Research for Development in Asia

by
Kirit S. Parikh

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Acronyms

BCSIR	Bangladesh Council of Scientific and Industrial Research
BT	Biotechnology
CAS	Chinese Academy of Sciences
CISIR	Ceylon Institute of Scientific and Industrial Research
CR	Cultural Revolution
CSIR	Council of Scientific and Industrial Research (India)
EPW	Economic and Political Weekly (India)
FDI	foreign direct investment
GDP	gross domestic product
GNP	gross national product
HDI	Human Development Index
ICAR	Indian Council of Agricultural Research
ICT	Information and communication technologies
IIT	Indian Institutes of Technology
IMF	International Monetary Fund
IPR	intellectual property rights
ISI	import substitution industrialization
ISID	Institute for Studies in Industrial Development (India)
ISRO	Indian Space Research Organization
IT	Information Technology
ITRI	Industrial Technology Research Institute (Thailand)
LEMRENAS	Institute for National Research (Indonesia)
LIPI	Indonesian Institute of Sciences
MIMAP	Micro Impacts of Macroeconomic and Adjustment Policies Program Initiative (IDRC)
MIPI	Council for Sciences of Indonesia
MIT	Massachusetts Institute of Technology
MITI	Ministry of International Trade and Industry (Japan)
MNCs	Multinational Corporations
MOSTE	Ministry of Science, Technology and Environment (Thailand)
NGOs	Nongovernmental organizations
NRM	Natural Resources Management
PBR	People's Biodiversity Registers
PBRD	products based on own R&D
PCSIR	Pakistan Council of Scientific and Industrial Research
R&D	Research and Development
RCR	Relative Citation Rate
S&T	Science and technology
STCI	Science and Technology Capacity Index
SAP	Structural Adjustment Program
SCI	Science Citation Index
SIRIM	Standards and Industrial Research Institute of Malaysia
SMEs	small and medium enterprises

SSCI	Social Science Citation Index
TAPI	Technology Application and Promotion Institute
TFPG	total factor productivity growth
TISTR	Thailand Institute of Scientific and Technological Research
TRIPS	Trade-Related Aspects of Intellectual Property Rights
UNDP	United Nations Development Programme
USSR	Union of Soviet Socialist Republics

Executive Summary

Introduction

Research can promote development that improves social well-being and economic equity, ensures environmental sustainability, and leads to gender equity. For this to occur, it requires technological research and policy research. Empirical estimates of returns to research and development (R&D) at the economy level are quite high. Lederman and Maloney (2003) estimate a return of 78 percent in terms of gross domestic product (GDP) for R&D expenditure. Returns to R&D decline with per capita GDP as the relatively poor countries face even greater distances to improve and catch up to the technological frontier. To close that gap, poorer countries need research and innovation.

State of research

The development strategies followed by Asian countries have affected their demand for and supply of research. After independence, most Asian countries pursued industrialization and self-reliance and followed an import substitution industrialization (ISI) course. While some persisted with it for a long time, particularly the South Asian countries, others moved on to export-led growth strategies quite early on. The ISI called for import of technology, learning, assimilation, and reverse engineering requiring imitative innovation. When domestic industry enjoyed high protection, as in South Asia, the cost effectiveness of newly developed technology was a secondary concern. Where exports were emphasized, the demand was for innovations that lead to industrial competitiveness in cost and quality. The Asian "tigers" and "cubs" focused their research accordingly.

To supply research, many Asian countries established national-level bodies, academies, or councils for science and technology and for agriculture. These in turn set up institutions and laboratories. Because of the low levels of education at independence, Asian countries devoted great effort into developing educational systems and universities. These have also supplied researchers and research facilities. In terms of researchers per million population in the mid-1990s, Japan had 4,900, Singapore 2,300, Korea 2,200, and Taiwan 2,100. Compared with that, Mongolia had 900, China 450, Viet Nam 255, India 150, and other countries ranged from 90 to 200. The highest spenders were Japan and Korea, who spent 2.8 percent of their gross national product (GNP) on R&D, followed by Taiwan (1.79%) and Singapore (1.13%). Pakistan at 0.92 percent is a relatively high spender followed by India (0.73%) and China (0.61%). Asian countries need to invest more in research and engage more researchers.

On the educational front, women have lagged behind men in South Asian countries. The gap at the tertiary level is high. Although women often perform better than men at the MSc examinations, securing top ranks and medals, their role in research remains limited. The Philippines shows equal gender participation in research where the publication rate of women exceeds that of men. Yet women with a MSc wait longer for promotion. Equity at the tertiary level and in career advancement needs to be realized. Women also occupy very few decision-making posts in Asia. In 1998 the highest percentage of ministerial-level posts held by women was 16 percent in Malaysia.

Many Asian countries created agricultural research systems in the 1950s and 1960s to push agricultural development. These contributed to their green revolutions. The estimates of internal rates of return on agricultural research range from 19 percent to over 100 percent. International research institutions provided knowledge and enhanced capacity.

With few exceptions, Asian countries have a poor record in the number of publications and of relative citation rates (RCRs) in major English-language international journals. Comparison of publications from citation indices reveals a country's improvement over time. Cross-country comparisons can be misleading, however. When publications in local journals and in languages other than English are included, the picture is very different. For example, China published 101,983 science and technology papers in 1993, but in the five years in the period 1989-93, only 27,172 were mentioned in international citation indexes.

Interest in patents is increasing in Asian countries with more and more patents being filed. However, the number of patents filed in the USA is very small for most countries, except Korea and Taiwan. In most Asian countries, research capacity to deal with a range of policy issues is limited. In many policy areas one would have difficulty identifying more than one or two researchers. Thus, society does not benefit from alternative viewpoints.

The environment for research

Many Asian countries exhibit strong political support for science and technology. They also have a cultural background that respects learning and knowledge. In many Asian countries, academic researchers have access to government as members of working groups, advisory committees, and so on.

Until recently, research, including policy research, was supported mainly by government. Even when funding is obtained from multilateral agencies or donors, it is the government that approves the projects. In some Asian countries, donors and multilateral agencies play a major role, with significant funds available for consultancies but little for core research. Lack of money for core research is a problem in many countries. Sustained research and capacity-building for policy analysis is often neglected. The role of private research has been growing. In the 1990s, the role of business enterprises has risen dramatically in Indonesia, Korea, Malaysia, and Singapore. In Japan, business has held a dominant position since the 1980s.

A strong case can be made for government support for research: it has an important role to play in basic research, agricultural research, research on reproductive health/rights, environmental research, defence or research related to critical so-called dual-use products, and research in areas that requires a multi-institutional approach. However, government funding often comes with strings attached. It imposes a large measure of uniformity and mediocrity. Public sector dominance in policy research might discourage the dissemination of "unpleasant" conclusions. This is critical for social science research.

The few successful examples of leapfrogging suggest that success depends on a number of factors, including the technological regime of the industry, institutional set-up, whether the industry is scale-intensive, less science-based, and has a more predictable innovation path, and government policy.

The process of structural reform could lead to induced learning, bridging the technology gap, and affecting indigenous technological development. Competition from well-established multinational corporations (MNCs), the jealous protection of intellectual property by the developed countries, and an intellectual property rights (IPR) regime that does not adequately protect indigenous knowledge and facilitates biopiracy, pose challenges. With fiscal discipline, public resources for research decline. There is a grave danger that important research for development will not be funded by the private sector. Even in areas where research results are appropriable, if the IPR regime does not evolve in step, the private sector could delay its entry. Structural reforms can be, but need not be, harmful to domestic R&D and with appropriate policies in place, they can increase its effectiveness. These policies include an appropriate role for public research and an appropriate IPR regime.

Asian countries, like all ancient civilizations, possess significant amounts of indigenous knowledge. China and India have their own medicinal systems. The many tribal and indigenous groups have their own trove of knowledge about plants, animals, nutrition, health care, and livelihoods. Traditional knowledge is valuable. Biotech firms have strong incentives for bioprospecting and biopiracy. Traditional knowledge does not lend itself easily to concepts of property in any form known to IPRs. The question of how holders of traditional knowledge should be rewarded needs to be resolved.

Concluding comments

Once Asia reaches the levels of research effort in terms of researchers per million persons comparable to the industrialized countries, the flow of innovations would be mind-boggling. That time is not too far in the future. Will the current IPR regime facilitate such flows or create a gridlock of claims and counterclaims?

How to move forward is a formidable test. The importance of policy research should not be underestimated. There is a paucity of policy research in many areas. Without its presence, countries do not benefit from a plurality of advice. Independent policy research needs more support. Sustained support for core research and for institution-building is also scarce. Multidisciplinary policy research for example, on environmental issues usually receives inadequate support and faces many institutional obstacles. Policy research could be made more effective if, besides being multidisciplinary, it involved stakeholders in the research process. We need to better understand the problems of women researchers. This can help eliminate discrimination and facilitate women's fuller participation. Research to help establish the rights of indigenous people over their traditional knowledge is also needed.

Introduction

Research can promote development in many ways, leading to improvements in social well- being, economic equity, environmental sustainability, and gender equity.

These goals are easier to achieve with rapid economic growth that in turn fuels job creation. Growth in productivity is important to achieve rapid growth for which innovation and technical change can be very helpful. Research and development (R&D) that increases industrial productivity and competitiveness contributes to industrial development.

Development can also be stimulated by improving agricultural productivity. In fact, in land-scarce Asian countries, with the bulk of the population dependent on agriculture, it is critical. Thus, R&D focusing on land productivity and crop yields and for developing new crop varieties, is of vital importance for Asia.

For growth that leads to job creation, the development of appropriate technology is crucial. Many researchers in developing countries, driven by idealism, have great fascination for appropriate technology.

In the globalizing world of rapid technical progress with the information and communication technologies (ICT) revolution and the emergence of the knowledge economy, research for development can be very fruitful for countries. Without it, they will have difficulty keeping up, let alone catching up with the more industrialized countries. Even when new technology is imported, some innovation is needed to adapt and to assimilate it.

Social well-being and economic equity require food and water security, improvements in health and education, empowerment of the disadvantaged, and protection of indigenous rights. Sustainability calls for natural resource management (NRM), which is also needed to protect the livelihoods of people, particularly the poor. NRM needs the participation of people. Without the willing cooperation of all, it would be difficult to avoid natural resource degradation in the land-scarce and densely populated countries of Asia. This calls for institutional innovation.

Limiting demand for exhaustible resources, the development of alternatives, based on renewable resources and the wise use of renewable resources, requires research — research to develop technology to use renewable resources, research to make them competitive, research to develop technology of conservation, and research for recycling technology.

To realize gender equity we need to encourage a change in mindset. Awareness of inequity, acceptance of its prevalence, and a desire to set it right can be facilitated by social and psychological research.

However, with all the research and all the technology in the world, the objective of rapid, equitable, and sustainable development will not be realized without an appropriate set of policies and an institutional environment that facilitates their effective implementation. We need policies that stimulate rapid growth, that stimulate capacity to innovate, that facilitate adoption of appropriate technology, policies for redistribution and for participative management of natural resources. Thus, policy, economic, social, institutional and organizational, and political science research can contribute to development.

The state of research and the environment for research in Asian countries is diverse. The heterogeneity of Asian countries can be seen if we look at the various development indicators. Tables A.1-A.8 in the Appendix summarize these indicators from the UN Development Programme (UNDP) 2002 *Human Development Report* 2002.

Some features that stand out from the data are shown in Table 1, which also includes the Science and Technology Capacity Index (STCI) of Francisco Sagasti (2002).

While there are exceptions, by and large, countries with a high human development index (HDI) are also countries with high gross domestic product (GDP).[1] Many countries have realized significant improvement in their HDI over the past 25 years, usually accompanied with high growth rates of GDP. The gender development index (GDI) seems to correlate with the HDI. The Sagasti S&T Capacity Index does not seem to show any obvious pattern in Asia, though for his sample of 85 countries, Sagasti does observe "high correlation between the S&T Capacity Index and the Human Development Index calculated by UNDP."

Not all countries with relatively good performance in Asia exhibit a strong science capacity. However, the three high-income countries, Japan, Singapore, and the Republic of Korea, have relatively high scores on the S&TCI.

To look at the research scene in Asian countries, countries are grouped as follows:

	Asian giants	China and India
	Asian tigers	Republic of Korea, Taiwan, Singapore, and Hong Kong (China)
	Asian cubs	Indonesia, Malaysia, Philippines, and Thailand
	Other large countries	Population over 5 million
	Other small countries	Population less than 5 million

For comparison, Japan is included as a developed Asian country.

[1] Sagasti, F. 2002. Knowledge, Technology and Production: An Essay on Science and Technology for Development. Mimeo First draft. Foro Nacional/Internacional. August 2002.

State of Research in Asia

The countries of Asia differ widely in terms of their population, economy, income levels, and in their emphasis on science and technology and their capacity for research and development. Their individual development strategies and objectives affect their demand and supply of research.

Development strategies and demand and supply of research

The Asian giants: China and India

China

After liberation in 1949, China followed an import substitution and infrastructure-building strategy until its break with the USSR in 1959. Self-reliance and defence research became paramount. The Cultural Revolution (CR) of 1965-76 downgraded scientists and scientific research. Thus, the number of natural science publications/books fell to less than 200 in 1968 from 16,000 in 1958 (Jain and Kharbanda 1999). China shifted in 1978 to a market-oriented approach, freeing its scientists from most ideological constraints. The export orientation and rapid growth of the last 20 years has seen China expand its higher education and research capabilities. It now aggressively pursues higher technical education, information technology (IT), biotechnology (BT), and global competitiveness.

In November 1949, the Chinese Academy of Sciences (CAS) was established with 21 research institutes, merging the Academia Sinica and the Peking Academy. By the end of the 1950s, China's research architecture was composed of five major sectors with CAS as the principal academic body for scientific research. The overall structure of the research system in China in the 1950s closely followed the Soviet model by distinguishing between basic and applied research and reflected the division of labour between CAS and the industrial sectors.

