Transforming East Asian Economies

for More Knowledge Utilization

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I. Introduction

This paper deals with two inter-related issues: the transformation of East Asian economies to the innovation-driven economy and the way to strengthen technological knowledge in the region. The first issue stems from the 'Asian Miracle' debate and the 1997 Asian financial crisis, which awakened economies in the region to the importance of technology and innovation. The second issue is related to the recent trends of increasing FTAs and efforts for regional integration.

More specifically, the paper raises the following questions:

- How is the progress in the transformation towards the innovation-driven economy in East Asia?
- Are governments making great efforts for the transformation?
- What is the relationship between internationalization (or globalization) and the transformation of the economy?
- What will be the effects of regional integration on the transformation?

In order to explore answers to these questions, the paper at first reviews changes in industrial structure in East Asian economies in the 1990s. Then the level or status of 'innovativeness' of each economy is evaluated by focusing on some characteristic factors. Each economy's overall efforts in general and those of the government in particular for the transformation are assessed. Finally, the transformation of the economy in the context of international relationships is reviewed. The paper concludes with derived implications and suggestions for future actions of individual economies and economies as a group.

II. Economic Development and Industrial Structure

An economy can grow by factor augmentation or by increasing productivity. The former type of growth is the extensive growth and the latter is the intensive growth. The former usually dominates an economies' development in the earlier stages and the latter dominates the later stage. Since the earlier period of extensive growth is characterized by factor augmentation, it is also called the factor-driven economy whereas the later period of intensive growth is called the innovation-driven (or innovative) economy.

Whether Asian economies entered in the stage of innovation-driven economy or not was questioned by the so-called 'Asian Miracle Debate' in the middle of the 1990s. From the beginning, it was an empirical question since the core of the debate was whether East Asian economies were still in the stage of extensive growth or not. Krugman (1994) claimed that the growth of East Asian economies (in particular, the four tigers) were due to high savings and investment in capital or labor growth whereas the contribution of productivity to economic growth was negligible. Later his claim was criticized or corrected on the basis of different empirical results (e.g. Lau. 2002). In this paper, instead of econometric analyses, simpler statistical analyses are used to assess whether these economies entered in innovation-driven economies or not. Since drawing a line is rather difficult and ambiguous, we will focus on trends.

Table 1 shows selective indicators for development in the 1990s in these economies. Those economies hit by the Asian financial crisis such as Thailand, Malaysia, Philippines, Indonesia and Korea realized lower GDP per capita in 2000 than in 1995, but still higher than in 1990. All economies show increasingly high-tech export share of total manufacture exports over time. Especially, economies such as Singapore, Malaysia and the Philippines showed 60 percent or higher shares of high-tech exports in 2000.[1] The share of the service sector has been steadily increasing in all economies and GDP growth rates are very high. These indicators show that the East Asian economies are moving in a desirable direction.

Table 1. About here

Focusing on the changes in the manufactory industry structure in terms of technological level is one method used to examine the transition from the factor-driven economy to the innovation-driven economy. For this, yearly manufacture production (sales) was sub-divided into four classes: high-tech industry, medium-high-tech industry, medium-low-tech industry and low-tech industry. The classification of technology level follows the OECD method and UNIDO's Industrial Statistics Database was used for the data. Some economies

[1] However the high-tech exports in some economies may not be high-tech exports in a strict sense. We will return to this later.

do not have a complete set of data for the entire period of the 1990s.

Table 2, Table 3 and Table 4 show the trends in industrial production in Korea, Singapore and Malaysia as examples. Other economies are not shown due to space constraints. The tables show that in all three economies the share of high-tech industrial production increases over time whereas that of the low-tech industry decreases. However, a phenomenon, very difficult to understand, is observed. That is, the share of high-tech industries in Singapore (e.g. 46.3 percent in 2000) and Malaysia (e.g. 41.2 percent in 1999) are higher than the share of high-tech industry in Korea (e.g. 13.9 percent in 1999) in the observed period. If the definition of technology-specific industry is correct, this implies that Singapore and Malaysia have developed a more advanced industrial (manufacturing) structure than Korea, which is hardly acceptable, at least in the case of Malaysia.

