Innovations and Economic Growth in a Fast Changing Global Economy: Comparative Experience of South East Asian Countries

By
Lakhwinder Singh
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Lakhwinder Singh, Department of Economics,Punjabi University,Patiala 147002
India.
E-mail:lkhw2002@yahoo.com.

1. Introduction

Innovations spur growth and economic transformation is widely acclaimed in economic growth literature. Innovations entails organizational as well as changes in the rules of the game. Thus, transition in the national innovation system is the fundamental determinant of long-run economic growth and development. This is being reflected through the changes which are occurring in the economic structure of an economy as well as in the structure of the innovation system. Since the national economies are growing in the interdependent world, therefore national innovation system is continuously being influenced by the changes occurring in other parts of the world. Asian continent has distinctly achieved high rates of economic growth and has emerged as the growth pole of the global economy. It has also emerged as the hub of innovative activities in the fast pace of globalization. Within Asian continent, there are wide differentials in the stage of economic development and transformation as well as in the national innovation systems. Two distinct patterns of economic transformation and systems of innovations which has evolved over time are-one, based on building strong industrial sector as an engine of innovations and growth; two, the engine of growth is the service sector and innovation system is heavily dependent on foreign capital. Recently, while recognizing the innovative capacity of some of the Asian countries, foreign R&D has devastated the boundaries of the Asian innovation system. Domestic agents of production have realized that there lies a dire need for the support of the state when innovations are being done on the frontiers of knowledge. Situational assessment surveys have also supported the view that Asian countries are fast approaching towards the frontiers of knowledge and innovations. Asian countries, themselves are competing to fast approach towards frontiers of knowledge and innovations so that newer areas of commercial activities can be explored and exploited in the global market. Transformation of East Asian countries from imitation to reaching the frontier areas of innovations in a short span of time is a question which begs for an explanation. This paper attempts to provide some plausible answers and is divided into five sections. Apart from introductory section one, the transformation of the production structure and the factors that have determined it are analyzed in section two. Innovation systems across Asian countries and indicators of innovations based on input-output measures as well as situational assessment surveys have been presented in section three. Fourth section contains the discussion related to innovation policies and institutional arrangements which caused the success in some cases and lack of it in others. Fifth section investigates the role of international agencies to enact rules of the game in an open innovation system and the national governments in terms of enacting innovative interventions in the fast globalizing world economy. Policy implications for other developing countries that emerge from the innovations and fast development experience of the successful East Asian countries will be presented in the concluding section.

2. Structural transformation in Asia:

The evolutionary economics has recognized the role of technology and institutions in the process of long run economic growth. The interaction between economic and non economic factors stressed by the theories of evolutionary economic growth generates dynamism in the economic system that brings in continuous economic transformation. The factors that drive economic growth (technologies and institutions) and structural transformation in one era to the other itself go on changing. The process of economic growth thus brings in economic transformation and non steady state economic growth. Technology has emerged as a distinct and key factor that determines changes in the long run economic growth and structure of the economy. It needs to be noted here that the innovations are of two types that is radical and incremental. Radical innovations open up new opportunities and push the frontiers of knowledge which dramatically alter the existing economic structure. Incremental innovations not only improve the practices of the existing technologies but are potent factor of diffusion of the radical innovation that engineer structural change in the economic system. However, imitation tends to erode differences in technological competencies across economic activities and over time that reduces differentials and gaps in economic activities. Therefore, radical and incremental innovations are a source of structural transformation and divergence in economic growth and imitation acts as an agent of reducing productivity gaps and initiates the process of convergence. Both the processes of innovations are continuously remains in action and the combination of the two that actually determine the economic transformation and convergence in the economic system (Fagerberg and Verspagen, 2001).