The total number of research institutes under CAS grew from 21 in 1950 to 120 in 1965. As part of the Soviet influence, an important event in this period was the launching of the first long-term 12-Year Plan (1956-67) for S&T development in 1956. The Plan was drawn up with the assistance of 200 scientists and the advice of Soviet experts. The main objectives included the achievement of scientific and technological excellence to catch up with the advanced countries within 20 years. It prioritized four sectors: computers; semiconductor technology; electronics and automation; and atomic energy and jet technology. This plan is said to have ended in 1962, five years ahead of schedule.

The Cultural Revolution played havoc with China's scientific institutions. The highest scientific body, the Scientific and Technology Commission, was abolished. In 1967, the CAS budget was cut 84 percent, falling to 1965 budget levels, and was further reduced by 1976. CAS also lost more than 60 percent of its major research institutes and by 1976, only 36 were left, most directly linked to defence and military technologies (Yan Jici 1988). Basic research activities virtually ceased until about 1973. Higher technical education was also disrupted. The number of universities was drastically reduced and China lost an entire generation of educated personnel during 1965-76 (Kharbanda and Qureshi n.d.). However, the political leadership guarded the high technology and military-related research organizations from major upheavals. Projects in electronics, lasers, semiconductors, advanced computer technology, and nuclear and space programs continued to draw considerable financial and political support. For example, China detonated atomic and hydrogen bombs in 1964 and 1967, respectively, developed the first hybrid rice in 1973, and launched several satellites between 1970 and 1976.

In 1979, the CAS was revamped. By the early 1980s, the new leadership restored the whole spectrum of the S&T system that had been dismantled during the CR. In this new, market-oriented phase, emphasis was put on research to strengthen productive technology, technology development and application, and learning, absorbing, and adopting foreign technology.

India

India's development strategy can be characterized as import substitution industrialization (ISI) from 1947 till 1990 in a mixed economy framework based on central planning implemented through product licensing which controlled technology production. Protection was afforded through import quotas and high import tariffs. This period can be divided into three subperiods. The first, up to the mid-1960s, focused on infrastructure building and heavy industries through the public sector. The second phase, from the mid-1960s onwards, saw greater emphasis on agricultural development. The 1980s witnessed gradual deregulation of industries and relaxation of controls. In June 1991, the process of dramatic policy reforms, liberalization, deregulation, export orientation, and privatization began.

At the time of independence in 1947, India had a record of scientific accomplishments, in some cases, at the highest international level. Science policy was articulated in the government's Scientific Policy Resolution (1958). In 1947, India had a very small industrial base. For example, the total installed power generating capacity was only 2300 MW in 1951. To encourage industrialization, large public sector investments and foreign collaboration were involved in developing infrastructure, capacity, and production. Rapid growth of higher technical education was pushed with the creation of many centres of excellence. Nuclear energy, defence research, and Council of Scientific and Industrial Research (CSIR) programs were launched. With its foreign exchange shortages, India focused on import substitution and reverse engineering. India recognized only process patents but no product patents, as many industrialized countries had in the past, following alternate process routes to catch up. This path required highly innovative research. In the mid-1960s, severe droughts and the need to import massive quantities of food shocked the nation. This led to greater emphasis on agricultural research, which sustained the green revolution. Over the past three decades, significant accomplishments in nuclear and space technologies, defence research, IT, and BT, and many other industrial sectors has been made.

In some areas, a mission mode of research was followed. It was recognized that all the links in the innovation chain — from discovery, product design, prototype testing, manufacturing, marketing, sales, and service — are important. It was also recognized that research on basic science is important but not always necessary for innovation. Atomic energy, space research, and defence research were grouped under this mode.

India's CSIR, which was established in 1942 was asked to set up research laboratories in diverse fields. In 2000-01 CSIR comprised 40 research establishments with a total staff of 21,228, (15,780 S&T staff), with budget of Rs.11070 million (US$1=Rs.46.50). At the same time, four Indian Institute of Technologies (IITs) were established in the 1950s "along the line of MIT" to provide quality education in science and engineering. Prime Minister Nehru's personal commitment to India's scientific and technological development was reflected in many ways. For instance, he always inaugurated the annual conference of the Indian Science Congress, a tradition that subsequent prime ministers have continued. Nehru also strengthened the Indian Council of Agricultural Research (ICAR) and set up the Atomic Energy Commission. India's prime ministers have generally kept the ministries and departments of atomic energy, science and technology, space, electronics, and biotechnology under their control. Thus, S&T has the backing of the highest political level in India.

The Asian tigers

The Asian tigers followed an outward oriented, export-led growth strategy. In the early years, they imported technology, assimilating and imitating. However, their export orientation required quality and cost competitiveness that called for continued innovations. Singapore also promoted skill formation through its Skills Development Fund. As they gained experience, improved their research abilities, and developed their economies, the tigers became more ambitious and sought technological leadership in selected areas through leapfrogging.

The Asian cubs

The Asian cubs — Indonesia, Malaysia, Philippines, and Thailand — also followed export oriented growth strategies but at a somewhat later date. Their demand for research was to enhance their competitiveness. Thailand, which also encouraged foreign direct investment (FDI), was one of the fastest growing economies in the world in the second half of the 1980s. However, low levels of technological upgrading and indigenous R&D activity accompanied Thailand's reliance on FDI and the pattern of technology upgrading through backward linkages by Thai industry, which mainly preferred to buy foreign technology. (Sen and Kunal 1995). Much of Thailand's R&D budget went to agriculture.

Malaysia

The Standards and Industrial Research Institute of Malaysia (SIRIM) was established in 1975 under the SIRIM (Incorporation) Act 157 as a multidisciplinary research and development agency under the Ministry of Science, Technology and the Environment. In September 1996, SIRIM Berhad became a wholly owned incorporated company of the Malaysian government under the Ministry of Finance.

Its role is to spearhead industrial research and development toward developing national capability in industrial technologies. It is also entrusted with the task of upgrading quality through standardization and providing technical and consultancy services aimed at enhancing the competitiveness of Malaysian industries. SIRIM Berhad acts as a development arm of the government in developing national capacity and capability in strategic technological areas.

Its mission is to "enhance our customers competitiveness through technology and quality, as well as to fulfill the needs of stakeholders." SIRIM Berhad plays a pivotal role as a champion of quality and technology development while providing the necessary channel for technology transfer through institutional and technical infrastructure support mechanisms.

Indonesia

After the proclamation of Indonesian independence on 17 August 1945, the government began to study the existing administrative structure of scientific research. The Council for Sciences of Indonesia (MIPI) was founded as an autonomous organization under the Ministry of Education. In 1962, the government transferred MIPI to the newly created Ministry of National Research, in order to establish and administer a number of national research institutions. Four years later, the ministry lost its status and was converted into The Institute for National Research (LEMRENAS). In 1967, LEMRENAS was abolished and the Indonesian Institute of Sciences (LIPI) was mandated to continue the work of LEMRENAS and MIPI.

The main objectives of LIPI are to assist the president in organizing research and development, and to provide guidance, services, and advice to the government on national science and technology policies. In addition, LIPI is designated to carry out R&D in science and technology, to encourage and develop science consciousness among the Indonesian people, to improve the capability of the scientific community, to develop and improve cooperation with national and international scientific bodies in accordance with existing laws and regulations, and assist the government with the formulation of national science policy.

Philippines

In the Philippines, the Technology Application and Promotion Institute (TAPI) was established in 1987 to serve as the implementation arm of the Department of Science and Technology in promoting and commercializing technologies and in marketing the services of the Department.

TAPI's objectives are to accelerate economic growth through the application of science and technology, particularly in the countryside, encouraging the establishment of productive technology-based enterprises.

Thailand

The Thailand Institute of Scientific and Technological Research (TISTR) is a nonprofit state enterprise operating under the Ministry of Science, Technology and Environment (MOSTE). TISTR was originally set up by the Applied Scientific Research Corporation of Thailand Act B.E. 2506 (1963), which was repealed and replaced by the Thailand Institute of Scientific and Technological Research Act B.E. 2522 (1979) following the establishment of MOSTE in the same year.

The objectives of TISTR are to initiate and conduct research and to provide scientific and technological services to state agencies and private enterprises to advance economic and social development; to conduct scientific and technological research in order to promote the utilization of natural resources appropriate to economic conditions, the environment, health, and welfare of the people; to improve productivity in accordance with government policies by propagating the results of scientific and technological research to benefit the country in agriculture, industry, and commerce; to train scientific and technological researchers; and to provide for testing and evaluation services.

The Industrial Technology Research Institute (ITRI) was established in 1973 as an independent nonprofit organization. The Institute comprises: Union Chemical Laboratories; Mechanical Industry Research Laboratories; Electronic Research and Service Organization; Computer and Communication Research Laboratories; Opto-Electronics and Systems Laboratories; Energy and Mining Research and Service Organization; and the Materials Research Laboratories. Also affiliated are the Center for Measurement Standards, the Center for Pollution Control Technology, the Center for Industrial Safety and Health Technology Development, the Office of Planning and Technical Marketing, and the Center for Aviation and Space Technology.

Its objectives are to conduct research and provide technical services to industry in order to accelerate the development of industrial technologies.

Other large countries of South Asia

Bangladesh

In the decade following its independence in 1971, Bangladesh followed a development strategy of import substitution, under a state-controlled economy. In the 1980s, Bangladesh embarked on a structural adjustment program imposed by the International Monetary Fund (IMF), which it extended. During 1989-90, that policy was changed and rapid liberalization, export promotion, and outward orientation took place. Bangladesh's economy accelerated and attained a growth rate exceeding 6 percent over the 1990s.

The Bangladesh Council of Scientific and Industrial Research (BCSIR) originated from the East Regional Laboratories of the Pakistan Council of Scientific and Industrial

Research (PSCIR), established in Dhaka in 1953. Subsequently, PCSIR Laboratories Rajshaln and Chinagong were established in 1965 and 1967, respectively. After independence, BCSIR was reconstructed as the present BCSIR by government resolution.

The objectives of BCSIR are among others, to initiate, promote, and guide scientific industrial and technological research connected with the establishment and development of industries. It is also directed to establish, maintain, and develop laboratories, workshops, centres, and organizations to further scientific and industrial research, with the object of utilizating and exploiting Bangladesh's economic resources to maximum benefit.

Pakistan

Pakistan has experienced frequent political changes and military coups, and its development strategy has changed with them. Pakistan protected its industries in its early years. However, during the 1950s, the country saw six prime ministers and three governors general. Under the rule of General Ayub Khan in the 1960s, Pakistan followed the protected industries path. The 1970s saw a strengthening of socialistic policies as in India and Sri Lanka, with nationalization of banks and more controls on trade. The process of liberalization and deregulation began in the 1980s and has continued in the 1990s despite four changes of government.

The Pakistan Council of Scientific and Industrial Research (PCSIR) was created in 1953 under the Ministry of Industry. It was transferred to the newly established S&T Research Division in 1964 and came under the Ministry of Science and Technology in 1973 when the Ministry was established. The focus of PCSIR's efforts has been to help small and medium enterprises (SMEs). Pakistan has put considerable emphasis on nuclear research and has, like India, developed the atomic bomb.

Sri Lanka

Sri Lanka was a colonial, free market economy until 1960. In 1961, it embarked on import substitution industrialization. In 1970, the ISI policy and socialism were pursued with greater vigour. In 1980 Sri Lanka reversed gears, liberalized, and embarked on an export-oriented strategy. These policies continued in the 1990s despite the change in governments. The nature of demand for R&D has evolved from imitative innovation for import substitution to innovation for industrial competitiveness.

The Ceylon Institute of Scientific and Industrial Research (CISIR) was set up in 1955. In early 1991, CISIR reformulated its R&D policies and strategies to suit the new demand from industry and other economic sectors arising out of the country's new industrial policy. The new policy underlined the need for the CISIR to be market-oriented and demand-driven with respect to its R&D and service functions, with a view to being self-financing. Subsequently, the CISIR underwent a major restructuring program and new mission and value statements were articulated in 1993.
Its major objective is to support industry by:

- undertaking on contract, testing, investigation, and research, for improving product quality, technical processes, and methods used in industry;
- providing technical services and consultancies;
- engaging in activities connected with technology transfers, the adaptation of technologies, and development of new technologies; and
- conducting data collection and dissemination and undertaking training programs.

Broad indicators

Table 2 shows the broad indicators, number of researchers, and resources for research in the region.

Apart from Japan, the Asian giants have by far the largest number of researchers. However, in terms of R&D expenditure as a percentage of GDP and researchers per million inhabitants, the tigers are a distinct lot. The cubs show relatively low expenditure on research. Compared to a developed country like Japan, most Asian countries have far to go.

The highest spenders are Japan and Korea who spend 2.8 percent of their GNP on R&D, followed by Taiwan (1.79%) and Singapore (1.13%). Pakistan at 0.92 percent is a relatively high spender followed by India (0.73%) and China (0.61%).

Asian countries need to invest more in research and engage more researchers.

Human resources

Most Asian countries set up engineering and technical training institutions soon after independence. These capacities have often expanded ahead of demand. Thus, in India in the early 1970s, there were reports of some 60,000 unemployed engineers amid suggestions to cut back admissions. Fortunately, this was not done. One needs to develop capacity slightly ahead of demand. If India had not done so, it would not have reaped the benefits of the IT boom in the 1990s.

Table 3 compares the higher education scene in S&T for the Asian giants, China and India. Total enrolment in institutions of higher learning was more than 2 million in China in 1990 and exceeded 5 million in 1994 in India. Enrolment for PhDs was 18,000 and 55,000, respectively.