Table 2, 3, 4. About here

In order to discuss this in more detail, the production shares of technology-specific industries in eight economies in the most recent period in terms of data availability are summarized in Table 5. The share of high-tech industry is exceptionally high in Singapore (46.3 percent) and Malaysia (41.2 percent); lower than Japan (13.7 percent) and Korea (13.8 percent), and lowest in Indonesia (5.3 percent), China (9.9 percent) and Thailand (10.2 percent). Therefore, Singapore, Malaysia and the Philippines (18.7 percent) are all higher than Japan and Korea.

Table 5. About here

Since the rate of value-added is a better measure than mere production (sales) for performance of an industry, the rates of value-added were also calculated. The behavior of rates of value-added does not show any consistent trends. However, two interesting results are observed. (See Table 6.) First, rates of value-added in an economy are similar, regardless of technology levels. Second, Korea, Japan and Singapore show high rates of value-added around 40 percent. The rates in the Philippines and Indonesia are very high, close to the above three economies. Since Indonesia showed the lowest share of high-tech industry production, these

results imply that there is no direct correlation between the rates of value-added and the level of technology of the industry.

Table 6. About here

These observations raise a fundamental question. Since the high-tech industry is known for a high value-added industry in general, for what reason is the relationship not observed in these economies? The first plausible deduction is that if the OECD classification and definitions are used there can be upward biases in the definition of technology-specific industry in developing economies.[2] Another reason may be found in the relationship between FDI and high-tech exports. That is, high-tech exports in developing economies with high presence of FDI are affected by the export orientation of MNCs. Table 7 summarizes some statistics related to these views.

Table 7. About here

As shown in the Table, R&D/GDP ratios of Japan, Korea, and Chinese Taipei are higher than or similar to the OECD average of about 2 percent, whereas all Southeast Asian economies, China and Singapore show lower ratios than the OECD average. Singapore is close to the OECD average, but Thailand, the Philippines and Indonesia show less than 0.2 percent. Thus, the effort for R&D and resulting indigenous technological capability of these economies seem to be weak. The ratio of FDI/aggregate investment is the highest in Singapore (22.1 percent) and the Philippines with Thailand following. However, the ratios of Japan and Korea are low. Although we cannot draw any clear conclusion from these statistical comparisons, we can characterize the status and patterns of transformation of East Asian economies towards an innovation-driven economy as in Table 8. In terms of both industrial innovative (technological) capability, and foreign influence, three types can be distinguished. For example, Singapore belongs to progressing innovation-driven economy and depending on foreign capacity whereas Japan and Korea belong to a progressing innovation-driven economy with independence orientation.

[2] Mani(2000) discusses these problems in detail.

Table 8. About here

It is safe to say that these economies are moving to an innovative economy at least from the viewpoint of the trends in the share of high-tech industry in manufacturing and the increasing share of the service sector in the economy, as shown in Table 1.

III. Factors Characterizing the Transformation

In order to characterize and assess the transformation for each economy in more detail, four dimensions of the economy were identified and several indicators were reviewed for each dimension. The statistics for indicators as the average of the recent three years were normalized with respect to the OECD average as 1. The dimensions and statistics are summarized in Table 9.

Table 9. About here

Innovation capability of an economy was measured by ① human resource dimension, ② IT infrastructure dimension, ③ R&D capability dimension and ④ business environment dimension. This approach is similar to measuring the knowledge-based economy. In fact, since the distinction between the innovation-driven economy from the knowledge-based economy is blurred, this paper treats the two concepts equally. For each of the dimension, three indicators were chosen as shown in Table 9.

In order to measure the productivity or efficiency of the national innovation system in each economy, indicators such as R&D/GDP ratio, research manpower, education expenditure and FDI were used for input factors whereas share of high-tech export, number of patents, number of journal publications and technology balance of trade were used for output factors. The results are summarized descriptively together with the above four dimensional measures in Table 10[3].