Fast rate of economic growth and closing the productivity gaps have been the major feature of economic transformation of the East Asian countries during four decades of the twentieth century. This process of fast economic growth has not only increased per capita income but has made the East Asian economies as a hub of economic activities and widely acknowledged as the growth pole of the fast changing global economy. It is worth noting here that the East Asia has followed a distinct path of economic transformation for generating dynamism in their respective economic systems. The global economy as a whole has become service oriented (Table 1.). The service sector contributed 68 per cent of the total GDP of the global economy in the year 2004. Industrial sector contributed 28 per cent of the GDP and rest of the 4 per cent GDP contributed by agriculture sector in the year 2004. This clearly brings out the fact that transformation process has reduced the role of agriculture in global economy and now the engine of economic growth is the service sector. It is important note here that the less developed countries have also become heavily dominated by service sector. This seems to be premature economic transformation and defying the standard pattern of economic growth which have dramatically improved the per capita income as well as working condition in the advanced economies. The developing countries which prematurely become service oriented economies remain unable to grow at a fast rate and could not able to raise per capita income and living conditions of the majority of the workforce. However, the East Asian economies have followed the standard pattern of economic growth and transformation and successfully reduced the importance of agriculture sector both in terms of income and work force. China, Indonesia, and Malaysia are three countries which have been generating income from the industrial sector higher than the service sector. South Korea and Thailand are the two other countries which have been generating more than forty per cent of the GDP from the industrial sector (Table 1). If we compare East Asian countries with South Asian countries as well as with the global economy, it is the South East Asian countries where the engine of growth is industrial sector rather than agriculture and service sectors. The transformation process which followed the standard pattern is considered as a superior because of the fact that it along with raising the productivity and standard of living also brings in institutional, organizational and cultural changes. These changes make society more capable, productive, innovative and peaceful.

Table 1: Sectoral distribution of GDP across Asian Countries: 1960, 1980, 1990, 2000 and 2004

Sector/Country	Agriculture				Industry				Services			
	1960	1980	1990	2004	1960	1980	1990	2004	1960	1980	1990	2004
Bangladesh	57	50	30	21	7	16	22	27	36	34	48	52
Nepal	-	62	52	40	-	12	16	23	-	26	32	37
India	50	38	31	21	20	26	28	27	30	36	41	52
China	47	30	27	13	33	49	42	46	20	21	31	41
Pakistan	46	30	26	22	16	25	25	25	38	46	49	53
Sri Lanka	32	28	26	18	20	30	26	27	48	43	48	55
Indonesia	54	24	19	15	14	42	39	44	32	34	42	41
Philippines	26	25	22	14	28	39	35	32	46	36	44	54
Thailand	40	23	13	10	19	29	37	44	41	48	50	46
Malaysia	36	22	15	10	18	38	42	50	46	40	43	40
South Korea	37	15	9	4	20	40	42	41	43	45	50	56
Hong Kong	4	1	-	-	39	32	25	11	57	67	74	89
Singapore	4	1	-	0	18	-	38	35	78	61	-	65
World	-	7	6	4	-	38	33	28	-	53	61	68

Source: World Bank (2006) World Development Indicators 2006, Washington, D.C.: The World Bank.

The engine of successful structural transformation of East Asian countries has been regarded as industrialization. The process of fast industrialization and continuous changes in the industrial structure requires huge amount of investment in fixed capital which was provided by the high savings rates recorded in the East Asian countries (Table 2). East Asian countries have saved more than 30 per cent of the GDP and recently China recorded 42 per cent savings of GDP. Rapid industrial growth and transformation requires continuous accumulation of the new capital assets and thus dependent heavily on increasing in investment in the capital assets. Capital formation as a share of GDP was remained very high during the fast pace of industrial development of the East Asian countries. In the recent period, some of the East Asian countries have shown a decline in the capital formation (Table 2). Saving and investment rates have remained quite low in the global economy as well as in the South Asian countries which can be regarded as an important factor of slow growth of the industrial sector in particular and the economy as a whole in general. The success of industrialization is highly constrained by the availability of right kind of skilled manpower. This was provided by the East Asian countries compared with the South Asian countries where the indicators of human capital lag

Table 2: Savings, capital formation and productivity across Asian Countries

Country	Gross savings as a per centage of GDP 2004	Capital formation as a per centage of GDP		Labour productivity in manufacturing 1995-99 $ per year
		1990	2004	
Bangladesh	31	17	24	1711
Nepal	27	18	26	-
India	23	24	24	3118
China	42	35	39	2885
Pakistan	23	19	17	-
Sri Lanka	19	23	25	3405
Indonesia	24	31	23	5139
Philippines	37	24	17	10781
Thailand	31	41	27	19946
Malaysia	35	32	23	12661
South Korea	34	38	30	40916
Hong Kong	32	28	22	32611
Singapore	45*	36	18	40674
World	20	23	21	-

Source: As in Table 1.