In 2000, India produced 11,000 PhDs of which 5,300 were in science and engineering. The crème de la crème of India's technical institutions, the Indian Institutes of Technology have some 5,000 PhD students on their rosters.

By and large, the Asian countries have focused on developing their human resources for research.

Gender equity

To what extent have women been a part of the research scene in Asia? The picture is quite disappointing. The inequity starts with education. Table 4 shows the levels of enrolment and literacy rates by sex in Asian countries. The illiteracy rates for age 25 + are much higher for women. Even for the age group 15 to 24, reflecting tomorrow's researchers, the illiteracy rates for women are more than 50 percent for Bangladesh, Nepal, and Pakistan, between 25 to 35 percent for Cambodia, Laos, and India, and below 10 percent for other Asian countries for which data is available. At the 3rd level, the enrolment ratio is again unfavourable to women in most Asian countries, with the exception of Mongolia and the Philippines. Girls' share of 2nd level gross enrolments is much more encouraging and shows a closing gender gap. Barring India, Nepal, Malaysia, and Pakistan, all other countries have 1998/2000 rates for women within 10 percent of that of men, and in many countries it is higher for women.

It appears it will take years for women to catch up with men in terms of research jobs as they do not have the education required for a research job. The problem, however, is more complex.

The Philippines is a country where women have nearly attained equality in education. Women constitute 53 percent of researchers with a MSc and/or PhD in four agricultural research institutes. In Thailand they constitute 44 percent in government research organizations, and in Sri Lanka 27.5 percent in 19 research institutes.

One study from the Philippines (Brush et al. 1995) showed that women with a MSc publish 4.29 papers per year compared to 3.89 papers by men. Even married women publish more papers than men. Yet the average time between promotions was 63.7 months for women scientists, compared to 38.3 months for men. However, for those with a PhD, the difference between men and women for promotion, as well as senior positions, is small. A PhD is an equalizer.

Also, no difference was recorded between the rate of leaving an organization between men and women, though the reasons for leaving were very different. Women mostly left for family reasons and men for economic reasons.

This highlights the importance of closing the gap in tertiary education and eliminating unfounded prejudices about women's stability and productivity.

In India, the majority of rank holders and medal winners at the postgraduate level in sciences are women. Yet they seem to fade from research careers for a variety of reasons. Marriage and family priorities (possibly dominated and determined by the husband and his relatives) may be one reason. Discrimination in the work place may be another (see Table 5). In a hierarchic system — and most government institutions are — smart women may find it harder to work under less intelligent bosses. These impressions need to be verified through detailed studies. Of India's numerous research laboratories and institutions, few have ever had a woman director.

Women in Asia occupy very few decision-making posts (see Table 6). The highest percentage of ministerial-level posts held by women was 16 percent in Malaysia in 1998. Most other countries have even fewer women ministers. This is ironic, as Asian countries, particularly in South Asia, have had a number of female prime ministers (Indira Gandhi in India; Sirimao Bandarnayake and Chandrika Kumartunge in Sri Lanka; Benezir Bhutto in Pakistan; and Khaleda Zia and Shaikh Haseena in Bangladesh).

Research for agricultural development

Since their independence in the late 1940s or early 1950s, many Asian countries have made significant efforts in agricultural research. This is seen in the expenditure on agricultural research as presented in Table 7. Many research institutions have been established (see Table 8 and www.asti.cgiar.org website country profiles).

Outcomes of agricultural research can be reflected in the increases in yield and output. The returns to agricultural research have been very high, as demonstrated in Table 9. The internal rate of return ranges from 19 percent to more than 100 percent. This suggests that countries should spend more on agricultural research.

International agricultural research has played an important role in the Green Revolution, ushered in by the Mexican dwarf wheat variety and sources of germ plasm for new rice varieties. Evenson (1997) reports that a large number of new rice varieties released in most countries had germ plasm from another country, access to which was facilitated by international research institutions.

Research for industrial development

Empirical estimates of returns to R&D at the economic level are quite high. Lederman and Maloney (2003) estimate a return of 78 percent in terms of GDP for R&D expenditure. They also find that returns to R&D decline with per capita GDP. This is understandable as countries with a higher per capita GDP are closer to their production possibility frontiers. Relatively poor countries have greater margins of improvement and catching up. The authors conclude that just to catch up to advanced economies, poorer countries need research and innovation.

Since many of the Asian developing countries have followed a path of import substitution, imitation, and reverse engineering, research has had a greater emphasis on innovation rather than discovery, on adaptation rather than basic research. Nonetheless, some basic research is needed to know what to imitate and how. Yet such research is less publishable, certainly in leading international journals. The conventional indicators of effectiveness of research, publication lists, citation indexes, and patents, must be used with caution. Yet they remain the only available systematic indicators. Citation indexes provide a measure of how "good" basic research is and how it has changed over time. Table 10 compares the total papers and the impact factor of research by different research organizations in India. The impact factors are lowest for the Indian Council of Agricultural Research (ICAR) followed by the Indian Space Research Organization (ISRO). Yet, in both areas, research outcomes have been considered outstanding. Agricultural research has led to a widespread and continuing green revolution which has turned India into a major surplus grain country. India's space capabilities are reflected in its ability to launch geosynchronous satellites, in the multi-application satellites that it designs, builds, and launches, and its competitive satellite launch services to other countries.

When the focus is on applications, comparing performance by using the citation index measure across countries may be misleading. It can however, indicate changes taking place over time in a country or an organization.

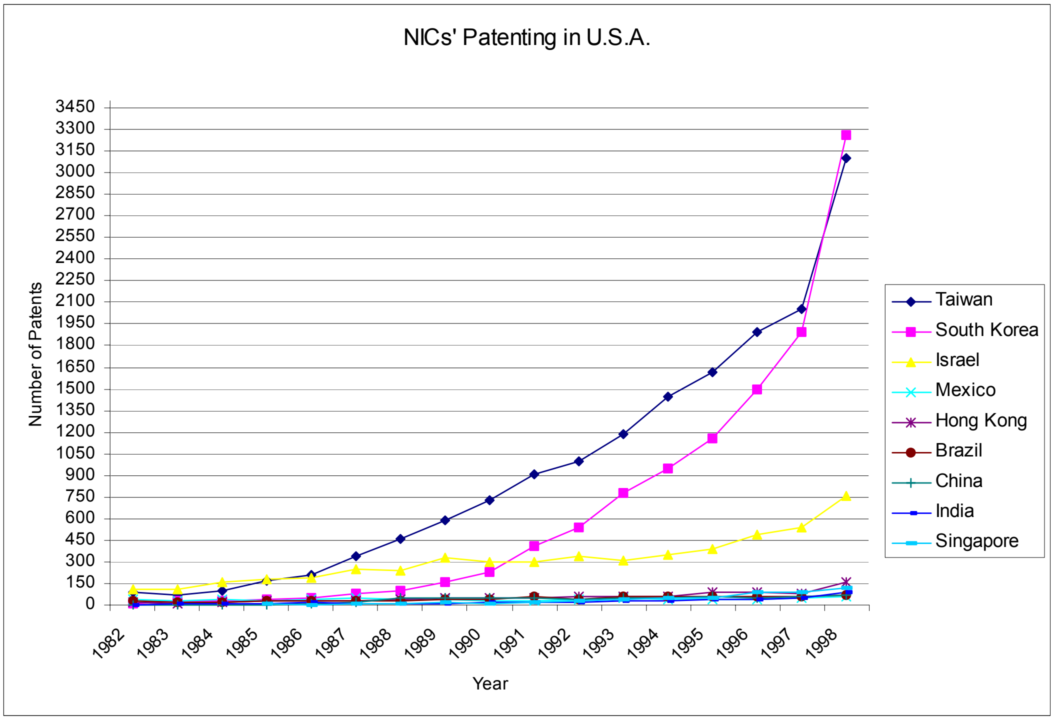
Table 11 presents a cross-country comparison of publications in peer-reviewed scientific journals. It also gives the relative citation rate (RCR) that measures observed citation rate/expected citation rate. An RCR of less than one indicates a below average citation. This is the case for most developing countries. In a country with a prolific publishing output, the citation rate is likely to be higher. One should not give too much weight to the RCR, although it can be an indicator of changing quality. Hong Kong, Singapore, and Thailand have shown improvement over time, whereas India, China, Malaysia, and Pakistan do not show significant improvement in RCR.

One of the drawbacks to the Science Citation Index (SCI) is that it may not cover many local journals or may cover only English-language journals and periodicals. Tables 11 and Table 12 illustrate the discrepancies in coverage. Table 12 cites Chinese output of 101,983 published papers in 1993, whereas in Table 11 only 27,172 papers were recorded for China during 1989-93 using standard citation sources.

One indicator of applied research is the number of patents. However, the tortuous effort expended to secure a patent may only seem worthwhile within a regime of intellectual property rights and a culture of patenting. The recent global discussions on Trade-Related Aspects of Intellectual Property Rights (TRIPS) have generated considerable awareness and interest in patents.

Figure 1 shows the number of patents registered in the USA for selected newly industrialized countries.

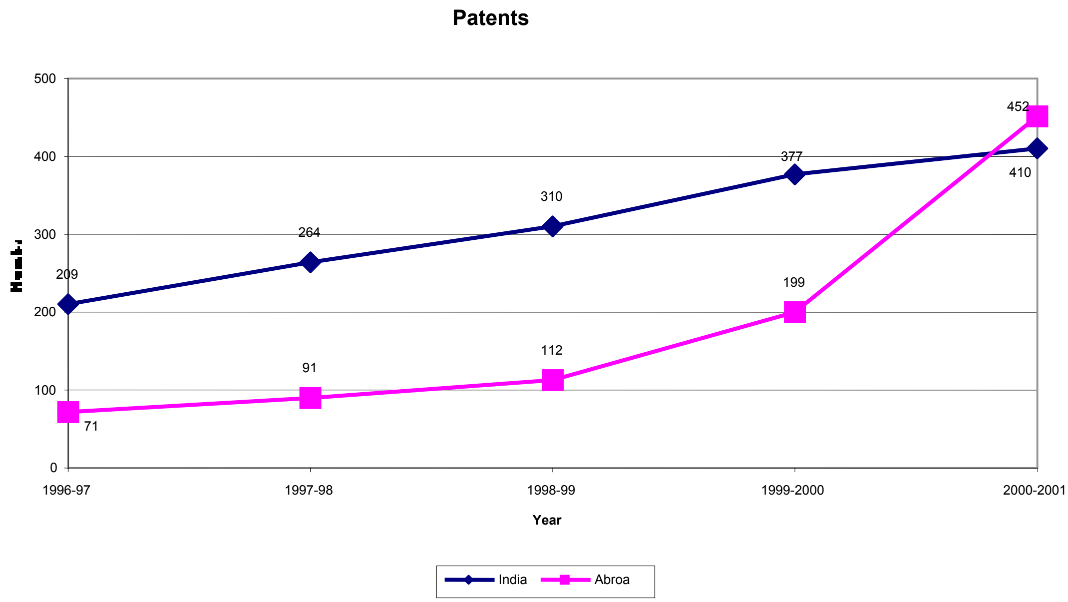
Figure 1. Patents by NICs in the USA.



Source: Forbes 2003.

Korea and Taiwan demonstrate rapid growth, with India and China well below. This may reflect the countries' different research goals, and the quality of research. There has been an increasing emphasis on registering patents and protecting intellectual property rights in many developing countries in recent years. This is reflected in the growth of patents obtained in the USA by India's CSIR, as shown in Figure 2.

Figure 2. Patents filed by CSIR, India.



Source: CSIR. Annual Report 2000-01. New Delhi.

Similar growth in patent filing is also seen in Taiwan and Sri Lanka. Taiwan filed 34,343 patents in 1990 and 43,461 in 1995. Similarly, Sri Lanka granted 35 patents in the three-year period ending in 1984 and 164 patents in the three-year period ending in 1998.
In terms of "patent points," Taiwan and Korea have reached developed country status, as shown in Table 13. Table 14 shows how patenting activity has increased in China, jumping from 7,836 patents in 1992 to 17,256 in 1997. Table 15 shows the type of patents by organization. As expected, firms dominate the patent process, with hardly any applications from R&D institutes and universities.

Social science research for development

Social science research can inform development problems and policies. It is, however, difficult to establish causality between a particular research output and a change in policy. The impact of policy research takes place in many ways: it creates a consensus for a particular policy change; the skills and knowledge of researchers affect policy when they become policy advisors or policymakers; and research results may bring a new perspective to an issue. It is difficult to find indicators to evaluate this impact.

An analysis of two publication indexes illustrates the difficulties in evaluating research outputs. Table 16 lists the number of publications by author's country, as found in the Social Science Citation Index (SSCI) for 1997,[3] and the Econlit database of economic literature from 1969-2003 (May), compiled by the American Economic Association.

The very small number of publications by China in the SSCI reflects the English language bias of these indexes. Hong Kong published nearly 50 percent more than India in the SSCI in 1999. The Econlit search is based on the country name appearing in the title, affiliation, keywords, abstract, or geographic description. Some papers may not have included the country name in this criteria, and so would not appear in the index. This then, is only a rough indicator of the research related to or by the nationals of a country. Most of the larger countries have an active publishing sector. In the case of economic research, several popular local journals exist, such as India's Economic and Political Weekly (EPW), which are not listed in Econlit. EPW is an outlet for much of India's applied policy research and yet is ignored by Econlit. The Institute for Studies in Industrial Development's (ISID) database of 100 Indian social science journals lists 120,000 entries, compared to only 9,431 in Econlit (Table 16). (ISID website www.isid.org.in).

Though many policy research institutions in India are autonomous, they are mostly supported by government. Such funding is generally automatic with a peer review process that is not too rigorous. Even when funding from multilateral agencies or donors is obtained, a project must be cleared by the relevant government ministry. In China, researchers are mostly funded by government. In Viet Nam, each ministry has its own research institute.

