, people, training, investment and information (Baldwin, 2011, pp. 11-13).

The *2nd unbundling*, ushered in primarily by the marked reduction in cost of and great improvement in the quality of information and communication technologies, enabled the coordination of the complex production process undertaken over a very wide geographic space. The ICT revolution provided the opportunity to fragment the production process into clearly definable tasks or stages, modularise them with corresponding outputs, and situate the undertaking of the various tasks with corresponding outputs in different places and countries in order to reduce cost and improve efficiencies; i.e., "unbundle the factories" to maximise the benefits from scale economies and comparative advantage (Baldwin, 2011, p. 12). The modularisation of the production process allows both off-shoring of some tasks to affiliates in other countries and outsourcing of certain tasks to other firms located nearby or even far afield in a country or other countries depending on the various decision considerations of a given firm. The marked reduction in ICT cost and marked increase in ICT quality allows the coordination of such a geographically spread out production process. The result is a production network or a supply chain.

Nonetheless, face to face consultation and coordination remains important for effective coordination of the various tasks. Moreover, the increasing emphasis on just-in-time operations meant that the production flow needs to be tightly controlled, such that parts that are required often or are particularly critical requiring specialised skills need to be produced at or near the main plant while other tasks and parts could be farther afield to benefit from lower production costs. Thus, good infrastructure, efficient logistics, and fast import/export and customs clearance are critical requirements in support of well-functioning production networks.

Note that availability and cost of skills, related support services and specialised inputs are also important in the determination of the appropriate spatial dimension of the dicing of the production process and value chain of a firm. Thus, there are sometimes broad classification of countries into headquarter countries where headquarter functions and key research and development activities are undertaken and the factory countries where much of the production takes place. Nonetheless, even R & D functions as well as a substantial portion of management and administration functions could be fragmented and undertaken in different locations or countries taking into account both the benefits and costs of such fragmentation. Thus, the surge in knowledge process outsourcing and business process outsourcing, of which India and the Philippines are global leaders. But because of the importance of face to face coordination and just-in-time production operations, production networks across countries are usually regional rather than global, e.g., “Factory East Asia”.

Arndt (2002) highlighted that the effects of relocating the labour intensive components to low labour cost countries are similar to the effects of technical progress and the resulting higher productivity would lead to higher economy wide wages. This is the crux of the incentive of firms to fragment their operations to reduce cost as well as the benefits to the society.

The description above of the 2nd unbundling presents one key defining difference between 20th century trade and 21st century trade, emphasised by Baldwin, which is that the latter is also as much, if not more, of trade involved in *making things*, and not only in *selling things* (as it was in the 20th century trade). This is reflected in the surge of trade in parts and components that for the most part are related to production networks.

One key element of the 2nd unbundling and the accompanying production networks is that the geographic dispersion of the production necessitated the internalisation of the coordination of the production stages. This means that the offshoring of stages of the production demands that the complementary advanced country technology, management, skills training, quality control, etc. need to be brought in together with the new factory in the destination country (primarily a developing country). In a sense, the foreign direct investment into the developing country comes with a package of not just funds but also technology, management, etc. as well as long term business relationship (i.e., assured export market). At the same time, the foreign firm investing in the developing country needs good infrastructures and logistics-related services such as telecommunications, internet, express parcel delivery, air cargo, trade related finance, customs clearance, etc. in order to operate well and seamlessly with its other production stages in other countries. This is the trade-investment-services-intellectual property nexus that embodies the 2nd unbundling and the corresponding 21st century trade (Baldwin, 2011).

In effect, whereas "20th century trade is the selling of goods made in factories in one country to customers in another… (and therefore) goods are 'packages' of a single nation's productive factors, technology, social capital, governance capacity, etc." (Baldwin, 2011, p.13*)*, 21st century trade involves "…continuous, two-way flows of things, people, training, investment, and information that used to take place within factories and offices…" (*Ibid)*, and as such, 21st century trade is not only about selling things (the focus of 20th century trade) but also about making things (via production networks).

At the same time, the *2nd unbundling* provides a new major and faster mechanism for the host developing countries to get on the road to substantial industrialisation as manifested in the ability to export of industrialised products. In the 1st unbundling and 20th century trade, successful export of industrialised products necessitates that a developing country must have developed the competencies in most of the stages to produce the whole product as competitively as advanced industrialised countries. This in turn almost requires that the country has successful import substitution of hitherto industrialised products similar to the case of South Korea. In contrast, the 2nd unbundling allows developing countries to focus first on the production stage (s) where they have comparative advantage and be able to join the regional production networks.

In the case of ASEAN, this is best exemplified in recent years by Viet Nam's dramatic rise of electronics related exports accompanied by equally dramatic rise in imports of electronic related products that were used for the assembly of electronics products for eventual exports. This is also the case to a large extent for Thailand and Malaysia albeit over a wider range of products and in some cases with deepening domestic local value added. This is also the case for the Philippines but over a much narrower range of intermediate goods products.

Off-shored production in developing countries involve "…very firm specific slices of the parent company's know-how" (*Ibid*, p.26) and the factories tend to be fully owned or controlled by the parent company; as such, there is less technology dissemination to the rest of the economy. Thus, while there is industrialisation as indicated by the export of industrial products, this is not the same as the successful import substitution policies of Korea or Taiwan; the effect could be one of "enclave industrialisation" (Baldwin, 2011, p.26).

The challenge therefore in the *21st century unbundling* and production networks is how to use it as a catalyst for industrialisation and higher growth path but without succumbing to "enclave industrialisation". This calls for, among others, (a) developing more of the export oriented industrial clusters (of both foreign- owned and locally owned firms) because the thicker and more widespread the clusters are, the greater are the potentials for greater economies of scale and larger technology spill-over; (b) developing mechanisms that encourage firms to deepen local support firms and industries through technology transfer and long term business relationships; (c) deepening capacities of local firms and institutions to absorb, modify and innovate on new technologies and practices; and (d) investing in human capital to strengthen absorptive capacity for new technologies and practices. All the above call for an enabling policy, regulatory and institutional environment that is open to foreign investment, technology and talent, more uniform trade and regulatory regimes between the export-oriented industrial clusters and the rest of the economy, and improved physical and institutional connectivity between clusters, regions in a country, and countries.

To a large extent, the road to robust industrialisation in Thailand and Malaysia (in electronics and electrical machinery and parts) is anchored on the deepening and widening of the industrial clusters linked to regional production networks together with the strengthening capacities of local firms, institutions and people to absorb and adapt technologies and production systems over time. The Philippines has been less successful so far in deepening its footprints in regional production networks in part because of the relatively less attractive investment climate relative to other AMSs as well as because the production stage for the Philippines tends to be in the assembly and testing of highly technology intensive parts where there is little domestic market and where the domestic firms do not have the technological capability to participate; hence, to some extent, this was a case of 'enclave industrialisation". It has been in the outsourcing of business related services where the country has experienced spectacular success, a reflection of the latent comparative advantage of the country.

The most successful in leapfrogging the value chain in the production networks is of course Singapore where it is essentially in the innovation frontier but still linked tremendously to production networks. Indeed, Singapore had been an artful implementer of production networks or production sharing during the past three decades or so with its cross-border production sharing with Riau and Johor for the more labour intensive operations as a competitiveness tool vis-a-vis competition from cheaper emerging countries while exporting more technology intensive and specialised products.

For AMSs that have not yet been integrated into the regional production networks; e.g., Myanmar, joining the production networks entails largely having a relatively favourable investment climate for multinationals which are the drivers of regional production networks, good connectivity and infrastructure near seaport and/or airport, and comparatively low labour costs. To a large extent, implementing the relevant policy measures and regional initiatives in the AEC Blueprint would address these prerequisites. After the success of Viet Nam and progress in Cambodia, it is likely that it would just be a matter of time for countries like Myanmar to be able to join the regional production networks.

The discussion above suggests that the industrialisation process in a number of ASEAN countries has a lot to do with production networks and increasingly deepened and widened by complementary domestic policies. This is not quite surprising since it is ASEAN countries and China that have been part and parcel of the regional production networks in East Asia alongside Korea and Taiwan and to a large extent led by Japan. The resulting industrial transformation in a number of AMSs, while less spectacular and much more gradual than China, is nonetheless remarkable as well. It is worth noting that Baldwin (2011) put the ushering of the 2nd unbundling during 1985-1995, precisely the decade of high inflows of foreign direct investment especially from Japan in the aftermath of the Plaza Accord, surging manufactured exports, and high economic growth for Indonesia, Malaysia, Singapore and Thailand; i.e., "ASEAN's golden decade". Moving forward, deepening the industrialisation process involves moving the production networks forward both domestically as well as regionally, primarily through the ASEAN Economic Community.

The discussion above also suggests that the facilitative environment at the regional level for regional production networks does not only call for trade liberalisation but also for much deeper regional integration that deals with quite a bit of behind the border policy and regulatory areas. This is partly because production fragmentation across countries amplifies the trade costs in view of the larger number of cross-country flow of inputs in order to complete a final product Yi, 2003 as referenced in Koopmans, et.al, 2010, p.6). At the same time, the discussion above suggests that to a large extent, many of the measures towards an enabling policy, regulatory and institutional environment for the robust growth of, and industrialisation arising from, industrial clusters and regional production networks are captured in the AEC Blueprint. ***Thus, the AEC Blueprint is not just an enabler of regional economic integration but also a facilitator of economic development and industrialisation of AMSs. As such, the effective implementation of the measures for AEC post 2015 would help bring forth the full flowering beyond 2015 of the "ASEAN Miracle".***

Global value chains, regional production networks and ASEAN.

In view of the prevalence nowadays of fragmented production with different stages of production being undertaken in different countries, it is worthwhile to trace the value added of exports and imports by country, and in effect allow for a snap shot of the global value chain. Koopman, Powers, Wang and Wei (2010) did just that by marrying international trade data and input-output tables around the world. They decomposed gross exports into (a) domestic value added, foreign value and with domestic value added returned from abroad; (b) domestic value added further decomposed into that portion that was absorbed by the direct importer as final goods or as intermediate inputs or that portion that was processed and exported to third countries either as final goods or intermediate inputs; and (c) similarly, foreign value added further decomposed into final goods and intermediate inputs. The authors also estimated the Global Value Chain (GVC) participation rate. The GVC participation rate of a country is the sum of the percent share of a country's intermediate exports used in other countries' exports and the percent share of imported intermediates in its own production.