behind. Adequate supply of skilled manpower has allowed East Asian countries to move up the industrial ladder from textile to simple assembly of machines and to high-tech industries. International trade has been regarded as a potent factor in the successful industrial transformation of the East Asian countries. Furthermore, it is the importance of capital goods and parts for assembly which has had stronger impact on productivity growth (Yusuf, 2003). Industrial productivity and rate of economic growth has been widely acclaimed as a fundamentally dependent on the science and technological development. East Asian countries achieved higher value added per worker in the manufacturing (Table 2) while investing heavily in science and technology compared with the South Asian countries (Singh, 2006). FDI as a factor of faster economic growth has been very important in the economies of Malaysia, Thailand, Singapore, Indonesia and China. However, South Korea and Taiwan has been able to achieve high productivity growth based on domestic investment and more so in science and technology. Therefore, there are two distinct patterns of economic transformation in East Asia, one based heavily on FDI and other on domestic efforts. Productivity differentials show that productivity of industrial activities is very high in the later case (Table 2).

3. Asian Innovation System in Transition:

Knowledge, science and technology have become a key component of contemporary economic and social systems. Recent spurt in economic literature on evolutionary and endogenous growth theory has empathetically argued how knowledge has become a decisive factor in economic systems of production. Knowledge accumulation not only explains existing across country and inter as well as intra economic activity productivity gaps, but also predicts increase in productivity gaps if knowledge accumulation differentials persist and perpetuate. Thus knowledge generation and accumulation process have severe implications for the future status of the national economic system in the fast changing global economy. It is important to note here that the knowledge generation process in the national economic system has undergone a fundamental non reversible structural change in the developed countries. It is the transition from fundamental research to applied one. This phenomenon has been described as a dual "crowding out". Firms are now increasingly engaged in applied research and do not finance fundamental research either in house or in the institutions of higher learning is one form of crowding out. The other form of crowding out is the near absence of fundamental research from the public laboratories and the university research (Soete, 2006). This kind of change in the knowledge generation process has occurred towards the last quarter of the twentieth century. Another great transition in the knowledge production which has also occurred is the emergence of Asia as a hub of research and development activities leaving behind Europe. North America continues to dominate in R&D and accounted for 37 per cent of the world's R&D expenditure in 2002. Asia has emerged as the second largest investor in innovative activities with 32 per cent share of global R&D. Europe's share of global R&D expenditure is just 27 per cent (UNESCO, 2004). The share of R&D expenditure of North America and Europe has declined at a rate about one per cent during the period 1997 to 2002.The R&D expenditure has been increasing in Asia at a 4 per cent per annum during the same period. This clearly shows that Asian countries have been able to strengthen the national innovation systems. This has occurred because of the fact that the fast growth of industrialization exhaust soon the opportunities of adaptation and thus force the economic agents of production to investment more in innovative activities to maintain the lead in productivity growth and competitiveness advantage over the immediate rivals. It needs to be noted here that there exist substantial differentials in innovative activities across Asian countries (Table 3).

The most important input indicator of innovation is research and development expenditure intensity. South Korean has remarkably achieved high R&D intensity, that is, 2.64 mean value for the period 1996-2003. This high R&D intensity is comparable with the United States of America but lower in comparison with the highest spender countries like Israel, Sweden and Japan with R&D intensities 4.93, 3.98 and 3.15 respectively. Taiwan and Singapore are the other two high R&D intensity achievers with 2.20 and 2.15 R&D-GDP ratios respectively. China is fast catching up with high R&D intensities countries of East Asia. China's R&D intensity for the period 1996-2003 was 1.31 (Table 3). China has recorded dramatic growth of R&D expenditure with doubling its global share from 4 per cent to 9 per cent during the period 1997 to 2002(UNESCO, 2004). Rest of the East Asian countries has been increasing their respective R&D intensities, however, expending less than one per cent of GDP. Among the South Asian countries, India has well developed national innovation system but slowly forging ahead in innovations yet spending less than one per cent of GDP (0.88 average of 1996-2003).

