1-1-2002

Strengthening the knowledge economy

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Abstract

What is knowledge ecomony? The knowledge economy could be defined as one where "comparative advantage [is] much less a function of natural resource endowments and capital-labour ratios and much more a function of technology and skills". [13] Its development is the product of two forces: a rise in the knowledge intensity of economic activities and an increasing globalization of economic affairs. It is driven by the revolution in information and communications technology, the increasing pace of technological change and by national and international deregulation. [14]

Keywords

strengthening, knowledge, economy

Disciplines

Business | Social and Behavioral Sciences

Publication Details

Garrett-Jones, SE, Strengthening the knowledge economy, in Ghani, E, Markels, M, Vongviriyatham, R, Garrett-Jones, SE, Wiliapich, U & Tapahudee, S (eds), Thailand Economic Monitor: Positioning for a Sustainable Recovery, 2002, 45-57, Bangkok: The World Bank.

CHAPTER 4

STRENGTHENING THE KNOWLEDGE ECONOMY

Framework for a knowledge economy

What is a knowledge economy? The knowledge economy could be defined as one where "comparative advantage [is] much less a function of natural resource endowments and capital-labor ratios and much more a function of technology and skills".[13] Its development is the product of two forces: a rise in the knowledge intensity of economic activities and an increasing globalization of economic affairs. It is driven by the revolution in information and communications technology, the increasing pace of technological change and by national and international deregulation.[14]

From a policy perspective the knowledge economy can be seen as consisting of four main inter-related spheres.[15] These are:

- **Innovation Systems**: R&D, diffusion of technology, links between science and industry, firms focusing on new technology, industry clusters.
- **Human Resource Development**: basic education, scientific and engineering talent, lifelong learning, job training, organizational learning and innovation.
- **Business Environment**: regulatory environment, intellectual property rights, competition policy, tax rates, physical infrastructure.
- **Information and Communications Technology (ICT) Infrastructure**: investment in ICT, digital networks, access to and use of ICT, growth of electronic commerce and enterprises.

This Monitor focuses on the skill and technological components of the knowledge economy, an area where Thailand is low in global competitiveness rankings.

The most industrialized economies have addressed many of the fundamental infrastructure needs of a knowledge-based economy and are focusing on improving their innovation systems and promoting the development and use of ICT systems and services. However the situation is less positive in Asian economies such as Thailand that are at a relatively early stage in building innovation and knowledge infrastructures. A recent APEC report comments, "Along with their marketplace laws, [they] face the need to build their economy's skills base, further modernize their physical infrastructure and invest in strengthening their science and technological capabilities".[16]

The 'knowledge system' is composed of three parts; locally-owned Thai firms (especially

[13] L. Thurow. 'New Tool, New Rules: Playing to win in the new economic game', *Prism*.
[14] J. Houghton and P. Sheehan. *A Primer on the Knowledge Economy*, Centre for Strategic Economic Studies, Victoria University, Melbourne, 2000; Dahlman, C.J and Aubert, J.-E. *China and the Knowledge Economy: Overview*, WBI Development Studies, The World Bank, Washington D.C. (n.d.)
[15] APEC, *Policies for Promoting the Development of Knowledge-Based Economies.*
[16] APEC, op cit, p. 127.

SMEs), multinational or global corporations (who possess product and process technologies that are more advanced than the local versions) and other knowledge institutions such as schools/universities and government research institutes.[17] Since firms and their workers are the key components of a knowledge economy the question is "what actions can governments take to help firms and workers more effectively acquire, develop and utilize knowledge".[18]

A central problem is that many government institutions and incentive schemes for industrial technology and skills upgrading are following old policy models which focus more on single entities (whether firms or institutions) than on knowledge networks, interactions and supply chains.

Importance of a knowledge economy for Thailand

The importance of the knowledge economy for Thailand has been highlighted in the Ninth Plan. The Thai government's policies broadly recognize the importance of improving skills and technological capability in all economic and social sectors.[19] One specific goal for domestic markets and rural communities is to "increase production efficiency by promoting research and utilizing local knowledge as well as modern technological know-how". For industry, the policy supports cooperation in research, technology and product development between small and medium-sized enterprises (SMEs) and other public and private sector organizations (including those in higher education). The aim is to assist Thai firms to obtain technology and intellectual property from all sources and ensure a supply of qualified personnel.