The results of Koopman, *et al*. for Emerging Asia, Asian NICs and Japan are presented in **Table 4.1** based on 2004 data. The decomposition of gross exports in **Table 4.1** as well as the GVC participation rates give some interesting results. Note that the decomposition is for all commodity exports, and not just on machinery products which are the usual focus of empirical analyses on regional production networks. Nonetheless, the results in **Table 4.1** are suggestive.

Table 4.1: Decomposition of Gross Export

Country	Basic Decomposition						GVC Participation (Vertical trade, OECD)
	DVA in direct exports of final goods	DVA in intermediates absorbed by direct importer	Indirect DVA exports to third countries	Returned DVA	Foreign value added	Total	
Advanced economies							
Australia, New Zealand	27	33.6	27.4	0.6	11.5	100	39.4
Canada	23.5	36.2	10.9	1.3	28.1	100	40.4
EFTA	23	36.3	14.7	0.8	25.2	100	40.8
Western EU	38.1	29.6	13.5	7.4	11.4	100	32.3
Japan	38.4	18.5	28	2.9	12.2	100	43.1
United States	32.5	27.6	14.6	12.4	12.9	100	39.9
Asian NICs							
Hong Kong	27.2	25.8	18.9	0.6	27.5	100	47
Korea	29.5	13.5	22.3	0.9	33.9	100	57
Taiwan	19.2	12.6	26.4	0.8	41.1	100	68.2
Singapore	11	13.1	12.2	0.6	63.2	100	76
Emerging Asia							
China Normal	44.2	20.3	19.7	1.2	14.6	100	35.5
China Processing	28.8	10.2	4.1	0.3	56.6	100	61
Indonesia	20	28.1	28.4	0.6	22.9	100	51.9
Malaysia	16.7	17.7	24.1	0.9	40.5	100	65.5
Philippines	17.6	11.1	29	0.4	41.9	100	71.2
Thailand	27.9	14	18.1	0.3	39.7	100	58.1
Viet Nam	32.9	15.3	14.4	0.4	37	100	51.8
Rest of East Asia	35.3	26.9	16.1	0.1	21.7	100	37.9
India	30.2	30.8	18.6	0.4	20.1	100	39
Rest of South Asia	48.8	19.2	10.6	0.1	21.3	100	32

Other emerging							
Brazil	27.4	40.7	19	0.3	12.7	100	31.9
EU accession countries	28.7	29.2	10.4	1	30.8	100	42.1
Mexico Normal	23.5	41.1	17.4	0.6	17.3	100	35.3
Mexico Processing	20.6	10.1	5.6	0.3	63.4	100	69.3
Rest of Americas	23.8	40.6	20.4	0.7	14.4	100	35.6
Russian Federation	9.5	49.1	30.5	0.7	10.2	100	41.4
South Africa	23.1	34.5	24	0.2	18.2	100	42.4
Rest of the world	15	45.6	22.4	2.5	14.6	100	39.5
World average	29.2	27.7	17.5	4	21.5	100	43

Notes: All Columns are expressed as a share of total gross exports. DVA refers to domestic value added. Country groupings follow IMF regions.
Source: Koopman, *et al*. (2010).

The table shows that Indonesia has the highest share of domestic value added to total value of gross exports among AMSs in the table, a reflection of its comparatively heavier dependence on natural resource based products. Of the AMSs in the table, Indonesia is the least dependent on production networks for its exports; the share of foreign value added to the gross value of exports of around 23 percent is the lowest among AMSs. India is almost similar to Indonesia; it too is not yet well integrated in regional production networks; indeed, its participation rate in the global value chains is much lower than Indonesia’s. In contrast, Singapore is very heavily dependent on foreign value added for its exports at 63 percent, and at the same time, its GVC participation rate is the highest among the AMSs. This reflects the sheer lack of production space in the city state so much so that it has to rely heavily on imported components for its exports of intermediate products.

The Philippines and Malaysia have the second and third lowest shares of domestic value added to gross exports, a reflection of the heavy reliance of both countries on electronics and electrical machinery parts and components exports. It is also worth noting that most of their exports are used as intermediate inputs by the direct importing countries or processed further and exported to other countries either as final products or intermediate inputs. In effect, the commodity composition of Philippine and Malaysian exports is mainly for parts and components and other intermediate inputs; not surprisingly, much of the foreign value added into the Philippine and Malaysia exports is for intermediate inputs. This is reflected in the GVC participation rates of the two countries, with the Philippines second to Singapore among all the countries in the sample of Koopmans, et al. Note how similar is the structure of exports of Malaysia and the Philippines to that of Taiwan, which also relies on imported inputs to be processed for export as mainly intermediate inputs. The three countries are well integrated in regional production networks, specialising in the intermediate goods segments of the supply chain.

Thailand and Viet Nam are somewhat similar in their composition of exports. Both countries rely somewhat lesser than the other AMSs on foreign value added for their exports; moreover, a larger proportion of their exports is for final goods. This reflects the heavier reliance of the two countries on processed and unprocessed agriculture food products and on downstream manufacturing for final goods (e.g., cars and trucks for Thailand, garments for both). Viet Nam shares with Indonesia in having the lowest GVC participation rates among AMSs. Thailand's aggregate numbers belie the fact that the country is very much tightly linked with East Asia's regional networks primarily in machinery goods, best exemplified by the automotive and hard disk drive industries. Similarly, Viet Nam has increasingly been wedded into the regional production networks in recent years (not quite captured yet in 2004) as the discussion below shows.

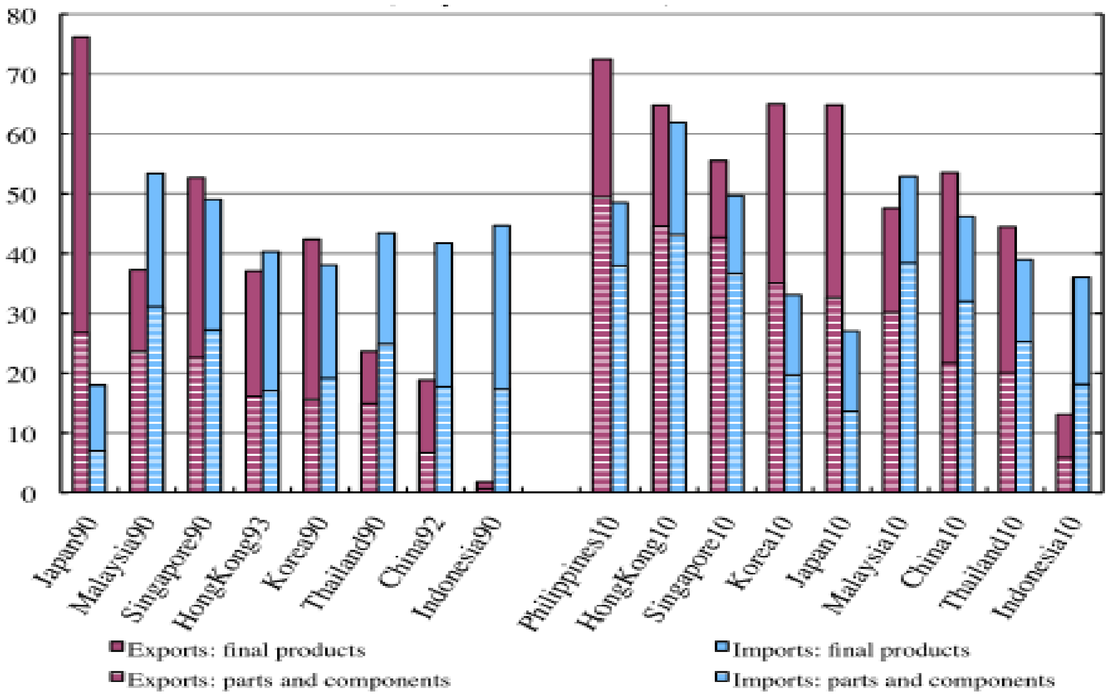
It is worth noting the "dualistic" nature of China's exporting system, similar to that of Mexico. China and Mexico are the world's top two users of processing trade, the latter characterised by the famous "maquiladoras' in Mexico's border cities with the USand the former exemplified by the spectacular success of the special economic zones. Arguably, China's processing trade is a critical component of East Asia's regional production networks, heavily dependent on foreign inputs and with exports that are primarily of the downstream assembly products (as of 2004). The GVC participation rate of China processing is correspondingly very high, in sharp contrast with China's normal trade with is almost similar to that of India with a much lower reliance on imported inputs and much lower GVC participation rate.

Koopman, *et al.* (2010) describes the value added of international trade and indicated countries' participation in the global value chain. Global value chains are not quite the same as regional production networks, however, as the latter presumes high frequency back and forth interactions among the network players within a tight production flow. The machinery goods trade provides a much better indication of the evolution of regional production networks because machinery goods industries are parts intensive.

Mitsuyo Ando and Fukunari Kimura have been at the forefront of studies on regional production networks in East Asia drawing from detailed analyses of machinery goods trade in the region. **Figure 4.1**, taken from Ando and Kimura (2013), shows the marked rise in the share of import and export of machinery parts and components and final products from the early 1990s to 2010. The most dramatic has been the case of the Philippines where machinery trade was relatively minor to figure at all in the tabulation to become the most important component of the country's exports and imports by 2010. Malaysia, Thailand and to a less extent Indonesia experienced significant increase in the share of machinery exports to total exports. Moreover, there is a significant shift from an apparent net importing position to an apparent net exporting position in machinery trade for Malaysia and Thailand during the period. Singapore's reliance on machinery trade also increased during the period. Singapore and the Philippines are the AMSs where there is heavy concentration on machinery parts and components for their exports and imports, while Thailand has a larger share of final goods. The picture coming out of **Figure 4.1** is consistent with the decomposition of aggregate exports of AMSs discussed above.

Figure 4.1: Machinery Trade in East Asia: Shares in Total Exports / Imports

(Early 1990s and 2010)



Source: Ando and Kimura (2013).

The figure also shows the marked increase in the share of machinery trade in China's exports. Moreover, considering that China has an aggregate net trade surplus position, the figure indicates that China has turned from being a net importer in machinery trade to being a net exporter in machinery trade. Indeed, although it is not clear from the figure, considering that China has become the world's number one trading nation, the significant increase in the share to total exports and the marked shift in the net trade position in machinery is emblematic of one of the major developments in the global trade in parts and components during the past two decades. Specifically, China successfully joined the US, Germany and Japan as the dominant foursome in global supply chains. Indeed, China has become the biggest supplier of intermediate products globally together with the US at the same time that it has become the world's largest buyer of intermediate products which it needs to support its role as the world's key provider of manufactured final goods (see Baldwin, 2013). The surge of China into a dominant manufacturing nation with extensive import and export of manufactures is indicative of its dominant role in East Asia's production networks in part through the extensive use of processing trade as indicated in **Table 4.1** earlier.