Human capital engaged in national innovation system is another important input indicator of innovations. This is the only active factor which makes use of the innovation infrastructure arrangements and feeds on innovations as well as generates new knowledge and improves upon the existing one. Therefore, quantity and quality of researchers engaged in various innovation activities does matter for the outcomes of innovations. The highest number of researchers, 6517 per million people, was employed by Taiwan in innovation activities followed by Singapore 4745 and South Korea 3187 respectively during the period 1996-2003 (Table 3). Other important countries which have engaged significant number of human capital in innovation activities are China and Hong Kong (663 and 1564 per million researchers respectively). When we compare East Asian countries with South Asian countries in terms of number of researchers employed in

Table 3: Input indicators of innovations across Asian countries.

Country	Researchers in R&D per million people 1996-2002	Share of R&D expenditure in GDP (in per cent) 1996-2002	UNCTAD innovation capability index 2001	Technological Sophistication index	Company spending on R&D index	Firm level technology absorption index
Bangladesh	-	-	0.121 (106)	2.3 (77)	2.4 (75)	4.1 (71)
Nepal	59	0.66	-	-	-	-
India	119	0.85	0.285 (83)	3.8 (42)	3.6 (32)	5.5 (16)
China	663	1.31	0.358 (74)	3.9 (39)	3.6 (34)	4.7 (48)
Pakistan	86	0.22	0.137 (100)	-	-	-
Sri Lanka	181	0.18	0.317 (79)	3.2 (58)	3.4 (39)	4.6 (57)
Indonesia	-	-	0.261 (87)	3.0 (63)	3.3 (48)	4.7 (49)
Philippines	-	-	0.423 (64)	3.2 (56)	3.0 (55)	4.4 (63)
Thailand	286	0.24	0.488 (54)	3.8 (41)	3.3 (45)	5.2 (31)
Malaysia	299	0.69	0.467 (60)	4.6 (23)	4.1 (23)	5.3 (25)
South Korea	3187	2.64	0.839 (19)	5.2 (17)	4.8 (11)	5.8 (10)
Hong Kong	1564	0.60	0.563 (45)	4.5 (25)	3.4 (37)	5.2 (32)
Singapore	4745	2.15	0.748 (26)	5.6 (9)	4.6 (16)	5.9 (9)
Taiwan	6517	2.20	0.865 (15)	5.3 (13)	4.9 (10)	6.0 (6)

Source: World Bank (2006); UNCTAD (2005); and Cornelius, Porter and Schwab (2003).

innovation activities, South Asian countries lag much behind the East Asian countries (Table 3). This clearly shows the edge of East Asian countries in innovation infrastructure and capability to generate innovations.

Innovation capability index (ICI) has been developed by UNCTAD based on three kinds of broad measures such as innovation inputs, innovation outputs and human resource base for technology activity. This index is based on quantitative criteria to arrive at values for the countries and on the basis of values countries are reckoned in terms of global ranks among the 117 countries. Two Asian countries, that is, Taiwan and South Korea ranked as high innovation capability with global ranking in 2001 was 15 and 19 respectively. China and other East Asian countries were recorded medium innovation capability ranks among the 117 countries (Table 3). It is important note here that all the South Asian countries recorded values quite low and global ranking falls in the category of low innovation capability countries (UNCTAD, 2005). It needs to be noted here that China and India in terms of absolute level of R&D expenditure and researchers engaged in innovation activities are global powers but there reckoning is low because of their large population size. Situation assessment survey based on qualitative information with regard to assess the innovation capability also shows a similar picture and confirms the transition of the Asian countries on the technological ladders. Survey based three indices-scores and ranks- technological sophistication index, company spending R&D index and firm level technology absorption index have shown wide differentials across Asian countries. Taiwan and South Korea, according to three indices, are high innovation capability countries among the 77 countries under consideration. However, other East Asian countries ranked either medium or low innovation capability countries on the basis of three qualitative innovation capability indices developed by World Economic Forum (Table 3).

Output measures of innovations presented in Table 4 shows dramatic differentials in innovations across Asian countries. South and South East Asian countries have emerged as significant contributors to global pool of knowledge. In absolute numbers, China, India and South Korea contributed to the global pool of knowledge through publishing research papers in scientific and engineering journal. Singapore and Hong Kong have also contributed significantly while publishing 2061 and 1817 research papers respectively in 2001 in scientific and engineering journals. Other South and East Asian countries lag far behind in terms of their contribution to global pool of knowledge. High-Tech exports as a share of manufacturing which is another output measure of innovation shows very high degree of science based manufactured commodities provided to the global economy by the South -East Asian countries. However, South Asian countries performed poorly on