[3] For more detailed statistical results, see Hong (2003).

Table 10. About here

Results show that Japan already has shifted into a leading innovative economy considering indicators such as patent application, R&D expenditure, and scientific and technical journal articles. Singapore, Korea and Chinese Taipei are shifting into innovative economies, showing impressive performance and capability in information and communication industries. However their successful transition and implementation into innovative economies are mainly sustained by the adoption and diffusion of and application for innovation rather than by leading innovation activity itself. In contrast, China shows great potential for innovative ability as a source of economic growth, even though this country is at the very early stage of an innovation-oriented economy.

IV. Evaluation of Strategies, Policies and Efforts for the Transformation

Finally it was examined that governmental efforts practiced by various policies and strategic plans cause strong positive effects on implementation into innovative economies in East Asian countries. This also classified four types of groups according to governmental roles in and characteristic policies for implementation. For example, Singapore is evaluated as the model case characterized by its government's long-term vision and systematic approach in turning their economy into an innovative one.

For the examination, various documents issued in each economy and APEC and the literature have been reviewed. There is abundant literature on the subject[4]. The evaluation of transformation efforts was performed in three ways. First, through the literature and governmental document survey and review, strategies, major policies and efforts were identified with resource allocation and programs. However, this kind of evaluation is not exhaustive and subject to a certain extent (editor's note- subject to what?). Second, the changes in the indicators in the recent three years were examined and evaluated. Finally, all of these were

[4] For example, see Masuyama and Vandenbrink (2003).

combined and a descriptive assessment was derived, which is summarized in Table 11.

Table 11. About here

The efforts of Thailand, Philippines and Indonesia are less impressive. However, all other economies are very active for transforming their economies into an innovation-driven one. If this is the case, the knowledge or innovation capability gap between these two groups may widen in the future. In order to avoid this undesirable future, not only individual economy's efforts should be encouraged but also international, regional and global efforts for sharing knowledge and enhancing indigenous technological capability should be accelerated.

V. International Knowledge Sharing and Innovation Capability Building

An economy's innovation capability is affected by international relationships. It is well known that trade, FDI, international licensing or technology transfer, exchange of manpower, collaborative R&D, governmental or public cooperation and strategic alliances are all effective in one way or another. Although the degree of effects depend on many factors, usually these international activities are favorable to domestic innovation capability building (See Saggi, 2000?)

In order to facilitate the discussion, Figure 1 is presented here on the basis of the above review and East Asian economies' pattern of transformation shown in Table 8.

Figure 1. About here

Three representative economies are depicted in terms of the degree of internationalization, presence of FDI, technological (or innovation) capability and the degree of technological independence, which are measured along four axes in the figure. Four equal quadrants are formed. The measure of each degree is not accurate, but presented here for illustrative purpose. In terms of technological capability Korea is the highest, Singapore is the second and Malaysia is the third. Singapore is the highest in internationalization and FDI ratio. The pattern of Malaysia is similar to Singapore, but the scale is much

smaller. The technological independence (i.e. indigenous capability) is in the order of Korea, Singapore and Malaysia.

The figure indicates that an economy can enhance its technological capability (the causal relationship is not shown, however) either by foreign sources (like Singapore) or by its own sources (like Korea). In either case, it seems that internationalization is highly correlated with technological capability. Recently, in parallel with globalization, various institutions such as FTAs have strengthened regional cooperation. These trends are desirable for enhancing innovation capabilities of involved parties. However, the process is not automatic. Musik (2004) reports that NAFTA has not automatically enhanced Mexico's indigenous technological capability. The slow progress in ECOTECH in APEC also implies that international knowledge sharing more desired than easily achievable. It seems that the best way to enhance innovation capability, thus transforming the economy, is to combine domestic sources (efforts) and external sources (efforts) for synergy effects.