Ando's and Kimura's (2013) analysis of the machinery trade data for 2007-2011 during and after the global financial crisis point to the further evolution and restructuring of the machinery sector and trade in the region. Specifically, machinery trade within East Asia recovered more quickly than the rest of the world; it is increasingly more focused on East Asia as a market; and is increasingly bringing in the CLMV region (essentially Viet Nam at the moment) into the regional production networks (see **Table 4.2**). **Table 4.2** shows the increase in the global shares of China and CLMV (Viet Nam) to both exports and imports of machinery parts, components and final products during 2007-2011; in contrast, the global shares of ASEAN 4 (Indonesia, Malaysia, Philippines and Thailand) decreased for machinery parts and components but increased in machinery final goods.

Ando and Kimura (2013), in examining the evolution of a number of product-country pairs intra-regionally and with the world, found that despite the decline in the number of machinery products exported to the world after the global financial crisis, the number of product-country pairs within East Asia increased, suggesting the more robust trading and likely deepening and widening production and trading relationships within the region on machinery parts, components and final goods. Much of this widening and deepening appears to be driven primarily by the product expansion of China exports of final goods with ASEAN in part from its imports of parts and components from ASEAN, the deepening linkages of South Korea in regional production networks, and the strengthening of links between Viet Nam with the ASEAN 4 as well as with China.

In short, Ando's and Kimura's (2013) paper points to the further strengthening of intra-regional trade in machinery products in East Asia and to the further restructuring of the regional production networks in East Asia in recent years. The paper also brought out that the regional production networks in East Asia are increasingly producing goods for the growing East Asia market. In effect, East Asia is moving from mainly "Factory East Asia" to increasingly "Market East Asia" driven by comparatively more robust economic growth and the consequent rise of the middle class in the most populous continent on earth. It is this internal virtuous dynamic of deepening and widening production networks and robustly growing regional markets that offer substantial opportunities to ASEAN to becoming an even more important cog and player in the region's production networks. In the process, ASEAN's industrialisation and economic transformation process accelerates and deepens.

Table 4.2: Intra-Regional Trade of East Asia 9: Value and Share

	Exports					Imports				
Destination/ Origin	**2007**	**2008**	**2009**	**2010**	**2011**	**2007**	**2008**	**2009**	**2010**	**2011**
a) All Products										
Value (nominal): 2007=1										
World	1	1.13	0.93	1.21	1.35	1	1.03	0.83	1.1	1.35
East Asia 15	1	1.12	0.95	1.26	1.4	1	1.12	0.93	1.23	1.42
Share: World=100										
World	100	100	100	100	100	100	100	100	100	100
East Asia 15	48.1	47.6	49.1	50	50.1	53.4	50.2	51.5	51.6	48.7
China	12.6	12.3	13.6	13.9	13.9	14.8	13.9	14.5	13.8	13.2
CLMV	1.5	1.7	1.9	2	2.2	0.8	0.9	1	0.9	1.1
ASEAN 4	7.9	8.2	8	8.5	8.6	10.6	10.2	10.2	10.6	10.1
ASEAN 5	9.1	9.6	9.5	10	10.3	11.3	10.9	11	11.3	11
ASEAN 10	12.9	13.4	13.5	13.8	13.9	14.8	14.5	14.6	14.9	14.4
NIEs 4	19.6	18.9	19.2	19.4	19.1	16.6	15.2	15.7	15.9	15
Japan	6.5	6.5	6.3	6.1	6.1	10.4	9.9	9.9	10.2	9.1
b) Machinery Parts and Components										
Value (nominal): 2007=1										
World	1	1.06	0.94	1.19	1.31	1	1.05	0.91	1.19	1.27
East Asia 15	1	1.04	0.95	1.19	1.3	1	1.04	0.9	1.22	1.28
Share: World=100										
World	100	100	100	100	100	100	100	100	100	100
East Asia 15	63.9	62.4	65.1	64	63.5	69.9	69.3	69.3	71.3	70.7
China	20.9	20.9	23.6	22	22.8	14.2	15.1	15.3	15.1	15.7
CLMV	0.7	0.9	1.1	1.1	1.3	0.3	0.4	0.4	0.5	0.6
ASEAN 4	10.5	10.3	9.7	9.8	9.3	12.5	11.7	11.1	11.9	11.2
ASEAN 5	11.1	11.1	10.6	10.8	10.5	12.8	12.1	11.5	12.4	11.8
ASEAN 10	15.7	15.1	14.8	15	14.1	17.2	16.7	16.4	17.1	16.4
NIEs 4	26.2	24.7	25.6	26.3	25.2	28.2	27	27.9	28.7	28.2
Japan	5.7	5.6	5.1	4.8	4.8	14.7	15.1	14.6	15.1	15

c) Machinery Final Products										
Value (nominal): 2007=1										
World	1	1.11	0.91	1.16	1.29	1	1.11	0.99	1.28	1.54
East Asia 15	1	1.12	0.99	1.32	1.52	1	1.12	0.97	1.29	1.51
Share: World=100										
World	100	100	100	100	100	100	100	100	100	100
East Asia 15	30.4	30.6	33.3	34.7	35.8	58.7	59	57.2	59	57.8
China	6.2	6.2	6.6	7.4	7.5	23.4	23.1	24.5	25.3	25.5
CLMV	0.9	1.1	1.3	1.3	1.5	0.3	1.3	0.5	0.5	0.7
ASEAN 4	4.6	5	5.1	5.5	5.7	9.9	10.2	9.9	10	9.1
ASEAN 5	5.2	5.8	6.1	6.4	6.7	10.2	10.6	10.4	10.5	9.7
ASEAN 10	8.4	9.1	9.9	9.6	10.2	13.3	14.5	13.8	13.2	12.6
NIEs 4	14.6	14.3	15.6	15.8	16.2	11.4	10.7	10.4	10	10.6
Japan	4.2	4.1	4.7	4.7	4.8	13.6	13.7	11.8	13.2	12

Source: Ando and Kimura (2013).

Dynamic and Competitive Industrial Clusters

The chapter highlights that in addition to being more integrated and contestable, it is important for AMSs and ASEAN to engender industrial clusters that are both integrated domestically and regionally as well as to invest more to upgrade AMSs' technological capabilities and be more innovative. Two corollary policy imperatives are worth noting, i.e., the need to invest in, retain or attract human capital and the need to ensure favourable environment for private investment both local and foreign.

ASEAN success stories in industrial clusters. ASEAN already has success stories of globally competitive large industrial clusters that have substantially shaped industrial development in the countries concerned. Perhaps the one most prominent at the moment is **Thailand's automotive industry** cluster based around Bangkok, the Eastern Seaboard provinces (especially Chonburi and Rayong) and the Northern provinces of Patumthani and to a less extent Ayutthaya. Thailand's automotive cluster is now the Detroit of Southeast Asia, the only ASEAN country with a trade surplus in automotive products and accounting for about 1.1 percent of global exports in 2008 as against only 0.3 per cent in 1996 (Techakanont, 2012). Thailand has a trade surplus on automotive products and a trade deficit on automotive parts vis-a-vis the rest of AMSs, an indication of the regional production network in the automotive industry in the ASEAN. The automotive industry is an ideal industry for production networks and industrial clusters because a vehicle requires hundreds if not thousands of parts and components and some parts are bulky so much so that assembly operations is more cost effective if parts suppliers, especially the critical and bulkier ones like engines, are sourced near the assembly plants.

One critical distinguishing characteristic of Thailand's automotive industry is the dominant role of leading MNCs in the industry, especially the Japanese car companies led by Toyota and also by Western car companies like Ford and GM. The leading automotive MNCs brought in a number of their suppliers to Thailand to be near their assembly plants in Thailand. They also provided technical advice and support to local parts makers in part because of Thailand's localisation policy until the 1990s and because of the logic of greater cost efficiencies from transport costs and inventory costs (with just-in-time operations) with the presence of capable parts suppliers near their assembly plants. The elimination of the local content requirement in 2000 and the corresponding liberalisation of the automotive parts industry provided further impetus for local parts makers to be globally competitive or else they would be replaced by imports in the MNCs' supply chain. The end result is an increasingly robust and thick network of primary (Tier 1) and secondary (Tier 2) suppliers to the assemblers in Thailand's automotive cluster. The global competitiveness of Thailand's automotive industry is perhaps best captured not by its share to global exports but by the fact that the leading MNC car assemblers started launching new models for the whole world in Thailand, especially of pickup trucks where Thailand is the global leader in the 1-ton pickup truck category (Techakanont, 2011, p.208).

The rise of Thailand's eastern seaboard at the centre of Thailand's automotive industry is the result of Thailand's government plan initiated in the mid-1980s to establish an industrial cluster in three eastern provinces (Chachoengsao, Chonburi and Rayong) (Techakanont, 2011, p.200). The Eastern Seaboard Development (ESB) Plan, opposed at its start by the World Bank, is in fact a grandiose program that featured 16 major infrastructure projects like deep seaports (especially Laem Chabang), highways (e.g,, Bangkok-Chonburi

Highway, Outer Bangkok Ring Road, Chonburi-Pattaya New Highway), railways, water pipelines, reservoirs and heavy industry complexes. It is worth noting that Japan virtually financed all the 16 major infrastructure projects over a span of about 20 years through low interest loans from its Overseas Economic Cooperation Fund. (See Hill and Fujita, 2007, pp. 22-25.) The success of the ESB Plan is that the region is the second most important manufacturing region in the country (after the Central Region) with a diversified base; i.e., refined petroleum, automotive, petrochemical and machinery sub-sectors (Techakanont, 2011, p.201).

In addition to the infrastructure investments, the industrial estates in the region and the rest of the country "…compete with one another to entice foreign direct investment but under national guidance and monitoring" (Hill and Fujita, 2007, p.26). They provide "one stop" service to clients, assisting newcomers on all required permits and in securing government subsidies, bank loans, etc. Hill and Fujita (2007) also present cases where the industrial estate, a public-private partnership, facilitates exchange of information and learnings on compensation and training programs, changes in government regulations including labour regulations, safety issues, etc.; the estate also has a training centre. Moreover, because the estate is large, it contains a wide range of private and government services including customs house, hospital, banks, accounting and consulting firms, international schools, etc. (Hill and Fujita, 2007, pp. 25-26).