Table 4: Output indicators of Innovations across Asian countries

Country	Scientific and technical journal articles in numbers 2001	High-Tech exports and its share in manufacturing 2003		Royalty and license fees in million dollars 2002		Patent applications by residence of inventor	
		$millions	%	Receipts	Payments	1991-1993	2001-2003
Bangladesh	177	3	0.00	-	5	-	-
Nepal	39	1	0.00	-	-	-	-
India	11076	2840	5.00	25	421	56	909
China	20978	161603	30.00	236	4497	130	849
Pakistan	282	150	1.00	10	95		
Sri Lanka	76	60	1.00	-	-	10	64
Indonesia	207	5809	16.00	221	990	10	13
Philippines	158	13913	64.00	12	270	10	50
Thailand	727	18203	30.00	14	1584	-	-
Malaysia	494	52868	55.00	20	782	19	165
South Korea	11037	75742	33.00	1790	4450	1472	8356
Hong Kong	1817	80119	32.00	341	864	146	679
Singapore	2603	87742	59.00	224	5647	85	788
Taiwan	-	-	-	-	-	2598	12453

Source: World Bank (2006).

this count. Higher contribution of most of the East Asian countries in high tech exports seems to be based on the intra industry trade because of the presence of MNCs in these countries. On the contrary, high-tech exports originating from Taiwan and South Korea are based on the domestic companies which had been nurtured by the national innovation system of the respective countries. Some what similar trends can be found in terms of patent applications filed by the residents of innovator countries in the US patent office. The number of patent applications has dramatically increased during the period 1991-1993 to 2001-2003 in most of the Asian countries (Table 4). Royalty payments made by the Asian countries indicates that Asian countries are still high dependent in terms of technology from the developed countries. However, majority of the countries do receive payments in lieu of technology exports and licensing of technology. South Korea has dramatically bridged the gap between payments made and payments received. This clearly indicates that countries which have developed national innovation systems are able to reduce foreign dependence on technology. East Asian countries such as Malaysia, Indonesia and Philippines that are FDI dependent still have to depend more on foreign services of technology and hence higher royalty payments compared with receipts.

Asian countries have been continuously interacted in the international economy to bring in technology and practices which are superior and beneficial for enhancing its domestic requirements. Domestic efforts to absorb technologies developed somewhere else have allowed Asian economies to put in place institutional arrangements for supporting economic agents of production to become international competitive while reducing foreign dependence of technology. This process can be characterized as technology import substitution. Technology import substitution process has enabled the national innovation system to develop competitive advantage for the firm producing goods and services in these typical areas. Therefore, the leading global players of knowledge activities have recognized the innovative capability of the Asian countries and revealed in a recent UNCTAD survey their preference to locate R&D centers in Asian countries. Foreign affiliate R&D centers have been growing at a fast pace in the Asian countries. China alone received 700 foreign affiliate R&D centers between 2002 and 2004. India and Singapore is now hosting more than hundred foreign affiliate R&D centers respectively. China, India and Singapore have a very high degree incidence of establishing foreign affiliate R&D centers up to 2004. The situation assessment survey has also revealed that the leading TNCs will prefer to locate R&D centers in most of the Asian countries (Table 5). China and India have emerged undisputed sites for location of foreign R&D centers between 2005 and 2009 and were preferred by 61.8 per cent and 29.4 per cent respectively of the firms surveyed in 2004. Their respective global ranks are first and third. Other important Asian countries which have been highly rated as preferred location for R&D centers by global knowledge players are Singapore (rank 11), Taiwan (rank 12), Malaysia (rank 15), South Korea (rank 16) and Thailand rank (17) (Table 5). This is an ample proof of the well developed innovative infrastructural facilities and conducing innovation institutional arrangements along with highly skilled innovative and cheap human capital.

Table 5: Indicators of foreign firm innovation investment destinations

Country	Current foreign R&D location of TNCs 2004 (per cent)	Prospective R&D location of TNCs 2005-2009
China	35.3 (3)	61.8 (1)
India	25.0 (6)	29.4 (3)
Singapore	17.6 (9)	4.4 (11)
Taiwan	5.9 (23)	4.4 (12)
Malaysia	-	2.9 (15)
South Korea	4.4 (26)	2.9 (16)
Thailand	4.4 (27)	2.9 (17)

Source: UNCTAD (2005).