In some Asian countries, donors and multilateral agencies play a large role. In Cambodia, most of the research funding is from foreign donors. As a result, there appears to be more funding available for consultancies, but little for core research, a common problem for many countries. Donors, although willing to pay large amounts to foreign consultants, are critical of supporting overheads in local institutions. The importance of sustained research and capacity-building for policy analysis is clearly evident from the experience of the International Development Research Centre's (IDRC) MIMAP project (Micro Impacts of Macroeconomic and Adjustment Policies Program Initiative), in Bangladesh, the Philippines, and India.

A large presence of international nongovernmental organizations (NGOs) — 150 in Nepal alone — can distort the local research setting. An internal brain drain can take place, as NGOs attract researchers, offering higher salaries. In one sense, one could argue it is a better situation, as the researchers are still working within their own borders.

In most Asian countries, a position in a research institute is usually a permanent position. Yet the incentive and motivation to remain productive and overcome complacency must come from within.

The research capacity to deal with policy issues is limited in most countries; even in India, which has a vigorous and relatively developed social science research community. Even though government-supported research institutes are generally free to pursue their own research, the agenda of economic policy research in India is very narrow. A disproportionately portion of the focus of poverty research is descriptive rather than prescriptive. In many policy areas, one would have difficulty identifying more than one or two researchers. Thus, society does not benefit from alternative viewpoints. The economic reforms initiated in June 1991 threw up a new set of questions, not addressed till then by Indian researchers. Some of these are now getting more attention.

For policy research to be effective, policymakers must be open to suggestions from academics. In many Asian countries, academic researchers have access to government through working groups, advisory committees, and so on. Of course, final policy decisions factor in many other considerations.

The Environment for Research

The context in which research is carried out greatly determines its success. Political support, the cultural environment, institutional framework, funding mechanisms, and the economic policy environment are all critical.

Political support and cultural attitudes

Political support for science and technology and R&D is high in many countries, as reflected in researchers per million inhabitants. Of the 16 countries listed in Table 2, only three have fewer than 100 R&D personnel per million inhabitants. Asian countries, with their common experience of colonial rule by technologically and industrially advanced European countries have, by and large, recognized the importance of technological self-reliance and industrialization. Most, I think, share the sentiments expressed eloquently by Jawaharlal Nehru:

> I am convinced that of all the big problems that face India today nothing is more important that the development of scientific research, both pure and applied, and scientific method. This is indeed the basis and foundation of all other work. … The extensive use of that method can only come through a properly directed education and a large number of research institutions which deal with pure science as well as the innumerable applications of it.

Traditionally, Asians respect learning. Teachers, as per a Sanskrit saying, are to be considered as gods. Researchers enjoy high social status. In the Buddhist tradition, knowledge and wisdom command more respect than wealth. Thus, attracting bright persons to academic and research jobs has not been a problem for Asian countries. Achieving their potential, however, requires resources and an appropriate institutional framework.

Financial resources

Until recently, most of the research in Asian countries was supported mainly by government. However, the role of privately funded research is growing. Table 17 shows funding by source. In the late 1980s, governments covered the majority of R&D expenditure in most countries. In the 1990s, the role of business enterprises increased dramatically in Indonesia, Korea, Malaysia, and Singapore. In Japan, business has held a dominant position since the 1980s.

Funding sources for R&D in China are shown in Table 18. Here, the government share has declined while enterprises' share has gone up. Of course, many Chinese enterprises are government-owned.

In the 1950s, 1960s, and 1970s, most Asian countries followed a strategy of import substitution industrialization. Thus, technology acquisition through imports, absorption, and reverse engineering was promoted. While such innovations are better done in client-funded research projects, much research was done in publicly funded research institutions. As a result, its effectiveness was limited, as evidenced by a number of review committee reports by India's CSIR.

The dominance of public institutions: some implications

A strong case can be made for government support for research:

- Basic research is a public good and as not all the benefits are apparent or appropriable, the market would underinvest
- Uncertain research outcomes call for a diversified portfolio
- Some kinds of research require wide diffusion to gain benefits, e.g., in crop variety research, in reproductive health/rights, or in environmental research
- In sectors in which technology cannot be acquired, for example, defence/military research or research related to critical so-called dual-use products
- Organized research in special areas that require a multi-institutional, concerted effort with a targeted mission.

The need for public funding does not imply that research should be done in public institutions. The institutional architecture in many Asian countries is one where public institutions dominate. This has some implications, particularly for policy research.

The trouble with relying on government funding is that it often comes with many conditions. Coping with bureaucratic procedures is one such condition. Even when a research institution is fully autonomous and operating without political interference, government ownership, even once removed, imposes a large measure of uniformity and mediocrity. R&D requires creativity and thrives on freedom and meritocracy, which can be difficult in government supported institutions. Pay scales become uniform across disciplines, promotions become time bound, and job security becomes inviolable. Merit-based promotions or incentives raise the ire of trade unions. This describes the Indian research environment, but it could easily fit other countries where government- supported institutions dominate.

True, government funding does not have to be channeled through government institutions. There could be competition among private institutions and individual researchers for government funding. Maintaining the integrity of such a mechanism is critical for its success. Even when competition for research funding is introduced, who you know may matter more than the merit of your proposal.

Another difficulty with public sector dominance in policy research is that it might discourage the dissemination of "unpleasant" conclusions. This is critical for social science research but not so important for R&D in science and technology. However, freedom of thought is important for lateral thinking and a closed and authoritarian regime can seriously hinder S&T research for years. When public masters, bureaucrats, and politicians change periodically, researchers may become paralyzed and shy away from research that might undermine, embarrass, or oppose present or future masters. In the mid-1980s I worked with many researchers from Eastern Europe at the International Institute for Applied Systems Analysis in Austria and was struck by their reluctance to make even conditional policy statements. I often heard "but this is politics; how can I say anything." We have also seen how China's Cultural Revolution nearly destroyed its research capacity.

Institutional set-up for leapfrogging: lessons learned

While the focus of research in many Asian countries has remained on catching up to the technological frontier, the desire to leapfrog to the front has always been strong. There are a few success stories.

China

A Chinese electronic publishing system now dominates the world market and is a major success story (Lu and Lazonick 2001). It was developed under a mission-oriented program started under central planning. It involved a coordinated effort by a number of institutions and was funded by the government. Innovative algorithm, software, and application specific integrated circuits were developed.

The scope to develop this product existed because the large domestic market was protected and the outside market was too small to attract interest. High-tech capacity creation requires coordination and public funding. Even Silicon Valley and Boston's Route 128 were promoted by the US Defence Department, NASA, MIT, and Stanford.

Korea

Korea has leapfrogged in a number of sectors. In fact, Korean industrial patents in the USA have increased at a faster rate than US patents over 1986-93 (Lee and Lim 2001). Among the more noteworthy examples is the automobile industry, where Korean cars enjoy a high global market share, the development of the 64 Mbit D-ram chip, and development of the CDMA cell phone.

The automobile industry is scale-intensive, less science-based, and has a more predictable innovation path. Latecomers have a chance to catch up and can set clear R&D targets with low risk. (Another example is the 2001 development of the *Indica*, a passenger car built by Tata in India, which sells internationally.)

The D-Ram industry has a high frequency of innovation but the path of innovation is predictable.

The CDMA cell phone created a new path and required public-private partnerships with government playing a critical role in forming a consortium.

Taiwan
Taiwan has developed through a consortium route a number of innovative products (Mathews 2002). These include the Ethernet data switch (1992-96), the four-cylinder automotive engine (1992-97), and the electric scooter (1991-96). These consortia have been organized by ITRI, which identifies technological issues and develops specifications and prototypes. ITRI also helps to secure access to new technology on behalf of Taiwanese firms.

However, the consortium approach did not work in the machine tool industry, where the frequency of innovation is low and producers, who use machine tools, want high quality products. Also, use of these tools requires investment in worker's skills and breaking into the market is difficult. By and large, the Korean consortia have not worked as well as its Japanese counterpart (Sakakibara and Cho 2002).

Thus, the technological regime of industry, institutional set-up, and government policy, contribute to the success of leapfrogging.

Some Asian countries like India, China, Singapore, and Taiwan have set up ambitious programs to gain global technological leadership in some sectors.

Structural reforms and globalization

The process of structural reforms could affect indigenous technological development and the research scene. Competition from well-established multinational corporations (MNCs), jealous protection of intellectual property by the developed countries, and an intellectual property rights (IPR) regime that does not adequately protect indigenous knowledge and even facilitates biopiracy, pose difficult challenges.

Most Asian economies have liberalized trade, deregulated industries, are outward-oriented, and welcome foreign direct investment. Liberalization may promote imports of technological know-how and capital goods, discouraging products based on own R&D (PBRD). On the other hand, removing size restrictions on domestic firms might stimulate domestic R&D. Katrak (2002) finds that in India during 1991-98 (major reforms began in 1991), the share of PBRD did not go down and domestic R&D went up in two industries for which data was available. Ramani (2002) also argues that when other factors are accounted for, in-house R&D and technological imports do not seem to be related.

Munari et al. (2002) found that privatizing a firm with in-house R&D reduces R&D allocation as a percentage of sales, shifts the focus to short-term projects, lowers employment in R&D, and gives greater attention to R&D productivity.

Trade liberalization can lead to induced learning and helps bridge the technology gap. Both exports and imports are important as exports have to compete with quality and price and domestic products must compete against imports. The learning that takes place depends on the nature of traded goods. A country's trading partners are a key factor in determining trade-induced technology spillovers (Chuang 1998). Openness is a prerequisite, but not a sufficient condition for learning.

Thailand, with its large inflows of FDI and openness to trade, has not acquired much innovation capacity (Intarakumnerd et al. 2002). Though it emphasized human resources development, the weakness of the macroenvironment and of the national innovation system did not match up. Korea and Taiwan showed extraordinary intensive learning for catching up, demonstrating purposive strategic management. Thailand has acquired little capability for design and reverse engineering among SMEs. Foreign direct investment was promoted in Thailand for employment generation, unlike in Korea and Singapore where FDI was also used to augment local technological capability. Thailand did not have a selective industrial policy nor were tariffs and entry restrictions related to technological capability.

The S&T Ministry and the Ministry of Industry in Thailand do not work together, unlike Japan's Ministry of International Trade and Industry (MITI), Singapore's Economic Development Board, or Korea's Economic Planning Board. Poor linkages among universities, industries, and firms within an industry resulted in low spillover from MNCs. Fiscal and financial incentives were also ineffective. Thus, even during the high growth era of 1978-90, the total factor productivity growth (TFPG)[2] was small. One should, note, however, Thailand's R&D effort was mostly directed to agriculture, which received 42 percent of total R&D expenditure compared to only 7 percent for industry.

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[2] While the East Asian tigers (Taiwan, South Korea, and Singapore) and the cubs (Indonesia, Thailand, Malaysia, and Philippines) have had rapid economic growth, the TFPG has been rather small (Collins and Bosworth 1996). Collins and Bosworth estimate that over 1960-94, the TFP growth rate was 2.0 for Taiwan, 1.5 for South Korea, 1.5 for Singapore, 0.8 for Indonesia, 1.8 for Thailand, 0.9 for Malaysia, -0.4 for the Philippines, 1.1 for China, and 0.8 for South Asia. These numbers look small compared to their impressive growth rates. Rodrik (1998) has observed that East Asia's TFP is still "quite respectable." TFPG calculation involves many pitfalls. The data on capital stock is hard to find. The assumptions made on depreciation rates, etc., to put a capital time series together, can lead to large errors in TFPG estimates. As Stiglitz (1998) observed, "Any visitor to the cities and factories of East Asia comes away impressed by the enormous technological progress in the last decades. The Young, Kim, Lau, et al. results are not very robust." TFPG data as an outcome of research for development poses many difficulties and has not been used here.

With structural reforms and the ensuing fiscal discipline, public resources for research decline. In Asian countries, as seen earlier, the share of public funding for research has fallen. However, total resources for research have not gone down in most countries over the 1990s. The private sector now bears a larger share. This should give greater client orientation to research and increase the effectiveness of research resources. However, there is a grave danger that important research for development would not be funded by the private sector. Even in areas where research results are appropriable, if the IPR regime does not evolve in step, the private sector would delay entry.

Many countries that depend extensively on funding by aid agencies or multilateral institutions find that the funders agencies dominate their research agenda.

The private sector is also more interested in quick results. Many aid agencies and multilateral institutions also want to show quick results. While quick results are welcome, it does make it difficult to find sustained support needed for long-term research and capacity and institution-building. Structural reforms are likely to aggravate this problem.

Governments undergoing structural reforms should reorient their priorities and restructure their expenditure in areas where resources won't flow from other sources.

Structural reforms can be but need not be harmful to domestic R&D and with the appropriate policy responses in place, they can increase its effectiveness. These policies include an appropriate role for public research, incentives for private sector expenditure on research, and incentives to establish linkages among universities, research institutions, and firms and an appropriate IPR regime.

IPR regimes, indigenous knowledge, and TRIPS

The IPR regime evokes great passion in developing countries. There is some evidence, (Varsakelis 2001), that patent protection increases R&D expenditure as a percentage of GDP. The Asian developing countries have also started to obtain patents. However, the question of ownership over indigenous and traditional knowledge and the rights over it do raise questions about the patent regime (Mathur 2003).

Asian countries, like all ancient civilizations, possess a significant amount of indigenous knowledge. China and India have their own medicinal systems. The many tribal and indigenous groups have their own fund of knowledge about plants, animals, nutrition, health care, and livelihoods. This knowledge needs to be documented, preserved, and scientifically tested.