Penang electronics cluster and the **Singapore-Johor electronics cluster** are the other two well-known globally significant industry clusters in ASEAN. Like Thailand's automotive industry, the **Penang cluster** is MNC-driven, perhaps more overwhelmingly so, with about 83 percent of all fixed assets of the electronics industry in 1998 in Malaysia's key electronics clusters being foreign owned (Rasiah, 2002a). Leading MNCs like Intel and Dell have led the growth and deepening of the electronics industry in Penang since the 1970s from assembly initially to packaging and testing of semiconductors, to high volume production of electronic components, thence hard disk drives, then personal computer and the like (Best, 1999). Penang is a major component of the global production networks of many of the world's leading electronics firms. "Penang offers capabilities for state-of-the-art manufacturing and rapid ramp-up to high performance standards to market-led or design-led companies from anywhere in the world" (Best, 1999, p.17).

The global electronics industry is innovation driven with short product cycle; thus, having the leading electronics firms in Penang (and other electronics clusters in Malaysia such as the Klang Valley) provides a key motor of the dynamism of the electronics cluster in Penang. For while product innovation occurs mainly outside of the country such as the Silicon Valley, Penang's capacity as a high volume manufacturing cluster means that the cluster continues to evolve.

Equally important, Penang's strong systemic synergies, inter-firm linkages, and "open integrated business networks" (Rasiah, 2002, p.28) have been very important in deepening Penang's capability in electronics related manufacturing over the years, with a higher level of technology diffusion and local sourcing, thereby resulting in more flexible manufacturing operations in Penang which is an important consideration in an industry that is more prone to greater swings in market demand. The Penang Development Corporation (PDC), a government entity, and the Penang state government actively wooed the world's leading firms in semiconductors and components initially in the 1970s, then in disk drives in the later 1980s, followed by computers in the 1990s and opto-electronics in the early 2000s.

The diversification helped Penang sustain growth and acceleration of inter-firm linkages as well as deepen further tacit knowledge in the region. MNCs in Penang actively supported the development of local supplier base; indeed, many of the notable local suppliers are owned, managed and/or operated by former MNC employees or managers. In effect, the leading MNCs were important training ground for the development of local entrepreneurship. And a few of the local supplier firms have grown substantially to have branches in other countries in the region. The Penang Development Corporation (PDC) actively facilitated the business matching between potentially capable local firms and the innovative MNCs. PDC established the Penang Skills Development Center (PSDC) and later the Penang Design Center and worked with the MNCs in ensuring that the worker skills needed by the firms are provided effectively

Nonetheless, it is ultimately the inadequacy of highly skilled talents, primarily graduates of tertiary and post graduate educational institutions, and not much the purview of the PSDC, which constrains Penang and the other electronics clusters in Malaysia to move even further in the value chain, which is in the frontier of product innovation and development (Rasiah, 2002; Best, 1999). The issue of human capital development is discussed in the succeeding section.

The Singapore-Johor electronics cluster started in Singapore, where the electronics industry in ASEAN began in the late 1960s, initially as a semiconductor assembly plant of simple integrated circuits for re-export to the United States. Like in Penang, Singapore's electronics industry is preponderantly foreign MNCs. The electronics industry is one of the most important manufacturing industries in Singapore.

As wages in Singapore, with its very small labour pool, rose substantially, labour intensive factory operations were relocated to Johor (mainly) but with Singapore focusing on the more engineering intensive activities like automation, product redesign, etc. and service related activities such as logistics functions in regional procurement (e.g., logistics, procurement, financial and business services). Given its limited labour base, Singapore could not compete on mass manufacturing production; instead, it developed high value regional SME supply base of machine tooling, metal working, plastic processing, die and mould making, instrument making, and related specialist inputs into manufacturing. It focused on delivering low cost, high quality production engineering inputs and services. It became a "packager and integrator" like Hong Kong, embodying a complex of activities to match demand and supply on local, regional and even global levels. The complex of activities include headquarters for management, financing, technology, design, prototyping, quality control, marketing, and distribution service between disperse assembly plants, etc. Underpinning this flexible niche manufacturing-services cluster are the ease of doing business (that allows for the ease of start-up and efficient operations) and the country's system of education with a heavy bias for engineering and technical skill formation, which includes the supplementation of formal education with training in specialist industrial training institutes for producing qualified craftsmen and technicians. (See Best, 1999.)

China's industrial clusters. China's experience is instructive. China's rapid rise to an export giant in the world economy owes a lot to the rapid growth of its industrial clusters; indeed, as Zeng (2011) avers, industrial clusters have been a competitive engine for China. The breadth and scale of China's industrial clusters are awe inspiring. Thus, for example, China's Zhejiang province has more than 300 clusters that can enter into the world's top 10 in their sectors, and another 100 in second position. Wenzhou's footwear clusters account for one-eighth of the world's total, with more than 300,000 employees. Around 228 clusters in Guangdong, one of China's richest provinces, accounted for 25 percent of the total provincial GDP in 2007, effectively the main driver of the provincial economy. As an example of the importance of Guangdong's clusters, the textile cluster of Xiqiao (Guangdong) accounted for 30 percent of Guangdong's textile fabric market and 6 percent of the global market. (See Zeng, 2011.) The Pearl River Delta in Guangdong alongside the rest of China's coastal region especially Zhejiang, Fujian and Jiangsu provinces can be considered almost as the "factory of the world".

Most of the clusters in China grew spontaneously in response to market opportunities. However, the government, especially the local governments, gave "… all kinds of support to their development process" (Zeng, 2011, p.25). Zeng highlighted a number of reasons for the formation and growth of industrial clusters in China, including the economic reforms and opening up of China, the long history of production or business activities in a particular sector, entrepreneurs with tacit knowledge and skills in production and trading, and natural and human endowments including the abundance of low cost but relatively educated labour force. The abovementioned factors are likely present in most of the clusters in Indonesia and other parts of ASEAN.

Arguably, the seven factors that gave rise to the spectacular growth of the industry clusters in China during the past three decades are the following (see Zeng, 2011): (1) proximity to major local markets that are fast growing and are huge markets in their own right; (2) proximity to main roads, railways, highways and ports, with the latter especially important for the export oriented clusters; (3) foreign direct investment and the diaspora, with the implied access to new technology, management and export market; (4) effective local government support; (5) support from industrial associations and other intermediary organisations; (6) innovation and technology support from knowledge and public institutions; and (7) knowledge, technology and skill spillovers through inter-firm linkages.

Foreign investment and the Chinese diaspora, especially from Hong Kong and Taiwan, have been a very important factor for the formation of industrial clusters especially in China's coastal provinces like Guangdong and Fujian. The clusters like those in personal computer parts and products have benefited a lot from the technology and skills that were brought into the clusters, in large part considering that many of the Taiwanese firms are themselves at the forefront globally in the industries. The issue of technological transfer and firm linkages is discussed further in the succeeding section below.

Zeng (2011) emphasised that the success of the industrial clusters is inextricably linked with local governments' strong support and nurturing, mainly at the middle to later stages of the clusters when they have proven themselves and where the major focus of intervention is on addressing "market failure" or enhancing "externalities". Examples on support in infrastructures include building specialised markets or industrial parks to facilitate business activities and bring suppliers, producers, sellers and buyers together, thereby building forward and backward linkages to allow scaling up of the clusters. In "China's shoe capital", the city government built a large industrial complex that integrates technological training, trading, testing, production, information services, and shoe-related cultural exhibitions.

The responsiveness of the local governments is also manifested in the regulatory front. Thus, for example, when Wenzhou's reputation on shoe quality got a beating with the rapid expansion of the shoe industry, the local government issued strict regulations and quality standards for Wengzhou shoes and helped firms develop branded products. When stiff competition led to the lower quality textile products due to the use of cheap materials, the Puyuan Township issued decrees on the quality control and inspection system as well as product quality guarantee stipulation for cashmere which the township strictly enforced and ensured the quality of the products. (See Zeng, 2011.) It is worth noting that the quality control and guarantee system was decided and implemented at the township level and not even at the provincial level, reflecting a considerable degree of regulatory authority of local governments in the country.

China's local governments' technology, skills and innovation support are also worth mentioning. Zeng provides examples of this. Thus, the Xiqiao Township established an innovation centre that provided new products and innovation services at below-market prices; such services include technology consulting, IPR protection, professional training, testing and certification. Wenzhou's local government encouraged entrepreneurs to establish learning centres, set up or introduced professional shoe leather majors in local colleges and schools to build up the local industry's professional talent, and even invited Italian shoe firms to establish a footwear design centre in Wenzhou.

China's local governments also provided fiscal incentives and financial support to qualified enterprises. This is similar to the policies of most countries in the world. Perhaps what is more noteworthy are the innovative means of providing such support. Thus, for example, Xiqiao's local government provided financing guarantee to assist SMEs get access to bank credit and thereby allow them to update their equipment. In the Puyuan sweater cluster, firms with famous brands locating in the cluster were provided preferential land, tax and credits. The Xiqiao town also set up an award to individuals who can bring qualified enterprises into the clusters (Zeng, 2011).

In addition to the strong support and nurturing of local governments, institutions like universities and research institutes provide support for innovation and technology upgrading in clusters. For example, Wenzhou University set up a production technology research centre in cooperation with several firms focusing on "green" product development, clean leather production technology, etc. The centre also established a laboratory for Zhejiang province which, together with the university, has made significant contributions to producing and testing leather chemicals, genuine leather processing technology and performance tests. Industrial associations and other intermediary associations have also been contributing to the robust growth of clusters in China. Thus, for example, the Wenzhou shoe industry's association contributed in introducing new technologies, helping firms enter domestic and foreign markets through marketing and branding services, providing training in partnership with national footwear associations and the Beijing Leather College, etc.. Similarly, the toy industry association in Yunhe wood cluster in Zhejiang helped establish a wood toy productivity centre, testing centre, information centre, and research institute in Yunhe (see Zeng, 2011).

The discussion above shows a highly supportive, responsive and virtually comprehensive institutional support system in China. Together with the favourable policy and incentive regime arising from the open door and the accompanying reforms, the heavy investments in infrastructure and trade facilitation, and the entrepreneurial spirit and business links of the Chinese people and diaspora, it is probably not surprising that China emerged as the global export powerhouse, driven to a large extent by its economic zones and numerous dynamic industry clusters.