4. Public Policy Support for Innovations across Asian Countries:

Economic growth and competitive advantage of national economies in the post world war period remained highly dependent on public support policies (Stern, 2004). Economic agents of production have been nurtured through the support of right kind of economic incentives and institutional arrangements. Innovativeness of the economic agents of production in a national economy thus has remained also highly dependent on technology policy instruments and institutional arrangements (Yusuf, 2003). It has been widely acknowledged and recognized that the leading developed countries and industries, which are adding to the global pool of knowledge through novel innovations and maintaining competitive edge, are highly dependent on well enacted public support system in terms of instruments and institutions (Jaumotte and Pain, 2005; Ruttan, 2001). Public support-direct and indirect-for technology generation and diffusion has been justified on the ground that economic agents of production generally under invest in innovation related activities compared with socially desirable level (Arrow, 1962 ; Nelson, 1959). Why do firms generally under-invest because of the fact that knowledge has a quasi public good characteristic? Therefore, knowledge is difficult to appropriate perfectly by the generators even if what so ever the institutional arrangements for appropriations of knowledge are made. If there exist a knowledge gap between the two economic agents of production, then follower have an advantage of receiving some amount of knowledge without paying for it has been characterized as spillover effect. Innovations are risky activities and involve huge amount of resources along with proven lower private returns than that of the public returns (Jones and Williams, 1998). Thus, private funding agencies and institutions are usually reluctant to finance such projects. This results into shortage of financial resources to individual agents which are involved in innovative activities and is popularly called as financial market failures. Innovative activities usually employ highly skilled labor and in the absence of appropriate educational institutions, skilled labor shortages generally results. This is an accepted responsibility of the state to mitigate the skill shortages of the labor which will provide desired human capital to private economic agents engaged in innovative activities. Asymmetric information is the other source of justification for the public policy intervention in innovative economic activities and also direct and indirect support to those who are engaged in innovative activities.

In order to address the market failure, governments of the developed countries have been putting in place a whole host of direct and indirect measures to encourage economic agents to commit more resources for innovative activities. The governments of developed countries have now well designed set of five principal policies to alleviate particular forms of market failure leading to under-invest in innovation. This response of the governments of the developed countries have not only eased perceived constraints on the incentive to private agents to innovate but have allowed to them to provide lead to push forward technology frontiers and remain competitive in the fast changing international economy.

East Asian countries have emerged as front runners in industrial economic activities during the import substitution regimes and have accumulated vast experience of public policy making. Public policy making in Asian and elsewhere have not only addressed appropriately market failures but fundamentally remained developmental in nature. Economic transition has allowed these countries to accumulate technology development experience while putting in place desired instruments and institutional arrangements for helping innovations to take place. The national innovation system in each one of the Asian countries has evolved during the period of economic transformation to address the problem of backward technology which recently has shown dividends. This process of moving from imitation to innovation has been covered in relatively at a short span time compared with the developed countries. However, there exist wide differentials in stage of technology development and support of public technology policy across Asian countries. One commonality which emerged from the technology development policy in committing resources for R&D is the dramatic shift from public funding to private one (Yusuf, 2003).

Government support extended by Singapore and Taiwan to their respective firms doing R&D in terms of subsidies and tax concessions is ranked very high among the 80 countries for which data was collected by the World Economic Forum. Singapore and Taiwan received out of seven scores points recorded score points 5.4 and 5.2 and ranked second and third respectively in the global reckoning (Table 6). Singapore government allowed firms double deduction on R&D expenses as tax incentive for R&D. The government has also enacted incentive schemes for companies for example innovation development scheme, funds for industrial clusters and promising local enterprise scheme. The tax system of Taiwan has also provided full deductibility for R&D expenses and also allowed accelerated depreciation. Malaysia and Korea were ranked 8th and 12th with score points 4.7 and 4.6 respectively so far as tax incentives and subsidies are concerned. Malaysia supported firms' R&D while providing nine different categories of tax incentives. The Korea government successfully supported private R&D by giving tax credits, allowed accelerated depreciation and lowering of import tariffs. Two emerging

Table 6: Institutional support indicators of innovations across Asian countries.