Table 1. Trends in Development Indicators in East Asian Economies

	Year	Per capita income (US dollar)	GDP growth rate	High-tech export share (%)	Service sector share (%)
Japan	90	24,273	5.3	23.8	58.3
	95	41,075	1.6	26.1	64.0
	00	37,494	2.4	28.3	76.7
Korea	90	5,893	9.0	17.8	48.4
	95	10,851	8.9	25.9	50.6
	00	9,822	8.8	34.8	52.7
China	90	332	4.0	-	31.3
	95	574	10.5	10.0	30.7
	00	847	7.9	18.6	33.2
Chinese Taipei	90	7,870	5.4	26.7	54.6
	95	12,437	6.4	36.5	60.1
	00	13,889	5.9	42.5	65.5
Singapore	90	12,401	9.0	40.0	65.3
	95	24,115	8.0	54.0	65.9
	00	23,071	9.9	63.0	65.6
Malaysia	90	2,409	9.0	38.2	42.6
	95	4,342	9.8	46.1	45.6
	00	4,037	8.3	58.9	43.6
Thailand	90	1,528	11.2	21.0	50.3
	95	2,834	9.3	24.0	49.7
	00	1,947	4.3	32.0	49.5
Philippines	90	719	3.0	32.5	43.6
	95	1,055	4.7	34.9	46.3
	00	987	4.0	58.6	52.9
Indonesia	90	638	9.0	1.2	41.9
	95	1,038	8.4	7.2	41.1
	00	723	4.8	16.2	35.8

Note: High-tech export share is for manufacturing exports. Chinese Taipei is GNP per capita.

Source: World Bank. *World Development Indicators*. Individual country's national statistics.

Table 2. Trends in Manufacturing Production by Technology Level in Korea

(Unit: $100 million, %)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
High-tech industry	340	373	381	455	572	802	812	755	567	797
	(9.4)	(9.0)	(8.8)	(9.7)	(10.5)	(11.6)	(11.1)	(11.4)	(12.9)	(13.8)
Medium-high-tech industry	1,070	1,213	1,268	1,383	1,666	2,150	2,325	2,136	1,299	1,769
	(29.6)	(29.2)	(29.4)	(29.5)	(30.4)	(31.1)	(31.8)	(32.1)	(29.5)	(30.6)
Medium-low-tech industry	925	1,131	1,194	1,282	1,497	1,896	2,052	1,916	1,282	1,601
	(25.6)	(27.2)	(27.7)	(27.4)	(27.4)	(27.5)	(28.1)	(28.8)	(29.1)	(27.7)
Low-tech industry	1,282	1,437	1,469	1,567	1,736	2,058	2,111	1,838	1,255	1,618
	(35.4)	(34.6)	(34.1)	(33.4)	(31.7)	(29.8)	(28.9)	(27.7)	(28.5)	(28.0)

Note: ( ) is the share of each group in the total.

Table 3. Trends in Manufacturing Production by Technology Level in Singapore

(Unit: $100 million, %)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
High-tech industry	189	222	275	350	446	482	474	422	481	561
	(32.8)	(35.3)	(38.9)	(41.0)	(43.2)	(43.2)	(42.0)	(43.5)	(45.9)	(46.3)
Medium-high-tech industry	118	124	127	156	198	216	241	207	235	273
	(20.5)	(19.7)	(18.0)	(18.3)	(19.2)	(19.3)	(21.4)	(21.3)	(22.4)	(22.5)
Medium-low-tech industry	174	182	199	231	260	289	288	238	235	275
	(30.1)	(28.8)	(28.2)	(27.0)	(25.1)	(25.9)	(25.5)	(24.6)	(22.4)	(22.7)
Low-tech industry	95	102	105	118	130	129	126	103	98	103
	(16.6)	(16.2)	(14.9)	(13.8)	(12.6)	(11.6)	(11.1)	(10.6)	(9.4)	(8.5)

Note: ( ) is the share of each group in the total.