Deepening industrial clusters: can clusters in traditional sectors in ASEAN be energised? The discussion so far revolved around successful, new, MNC driven clusters in ASEAN and the breadth and scale of China's clusters in traditional and new industries**.** Industrial clusters are also numerous in ASEAN, predominantly in traditional and not technology intensive industries. In contrast to China, however, most of the clusters are small, not dynamic and not competitive. Using Indonesia as illustrative case and comparing the results with China and the successful ASEAN industrial clusters can provide some insights.

Indonesia's clusters are numerous: Tambunan (2006) reported that the Indonesian government provided some support to 9,127 SME clusters in the whole country. Most grew largely autonomously over the years. That most of the clusters developed autonomously over time shows the benefits of geographic agglomeration of firms in a particular field or sector. However, clusters vary tremendously in their characteristics, from the "artisanal" clusters composed of low productivity - low wage - local market oriented micro and small firms, to the "active" clusters with firms using higher skilled workers and better technology serving the national market, to the "dynamic" clusters that are larger, where firms have extensive trade linkages abroad, and leading firms play dominant role, and ultimately "advanced" clusters where there is a high degree of inter-firm specialisation and cooperation, business networks of firms with input suppliers and providers of specialised services are well developed, linkages with associated institutions like universities and research institutes are good, and many of the firms are export-oriented (Sandee and ter Wingel as presented in Tambunan, 2006, p.8).

Tambunan (2006) avers that artisanal clusters dominate Indonesia's clusters; nonetheless, there are also many "active" clusters (e.g., roof tiles industry clusters, shuttle-cock industry clusters, metal casting industry clusters) and a number of "dynamic" clusters (e.g., textile weaving clusters in Majalaya and Pekalongan, wig and hair accessories industry cluster in Purbalingga, clove cigarette cluster in Kudus, handicraft cluster in Kasongan). The furniture industry in Jepara is classified either as a "dynamic" cluster or an "advanced" export oriented cluster similar to shoe manufacturing in Brazil, India and Mexico (Tambunan, 2006).

The structure of most Indonesia's clusters that are preponderantly craft-based domestic oriented clusters of microenterprises and SMEs is probably typical of most of the clusters in AMSs. The challenge for AMSs and ASEAN is how to engender more of the "dynamic" and "advanced" clusters as perhaps best exemplified by the electronics cluster in Penang, Malaysia, the automotive cluster in Thailand's eastern seaboard, and the numerous globally competitive industrial clusters in China.

Can there be more competitive and dynamic industrial clusters in Indonesia, and by extension, much of the rest of ASEAN? Can the more numerous but less dynamic clusters be energised? A comparison between China's and the successful ASEAN industry clusters, on the one hand, and Indonesia's predominant clusters, on the other, is instructive:

- First, China's major industrial clusters are strongly export-oriented while most of Indonesia's are not. In effect, China's firms are more attuned to the more demanding quality demands of the export market as well as tougher competition in the export markets. Penang's electronics cluster, Singapore-Jojor cluster and Thailand's automotive cluster are strongly export oriented.

- Second, China's government officials and clusters were aggressively courting foreign direct investments, with the attendant benefits on technology, skills and export market information and access. Penang, Singapore and Thailand were similarly aggressive in attracting FDI; indeed, they focused on the leading global players to invest in their clusters. In contrast, most of the clusters in Indonesia have virtually no foreign equity presence. It is worth noting that the most successful clusters in Indonesia, i.e., furniture cluster in Jepara and handicraft cluster in Kasongan, have considerable direct investments from foreign immigrants (Tambunan, 2006, p.9).

- Third, basing on Tambunan's (2006) table listing Indonesia's assistance programs to (mainly SME) clusters, the Indonesian government provides a wide range of assistance programs to the clusters. However, Tambunan avers that in general, cluster development policies in Indonesia have not been successful. China's interventions have been much more successful.

  A possible reason is that the scope and scale of government support appears to be very different. In the case of Indonesia, the common service facilities (CSFs) are likely the major facilities provided by the government in support of clusters. The CSFs include technical service units and provide extension and technical services and training courses, and serve as focal point for members to engender cooperative spirit and learning. However, the evaluation results indicate that the CSFs have largely done poorly and, at least until the early 2000s, most of the machines and equipments were outdated and therefore no longer very effective (Tambunan, 2006, p.15).

  This contrasts sharply to the case of Wenzhou's complex that integrates technological training, testing, information services and shoe-related cultural exhibitions. Or the case of the Puyuan cashmere sweater cluster where the city government helped build a logistics business centre, loading dock, warehouse, and parking lot. Or the case of Thailand's Eastern Seaboard Development Plan with its 16 major infrastructure projects including two deep seaports. As Zeng (2011) emphasised, the success of the industrial clusters in China is inextricably linked with local governments' strong support and nurturing. That is also evident in the case of Thailand and Penang.

- Fourth, there is an apparent strong focus on ensuring quality and supporting innovation even if China had low labour costs before. The successful Penang and Singapore experiences also highlight the importance of skill formation. Examples include Xiqiao's strict enforcement of quality control and product quality guarantee stipulation, or the city's investment in a company meant to develop new fabrics, new dyeing processes, and new printing formulas, or Wenzhou's setting up of college courses on professional shoe leather. This focus on technology development and innovation is shared by the other support institutions like universities and even industry associations as Zeng's paper brings out. The contribution of the Penang Skills Development Centre is also emphasised in studies on the Penang story; e.g., Best, 1999. Singapore's education system has historically been overwhelmingly focused on engineering and technical areas and formal education supplemented by training in specialised industrial training institutes, thereby providing a pool of skilled workers and professionals that the manufacturing and service sectors need. It is likely that none of these is undertaken by Indonesian local governments or the national government on a sufficient scale.

Way forward. Thus, to some extent, behind the apparent conflicting results on the impact of cluster development policies of China and the successful ASEAN clusters, on the one hand, and Indonesia (or a number of other AMSs), on the other hand, is the apparent difference in mindset, perspective, scale and approach to cluster development. What the comparison highlights is for Indonesia, and for that matter most of the other AMSs, to scale up substantially industrial clusters, encourage foreign participation, deepen them and strengthen their linkages internationally as much as domestically, correspondingly undertake more encompassing government interventions, and institute a more supportive business environment in order for industrial clusters to become a significant competitive engine for AMSs and ASEAN.

The World Bank (2009) provides a practical guide to develop a cluster-based competitiveness initiative. Given the resources needed to have effective support and nurturing in the scaling up of industrial clusters, it is clear that there is a need for prioritisation of what sectors and industries AMSs would focus on. The prioritisation and development of strategies for the sectors and location are best undertaken after (a) a careful contextualisation is made of how specific clusters of economic activities impact on the overall economy in terms of such variables as their relative importance to the economy, specialisation, linkages, etc., and (b) examining how strongly each cluster is organised around related aspects such as suppliers, service providers, associated institutions, regulatory bodies, etc.,. and (c) undertaking careful cluster analyses that include those on product and market segmentation, SWOT (strengths, weaknesses, opportunities and threats), and others. All these should be made with the aim of determining each cluster's competitive position and developing collective strategies with stakeholders. The description above brings out the importance of understanding the actual dynamics of the clusters and having deep engagements with cluster stakeholders.

It is apparent from the discussion that the scaling up of selected clusters is in effect a cluster-based competitiveness strategy and to a large extent a cluster-based industrial development strategy (or at least the contribution of the identified clusters to the overall industrial development strategy). Because a cluster-based strategy entails greater understanding of the spatial, inter-cluster, inter-industry, and inter-firm linkages, it can provide a more realistic and specific way to identify policy and institutional impediments to competitiveness and robust industrial development as well as a more fruitful way of engaging and partnering with various stakeholders of each of the selected clusters. These would include the specific ways forward such as policy, regulatory and institutional issues, workforce development, supply chain improvements, quality standards and branding, areas related to the development of specialised services and infrastructures, research and development aspects, and others. If well designed and implemented, an outward oriented cluster based approach in an integrated ASEAN has the potential of helping firms make full use of the opportunities and thereby encourage them to be supportive of reform efforts domestically for greater competitiveness in an integrated and highly contestable ASEAN.
As a summary note, it is worth noting the critical factors considered in the design and implementation of cluster policy in Viet Nam as they are of general relevance (taken largely from Vo, 2013):

- Policy targets should be properly selected and reasonably justified, focusing on some clusters only.
- The design and implementation of cluster policy should avoid too much institutional complexity.

- The promotion of clusters should be closely associated with the development of supporting industries.
- Reinforcing the innovation system and educational infrastructure is critical to the viable development of industrial clusters.
- One should refrain from thinking that Silicon Valley serves as the only model for cluster development. As the China examples show, cluster development is viable in industries other than the high technology ones.
- Cluster policy should incorporate consultations and partnerships with the business sector, addressing their concerns while harmonising their micro interests with the broader objectives of cluster development.
- Improving the business environment should be considered as a pillar for cluster development.

Towards Innovative ASEAN

Wide disparity in innovation capability and technological development in ASEAN. There is wide disparity in innovation capability among AMSs. One indicator of this is the filing of patents by domestic residents in the AMSs and in the US, which has a stringent filing system. **Table 4.3a** presents the data for the period 2006-2012 for patents filing in the US, taken from Rasiah (2013). Singapore dwarfs everybody in the ASEAN, followed by Malaysia. The gap between the two and the rest is very wide indeed. There are no patents filed by Cambodia, Lao PDR and Myanmar, virtually zero by Brunei Darussalam and Viet Nam, and extremely few by Indonesia. The table suggests that significant innovation activity is done essentially in two AMSs, i.e., Singapore and Malaysia. **Table 4.3b** gives the patent applications by residents for the period 2006-2011. The table shows much larger number of patent applications across the board for the AMSs: nonetheless, the disparity in innovation capability as measured by patents application is still large, with Singapore having a much higher number of patents filed per million people, followed by distant second, Malaysia, and then by Thailand.

Arguably the assumption of innovation as essentially R & D based technological product innovation implicit in the focus on patents is a restrictive definition of innovation. Increasingly, innovation is being viewed broadly to mean "The implementation of a new or significantly improved product (good or service), a new process, a new marketing method or a new organisational method in business practice, workplace organisation, or external relations" (OECD in WIPO-INSEAD, 2013, Annex 1, p.37). Innovation capability is the "…ability to exploit technological combinations and embraces the notion of incremental innovation and 'innovation without research'" (*Ibid.*).