Traditional knowledge is extremely valuable. About 40 percent of patents are due to expire by 2006. Biotech firms have strong incentives to discover and develop new, active ingredients from traditional medicine and hence the incidents of bioprospecting and biopiracy. Communities and countries that are rich in biodiversity and knowledge of traditional medicine may have much to gain if they are able to share in this traditional knowledge trade and the ensuing investment benefits, provided their knowledge is used with "prior informed consent" and they participate in the design of the potential trade and investment benefits rising from the globalization of the health care industry.

The neem tree (*Azadirachta indica*) is an example of the value of indigenous knowledge. It has been the subject of 153 patents worldwide, virtually all of which have used public domain traditional knowledge as a starting point. Another example is the attempt to patent turmeric in wound healing by the University of Mississippi Medical Center. The patent was challenged and struck down because of lack of novelty and not because of "prior art" as the USA does not hold traditional knowledge held outside its borders as "prior art."

To establish legitimate ownership in a number of countries, People's Biodiversity Registers (PBRs) are being set up with the support of public and civil society organizations. India has set up a program to set up a database of indigenous knowledge.

> Traditional knowledge does not lend itself easily to concepts of property in any form known as IPRs. To hail it as *sui generis* is inadequate without a system of use, rights, and obligations that can be created and operated at least at a national level. It is doubtful that an international *sui generis* system can be instituted without first constructing national *sui generis* systems although it would be useful that international guidelines be agreed upon so that at some stage the national systems created may be harmonized. With China having opted to bring traditional knowledge under IPR ownership, the main initiatives for *sui generis* systems appear to emanate from Peru, Egypt, Brazil and India. The question of who is entitled to seek protection of which forms of traditional knowledge and who may confer recognition and status on the holders of traditional knowledge in a *sui generis* modality raises a number of policy questions about the role of communities and functions of communally held knowledge in traditions that are part of heritage and culture as well as living traditions of habitat preservation and human interactions. Policy questions also arise about the structuring of economic incentives, about rights and obligations that are anchored in responses and behaviour rather than in resources. Questions of valuation are vital to the sharing in value-added and the role of private and public investors organized as nationally networked or globally networked bio-conservors and bio-collectors needs to be examined. Mere digitalization of published or codified information to ease the work of patent examiners cannot resolve the question of how holders of traditional knowledge should be rewarded for their care and feeding of ideas. (Mathur 2003).

Concluding Comments

The research scene in Asia is mixed. The Asian tigers have achieved high levels of performance. Some countries are full of promise. The Asian giants, China and India, conduct research efforts on a wide front. They have become outward-oriented and their exporting small, medium, and large enterprises will soon attain global competitiveness on a wide scale. They aspire to be technological leaders in many sectors.

Leapfrogging efforts in selected areas are currently under way in a number of countries. The ICT and BT revolutions offer opportunities that many Asian countries are keen to seize. Whether they can do it effectively or not depends on many factors, but mainly on their policies.

The Asian countries should spend more on research, as the returns are high in an environment of balanced publicly and privately funded research. They need to carry out institutional reforms to introduce meritocracy in their R&D institutions. They need to promote gender equity to mobilize the intellectual power of women. They need an effective incentive system including an IPR regime. They need to improve their policy regimes.

Once Asia reaches a level of research effort in terms of researchers per million persons comparable to the industrialized countries, the flow of innovations will be mind-boggling. That time is not too far in the future. Would the current IPR regime facilitate such flows or create a gridlock of claims and counterclaims?

Even the smaller countries, need not despair. Singapore and Hong Kong are examples of what small states can do. They need to set a vision and pursue it. They may, however, need help to get started.

How to move ahead is a formidable test. The importance of policy research should not be underestimated. There is a paucity of policy research in many areas. Countries do not enjoy a plurality of advice. Independent policy research needs more support. Sustained support for core research and for institution building is also scarce. Multidisciplinary policy research, for example, on environmental issues, usually receives inadequate support and faces many institutional obstacles. In fact, policy research can be made more effective, if in addition to being multidisciplinary, it also involves stakeholders in the research process itself. We need to better understand the problems facing women researchers and eliminate discrimination to facilitate their fuller participation. Research is also needed to help establish the rights of indigenous people over their traditional knowledge.

Appendix: Tables 1-18; Tables A1-A8

Table 1. Patterns of some development indicators in Asia.

Country		Population (in millions) (2000)	GDP per capita (PPP US$) 2000	HDI value 2000	GDI Value	GDP per capita annual growth rate (%)	% change in HDI trend from 1975 to 2000	Absolute change in HDI from 1975 to 2000	S&T Capacity Index (Sagasti Index)[a]
Asian developed country									
	Japan	127.1	26,755	0.933	0.927	2.7	9	0.079	0.83
Asian giants									
	China	1,275.1	3,976	0.726	0.724	8.1	39	0.203	0.33
	India	1,008.9	2,358	0.577	0.560	3.2	42	0.17	0.25
Asian tigers									
	Hong Kong, China (SAR)	6.9	25,153	0.888	0.886	4.6	17	0.132	0.28
	Korea, Rep. of	46.7	17,380	0.882	0.875	6.2	28	0.191	0.57
	Singapore	4.0	23,356	0.885	0.880	5.2	23	0.163	0.53
Asian cubs									
	Indonesia	212.1	3,043	0.684	0.678	4.4	46	0.215	0.12
	Malaysia	22.2	9,068	0.782	0.776		27	0.166	0.34
	Thailand	62.8	3,971	0.754	0.751	5.5	16	0.102	0.22
	Philippines	75.7	6,402	0.762	0.760	0.1	26	0.158	0.17
Other large Asian countries									
	Bangladesh	137.4	1,602	0.478	0.468	2.2	43	0.143	0.09
	Cambodia	13.1	1,446	0.543	0.537	1.9			
	Mongolia	2.5	1,783	0.655	0.653				0.03
	Myanmar	47.7	1,027	0.552	0.548	1.3			
	Pakistan	141.3	1,928	0.499	0.468	2.8	45	0.154	0.13
	Sri Lanka	18.9	3,530	0.741	0.737	3.2	20	0.125	
	Viet Nam	78.1	1,996	0.688	0.687	4.8			0.10
Other small Asian countries									
	Bhutan	2.1	1,412	0.494	..	4			
	Fiji	0.8	4,668	0.758	0.746	0.7	15	0.098	
	Lao People's Dem. Rep.	5.3	1,575	0.485	0.472	3.2			
	Maldives	0.3	4,485	0.743	0.739	5.8			
	Nepal	23.0	1,327	0.490	0.470	2.1	70	0.201	
	Papua New Guinea	4.8	2,280	0.535	0.530	0.5	27	0.115	
	Samoa (Western)	0.2	5,041	0.715	..				
	Solomon Islands	0.4	1,648	0.622	..				
	Vanuatu	0.2	2,802	0.542	..				
East Asia and the Pacific		1,859.1	4,290	0.726	..	5.9			
	South Asia	1,402.3	2,404	0.570	..	2.4			

Source:
Note: HDI: Human Development Index. GDI: Gender Development Index. PPP: Purchasing Power Parity
Two dots (..) indicate that data is not available or is not reported separately.

[a] Sagasti 2002.

Table 2. Resources for research.

Country	Year	Researchers per million inhabitants	R&D expenditure (% GNP)	R&D personnel		S&T Capacity Index
				Total	Researchers	
Japan	(1996)	4909	2.80	891,783	617365	0.84
China	(1996)	454	0.61	787,000	559,000	0.33
India	(1994)	149	0.73	336,589	136500	0.25
Hong Kong (China)						0.28
Korea, Rep.	(1996)	2193	2.82	135,703	99433	0.57
Singapore	1995	2318	1.13	9,497	7695	0.53
Taiwan	1995	2100	1.79	---	63,457	…
Indonesia	(1988)	182	0.19	36,185 (1984)	2160	…
Malaysia	(1996)	93	0.24	4,436	1893	0.36
Philippines	1992	157	0.22	14,578	9960	0.16
Thailand	1996	103	0.13	10,209	6038	0.22
Bangladesh	(1995)	52	0.03	16,629	6.097	…
Pakistan	1997	72	0.92 (1987)	36,706	9977	0.13
Sri Lanka	1996	191	0.19	4,281	3448	…
Viet Nam	1995	255	…	…	20000	0.10…
Mongolia	1995	910	…	3,599	2228	0.03

Source: Data from last 3 columns is from UNESCO, except for Taiwan (S&T white paper website: ….).
Column 4, S&T Capacity Index from Sagasti, F. Knowledge, Technology and Production. First draft. August. The S&TCI is a combination of internal capacity (number of scientists and engineers, R&D expenditures/GDP, exports of high tech sectors/total exports) and external linkages (scientific publications, number of patent application, and infrastructure, communications and technology index).

Table 3, Science and technology education in India and China.

Indicator	India	China
Number of institutions of higher learning	8421 (1994)	1065 (1993)
Total enrolment	5.007m (1994)	2.065m (1990)
Total number of teachers	0.286m (1994)	0.4m (1990)
Student/teacher ratio	17.5:1	5:1
Enrolment in postgraduate and research	531000 (1994)	107000 (1993)
Total number of postgraduates	476000 (1994)	89000 (1993)
Total number of PhDs	55000 (1994)	18000 (1993)

Source: Jain and Kharbanda (1999), Table 5, p.120.

Table 4. Basic education and literacy.

Country or area	2nd-level gross enrolment ratio (per 1000)		Girl's share of 2nd-level enrolment (%)	Percentage illiterate 1985/2000[a]				3rd level students per 1000		Women's share of 3rd level enrolment
	1998/2000		1992/1997	Ages 15-24		Ages 25 +		1992/1997		1992/1997
	W	M		W	M	W	M	W	M	
Afghanistan		..	25	..	..	..	..			
Bangladesh	56	52	..	60	43	..	..			
Brunei Darussalam	116	105	52	2	2	24	10			
Cambodia	12	22	36	26	16	..	..	0.3	1.7	16
China[i]	60	66	46	9	3	42	17	3.3	6.1	
India	40	59	38	35	20	..	..	4.8	7.9	36
Indonesia	54	56	45	5	3	34	16	8.1	15.2	35
Lao People's Dem. Rep.	29	42	39	29	15	..	..	1.5	3.6	30
Malaysia	104	94	57	5	4	31	15			
Maldives	44	41	..	2	2	5	5			
Mongolia	71	58	57	1	1	..	..	24.3	10.8	69
Myanmar	35	35	50	10	9	..	..	6.9	4.4	
Nepal	45	62	32	67	32	89	59	[1]		
Pakistan	32	46	32	58	29	..	..			
Philippines	79	73	..	3	4	9	7	34	25.6	57
Republic of Korea	97	98	48	<1	<1	..	..	41.8	70.1	37
Singapore	..	..	47	1	1	21	6	22.5	27.9	44
Sri Lanka	74	70	51	3	3	..	..	3.9	5.6	44
Thailand	80	78	..	2	2	11	6			
Viet Nam	61	68	..	7	7	22	8			
Japan	103	102	49					27.2	35.8	44
USA	95	94	49					58.4	48.2	56

Source: See Unesco Institute for Statistics website (http://www.uis.unesco.org, accessed December 2002) for second-level gross enrolment ratio; UN, Women's Indicators and Statistics Database (Wistat) for girls's share of second-level enrolment.

Note: Two dots (..) indicate that data is not available or not reported separately.

[a]Data refers to the latest year available after 1985. For the exact reference year, see UN, Statistics Division Social Indicators website (http://www.un.org/Depts/unsd/social/illiteracy.htm)

Table 5. Women's wages relative to men's.

Country/ area	Women's wages in manufacturing as a percentage of men's wages	
	1990	1995/2001
Asia		
Bangladesh	49	..
China, Hong Kong SAR	69	66
Malaysia	49	63
Myanmar	106	112
Philippines	..	80
Republic of Korea	50	58
Singapore	55	59
Sri Lanka	88	82
Thailand	64	68
Japan	41	59

Note: Two dots (..) indicate that data is not available or not reported separately

Table 6: Women in public life.

	% parliamentary seats in single or lower chamber occupied by women			% women in decision-making positions in government			
Country/area				Ministerial level		Subministerial level	
	1987	1995	2002	1994	1998	1994	1998
Asia							
Japan	1	3	7	6	0	8	3
China	21	21	22	6	..	4	..
India	8	8	9	3	..	7	..
Republic of Korea	3	2	6	4	..	0	..
Singapore	4	4	12	0	0	4	8
Indonesia	12	12	8	6	3	1	1
Malaysia	5	8	10	7	16	0	13
Philippines	9	9	18	8	10	11	19
Thailand	3	6	9	0	4	2	7
Bangladesh	9	11	2	8	5	2	0
Cambodia	21	6	7	0	..	7	..
Lao People's Dem. Rep.	..	9	23	0	0	5	0
Myanmar	..	..	..	0	0	0	0
Nepal	6	..	6	0	3	0	0
Pakistan	9	2	2	4	7	1	1
Sri Lanka	..	5	4	3	13	6	5
Viet Nam	18	18	27	5	0	0	5
Bhutan	2	0	9	22	0	0	8
Mongolia	25	4	11	0	0	0	0
Afghanistan	..	..	..	0	0	0	0
Brunei Darussalam	..	..	..	0	0	0	6
Maldives	2	6	6	5	6	6	11

Note: Two dots (..) indicate that data is not available or not reported separately

Table 7. Agricultural research in some Asian countries.

Country	1959	1971	1980
Agricultural research expenditures (000 constant 1980 US$)			
Japan	135414	575260	684276
China	54166	535344	643555
India	24825	66108	120167
Hong Kong	141	200	132
South Korea	2538	23381	29012
Taiwan	1975	5400	14000
Indonesia	564	8688	33200
Malaysia	3386	11740	30391
Philippines	2781	5499	9533
Thailand	1552	11740	21600
Bangladesh	-	2348	27613
Nepal	906	2163	2634
Pakistan	2256	4696	29899
Sri Lanka	3104	6340	5057
(Scientific Person Years)			
Japan	7200	13700	15671
China	1250	13500	17272
India	1150	1950	2345
Hong Kong	9	10	8
South Korea	300	744	960
Taiwan	250	375	452
Indonesia	15	340	1473
Malaysia	40	195	386
Philippines	200	600	640
Thailand	150	600	1264
Bangladesh	-	150	1320
Nepal	71	169	226
Pakistan	120	250	1212
Sri Lanka	50	105	422

Source: Pray 1991.