But if the will is there, what is the way? What progress has been made and what challenges lie ahead in expanding the knowledge base of the country? How can the government's goals best be achieved, given the current range of government initiatives and the relevant experience of other industrializing countries?

Recent studies in Thailand have argued for new ways of 'thinking about' industrial technology policy as it affects knowledge networks that involve clusters of innovative firms and collaboration between the business, public and education sectors. The studies identify current barriers preventing knowledge linkages. They highlight new ways of formulating and implementing policies that spread technological capabilities, raise standards and overcome barriers within firms to technology upgrading.

Table 4-1
Rankings of growth competitiveness component indices

Country	Global comp. Ranking	Technology Index Rank	Public Institutions Index Rank	Macroeconomic Environment Index Rank
Singapore	4	18	6	1
Korea	23	9	44	8
Malaysia	30	22	39	20
Thailand	**33**	**39**	**42**	**16**
Philippines	48	40	64	28

Source: World Economic Forum, Global Competitiveness Report 2001

Thailand is placed low in global competitiveness rankings. Thailand faces constraints in four areas:

- Secondary school enrollment rates that lag behind other countries in the region.
- Skills mix that is not suited to the emergence of a knowledge economy, where new industrial and services companies seek to increase productivity through technological and organizational change.
- Technological capability of Thai firms lags behind other countries in the region.
- Institutions and public programs that have been less effective than those of other countries in helping firms to upgrade their skills development, training, technology upgrading and 'knowledge networks'.

[17] Paul L. Robertson. *Firm-level incentives for research and training in developing economies*, m/s, University of Wollongong, Feb. 2002.
[18] Robertson, 2002, op cit.
[19] *Policy of the Government of H.E. Prime Minister Thaksin Shinawatra delivered to the National Assembly on Monday, 26 February 2001* (Unofficial Translation), Section 7.

Education

The need for skills in the labor force is now even greater as Thailand's industrial and service companies seek to increase productivity through technological and organizational change. Finding ways to improve the skills of young people and adults in Thailand is a high priority for improving competitiveness, boosting growth, reducing poverty and raising the quality of life.

Although it is not a focus of this Monitor, secondary education is the key to skills development. The limited provision of quality secondary education is a major bottleneck in skills development in Thailand. Enrollment rates in Thailand lag behind Malaysia, Korea and Philippines.
A recent Bank study on secondary education identified a number of challenges facing Thailand.

- Improving quality, efficiency and equity (priority issues are science, math, IT, teacher training and creating a learner-centered approach).
- Financing 12 years of basic education.
- Private and public provision of vocational education.

Skill development strategies

Thai companies face critical shortages of high quality engineers and of specific skills like tool and die making. Thailand is in the process of formulating a new Skills Development Act and an associated fund. A December 2001 workshop on skill development, which was part of the Country Development Partnership on Competitiveness, highlighted the lessons learned in Korea, Malaysia and Singapore in the management of skill funds, cooperation between the public and private sectors and cost sharing arrangements.

Thailand is formulating a new Skill Development Act which makes provision for pre-employment skill training, re-training for job changes, setting national standards for skills and accreditation and tax relief for training organizations and firms. The law also sets up a restructured Skill Development Fund (SDF) to pool government and employers' contributions, donor funds and income in order to provide loans to trainees and training organizers. Employers will contribute to the SDF only if they are unable to arrange the necessary training for themselves. The objective is to improve both the skills of workers and trainers, particularly for in-house training. However details of the SDF are still being worked out and will depend on the way it is implemented and administered.

Experience in Malaysia, Singapore and elsewhere suggests that successful SDFs share a range of characteristics.[20] Firstly, they are joint projects bringing together government, industry and training providers, sustained by industry and government funding with very strong industry involvement in, or control of, their management. They use a wide range of training providers: public sector organizations, in-house trainers, private trainers and expert consultants. They tend to provide *grants* to the firms seeking training and *loans* to the training providers. The overriding philosophy is one of 'firms accessing their own contributions' to the fund.

The scope of training schemes supported by funds is also wide, ranging from basic literacy to technical, craft and managerial skills. Recognizing that the training 'industry' itself may be weak, a crucial element is support for the development of training providers: through accreditation, promulgation and application of standards, and financial assistance for training infrastructure.