Table 4. Trends in Manufacturing Production by Technology Level in Malaysia

(Unit: $100 million, %)

	1990	1991	1992	1993	1994	1995	1996	1997	1999
High-tech industry	81 (22.8)	113 (25.8)	148 (28.2)	187 (30.8)	249 (33.2)	324 (32.8)	366 (33.7)	350 (33.2)	392 (41.2)
Medium-high-tech industry	64 (18.0)	85 (19.3)	98 (18.6)	114 (18.7)	137 (18.2)	183 (18.5)	208 (19.2)	206 (19.5)	160 (16.9)
Medium-low-tech industry	92 (25.9)	109 (24.8)	125 (23.7)	133 (21.9)	159 (21.2)	212 (21.5)	234 (21.5)	227 (21.5)	165 (17.4)
Low-tech industry	118 (33.2)	132 (30.1)	155 (29.5)	174 (28.6)	205 (27.3)	268 (27.1)	278 (25.6)	273 (25.8)	233 (24.5)

Note: ( ) is the share of each group in the total.

Table 5. Industrial Production by Technology level and by Economy

(Unit: $100 million, %)

	Japan (2000)	Korea (1999)	China (2001)	Singapore (2000)	Thailand (2000)	Malaysia (1999)	Philippines (1998)	Indonesia (2000)
High-tech industry	5,653 (13.7)	797 (13.8)	8,088 (9.9)	561 (46.3)	114 (10.2)	392 (41.2)	75 (18.7)	67 (5.8)
Medium-high-tech industry	14,215 (34.3)	1,769 (30.6)	20,123 (24.6)	273 (22.5)	272 (24.3)	160 (16.9)	67 (16.7)	261 (22.4)
Medium-low-tech industry	9,028 (21.8)	1,601 (27.7)	27,625 (33.8)	275 (22.7)	215 (19.2)	165 (17.4)	98 (24.4)	165 (14.2)
Low-tech industry	12,506 (30.2)	1,618 (28.0)	25,813 (31.6)	103 (8.5)	517 (46.2)	233 (24.5)	161 (40.2)	670 (57.6)

Note: 1. ( ) is the share of the industry in total manufacturing.

2. China’s unit is yuan.

Table 6. Comparison of Rates of Value-added by Technology-Specific Industry and by Economy

(Unit: %)

	Japan (2000)	Korea (1999)	China (2001)	Singapore (2000)	Thailand (2000)	Malaysia (1999)	Philippines (1998)	Indonesia (2000)
High-tech industry	36.8	47.3	23.3	36.7	21.5	26.3	37.2	37.8
Medium-high-tech industry	37.5	40.8	25.7	40.5	29.3	15.4	38.5	42.1
Medium-low-tech industry	39.0	40.2	26.7	25.3	28.1	19.9	33.3	30.4
Low-tech industry	40.9	44.7	28.3	42.5	22.9	19.1	48.1	33.0

Table 7. Factors Affecting Innovativeness of East Asian Economies

(Unit: %)

	Industrial structure in recent year		Rate of value-added of high-tech industry	R&D/ GDP (98-00 average)	FDI aggregate in vestment (2000)	Ranks
	High -tech	Low- tech				
Japan	13.7	30.2	36.8	2.95	1.10	High R&D intensity
Korea	13.8	28.0	47.3	2.56	7.08	High R&D intensity
China	9.9	31.6	23.3	0.84	9.54	
Taiwan	n.a	n.a	n.a	2.02	11.3	High R&D intensity
Singapore	46.3	8.5	36.7	1.85	22.13	High R&D intensity High FDI Depended
Malaysia	41.2	24.5	21.5	0.43	7.24	
Thailand	10.2	46.2	26.3	0.19	12.16	High FDI Depended
Philippin es	18.7	40.2	37.2	0.08	15.21	High FDI Depended
Indonesia	5.8	57.6	37.8	0.09	-16.62	

Note: Japan is for 1999.

Source: World Bank. *World Development Indicators 2002*, etc.

Table 8. Patterns of Transition to the Innovation-driven Economy in East Asia

	Depending foreign capacity	Middle	Independence orientation
Progressive economy	Singapore	Chinese Taipei	Japan Korea
Transitional economy	Malaysia	China	-
Weak basis	Philippines Indonesia	Thailand	-

Source: Hong, Y. S. 2003.