Table 8. Number of agricultural research institutions/centres.

Country	Number. of agriculture research institutes
Bangladesh	36
Bhutan	3
Cambodia	2
China	83
Fiji	10
India	141
Indonesia	42
Korea	40
Laos	7
Malaysia	14
Mongolia	7
Myanmar	5
Nepal	8
Pakistan	117
Papua New Guinea	6
Philippines	170
Samoa	3
Solomon island	6
Sri Lanka	35
Taiwan	37
Thailand	42
Tonga	1
Tuvalu	1
Vanuatu	5
Viet Nam	44
Source: http://www.asti.cgiar.org/profiles/india.cfm?arow=86	
Accessed 7th August 2003.	

Table 9: Rates of Return on Agricultural Research in Asia.

Region/country	Commodities	Period	Internal rate of return
Consumer/producer surplus approach			
Malaysia	Rubber	1932-73	24
Bangladesh	Wheat, Rice	1961-77	30 – 35
Pakistan	Wheat	1967-81	58
	Maize	1967-81	19
Meta Production Function			
India	Crops	1961-71	63
Philippines	Rice	1966-75	75
Indonesia	Rice	1972-77	100+
Bangladesh	Crops	1948-81	100+

Source: Pray and Ruttan 1990.

Table 10. Performance in basic research (1995-2001) – Research Organizations in India.
(Based on Science Citation Index CD version)

Year	Space		Atomic Energy		DRDO		ICAR		ICMR		IITs		CSIR	
	Total papers	Impact factor per paper	Total papers	Impact factor per paper	Total papers	Impact factor per paper	Total papers	Impact factor per paper	Total papers	Impact factor per paper	Total papers	Impact factor per paper	Total papers	Impact factor per paper
1995	47	0.85	487	1.36	131	1.01	156	0.65	101	1.59	1165	1.14	1576	0.89
1995	31	0.90	531	1.29	136	1.01	189	0.78	79	1.89	1202	1.11	1625	1.26
1997	48	0.91	536	1.58	124	0.88	170	0.87	88	1.33	1120	1.19	1563	1.47
1998	56	0.99	612	1.47	142	1.11	212	1.06	104	2.82	1283	1.16	1521	1.51
1999	56	0.95	628	1.23	116	0.88	234	0.84	109	1.95	1298	1.16	1699	1.54
2000	51	1.19	598	1.69	102	1.03	200	0.81	99	1.84	1279	1.24	1667	1.52
2001	70	0.97	486	1.47	137	1.01	215	0.91	111	1.78	1347	1.26	1700	1.70

Note: DRDO: Defence Research and Development Organization. ICAR: Indian Council of Agricultural Research.
ICMR: Indian Council of Medical Research. IITs: Indian Institutes of Technology.
CSIR: Council of Scientific and Industrial Research. SPACE: Department of space.

Table 11: Publication output and citation impact of select countries

Country	1980-84			1985-89[a]			1989-93[b]		
	Publications	Citations	RCR	Publications	Citations	RCR	Publications	Citations	RCR
USA	738074	9610923	1.03	801432	3656057	1.05	878866	4503074	1.06
UK	179918	1793857	1.04	194553	648918	1.02	210528	781406	1.07
Japan	134947	1016867	0.92	166553	447756	0.93	205323	614501	0.95
India	57655	142461	0.57	47372	45407	0.56	48661	52841	0.55
China (PR)	9367	13506	0.54	16598	12292	0.53	27172	26374	0.54
Hong Kong	1627	8822	0.70	3019	5111	0.74	4285	7817	0.76
Singapore	858	3094	0.58	1962	2272	0.66	3209	5198	0.80
Pakistan	706	1703	0.46	1108	808	0.52	1442	1131	0.51
Thailand	931	3828	0.63	1133	1954	0.64	1304	2293	0.69
Malaysia	865	2833	0.51	962	899	0.56	1257	1285	0.54

Source: [a] Braun et al. 1994. World science in the eighties: National performance in publication output and citation impact 1985-89 Vs. 1990-94, Scientometrics 29. pp.301-303.
[b] Braun et al. 1995. Scientometric weight of 50 nations in 27 science areas, 1989-93. Scientometrics 34. pp. 207-237.
Note: RCR: Relative Citation Rate = (ΣObserved citation rate / ΣExpected citation rate). The value of RCE > 1 indicates that the papers are, in average, more cited than the references standard.
Compiled by K.C. Garg, Scientist, NISTADS, New Delhi.

Table 12. Total and joint Chinese science and technology papers.[a]

	1992	1993	1994	1995	1996	1997
Total papers	98575	101983	107492	107991	116239	120851
Total university papers	53405	57332	63361	66494	72447	76986
Total R&D institute papers	25901	24621	24257	23623	24780	24821
Total firm papers	10489	10665	10134	8827	9022	8606

Source: Liu and White. 2001. Comparing Innovation Systems: A Framework and Application to China's Transitional Context. Research Policy, 30. pp.1091-1114.

Note: [a] Calculations based on data from the statistical analysis of S&T papers of China, 1992-1997, China S&T Information Institute.

Table 13. Number of US patent points awarded to major countries.

Country	1995		1994		1993		1992		1991	
	Points	Rank	Points	Rank	Points	Rank	Points	Rank	Points	Rank
USA	55,586.2	1	55,940.7	1	55,172.1	1	52,158.1	1	51,135.1	1
Japan	21,794.7	2	22,379.6	2	20,946.1	2	21,917.6	2	21,027.3	2
Germany	6,609.8	3	6,729.2	3	6,591.7	3	7,314.6	3	7,669.8	3
France	2,820.8	4	2,777.5	4	2,809.2	4	3,023.9	4	3,039.9	4
UK	2,502.5	5	2,250.0	5	2,264.0	5	2,424.6	5	2,800.3	5
Canada	2,097.6	6	2,022.4	6	1,907.4	6	1,974.4	6	2,029.4	6
R.O.C.	1,625.8	7	1,441.1	7	1,185.3	8	998.6	9	908.4	10
S. Korea	1,166.2	8	950.8	10	764.9	11	536.7	12	402.5	13
Hong Kong	92.1	23	63.5	23	61.2	23	62.9	24	51.3	27
Singapore	53.4	27	54.2	26	39.2	29	32.2	31	15.0	37

Source: International Technology Indicators Database. March 1996., CHI Research Inc., USA.

Table 14. Total and joint patenting activity in China.[a]

	1992	1993	1994	1995	1996	1997
Total patents	7836	12902	7576	7762	10898	17256
Total university patents	1214	1774	1078	891	854	774
University patents as % total	16	14	14	12	8	5
Total R&D institute patents	1705	2558	1514	1485	1387	1472
R&D institute patents as % total	22	20	20	19	13	9
Total firm patents	4917	8570	4984	5386	8657	15010
Firm patents as % total	63	66	66	69	79	87

Source: Liu and White. 2001.

[a] Calculations based on data from the Annual Review of Patents, 1992-1997, National Bureau of Intellectual Property Rights, Beijing.

Table 15. China patent type and organization, 1996.

Organization	(Percentage in each type of patent)		
	Invention patents	Utility patents	Design patents
R&D institutes	38	20	2
Universities	34	12	0
Firms	29	68	98
Total patents	654	5075	5161

Source: Based on Liu and White. 2001.

Table 16. Social science publications by Asian authors.

	Social Science Citation Index 1997[a]	Econlit 1989 to March 2003[b]
Japan	1272	15200
China	17	8802
India	466	9431
Hong-Kong	647	4303
Korea	225	4597
Singapore	216	3176
Taiwan	279	3119
Indonesia	38	2584
Malaysia	38	1847
Philippines	53	1960
Thailand	74	1668
Afghanistan	0	67
Bangladesh	40	1738
Cambodia	2	65
Lao (Laos)	0	115
Maldives	0	16
Myanmar / Burma	0	109
Nepal	13	342
Pakistan	32	3272
Sri-Lanka/Ceylon	18	783
Vietnam/Viet Nam	16	737
Bhutan	0	13
Brunei	4	64
Fiji	20	191
Kiribati	0	19
Mongolia	1	142
Papua New Guinea	0	308
Samoa	0	39
Solomon Islands	1	58
Vanuatu	2	32

Note: [a] By author's address.
[b] In title, keyword, abstract and geographic descriptor.

Table 17. Percentage distribution of gross domestic expenditure on R&D by funding source.

Country	Reference year	Currency	Total gross domestic expenditure on R&D	Business enterprise	Government (%)	Higher education (%)	Private nonprofit (%)	Funds from abroad (%)	Not distributed (%)
Asia									
India	1982	Rupee (36)	12 060 300	13.4	82.7	¡K	¡K	¡K	3.9
	1994		75 063 500	24.0	75.0	1.0	¡V¡V>	-	-
Indonesia	1984	Rupiah	279 000 000	-	100.0	-	-	-	-
	1994	(23)	244 843 000	76.4	15.8	0.5	-	7.2	-
Japan	1980	Yen	5 246 248 000	72.0	27.9	-	-	0.1	-
	1991		13 771 524 000	81.7	18.2	-	-	0.1	-
Korea, Rep. of	1980	Won	211 726 652	48.4	49.8	-	-	1.8	-
	1994		7 894 746 000	84.0	15.9	-	-	-	-
Malaysia	1988	Ringgit (7)	87 100	-	100.0	-	-	-	-
	1996		549 100	8.3	13.5	¡K	¡K	1.6	76.6
Pakistan	1984	Rupee (26)(7)	3 834 287	-	100.0	-	-	-	-
	1987	(26)(7)	5 582 081	-	100.0	-	-	-	-
Philippins	1984	Peso	614 080	23.6	60.8	2.4	¡K	13.0	0.1
	1992		*2 940 549	*1.9	*3.2	*70.2	¡V¡V>	*24.7	-
Singapore	1984	Dollar (25)	214 300	43.0	49.0	-	-	8.0	-
	1995	(25)	1 366 570	62.5	31.4	2.4	¡V¡V>	3.7	-
Sir Lanka	1983	Rupee (6)	217 608	./.	91.2 (28)	¡K	¡K	8.8	-
	1984	(6)	256 799	¡K	83.7	¡K	¡K	16.3	-
Thailand	1985	Baht	3 473 000	13.8	69.6	-	-	16.6	-
	1996	(29)	5 528 135	¡K	61.1	6.8	8.7	5.0	18.4
Viet Nam	1983	Dong	331 000	-	100.0	-	-	-	-
	1985		498 000	-	100.0	-	-	-	-

For general explanations and definitions, please refer to the beginning of this chapter.

Notes: (6) Data refer to government funds and funds from abroad.
(7) Data refer to government funds only.
(20) Data refer to scientific and technological activities (STA).
(22) Data refer to the general service sector only.
(23) Data refer to the productive sector only.
(24) Not including data for humanities and law financed by the universities' current budgets.
(25) Not including data for social sciences and humanities.
(26) Data refer to R&D activities that are concentrated mainly in government-financed research establishments. Social sciences and humanities in the higher education and general service sectors are not included.
(27) Not including funds from abroad.
(28) Business enterprise funds and government fund are counted together.
(29) Not including business enterprise funds
(36) Data refer to business enterprise and government funds only.

Two dots (..) indicate that data is not available or not reported separately.

Table 18. Sources of R&D funding.

	1988	1990	1994	1995	Increase 1988-95 (%) (RMB billion and share of total))
Total	28.1	42.1	74.2	88.4	213
Government	11.8 (42%)	13.9 (33%)	20.9 (28%)	23.1 (26%)	96 (-38)
Enterprises	10.1 (36%)	17.4 (41%)	29.9 (40%)	41.2 (47%)	308 (30)
Banks	4.9 (17%)	5.2 (12%)	11.1 (15%)	11.4 (13%)	133 (-26)
Other	1.3 (5%)	5.6 (13%)	12.3 (17%)	12.7 (14%)	877 (212)

Source: China, Science and Technology Indicators.Various years.