Country	Subsidies and tax credit for firm-level R&D	Quality of science and math education	University-industry research collaboration	Govt. procurement of advance technology products	Intellectual property protection
Bangladesh	2.2 (69)	3.3 (68)	2.2 (77)	2.5 (73)	2.1 (77)
India	4.3 (18)	5.1 (17)	3.4 (42)	3.3 (55)	3.4 (51)
China	4.0 (21)	4.4 (31)	4.5 (16)	4.7 (10)	3.6 (45)
Sri Lanka	3.1 (39)	4.0 (44)	2.9 (57)	4.5 (13)	4.0 (37)
Indonesia	2.3 (67)	3.6 (60)	3.5 (40)	3.7 (40)	2.4 (72)
Philippines	2.6 (61)	3.6 (58)	3.2 (49)	3.0 (64)	2.7 (64)
Thailand	3.4 (30)	4.0 (45)	3.8 (29)	3.8 (34)	4.0 (38)
Malaysia	4.7 (8)	4.5 (28)	3.8 (28)	4.7 (7)	4.4 (33)
South Korea	4.6 (12)	4.9 (22)	4.3 (20)	4.8 (6)	4.5 (29)
Hong Kong	2.0 (45)	4.1 (43)	3.6 (35)	3.9 (29)	5.2 (17)
Singapore	5.4 (2)	5.3 (10)	5.0 (9)	5.2 (1)	5.7 (12)
Taiwan	5.2 (3)	5.2 (15)	5.2 (7)	5.1 (3)	4.6 (27)

Note: Figures in parentheses are global ranks according to scores based on Executive Opinion Survey, 2002.
Source: Cornelius, Porter and Schwab (2003).

innovative countries-India and China- have been able to successfully support, in terms of providing subsidies and tax incentives, firm level R&D. Global ranks of Indian and Chinese subsidies and tax credit support at firm level were 18th and 21st with scores points 4.2 and 4.0 respectively (Table 6). Firm's perception of fiscal support of the government of Thailand is also quite satisfactory. However, the other South Asian and East Asian country countries have shown the availability of fiscal incentives for innovative activities but the firm perception and global ranking is quite low. This is understandable because of the fact that input and output indicators of these countries have also shown the early stage of development of their innovation systems.

The model of innovations emerged in the recent past in developed countries is the relationship between government, university and business enterprises. This is known in the literature of national innovation system as triple helix era. The university has emerged as a knowledge enterprise where government and business enterprises invest in research and draw on the commercially viable new knowledge generated by the university. This linkage is now considered essential for speedy delivery and uses of knowledge by business enterprises so that pace and competitive edge can be maintained in the dynamic global economy. It needs to be noticed here that Taiwan, Singapore and China have emulated the model of innovations triple helix era. This is clear from the high global ranking recorded by the business enterprises obtained on the basis of score points as per the perceptions of the business enterprises (Table 6). South Korea has also scored quite high on this count but still regarded as relatively having weak linkage between public research institutions and business enterprises (Yusuf, 2003). University-industry linkage was very weak in most of the Asian countries. It is almost at the stage of inception. This is where governments of these countries have to take measures such as extending financial support to educational institutions and public research institutions to graduate themselves from mere knowledge disseminator institutions to creators of knowledge. It is important to note here that supply and quality of researchers required for R&D was regarded very highly for countries such Singapore, Taiwan and India (Table 6). Other countries of Asian need substantive efforts in this respect to fulfill the requirements of the firms to ensure supply and quality of the skilled manpower. Government support in terms of procurement of advance technology products has been rated high and secured ranks first, third, sixth, seven and tenth by Singapore, Taiwan, Korea, Malaysia and China respectively (Table 6). However, South Asian country ranks on this count are very low except Sri Lanka compared with East Asian countries. Technology development experience of East Asian countries have shown that capability building and strengthening national innovation system under the lax intellectual property regime were quite helpful. It needs to be noted here that the stage of development and intellectual property protection is positively correlated. However, protection of intellectual property at early stage of national innovation system inhibits innovative activities. Therefore, lower global ranking in intellectual protection recorded by the business perception survey is understandable (Table 6). On the whole, East Asian countries have emerged among the front runners in terms of technology policy support to business enterprises a reason of successful development of national innovation system especially of Taiwan, Korea and Singapore. South Asian countries and other developing countries needs to learn a lesson or two from innovative and dynamic public technology policy support extended by the East Asian countries in terms of instruments and institutions for making business enterprises innovative.