Given this broad definitions of innovation and innovation capability, INSEAD and WIPO developed the Global Innovation Index (GII). The GII is the simple average of two sub-indices (i.e., Innovation Input Sub-index and the Innovation Output Sub-index) and each is built around pillars with each pillar further subdivided into sub-pillar that is composed of individual indicators. The pillars under the Innovation Input Sub-index are institutions, human capital and research, infrastructure, market sophistication and business sophistication. The two pillars under the Innovation Output Sub-index are knowledge and technology outputs and creative outputs.

Table 4.3.a: Filing of Patents in the United States, ASEAN, 2006-2012

Countries	2006	2007	2008	2009	2010	2011	2012
Malaysia	113	158	152	158	202	161	210
Singapore	412	393	399	436	603	647	810
Thailand	31	11	22	23	46	53	36
Philippines	35	20	16	23	37	27	40
Viet Nam	0	0	0	2	2	0	2
Indonesia	3	5	5	3	6	7	8
Brunei	0	0	0	1	0	1	0
Cambodia	0	0	0	0	0	0	0
Lao PDR	0	0	0	0	0	0	0
Myanmar	0	0	0	0	0	0	0

Source: Rasiah (2013)

Table 4.3.b: Number of Patent: Direct applications (per Million Population)

Origin	Country / Office	2006	2007	2008	2009	2010	2011
Resident	Indonesia	0.12	0.00	0.00	0.17	0.21	0.22
	Malaysia	2.02	2.50	2.95	4.44	4.25	3.64
	Philippines	0.25	0.25	0.24	0.19	0.18	0.20
	Singapore	8.76	9.62	11.03	10.27	11.77	14.33
	Thailand	1.58	1.43	1.36	1.55	1.81	1.36
	Viet Nam	0.23	0.39	0.37	0.44	0.34	0.33
	China	9.36	11.61	14.69	17.20	21.84	30.74
	India	0.47	0.52	0.53	0.59	0.72	0.71
	Japan	264.29	252.56	249.39	221.71	216.84	213.39
	Republic of Korea	264.84	269.98	264.67	263.65	271.31	282.50

Source: Patent: WIPO statistics database (2013). Population: UNCTAD Stat (2013)

The Innovation Input Sub-index and its five sub-pillars of the Global Innovation Index provide a good classification framework of the broad array of factors that influence technological development and innovation in a country. Sub-Pillar 1 on institutions includes political, regulatory and business environment. Sub-Pillar 2 on human capital and research includes education, tertiary education and research & development. Sub-Pillar 3 on infrastructure includes ICT, general infrastructure and ecological sustainability. Sub-Pillar 4 on market sophistication includes credit, investment and trade and competition. And Sub-Pillar 5 on business sophistication includes knowledge workers, innovation linkages, and knowledge absorption.

Table 4.4: Global Innovation Index 2013

Country	Global Innovation Index		Innovation Output Sub-index		Innovation input sub-index		Innovation Efficiency Ratio	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Brunei Darussalam	35.5	74	28	89	43.1	54	0.6	119
Cambodia	28.1	110	26.1	101	30	120	0.9	39
Indonesia	32	85	32.6	62	31.3	115	1	6
Malaysia	46.9	32	42.1	30	51.7	32	0.8	52
Philippines	31.2	90	30	77	32.3	108	0.9	24
Singapore	59.4	8	46.6	18	72.3	1	0.6	121
Thailand	37.6	57	32.6	61	42.7	57	0.8	76
Viet Nam	34.8	76	34	54	35.6	89	1	17
China	44.7	35	44.1	25	45.2	46	1	14
India	36.2	66	36.6	42	35.8	87	1	11
Japan	52.2	22	41.6	33	62.8	14	0.7	112
Korea, Republic of	53.3	18	44.5	24	62.1	16	0.7	95

Source: Dutta and Lanvin (2013) - Global Innovation Index 2013

Table 4.4 presents the GII scores and ranking for ASEAN member states, India and the + 3 countries. The table shows the wide gap in the scores and ranking of AMSs, i.e., from Singapore's 8th rank to Cambodia's 110th rank (there are no scores and ranking for Lao PDR and Myanmar). There is a strong positive relationship between the GII scores/ ranking and level of development; thus, the wide gap in GII in view of the wide variation in level of development among AMSs. Note that the gap in scores in the Innovation Output Sub-index is narrower than in the Innovation Input Sub-index, reflecting that some AMSs (especially Indonesia and the Philippines) have been more efficient in the utilisation of their innovation inputs. A look at the scores and ranking of the indicators and sub-pillars reveals significant comparative strengths in some areas such as percentage of graduates in science and engineering, percentage of creative goods exports, percentage of high and medium technology exports, and the state of cluster development. Nevertheless, the gap in innovation capability among AMSs as indicated by the GII scores and ranking is wide. In contrast, the gap among the + 3 countries is so much narrower.

The wide gap in innovation capability among AMSs reflects that AMSs are in different stages of technological development. Rasiah (2013) presents a typology of the phases or stages of technological development in terms of four key pillars of (a) basic infrastructure, (b) high technology infrastructure, (c) network cohesion, and (d) global integration. The first stage is initial conditions, followed by the learning phase, and then the catch up phase. The last two phases are the advanced phase and the frontier phase (see **Table 4.5**.). Rasiah puts the AMSs in the stages of technological development as thus:

- Cambodia, Lao PDR and Myanmar are in the first stage of Initial Conditions where the focus is on political stability and efficient basic infrastructure as well as integration into the global economy and where network cohesion is anchored on social bonds driven by the spirit to compete and achieve.

- Indonesia, Philippines, Thailand and Viet Nam are in the second stage of Learning Phase that is characterised by learning by doing and imitation, expansion of tacitly occurring social institutions to formal intermediary organisations for network cohesion, and integration in global value chains and regional production networks.

- Malaysia is in the Catch Up phase, where there is smooth integration with all institutions in the four pillars; developmental research and creative destruction become major sources of technological catch up thereby requiring greater focus on strengthening IPR mechanism, initiation of commercially viable R & D, access to foreign knowledge through licensing, acquisition of foreign companies and imitation, and the upgrading in global value chains.

- Singapore is in the Frontier stage with reliance on basic research and R & D laboratories to support creative accumulation activities, where intermediary organisations participate in two-way flows of knowledge between producers and users, and where the country is connected to frontier nodes of knowledge and has comparative advantage in high technology products.

Table 4.5: Typology of Policy Framework for ASEAN

Phases	Basic Infrastructure	High Tech Infrastructure	Network Cohesion	Global Integration
Initial Conditions (1) Cambodia, Lao PDR, Myanmar	Political stability and efficient basic infrastructure	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 meet demands of economic agents	Developmental research to accelerate creative destruction activities. Strong filing of patents in the US starts here	Strong participation of intermediary and government organisations in coordinating technology inflows, initiation of commercially viable R&D	Access to foreign human capital, knowledge linkages and competiveness 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 new to the universe. Technology shapers generate invention and design patents extensively here.	Participation of intermediary organisations in two-way flows of knowledge between producers and users	Connecting to frontier nodes of knowledge, and competitive export of high tech products

Source: Rasiah (2013).

Thus, ASEAN runs the entire range of technological development, from the basic initial conditions to the frontier of knowledge and technological development. This echoes the wide disparity in the patent filings and global innovation indices discussed earlier.

Technology transfer and the importance of inter-firm face to face contacts.

Drawing from the stages approach discussed above, technology development in the next decade and a half in lagging AMSs can be described to some extent as their moving up the technology ladder. This means CLM countries moving up to the Learner Stage initially, the Learner Stage countries (Indonesia, Philippines, Thailand and Viet Nam) moving up to the Catch Up phase and higher, and Malaysia moving up to the Advanced phase and eventually Frontier phase. It is apparent however from the characteristics of the stages of technological development that the prerequisites moving up the highest stage are particularly tough and therefore there is no certainty at all that countries can all eventually be at the frontier.

Strengthening technological development, value creation and innovation capabilities and performance in the region towards an Innovative ASEAN necessarily entails a wide range of policy, institutional, infrastructural and linkage initiatives as implied by the discussion above on the global innovation indicators and the typology of the trajectory of technological development. It includes, among others, (a) entering (for CLM countries) and deepening linkages (for the rest) in the regional production networks and value chains with a greater effort at enhancing technology spillover, transfer and diffusion, (b) facilitating greater investments in human capital and facilities, (c) stronger network cohesion for greater capacity for technology adaptation, absorption and innovation, (d) deepening domestic and international linkages in knowledge flows, and (e) a supportive policy, regulatory, and institutional environment for increased investments in value chain upgrading and for more technology and creativity intensive goods and services.

For most of the AMSs, accelerated technological development would entail accelerated technology transfer. Much of the technology transfer will be firm-to-firm. The results of the study of Machikita and Ueki (2013) on "who disseminates technology to whom, how and why" provide interesting insights on firm-to-firm technology transfer based on firm surveys in four ASEAN countries; i.e., Indonesia, Philippines, Thailand and Viet Nam, which interestingly are also the AMSs in the Learner stage in the typology of technology development discussed earlier.

The study results show that MNCs and Joint Ventures (JV) are more likely to make product investments and had higher product development capacities; the exception is in the product improvements based on new technology. More interestingly, when the firm respondents were classified on whether or not they undertook research and development, it is to be noted that local firms that have R & D also tend to introduce new products based on new technology as compared to other local firms. In contrast, MNCs and JVs with R & D operations do not differ with their counterpart local firms that do not do R & D in their propensity to introduce new products based on new technology. This may suggest that affiliates in ASEAN of MNCs rely on the R & D work of their parent firms for new products involving new technology. The policy implication of these results is clear: **encouraging local firms to undertake R & D work, as well as JVs and MNCs (especially those that undertake R & D), could lead to product and process improvements or innovations, which can be expected to improve competitiveness.**

The results of the Machikita and Ueki study also present interesting insights on the interplay of the channels of technology transmission and firm behaviour. Among the authors' findings are as follows (Machikita and Ueki, 2013):

- A foreign main buyer is more likely than a local main buyer to transfer technology to the producing firm.
- There is greater probability of technology transfer to the producing firm if its main partners (either as buyers or sellers) are from abroad, are MNC or JV, undertake R & D, are large (with 200 employees and up), and/or have capital ties with the firm.
- Technology transfer tends to be through face-to-face interaction among engineers or through licensing agreements with main suppliers if the main partner has capital ties with the firm or is in intra-firm/business groups; in contrast, if partners do not have capital ties, the main channels of technology transfer are through dispatch of experts for inspection and collaboration for new product.