Appendix Table A1:

HDI rank[a]		Life expectancy at birth (years) 2000	Adult literacy rate (% age 15 and above) 2000	Combined primary, secondary and tertiary gross enrolment ratio (%)[b] 1999	GDP per capita (PPP US$) 2000	Life expectancy index	Education index	GDP index	Human development index (HDI) value 2000	GDP per capita (PPP US$) rank minus HDI rank[c]
Asian developed country										
9	Japan	81.0	..	82	26,755	0.93	0.93	0.93	0.933	2
Asian giants										
96	China	70.5	84.1	73	3,976	0.76	0.80	0.61	0.726	0
124	India	63.3	57.2	55	2,358	0.64	0.57	0.53	0.577	-1
Asian tigers										
23	Hong Kong, China (SAR)	79.5	93.5	63	25,153	0.91	0.83	0.92	0.888	-9
27	Korea, Rep. of	74.9	97.8	90	17,380	0.83	0.95	0.86	0.882	1
25	Singapore	77.6	92.3	75	23,356	0.88	0.87	0.91	0.885	-4
Asian cubs										
110	Indonesia	66.2	86.9	65	3,043	0.69	0.79	0.57	0.684	1
59	Malaysia	72.5	87.5	66	9,068	0.79	0.75	0.80	0.782	-7
77	Philippines	69.3	95.3	82	3,971	0.74	0.91	0.61	0.754	20
70	Thailand	70.2	95.5	60	6,402	0.75	0.84	0.69	0.762	0
Other large Asian countries										
145	Bangladesh	59.4	41.3	37	1,602	0.57	0.40	0.46	0.478	-5
130	Cambodia	56.4	67.8	62	1,446	0.52	0.66	0.45	0.543	15
113	Mongolia	62.9	98.9	58	1,783	0.63	0.48	0.85	0.655	21
127	Myanmar	56.0	84.7	55	1,027	0.52	0.75	0.39	0.552	25
138	Pakistan	60.0	43.2	40	1,928	0.58	0.42	0.49	0.499	-7
89	Sri Lanka	72.1	91.6	70	3,530	0.79	0.84	0.59	0.741	19
109	Viet Nam	68.2	93.4	67	1,996	0.72	0.84	0.50	0.688	19
Other small Asian countries										
140	Bhutan	62.0	47.0	33	1,412	0.62	0.42	0.44	0.494	7
72	Fiji	69.1	92.9	83	4,668	0.73	0.90	0.64	0.758	17
143	Lao People's Dem. Rep.	53.5	48.7	58	1,575	0.47	0.52	0.46	0.485	-1
84	Maldives	66.5	96.7	77	4,485	0.69	0.90	0.63	0.743	9
142	Nepal	58.6	41.8	60	1,327	0.56	0.48	0.43	0.490	6
133	Papua New Guinea	56.7	63.9	38	2,280	0.53	0.55	0.52	0.535	-9
101	Samoa (Western)	69.2	80.2	65	5,041	0.74	0.65	0.75	0.715	-15
121	Solomon Islands	68.3	76.6	50	1,648	0.72	0.47	0.68	0.622	17
131	Vanuatu	68.0	34.0	..	2,802	0.72	0.56	0.35	0.542	-18
East Asia and the Pacific		69.5	85.9	71	4,290	0.74	0.81	0.63	0.726	-
South Asia		62.9	55.6	53	2,404	0.63	0.55	0.53	0.570	-

Note: Two dots (..) indicate that data is not available or not reported separately.
[a] The HDI rank is determined using HDI values to the sixth decimal point.
[b] Preliminary Unesco estimates, subject to further revision.
[c] A positive figure indicates that the HDI rank is higher than the GDP per capita (PPP US$) rank; a negative the opposite.

Table A2: Human development index trends.

HDI rank		1975	1980	1985	1990	1995	2000	Absolute change in HDI from year 1975 to 2000	% change in HDI trend from year 1975 to 2000
Asian developed country									
9	Japan	0.854	0.878	0.893	0.909	0.923	0.933	0.079	9.250585
Asian giants									
96	China	0.523	0.554	0.591	0.625	0.681	0.726	0.203	38.81453
124	India	0.407	0.434	0.473	0.511	0.545	0.577	0.170	41.769
Asian tigers									
23	Hong Kong, China (SAR)	0.756	0.795	0.823	0.859	0.877	0.888	0.132	17.460
27	Korea, Rep. of	0.691	0.732	0.774	0.815	0.852	0.882	0.191	27.641
25	Singapore	0.722	0.755	0.782	0.818	0.857	0.885	0.163	22.576
Asian cubs									
110	Indonesia	0.469	0.530	0.582	0.623	0.664	0.684	0.215	45.842
59	Malaysia	0.616	0.659	0.693	0.722	0.760	0.782	0.166	26.948
77	Philippines	0.652	0.684	0.688	0.716	0.733	0.754	0.102	15.644
70	Thailand	0.604	0.645	0.676	0.713	0.749	0.762	0.158	26.159
Other large Asian countries									
145	Bangladesh	0.335	0.353	0.386	0.416	0.445	0.478	0.143	42.687
130	Cambodia	..	..	..	0.501	0.531	0.543		
113	Mongolia	..	..	0.650	0.657	0.636	0.655		
127	Myanmar	..	..	..	..	..	0.552		
138	Pakistan	0.345	0.372	0.404	0.442	0.473	0.499	0.154	44.638
89	Sri Lanka	0.616	0.650	0.676	0.697	0.719	0.741	0.125	20.292
109	Viet Nam	..	..	0.583	0.605	0.649	0.688		
Other small Asian countries									
140	Bhutan	..	..	..	..	..	0.494		
72	Fiji	0.660	0.683	0.697	0.723	0.743	0.758	0.098	14.848
143	Lao People's Dem. Rep.	..	..	0.374	0.404	0.445	0.485		
84	Maldives	..	..	0.629	0.676	0.707	0.743		
142	Nepal	0.289	0.328	0.370	0.416	0.453	0.490	0.201	69.550
133	Papua New Guinea	0.420	0.441	0.462	0.479	0.519	0.535	0.115	27.381
101	Samoa (Western)	..	..	0.650	0.666	0.689	0.715		
121	Solomon Islands	..	..	..	..	..	0.622		
131	Vanuatu	..	..	..	..	..	0.542		
East Asia and the Pacific									
South Asia									

Note: Two dots (..) indicate that data is not available or not reported separately.

Table A3: Demographic trends.

HDI rank		Total population (millions)			Annual population growth rate (%)		Urban population (as % of total) [a]			Population under age 15 (as % of total)		Population aged 65 and above (as % of total)		Total fertility rate (per woman)	
		1975	2000	2015 [b]	1975-2000	2000-15	1975	2000	2015 [b]	2000	2015 [b]	2000	2015 [b]	1970-75 [c]	1995-2000 [c]
Asian developed country															
9	Japan	111.5	127.1	127.5	0.5	(.)	75.7	78.8	81.5	14.7	13.3	17.2	25.8	2.1	1.4
Asian giants															
96	China	927.8	1,275.1	1,410.2	1.3	0.7	17.4	35.8	49.5	24.8	19.4	6.9	9.3	4.9	1.8
124	India	620.7	1,008.9	1,230.5	1.9	1.3	21.3	27.7	32.2	33.5	26.9	5.0	6.4	5.4	3.3
Asian tigers															
23	Hong Kong, China (SAR)	4.4	6.9	8.0	1.8	1.0	89.7	100.0	100.0	16.3	13.9	10.6	13.4	2.9	1.2
27	Korea, Rep. of	35.3	46.7	50.6	1.1	0.5	48.0	81.9	88.2	20.8	17.2	7.1	11.6	4.3	1.5
25	Singapore	2.3	4.0	4.8	2.3	1.1	100.0	100.0	100.0	21.9	14.0	7.2	12.9	2.6	1.6
Asian cubs															
110	Indonesia	134.6	212.1	250.1	1.8	1.1	19.4	41.0	55.0	30.8	24.7	4.8	6.4	5.2	2.6
59	Malaysia	12.3	22.2	27.9	2.4	1.5	37.7	57.4	66.4	34.1	26.7	4.1	6.2	5.2	3.3
77	Thailand	41.1	62.8	72.5	1.7	1.0	15.1	19.8	24.2	26.7	22.0	5.2	7.8	5.0	2.1
70	Philippines	42.0	75.7	95.9	2.4	1.6	35.6	58.6	69.0	37.5	29.6	3.5	4.9	6.0	3.6
Other large Asian countries															
89	Bangladesh	75.6	137.4	183.2	2.4	1.9	9.9	25.0	34.4	38.7	32.9	3.1	3.7	6.4	3.8
130	Cambodia	7.1	13.1	18.6	2.5	2.3	10.3	16.9	26.1	43.9	38.6	2.8	3.4	5.5	5.2
113	Mongolia	1.4	2.5	3.1	2.2	1.3	48.7	56.6	59.5	35.2	25.9	3.8	4.2	7.3	2.7
127	Myanmar	30.2	47.7	55.3	1.8	1.0	23.9	27.7	36.7	33.1	25.3	4.6	6.0	5.8	3.3
109	Pakistan	70.3	141.3	204.3	2.8	2.5	26.4	33.1	39.5	41.8	38.4	3.7	4.0	6.3	5.5
145	Sri Lanka	13.5	18.9	21.5	1.3	0.8	22.0	22.8	29.9	26.3	22.5	6.3	8.8	4.1	2.1
138	Viet Nam	48.0	78.1	94.4	2.0	1.3	18.8	24.1	31.6	33.4	25.1	5.3	5.5	6.7	2.5
Other small Asian countries															
140	Bhutan	1.2	2.1	3.1	2.3	2.6	3.4	7.1	11.6	42.7	38.8	4.2	4.5	5.9	5.5
72	Fiji	0.6	0.8	0.9	1.4	0.9	36.7	49.4	59.9	33.3	28.2	3.4	5.7	4.2	3.2
143	Lao People's Dem. Rep.	3.0	5.3	7.3	2.2	2.2	11.1	19.3	27.1	42.7	37.3	3.5	3.7	6.2	5.3
84	Maldives	0.1	0.3	0.5	3.0	2.9	18.1	27.6	35.2	43.7	40.5	3.5	3.2	7.0	5.8
142	Nepal	13.1	23.0	32.1	2.2	2.2	5.0	11.8	17.9	41.0	37.2	3.7	4.2	5.8	4.8
133	Papua New Guinea	2.6	4.8	6.6	2.5	2.2	11.9	17.4	22.3	40.1	36.0	2.4	2.9	6.1	4.6
101	Samoa (Western)	0.2	0.2	0.2	0.2	0.8	21.1	22.1	27.6	41.2	36.6	4.6	4.7	5.7	4.5
121	Solomon Islands	0.2	0.4	0.7	3.4	3.2	9.1	19.7	28.6	44.8	41.6	2.6	2.9	7.2	5.6
131	Vanuatu	0.1	0.2	0.3	2.7	2.4	15.7	21.7	28.6	42.0	36.2	3.2	3.7	6.1	4.6
East Asia and the Pacific		1,293.2	1,859.1	2,107.8	1.5	0.8	19.7	37.7	50.1	26.9	21.3	6.2	8.4	5.0	2.1
South Asia		828.0	1,402.3	1,762.1	2.1	1.5	21.4	29.4	35.0	35.1	29.0	4.6	5.7	5.6	3.6

Note: [a] Because data is based on national definitions of what constitutes a city or metropolitan area, cross-country comparisons should be made with caution.
[b] Data refers to medium-variant projections.
[c] Data refers to estimates for the period specified.

Table A4: Commitment to education: public spending.

HDI rank		Public education expenditure [a]				Public education expenditure by level (as % of all levels) [b]					
		As % of GNP		As % of total government expenditure		Pre-primary and primary		Secondary		Tertiary	
		1985-87 [c]	1995-97 [c]	1985-87 [c]	1995-97 [c]	1985-86 [c]	1995-97 [c]	1985-86 [c]	1995-97 [c]	1985-86 [c]	1995-97 [c]
Asian developed country											
9	Japan	..	3.6	..	9.9	..	39.3	..	41.8	..	12.1
Asian giants											
96	China	2.3	2.3	11.1	12.2	29.5	37.4	33.2	32.2	21.8	15.6
124	India	3.2	3.2	8.5	11.6	38.0	39.5	25.3	26.5	15.3	13.7
Asian tigers											
27	Hong Kong, China (SAR)	2.5	2.9	19.8	17.0	31.5	21.9	37.9	35.0	25.1	37.1
25	Korea, Rep. of	3.8	3.7	..	17.5	47.0	45.3	36.7	36.6	10.9	8.0
23	Singapore	3.9	3.0	11.5	23.3	30.5	25.7	36.9	34.6	27.9	34.8
Asian cubs											
77	Indonesia	0.9	1.4	4.3	7.9	..	..	..	73.5	..	24.4
70	Malaysia	6.9	4.9	18.8	15.4	37.8	32.7	37.1	30.6	14.6	25.5
59	Philippines	2.1	3.4	11.2	15.7	63.9	56.1	10.1	23.3	22.5	18.0
110	Thailand	3.4	4.8	17.9	20.1	58.4	50.4	21.1	20.0	13.2	16.4
Other large Asian countries											
130	Bangladesh	1.4	2.2	9.9	13.8	46.1	44.8	34.7	43.8	10.4	7.9
89	Cambodia	..	2.9	..	..	..	..	..	..	..	..
113	Mongolia	11.7	5.7	17.1	15.1	10.7	19.9	51.2	56.0	17.3	14.3
109	Myanmar	1.9	1.2	..	14.4	..	47.7	..	40.3	..	11.7
127	Pakistan	3.1	2.7	8.8	7.1	36.0	51.8	33.3	27.9	18.2	13.0
145	Sri Lanka	2.7	3.4	7.8	8.9	..	..	90.2	74.8	9.8	9.3
138	Viet Nam	..	3.0	..	7.4	..	43.0	..	26.0	..	22.0
Other small Asian countries											
140	Bhutan	3.7	4.1	..	7.0	..	44.0	..	35.6	..	20.4
72	Fiji	6.0	..	..	..	..	..	..	..	..	..
143	Lao People's Dem. Rep.	0.5	2.1	6.6	8.7	..	48.3	..	30.7	..	7.4
84	Maldives	5.2	6.4	8.5	10.5	..	..	..	..	..	..
142	Nepal	2.2	3.2	10.4	13.5	35.7	45.1	19.9	19.0	33.4	19.0
133	Papua New Guinea	..	..	..	..	..	..	..	..	..	..
101	Samoa (Western)	..	..	..	..	..	..	..	..	..	..
121	Solomon Islands	4.7	3.8	12.4	7.9	..	..	..	..	..	..
131	Vanuatu	7.4	4.8	24.6	18.8	..	..	..	..	..	..

Note: Two dots (..) indicate that data is not available or not reported separately.
[a] Data refers to total public expenditure on education, including current and capital expenditure.
[b] Data refers to current public expenditure on education. Expenditures by level may not sum to 100 as a result of rounding or the omission of the
[c] Data refers to the most recent year available during the period specified.

Table A5: Literacy and enrolment.