Table 9. Comparison of Innovation Capability by Economy (Based on OECD Performance)

		Japan	Korea	China	Taiwan	Singapore	Malaysia	Thailand	Philippines	Indonesia	OECD Average
Human Resource	Public education expenditure	0.82	0.21	0.01	-	-	0.17	0.09	0.03	0.01	1
	Tertiary enrollment	0.78	1.14	0.11	-	0.73	0.20	0.46	0.58	0.20	1
	Researchers per population	1.56	0.65	0.14	1.18	1.03	0.09	0.07	0.06	0.36	1
IT Infrastructure	Internet penetration	1.00	1.32	0.08	0.90	1.13	0.64	0.15	0.06	0.04	1
	IT investment/GDP	0.93	1.58	2.96	0.93	1.38	1.70	0.60	1.23	0.90	1
	Efficiency of international call	0.32	0.34	0.10	0.38	0.55	0.26	0.24	0.30	0.28	1
R&D Capability	R&D/GDP	1.48	1.28	0.42	1.01	0.93	0.21	0.09	0.04	0.05	1
	Business R&D/Total R&D	1.12	1.15	0.95	1.05	1.05	1.01	0.54	0.67	-	1
	Patents	2.55	0.89	0.65	-	0.36	-	0.03	0.04	0.32	1
Business Environment	Profit rate after fax	-	1.10	1.38	-	1.09	0.95	1.05	0.93	0.61	1
	IPR protection	0.97	0.70	0.58	0.87	1.01	0.7	0.67	0.62	0.54	1
	Trade/GDP	0.28	1.18	0.61	1.19	4.45	3.08	1.56	1.50	1.07	

Sources: World Bank. 2002. *World Development Indicators*,; IMD. 2003. *World Competitiveness Yearbook*, etc.

Table 10. Evaluation of Industrial Structure and Innovation Capacity

	Industrial Structure		Innovation capacity				Innovation system		Remarks
	Share of high-tech industry production	Value added of high-tech industry	Man-power	IT	R&D	Biz environ-ment	In-put	Out-put	
Japan	○	○	□	□	□	○	□	□	Good in general
Korea	○	□	□	□	□	□	□	○	Although good in general, needs system reforms
China	△	△	△	○	○	○	○	△	Low level although potential is great
Taiwan	n.a.	n.a.	□	□	□	□	□	○	Good in general
Singapore	□	○	□	□	○	□	□	n.a.	Good in general
Malaysia	□	△	△	○		□	○	n.a.	Medium level in general
Thailand	△	△	△	△	△	□	○	△	Low level in general
Philippines	△	○	△	△	△	□	△	△	Low level in general
Indonesia	△	○	△	△	△	○	△	n.a.	Low level in general

Note: □ = strong, ○ = medium, △ = low, n.a. = not available

Source: Hong. Y. S. 2003.