- Face-to-face contacts with suppliers and capital goods producers tend to increase the chance of introducing relatively complex new products.
- Producing firms with buyers conducting supplier audits tend to make a greater variety of process improvements.
- Firms are less likely to undertake higher levels of product development if intermediate input is bought from local firms or JVs than if bought from MNCs. They are also less likely to undertake a wide variety of process innovations if the main supplier is local than if it is an MNC.
- Higher level of product development is more likely with higher R & D intensity, accepting engineers from suppliers, and collaborating with capital goods producers.
- Process innovation is more likely with higher in-house R & D (but mainly those that improve quality of product service; e.g., fewer defective products shipped or reduced production cost), downstream buyer audits, and dispatch of engineers to buyers.
- MNC producers tend to have MNC suppliers if they have MNC buyers. On the other hand, local firms tend to seek out local suppliers if they have local buyers. Linkages between local producers and MNC buyers are thin and with JV buyers still few.

The results show the importance of face-to-face contacts among engineers of the firms, especially with MNCs, and collaboration with capital goods producers for effective technology transfer, especially with respect to product innovation and more complex products. The policy implication is that ***there is social benefit, through technology transfer and innovation, to have greater ease in the mobility of engineers and other similar technical people and experts across countries***. At the same time, it is worth noting that the study also shows that face-to-face contacts among engineers is more likely if there is some capital tie up or it is within intra-firm or business group; or in effect, part of the business network or production network. Thus, ***encouraging foreign direct investments and stronger ties with the MNCs would be important for facilitating an environment for greater face-to-face contacts***, which the study shows lead to greater potential for higher level of product innovation.

The Machikita and Ueki study brings out that accelerating technological transfer is by encouraging local firms to invest in R & D, with the implicit mindset that innovation is the way to go to grow, and through more and deeper face-to-face contacts and collaboration among the technical people of the local firms and those of the MNC or JVs or from abroad. However, bringing in MNCs is not sufficient to accelerate technological development because as the study indicates, MNCs tend to source from other MNCs if their buyers are MNCs, resulting in weak links between the local firm suppliers and the MNCs as buyers. This relatively "close loop" arrangements among MNCs, with the potential of creating an "industrial enclave", would need to be encouraged to open up or to develop into a longer loop that involves local firms.

Knowledge flows and human capital development. Inherent in technology transfer, adaptation and innovation is knowledge flows; thus, the importance of human capital development and with that, the intermediation of both "invisible colleges" and "visible colleges" for skill formation. Moving up the technology ladder involves higher skill sets of the workforce; the success of the technology and industrial upgrading involves the successful and systemic melding of both the visible and invisible colleges of skill formation.

"Invisible college" involves the continuous investment of a company in shop-floor skills of its workforce; in many companies, this includes the learning from *kaizen* work system of promoting workforce engagement in incremental productivity through numerous small improvements. This tacit and experiential capital is an important aspect of human capital, in addition to formal education. The diffusion of such tacit and experiential capital is best achieved through the industrial cluster environment. Moreover, when the industrial cluster environment is an "open systems network" wherein "skilled, technical and managerial human capital interact and move freely between firms" (Rasiah, 2002a, p.12), there is greater likelihood of the cluster engendering entrepreneurship especially among the domestic populace. The experience of Penang, Malaysia exemplifies this, wherein the more successful Malaysian owned firms were established, staffed and/or managed by former employees and managers of MNCs in the city.

At the same time, the differing performance of Penang and Klang Valley, Malaysia's two major electronics clusters, on the innovation and entrepreneurship front brings out the importance of intermediary institutions (e.g., Penang Development Corporation) to help facilitate the creation of tight systemic network cohesion and open system networks that have proven to facilitate technology transmission and even local entrepreneurship which contributed to increased local sourcing of MNCs (Rasiah, 2002). Transmission of tacit knowledge and shop-floor skills can go beyond individual company training programs. The PSDC, for instance, an industry-led, company-state government partnership, is to some extent an institutionalised mechanism of shop-floor formation diffusion that enhances manufacturing and technician skills based on insights from the US' "Training Within Industry" program (Best, 1999). As Best (1999) emphasised "… regional advantage will depend not only on innovation but on the diffusion, successful application and improvement of proven technologies. SMEs the world over depend on skill formation agencies such as the PSDC for best practice methodologies and the improvement of capabilities." (p.29).

There are limits to what the intermediary institutions like PSDC can do in the technology development front, however. Moving further up the technology ladder necessitates that the formal education system, the **'visible colleges"**, produces scientists and highly educated and skilled engineers and professionals in order to have the capacity to generate new knowledge capital. It involves establishing or strengthening research institutions and engendering strong linkages with industry and universities. Rasiah (2002) considers Malaysia's weak human capital endowments relative to countries like Japan, Korea, Singapore, and the US, measured by the number of R & D scientists and engineers per million people, as the factor that severely constrained firms in Malaysia to drive innovations in the 1990s.

Recent indicators, however, seem to suggest some narrowing of the high technology human capital gap for Malaysia in recent years. **Table 4.6** presents some indicators on tertiary education and innovation linkages in ASEAN countries, China, India, Japan and Korea. The table appears to indicate that the severe disadvantage of Malaysia vis-a-vis competitor countries in science and engineering human capital in the 1990s appears to have narrowed in the 2000s. This is reflected, for example, in the comparatively higher percentage of graduates in engineering, manufacturing and construction, higher percentage of foreign students studying in the country, higher percentage of nationals studying at the tertiary level abroad, and degree of university/industry research collaboration as compared with countries like Japan and Korea. Where it appears to be lagging significantly behind is in the quality of its tertiary institutions as compared to institutions in China, Japan, Korea and even Singapore.

There are no in depth studies available on the nature and extent of network cohesion in major industrial clusters in many of the AMSs. Nonetheless, it is likely that the degree of such cohesion may not be as strong as in Penang, in part because the electronics industry is much more innovation driven and the leading MNCs are what Best (1999) calls the "development firms" that catalyse the formation of new firms because of their innovations and their embeddedness in the open system network in Penang. With the exception of Thailand's scoring very high in the percentage of graduates in engineering, manufacturing and construction, **Table 4.6** also indicates that many of the AMSs have a long way to go in terms of high technology human capital development. This is one area that AMSs, especially those in the Learner Stage group, would need to give more focus on. (Given its limited population base, Singapore aggressively relied on in- migration of highly skilled professionals, engineers and scientists from abroad.)

Table 4.6: Country Score of Components in Global Innovation Index 2013

Code	Pilar/ Sub-Pilar/ Indicator Name	Brunei	Cambodia	Indonesia	Malaysia	Phillipines	Singapore	Thailand	Viet Nam	China	India	Japan	ROK
2	Human Capital and Research	31.9	12.5	24.3	39.7	18.1	63.2	37.2	24.7	40.6	21.7	57.2	64.8
2.1	Education	45.9	26.3	40	47.8	21.3	55.7	42.7	56.8	68.7	27.6	66.7	59
2.2	Tertiary Education	48	11.2	21	49.9	23	81.4	53.1	17.4	11.7	6.5	35	56
2.2.1	Tertiary enrolment, %gross	19.6	14.5	23.1	42.3	28.2		47.7	24.4	26.8	17.9	59.7	103.1
2.2.2	graduates in science and engineering, %	20.7	12.5	22.8	36.7	24.3		53.2	16.8			20.5	30.9
2.2.3	tertiary inbound mobility, %	5.6	0.1	0.1	6.1	0.1	20.2	0.8	0.2	0.3	0.1	3.7	1.8
2.2.4	gross tertiary outbound enrolment, %	9.6	0.3	0.2	2.2	0.1		0.5	0.5	0.5	0.2	0.6	4
2.3	Research and Development (R&D)	1.9		11.8	21.3	9.9	52.4	15.7		41.5	30.9	69.9	79.3
2.3.1	Researchers, headcounts/mn pop	685.5		173.3	715.4	129.6	7188	575		1303		7066	
2.3.2	Gross expenditure on R&D (GERD). %GDP	0		0.1	0.6	0.1	2.1	0.2		1.8	0.8	3.3	3.7
2.3.3	QS University ranking average score of top3 universities (index)	0	0	32.6	44.2	26.5	55	38.2	0	74.9	44.8	81.7	73.6
5.2	innovation linkages	29.6	36.3	29.5	30.9	21.4	49.8	22.3	27.4	27.9	30.9	42	38
5.2.1	University/Industry research collaboration, index	47.8	42	53	66.4	40.9	76.5	50.2	37.3	56.2	47.5	67.1	61.7
5.2.2	state of cluster development, index	48.9	50.4	54.4	66.1	50.4	69.1	52.4	54.5	59.7	54.9	69.4	58
5.2.3	GERD financed by abroad, %	6.6			0.2	4.1	4.9	1.8		1.3		0.4	0.2
5.2.4	joint venture/strategic alliance deals/ tr PPP$ GDP	0.1	0	0	0.1	0	0.2	0.1	0	0	0	0	0

Source: Dutta and Lanvin (2013).

While much of the effort at improving the supply of engineers and other highly educated and skilled workforce would be at the national level, there is one major ASEAN initiative to help address the relative weakness of engineering education in many AMSs: the ASEAN University Network – Southeast Asia Engineering Education Development Network (AUN-SEED Net). An autonomous sub-network of AUN and operational since 2003, AUN SEED Net is a collaboration of ASEAN's 19 leading universities with the support of 11 leading Japanese universities through JICA. With the goal of promoting human resource development in engineering in ASEAN, the network has, among others, produced as of 2012 over 795 master's and doctorate scholarships, 426 collaborative research projects, 63 research grants for alumni, and 1,500 research publications (Tullao and Cabuay, 2013).

Given that enhancing the supply of high quality human capital can be expected to facilitate technology development, the issue of the capacity and quality of higher institutions of learning, and the corollary policy issue of liberalising education services in tertiary education comes to the fore. Liberalisation commitments in higher education services under the ASEAN Framework

Agreement on Services (AFAS) are not deep at the moment, with three countries not having any commitment at all. The country with the highest liberalisation commitment is Cambodia, followed at the significantly lower level by Indonesia, Myanmar and Thailand. Taking note that the quality of the tertiary institutions in many AMSs lags substantially behind those from Japan, Korea, China and Singapore, it would be advisable to ***liberalise the education services sector*** in AMSs especially at the tertiary level and specialised training institutes where there is greater tendency for individual financing of education.