	HDI rank	Adult literacy rate		Youth literacy rate		Net primary enrolment ratio		Net secondary enrolment ratio		Children reaching grade 5 (%) 1995-97 [a]	Tertiary students in science, math and engineering (as % of all tertiary students) 1994-97 [a]
		(% age 15 and above)		(% age 15-24)		%		%			
		1985	2000	1985	2000	1985-87 [a]	1998 [b]	1985-87 [a]	1998 [b]		
Asian developed country											
9	Japan	..	..	..	..	99	100	97	..	..	23
Asian giants											
96	China	71.9	84.1	93.1	97.8	94	91	..	50	94	53
124	India	45.2	57.2	60.0	72.6	..	..	..	39	..	25
Asian tigers											
27	Hong Kong, China (SAR)	87.8	93.5	97.7	99.2	96	..	65	..	..	..
25	Korea, Rep. of	94.5	97.8	99.8	99.8	96	97	85	..	98	34
23	Singapore	85.6	92.3	98.2	99.7	99	..	..	..	..	..
Asian cubs											
59	Indonesia	74.7	86.9	92.6	97.7	98	..	42	..	88	28
77	Malaysia	76.4	87.5	92.7	97.6	..	98	..	93	..	..
70	Philippines	90.9	95.3	96.4	98.7	98	..	51	..	..	..
110	Thailand	90.3	95.5	97.4	98.9	..	77	..	55	..	21
Other large Asian countries											
130	Bangladesh	32.0	41.3	40.2	50.7	54	100	19	..	..	..
89	Cambodia	57.9	67.8	69.9	78.9	..	100	..	20	49	23
113	Mongolia	97.8	98.9	99.1	99.6	94	85	..	53	..	25
109	Myanmar	78.2	84.7	86.5	90.9	..	..	..	..	..	37
127	Pakistan	31.4	43.2	41.4	57.0	..	..	..	..	..	..
145	Sri Lanka	87.1	91.6	93.9	96.8	..	100	60	..	..	28
138	Viet Nam	88.9	93.4	94.5	97.0	..	97	..	49	..	..
Other small Asian countries											
140	Bhutan	..	..	..	..	..	16	..	5	..	..
72	Fiji	86.1	92.9	96.8	99.1	98	100	..	76	..	..
143	Lao People's Dem. Rep.	30.7	48.7	47.5	70.5	71	76	..	27	55	..
84	Maldives	93.2	96.7	97.3	99.1	..	..	..	..	..	..
142	Nepal	26.5	41.8	39.5	60.5	58	..	19	..	..	14
133	Papua New Guinea	52.7	63.9	65.1	75.7	..	85	..	22	..	..
101	Samoa (Western)	73.5	80.2	81.2	87.1	..	96	..	65	85	..
121	Solomon Islands	..	..	..	..	..	..	..	..	..	..
131	Vanuatu	..	..	..	..	..	100	..	..	..	..
East Asia and the Pacific		74.7	85.9	93.1	97.4	..	..	..	..	..	..
South Asia		43.7	55.6	57.4	69.8	..	..	..	..	..	..

Note: Two dots (..) indicate that data is not available or not reported separately.

[a] Data refers to the most recent year available during the period specified.

[b] Enrolment ratios are based on the new International Standard Classification of Education, adopted in 1997. Unesco. 1997. International Standard Classification of Education. http://www.uis.unesco.org/en/pub/pub0.htm (February 2002.), and so may not be strictly comparable with those for earlier years

Table A6: Economic performance.

HDI rank		GDP			GDP per capita annual growth rate (%)		GDP per capita	
		US$ billions 2000	PPP US$ billions 2000	GDP per capita (PPP US$) 2000	1975-2000	1990-2000	Highest value during 1975-2000 (PPP US$)	Year of highest value
Asian developed country								
9	Japan	4,841.6	3,394.4	26,755	2.7	1.1	26,755	2000
Asian giants								
96	China	1,080.0	5,019.4	3,976	8.1	9.2	3,976	2000
124	India	457.0	2,395.4	2,358	3.2	4.1	2,358	2000
Asian tigers								
27	Hong Kong, China (SAR)	162.6	171.0	25,153	4.6	1.9	25,153	2000
25	Korea, Rep. of	457.2	821.7	17,380	6.2	4.7	17,380	2000
23	Singapore	92.3	93.8	23,356	5.2	4.7	23,356	2000
Asian cubs								
77	Indonesia	153.3	640.3	3,043	4.4	2.5	3,481	1997
70	Malaysia	89.7	211.0	9,068	4.1	4.4	9,151	1997
59	Philippines	74.7	300.1	3,971	0.1	1.1	4,072	1982
110	Thailand	122.2	388.8	6,402	5.5	3.3	6,896	1996
Other large Asian countries								
130	Bangladesh	47.1	209.9	1,602	2.2	3.0	1,602	2000
89	Cambodia	3.2	17.4	1,446	1.9	2.0	1,446	2000
113	Mongolia	1.0	4.3	1,783	-0.4	-0.3	2,127	1989
109	Myanmar	..	..	..	1.3	4.8	..	..
127	Pakistan	61.6	266.2	1,928	2.8	1.2	1,928	2000
145	Sri Lanka	16.3	68.3	3,530	3.2	3.9	3,530	2000
138	Viet Nam	31.3	156.8	1,996	4.8	6.0	1,996	2000
Other small Asian countries								
140	Bhutan	0.5	1.1	1,412	4.0	3.4	1,412	2000
72	Fiji	1.5	3.8	4,668	0.7	0.7	5,143	1999
143	Lao People's Dem. Rep.	1.7	8.3	1,575	3.2	3.9	1,575	2000
84	Maldives	0.6	1.2	4,485	5.8	5.4	4,485	2000
142	Nepal	5.5	30.6	1,327	2.1	2.4	1,327	2000
133	Papua New Guinea	3.8	11.7	2,280	0.5	1.4	2,666	1994
101	Samoa (Western)	0.2	0.9	5,041	0.4	1.9	5,041	2000
121	Solomon Islands	0.3	0.7	1,648	2.2	-1.0	2,226	1996
131	Vanuatu	0.2	0.6	2,802	0.1	-0.9	3,189	1991
East Asia and the Pacific		2,296.3	7,855.9	4,290	5.9	5.7	..	..
South Asia		693.5	3,347.3	2,404	2.4	3.3	..	..

Note: Two dots (..) indicate that data is not available or not reported separately.

Table A7: The structure of trade

HDI rank		Imports of goods and services (as % of GDP)		Exports of goods and services (as % of GDP)		Primary exports (as % of merchandise exports)		Manufactured exports (as % of merchandise exports)		High technology exports (as % of manufacturing exports)		Terms of trade (1980=100)[a]
		1990	2000	1990	2000	1990	2000	1990	2000	1990	2000	1999
Asian developed country												
9	Japan	9	8	10	10	3	3	96	94	24	28	196
Asian giants												
96	China	14	23	18	26	27	12	72	88	..	19	105
124	India	10	17	7	14	28	19	71	79	2	4	148
Asian tigers												
27	Hong Kong, China (SAR)	126	145	134	150	4	4	95	95	..	23	101
25	Korea, Rep. of	30	42	29	45	6	9	94	91	18	35	99
23	Singapore	195	161	202	180	27	14	72	86	40	63	81
Asian cubs												
59	Indonesia	24	31	25	39	65	43	35	57	1	16	56
77	Malaysia	72	104	75	125	46	19	54	80	38	59	47
110	Philippines	33	50	28	56	31	8	38	92	..	59	119
70	Thailand	42	59	34	67	36	22	63	76	21	32	72
Other large Asian countries												
130	Bangladesh	14	19	6	14	..	9	77	91	(.)	(.)	97
89	Cambodia	13	47	6	40	..	..	..	..	..	..	..
113	Mongolia	53	82	24	65	..	..	..	..	..	..	..
109	Myanmar	5	1	3	(.)	..	..	..	..	..	..	26
127	Pakistan	23	19	16	16	21	15	79	85	(.)	(.)	107
145	Sri Lanka	38	51	29	40	42	23	54	75	1	3	95
138	Viet Nam	33	..	26	..	..	..	..	..	..	..	..
Other small Asian countries												
140	Bhutan	32	60	28	30	..	60	..	40	..	..	..
72	Fiji	66	63	64	69	63	..	36	52	12	..	80
143	Lao People's Dem. Rep.	..	48	..	36	..	..	..	..	..	..	..
84	Maldives	70	86	27	104	..	..	..	46	..	..	..
142	Nepal	21	32	11	24	..	23	83	77	..	(.)	..
133	Papua New Guinea	49	42	41	45	89	98	10	2	..	42	..
101	Samoa (Western)	..	82	..	33	..	..	4	..	0	..	..
121	Solomon Islands	73	..	47	..	..	..	..	..	..	..	..
131	Vanuatu	77	..	46	..	..	..	13	..	20	..	..
East Asia and the Pacific		40	51	41	56	24	13	75	86	..	31	..
South Asia		15	19	11	18	..	40	71	58	..	3	..

Note: Two dots (..) indicate that data is not available or not reported separately.
[a] The ratio of the export price index to the import price index measured relative to the base year 1980.

Table A8. Gender-related development index.

		Gender-related development index (GDI)		Life expectancy at birth (years) 2000		Adult literacy rate		Combined primary, secondary and tertiary gross enrolment ration		Estimated earned income (PPP US$) 2000b		HDI rank minus GDI rankc
						(% age 15 and above) (200)		(%)a 1999				
HDI rank		Rank	Value	Female	Male	Female	Male	Female	Male	Female	Male	
9	Japan	10	0.927	84.4	77.4	..	..	81	83	16,601	37,345	-1
Asian giants												
96	China	77	0.724	72.8	68.5	76.3	91.7	73	73	3,132	4,773	3
124	India	105	0.560	63.8	62.8	45.4	68.4	49	62	1,267	3,383	-2
Asian tigers												
27	Hong Kong, China (SAR)	23	0.886	82.4	76.9	90.2	96.5	66	61	18,635	31,445	0
25	Korea, Rep. of	29	0.875	78.6	71.2	96.4	99.1	85	95	10,791	23,884	-2
23	Singapore	24	0.880	79.8	75.4	88.4	96.3	75	76	15,433	31,167	1
Asian cubs												
77	Indonesia	91	0.678	68.2	64.3	82.0	91.8	61	68	2,053	4,026	1
70	Malaysia	54	0.776	75.0	70.1	83.4	91.4	67	64	5,711	12,338	-1
59	Philippines	63	0.751	71.3	67.3	95.1	95.5	84	80	2,933	4,994	4
110	Thailand	60	0.760	73.2	67.3	93.9	97.1	61	60	4,907	7,928	1
Other large Asian countries												
130	Bangladesh	121	0.468	59.5	59.4	29.9	52.3	33	41	1,151	2,026	1
89	Cambodia	109	0.537	58.6	53.9	57.1	79.8	54	71	1,268	1,633	0
113	Mongolia	95	0.653	64.9	60.9	98.8	99.1	64	51	1,430	2,135	0
109	Myanmar	106	0.548	58.5	53.7	80.5	89.0	55	55	747	1,311	0
127	Pakistan	120	0.468	59.9	60.2	27.9	57.5	28	51	916	2,884	-4
145	Sri Lanka	70	0.737	75.3	69.5	89.0	94.4	71	68	2,270	4,724	4
138	Viet Nam	89	0.687	70.6	65.9	91.4	95.5	64	69	1,635	2,360	2
Other small Asian countries												
140	Bhutan	..	..	63.3	60.8	..	..	..	..	..	..	..
72	Fiji	65	0.746	70.9	67.4	90.8	94.9	83	84	2,367	6,892	-2
143	Lao People's Dem. Rep.	118	0.472	54.8	52.3	33.2	64.1	52	65	1,242	1,909	2
84	Maldives	68	0.739	65.8	67.3	96.8	96.6	77	77	3,329	5,582	3
142	Nepal	119	0.470	58.3	58.8	24.0	59.6	52	67	880	1,752	0
133	Papua New Guinea	110	0.530	57.7	55.8	56.8	70.6	35	42	1,670	2,840	1
101	Samoa (Western)	..	..	72.8	66.2	79.0	81.2	67	63	..	..	..
121	Solomon Islands	..	..	69.7	67.2	..	..	..	..	..	..	..
131	Vanuatu	..	..	69.8	66.7	..	..	..	..	..	..	..
East Asia and the Pacific		..	..	..	..	..	..	..	..	..	..	
South Asia		..	..	..	..	..	..	..	..	..	..	

Note: Two dots (..) indicate that data is not available or not reported separately.

[a] Preliminary Unesco estimates subject to further revision.

[b] Because of the lack of gender-disaggregated income data, female and male earned income are crudely estimated on the basis of data on the ratio of the female non-agricultural wage to the male non-agricultural wage, the female and male shares of the economically active population, the total female and male population and GDP per capita (PPP US$) (see Technical note 1). Unless otherwise specified, estimates are based on data for the latest year available during 1991-2000.

[c] The HDI ranks used in this column are those recalculated for the 146 countries with a GDI value. A positive figure indicates that the GDI rank is higher than the HDI rank, a negative the opposite.

Technical notes:

1. HDI regressed against an appropriate non-linear function of GDP explains 88 percent of variation across all countries. For Asian countries in Table A1 we see that countries with HDI < 0.5 have GDP/capita (PPP) of < US$1930. No country with GDP/cap above US$ 3000 has an HDI less than 0.68. The two striking exceptions of the 21 countries in Table 1 are Viet Nam and Myanmar who show relatively higher HDI than what their GDP/cap would suggest.
2. These observations were conveyed in a personal conversation, by India’s leading scientist and science policymaker, a keen observer and knowledgeable about the scientific world, a former Minister of State for Science, Professor M.G.K. Menon.
3. I had access to only one year’s database. One would need to do it for many years.

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