4. Open national innovation system and policy agenda for national and international public agencies:

National innovation systems have been evolved in the developed countries without external intervention and political pressures. Competitive edge of developed economies and of industries has been achieved with substantive public support both direct and indirect. This does not mean that developed countries have not learned from the experience of each other during the evolution and development of national innovation system. Firms chosen to invest in other developed countries as well as formulated joint ventures to draw on the best practices of others are an ample proof of learning from each others. Therefore, the national innovation systems have remained quite open and learning took place mainly under the framework of national technology policy.

On other hand, East Asian economies surged ahead in transformation process and succeeded in industrialising their economies as well as building innovation capabilities during the last quarter of the twentieth century. National innovation system is still at its stage of infancy. South Asian countries are striving to put in place the national innovation system which allows its firms to be productive and competitive. It is important to note here that there are wide differentials in productivity and per capita income across countries. This reflects the knowledge gaps and application of knowledge gaps for productive economic activities. However, openness in trade based on rules and regulations framed by global governance institutions have allowed in secure monopoly rights to firms which have gained competitive edge from their respective national innovation systems. The intellectual property rights enacted and implemented by World

Trade Organisation has been increasingly being questioned both by the academic economists and governments as well as some global institutions. An interesting contribution in this regard is by the World Development Report of the World Bank 1998/1999. This report clearly identified the role of the government in developing countries to develop the capabilities to generate knowledge at home along with providing help to domestic agents of production to take advantage of the large global stock of knowledge. It is significant to note here that the United Nations Development Prorgramme (UNDP) has gone much ahead in terms of identifying the knowledge gaps existing between developed and developing countries and articulated the arguments against the strict intellectual property rights regime enacted and implemented by the World Trade Organization (WTO). Furthermore, the UNDP has not only suggested innovative and fundamental role of the governments of the developing countries in generating capabilities that matter for knowledge development but also identified knowledge as a global public good and role of international community in reducing the knowledge gaps (UNDP, 2001; and Stiglitz, 1999). Apart from making suitable public innovation policies to strengthen national innovation systems, the government of developing countries should also strive hard to seek cooperation among themselves as well as of the international institutions and agencies to negotiate in the WTO framework. Specifically, the negotiation should be with regard to MNCs operation in their markets, for doing similar innovative investment as has been done in the home countries. It should also assess losses of domestic firms and seek compensation for using it to create innovative capabilities to strengthen innovative infrastructure at home. The two step strategy suggested above will go a long way to make capable domestic agents of production to catch up spillover effect created by the international capital and fill the knowledge gap for sustained economic growth.

5. Concluding Remarks:

The analysis of structural transformation and national innovation system of Asian countries show that there are wide differentials in the pattern of structural transformation and technology development. Some of the East Asian countries have emerged another pole of innovations and technology development. East Asian experience of technology development has numerous lessons for the developing countries in general and South

Asian countries in particular in a fast globalizing world economy. First and foremost lesson which should be learnt from East Asian experience to succeed in the global economy is to reinvent the role of state to strengthen the national innovation institutional system. The developing countries are engaged in economic reforms to reduce the role of the state and provide larger space to market forces which essentially make the state scarce in economic activities. This strategy of making the state scarce in developing countries suffers from the draw back of substitutability of the state and the market and reduces the competitiveness of the domestic agents of production in the international economy. It is important to note here that intervention of the state in a fast globalizing world economy is more difficult but at the same time is very crucial and strategic. Therefore, reinventing the role of government policy in crafting the national innovation institutional arrangements for building and strengthening competitive advantage is direly needed. The East Asian economies have grown in an environment of import substitution and lax intellectual property regime which now is not available to the developing economies. Intellectual property regime enacted and imposed by the WTO has been restricting developing economies to put in place the national innovation system which has proven adverse effect on the global innovations and more particularly least developed countries. Developing country markets are invaded by multinational corporations without contributing towards generation of domestic innovation capabilities. The role of international institutions is to evolve policies which should decrease the knowledge gap through imposing conditions on multinational corporations to contribute in an equal measure the percentage of sales revenue expenditure on R&D in the host country as is being done in the home country. Reduction of fiscal deficit under the reform programme has easy options for the governments of the developing countries to cut down expenditure on institutions which are the backbone of economic development such as education, health and infrastructure. Further curtailing support to the R&D institutions- public and private-has a capacity to weaken the institutions which from a long term perspective matter a lot for economic growth and welfare.

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