Institutional and policy environment for technology transfer and innovation. For most AMSs, moving up the technology ladder ultimately requires much higher rate of investment in research and development. **Table 4.7** shows the ratio of R & D expenditures to GDP and the number of researchers in R & D per million population from the mid-1990s to the late 2000s. The table shows extremely low ratios for all AMSs except for Singapore and to some extent Malaysia. The ratios pale in comparison with the ratios for China and let alone Japan and South Korea. Not surprisingly, the number of researchers per million people is substantially higher in those countries and Singapore as compared to most AMSs. Although most AMSs can be expected to prioritise effective technology transfer through foreign direct investments and greater integration in regional production networks, it is apparent from Malaysia's ratios that AMSs wanting to move up from the Learner stage to Catch Up stage would have to significantly raise their R & D ratios to GDP. Moreover, effective technology transfer may also call for adaptive research in the host county. What this implies is that **AMSs would have to have stronger commitment to R & D moving forward beyond 2015 through substantially higher (and better) investments in R & D.** Research and development, if well implemented, has large potential positive externalities and social benefits. Hence, the government plays a substantial role in investing in and facilitating research and development.

Table 4.7: The R&D Situation in ASEAN, China, India, Japan, Korea: R&D Expenditure and Number of Researchers

Research and development expenditure (% of GDP)															
Country	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Brunei	-	-	-	-	-	-	0.02	0.02	0.04	-	-	-	-	-	-
Cambodia	-	-	-	-	-	-	0.05	-	-	-	-	-	-	-	-
Indonesia	-	-	-	-	0.07	0.05	-	-	-	-	-	-	-	0.08	-
Lao PDR	-	-	-	-	-	-	0.04	-	-	-	-	-	-	-	-
Malaysia	0.22	-	0.40	-	0.47	-	0.65	-	0.60	-	0.63	-	-	-	-
Myanmar	-	0.06	0.03	0.04	0.11	0.07	0.16	-	-	-	-	-	-	-	-
Philippines	-	-	-	-	-	-	0.14	0.13	-	0.11	-	0.11	-	-	-
Singapore	1.34	1.43	1.75	1.85	1.85	2.06	2.10	2.05	2.13	2.19	2.16	2.37	2.84	2.43	-
Thailand	0.12	0.10	-	0.26	0.25	0.26	0.24	0.26	0.26	0.23	0.25	0.21	-	-	-
Vietnam	-	-	-	-	-	-	0.19	-	-	-	-	-	-	-	-
Australia	1.65	-	1.51	-	1.57	-	1.74	-	1.85	-	2.17	-	2.37	-	-
China	0.57	0.64	0.65	0.76	0.90	0.95	1.07	1.13	1.23	1.32	1.39	1.40	1.47	1.70	-
India	0.63	0.67	0.69	0.72	0.75	0.73	0.71	0.71	0.74	0.78	0.77	0.76	-	-	-
Japan	2.77	2.83	2.96	2.98	3.00	3.07	3.12	3.14	3.13	3.31	3.41	3.46	3.47	3.36	-
Korea, Rep.	2.42	2.48	2.34	2.25	2.30	2.47	2.40	2.49	2.68	2.79	3.01	3.21	3.36	3.56	3.74
Researchers in R&D (per million people)															
Country	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Brunei	-	-	-	-	-	-	289.83	280.99	286.28	-	-	-	-	-	-
Cambodia	-	-	-	-	-	-	17.36	-	-	-	-	-	-	-	-
Indonesia	-	-	-	-	210.80	197.60	-	-	-	-	-	-	-	89.61	-
Lao PDR	-	-	-	-	-	-	15.83	-	-	-	-	-	-	-	-
Malaysia	89.14	-	153.03	-	274.31	-	291.94	-	495.09	-	364.64	-	-	-	-
Myanmar	-	7.59	7.64	11.46	-	12.66	18.35	-	-	-	-	-	-	-	-
Philippines	-	-	-	-	-	-	-	71.21	-	80.61	-	78.47	-	-	-
Singapore	2546.60	2643.67	3029.86	3276.83	4243.82	4205.13	4493.86	4900.54	5134.23	5576.49	5676.57	5954.64	5833.98	6173.16	-
Thailand	100.20	72.36	-	166.93	-	277.16	-	277.10	-	307.44	-	315.53	-	-	-
Vietnam	-	-	-	-	-	-	115.87	-	-	-	-	-	-	-	-
Australia	3331.99	-	3355.48	-	3443.97	-	3732.54	-	4038.61	-	4203.61	-	4293.93	-	-
China	446.93	475.58	388.70	421.68	547.67	581.21	630.30	666.55	712.20	855.54	930.91	1077.11	1198.86	863.21	-
India	151.98	-	115.40	-	110.01	-	-	-	-	135.81	-	-	-	-	-
Japan	4946.24	4999.87	5209.19	5248.96	5150.89	5187.09	4942.82	5169.98	5176.17	5385.04	5415.61	5408.91	5189.28	5179.94	-
Korea, Rep.	2212.10	2269.84	2034.08	2190.43	2356.50	2950.34	3057.18	3244.06	3335.84	3822.21	4231.01	4672.24	4946.94	5088.76	5481.49

Source: World Bank Data (2013).

The experience of Singapore provides some insights on strengthening the institutional support for technology development and innovation. In the early stage of Singapore's industrialisation drive, Singapore established institutions of technology in collaboration with foreign governments; i.e., Japan-Singapore Institute (JSI) for advanced information technology training, German-Singapore Institute (GSI) for training beyond Germany's master craftsman level to ensure the application and adoption of advanced manufacturing technology , and the French-Singapore Institute (FSI) for training in specialised industrial electronics, factory automation, and industrial computing. The institutes acquired the latest equipment and technology, and the local instructors and technical staff received first hand training in the head offices of the companies in Japan, Germany and France. (See Lim, 2013, pp. 5-8.) What is noteworthy in the Singapore example is that the training is on the latest technology and with the latest equipment, thereby reducing the training cost to new private investors and, as in the case of FSI, helped French companies interested in setting up business in Singapore. Thus, this is technology transfer and investment attraction rolled into one. The three institutes were transferred to Nanyang Polytechnic in 1993 (Lim, 2013); arguably the institutes provided strong pillars to Nanyang to grow eventually into one of the highest ranking universities in Asia today.

Research and Development (R & D) is now a key part of Singapore's economic strategy as it aims to be a research- intensive, innovative and entrepreneurial economy in the future. The planned R & D budget is expectedly much higher. What is noteworthy is the strong link to private enterprise and entrepreneurship. Thus, for example, EDB's Research Incentive Scheme co-funds the establishment of corporate centres of R & D excellence in Singapore. Similarly, the Industry Alignment Fund supports collaboration between public and industry researchers in order to have greater alignment of government funded research with industry needs. There is also government funding to support researchers and entrepreneurs to bring research results to commercialisation by supporting entrepreneur's proto-type and test-build new products and services (see Lim, 2013). It is this keen sense of aligning research and enterprise that is of particular relevance to other AMSs as they ramp up their investments in research and development in the future post 2015. This helps ensure that research bears economic returns to the country.

Another important pillar in Singapore's success story is the protection of intellectual property rights (IPRs). IPRs are critical in stimulating innovation; protecting IPR is likely also an important consideration for firm holders of IPRs before they transfer their new technologies and production processes to developing country firms together with clear policy environment for technology trade. As the AMS in the frontier stage of technology ladder, it is not surprising that Singapore has the most advanced IPR system in ASEAN. Malaysia, Thailand, Philippines, Indonesia, Brunei Darussalam, and Viet Nam have fairly developed IPR systems but enforcement is wanting compared to Singapore. Cambodia, Lao PDR and Myanmar lack the capacity and capabilities to implement and enforce IPR regulations consistent with the TRIPS agreement. The challenge for ASEAN is to how to harmonise IPR issues in the region in the light of the wide gap in development levels, balancing the need to stimulate innovation and ensuring it is for the interest of the wider society (Rasiah, 2013). Nonetheless, it is apparent that moving up the technology ladder has the corresponding requirement of greater reach and effectiveness of the protection of property rights. This is especially of great relevance to the AMSs in the Learner stage moving up to the Catch Up stage.

Finally, technological development is facilitated by a supportive business environment for investment and ease of doing business. In the end, much of the technological development is heavily shaped by private sector decisions in their investments, either embodied in capital goods or in R & D, and in their operations in terms of production linkages and arm’s length transactions. Higher investments, greater linkage internationally, and accelerated technology development can be facilitated in a more open economy with less distorted and more transparent, coherent, and stable regulatory environment. Higher investment and accelerated technological development is likely with more efficient and coordinated institutions and government agencies as well as better infrastructure and more skilled work force. The issues of supportive business environment for investment and ease of doing business and of regulatory coherence are discussed further in **Chapter 7** of this report. Nonetheless, it is worth noting that many of the above issues are addressed in the AEC Blueprint and the Master Plan on ASEAN Connectivity (MPAC). Thus the AEC Blueprint and MPAC also facilitate technological development in ASEAN.

***Accelerating technological development and engendering innovation in ASEAN: key recommendations on the way forward beyond 2015*.**

Expanding local firms’ participation in the “innovation-friendly loop” involving MNCs, accelerating technology transfer, and engendering innovation in ASEAN entail the following, among other things:

1. Encourage more local firms to invest in R & D and raise substantially the investment rate in R & D nationally in most AMSs.

2. Develop government facilitation programs where MNCs transfer technologies to selected local firms as future suppliers or sub-contractors through fiscal incentives to the firms and co-financing cost of technical experts to help local firms upgrade and meet the MNCs quality standards and become innovative themselves. This is akin to Local Upgrading Programs such as Singapore's.

3. Strengthen "visible and invisible colleges" for skill formation, human capital, and entrepreneurship. This calls for strengthening the quality of, and university-industry collaboration on, formal education especially in the technical, engineering and science areas. It also calls for strengthening network cohesion, encouragement of greater" shop-floor" or company skill formation, and establishment of institutionalised mechanisms for human capital development based technology transfer such as the Penang Skills Development Center or the advanced technical training institutes that Singapore established with the cooperation of Japan, Germany and France in the 1980s.

4. Improve the policy and institutional environment for technology transfer, adaptation and innovation. This includes some government co-funding support (with the private sector) for the establishment of specialised research institutes and training programs. It also includes better intellectual property rights protection.

5. Strengthen supportive policy and institutional environment for investment and business operations. This includes a wide range of areas that are measures for an integrated and highly contestable ASEAN discussed in the previous chapter. This also implies greater ease of doing business and more responsive regulatory regime (discussed in **Chapter 7** of the Report).