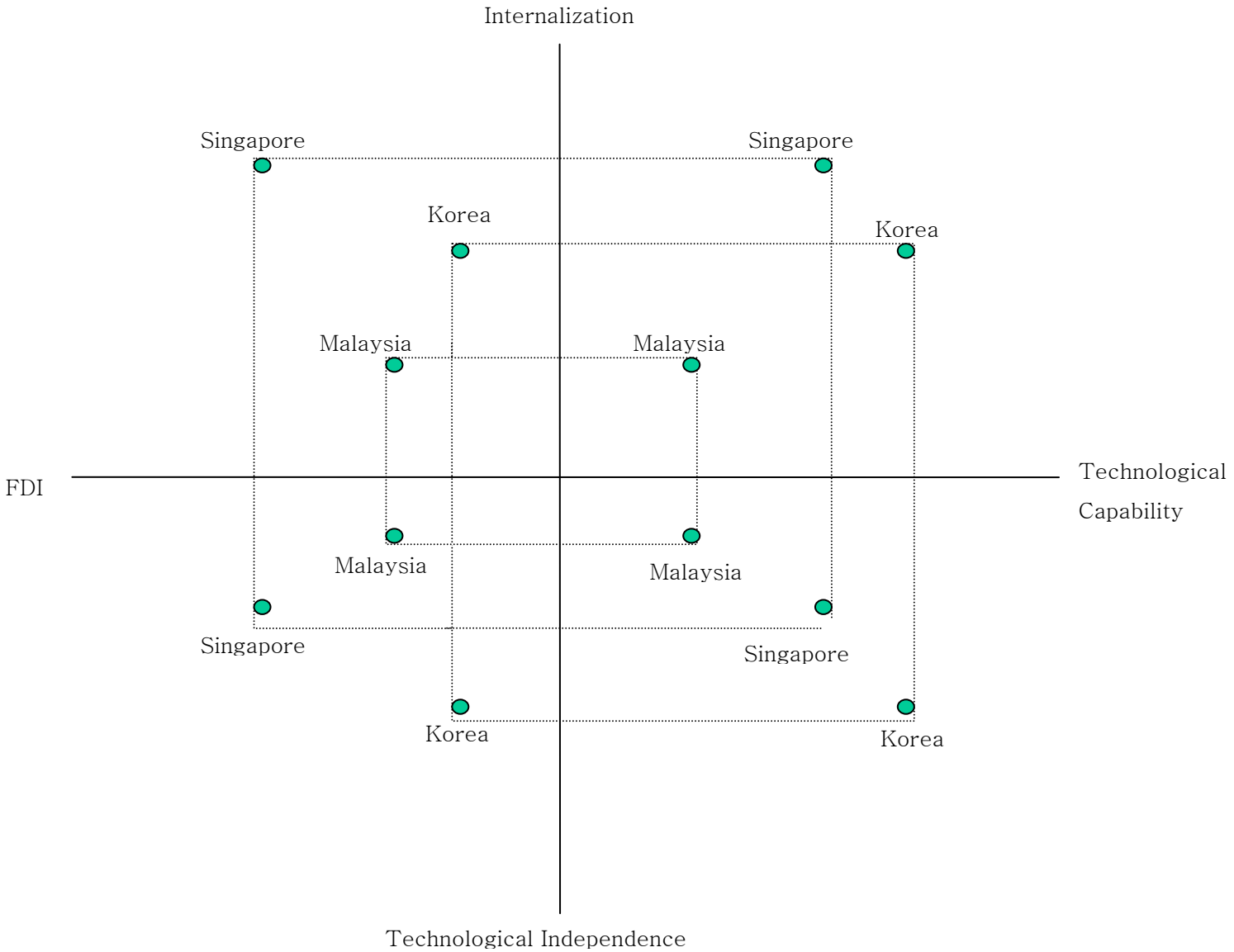
Table 11. Evaluation of Strategies and Policies for the Development of the Innovation-driven Economy by Country

	Start year of major strategy or plan	Main target year	Core competence-related policies				Efficiency related policies		Remarks
			Man-power	IT	R&D	Business environ-ment	In-puts	Out-puts	
Japan	2000	2005	○	□	□	△	□	○	S&T, Emphasis on IT, Active strategy
Korea	1997	2010	△	□	□	△	□	○	Transitional period for a new paradigm and strategy
China	2003	2010	□	□	□	△	□	□	Acceleration of economic development
Taiwan	2000	2010	△	□	○	○	○	○	Exploring new strategies
Singapore	1991	2000	○	□	□	□	□	□	Problems of excessive foreign dependency
Malaysia	2000	2020	△	□	○	△	△	△	Entering a stable course
Thailand	n.a.	n.a.	○	○	△	○	○	△	Weak
Philippines	1998	2010	△	○	△	△	△	△	Weak
Indonesia	2001	2011	△	○	△	△	△	△	Weak

Note: □ = high, ○ = fair, △ = weak

Source: Hong. Y. S. 2003.

Figure I. Internationalization and Technological Capability



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