A further essential element is the support that successful SDFs provide; for skills planning, the development of training strategies within firms, for cooperation on training between firms and

[20] Hong Tan, *Do Training Levies Work: Malaysia's HRDF and Its Effects on Training and Firm-Level Productivity*, Working Paper, World Bank Institute, July 2001; A. Dar, S.; Canagarajah and P. Murphy, *Training Levies: Rationale and Evidence from Evaluations*, draft m/s, Nov. 2001; S. Garrett-Jones, *Government Incentives for Technological Skills Development*, paper presented to 'Skills Development Fund Seminar', Dept. of Skill Development, Bangkok, 19 Dec. 200

within industries, employer groups and geographical regions.

The Skills Development Act is a welcome step but care is required in its implementation. Comments at the December 2001 workshop focused on the scope and administration of the new SDF. Imposing a levy only on firms that have no training activities would overlook firms that had the budget but not the expertise to implement a training strategy. Would it adequately encourage 'learning from other firms'? For example, would large companies and MNCs feel themselves 'outside' the scheme and thus be unwilling to assist? Strong employer representation, including the establishment of working committee(s) from particular industrial sectors, was strongly advocated as a counter to having the fund overly dominated by the public sector. While integration of public sector training was seen as highly desirable (e.g. vocational and university education), substantial involvement of the private sector in training was also seen as essential. It

Box 4-1
Skills development incentives in Singapore

Environment:

- Singapore has a sound education system, with a bias towards early vocational training.
- A range of public and private training providers operate in a competitive environment.
- A range of human resource development programs, including through the SDF, are in place.

Skills Development Fund: Financing and Administration

- The SDF is long-standing: established in 1979 under the National Productivity Board, Ministry of Trade and Industry.
- The SDF has evolved: originally established with employer subsidies, moved to planning training priorities in 1987 and adopted an SME focus in 1992.
- Funded by a 1% employer levy on low-paid, unskilled workers; at times the levy has been higher, 2% (initially) and 4%.
- Its budget in 1996-7 was S$86 million.
- Most of its budget comes from industry funding and interest on invested funds: only 2% is from government funds (1991 figures). However, expenditure is currently exceeding the amount raised from levies; and govemment 'tops up' the Fund.
- Assistance is provided on a cost sharing principle: SDF pays 50-80% of costs, employers pay 20-50%.
- It has provided grants for more than 500,000 training places.
- In 1990 30,000 approvals were made; a 90% success rate.
- It requires prior approval for programs, there is a 2-year wait for reimbursement in some cases.
- Monitoring and evaluation are carried out at three levels:
  - Macro level (skills shortages, redundancies)
  - Program level (various performance indicators)
  - Firms/trainees (client quality control/tracer studies)
- The SDF manages a broad portfolio of schemes and programs.

SDF Schemes & Programs

- Training Grants
  - Training Leave (for unskilled mature workers).
  - Training Vouchers (all firms are eligible).
  - Worker Training Plan (to support training in firms).
  - Training Needs Analysis Consultancy Scheme (assistance with training strategies for locally-owned firms).
  - Approved-In-Principle Scheme (pre-accreditation of public courses, making it easier for firms to use them).
  - Emerging/Critical Skills Development Grants (e.g., in nominated priority areas like robotics, wafer fabrication, health care).
- Basic Education for Skills Training - BEST (providing fundamental functional literacy/numeracy to 'Year 6' level).
- Worker Improvement Through Secondary Education - WISE (English, Math).
- Training Infrastructure Development.
- Partnerships with MNCs to set up industry-specific training centers.
- Financial assistance to trades union groups for training.

was suggested that the SDF should therefore provide encouragement for the 'training service industry' to expand its activities and to improve its quality, rather than simply acting as an industry watchdog. A cautionary note is provided by Korea, where an intrusive 'regulatory' approach to the eligibility of firm level training and the application of skills standards failed to produce any increase in training activity by firms.[21]

Technological capability and innovation within firms is weak

Technological capabilities in firms can be thought of as three interlocking sets of competencies: production capability (management and engineering), project execution (feasibility, training, execution) and innovation capability.[22] Put more succinctly these are 'the skills, technical knowledge and organizational coherence required to make industrial technologies function in an enterprise'.[23]

Technological capability is perhaps shown best when firms face the need to innovate, to *change* their products, processes or technological organization. However when it comes to technological innovation relatively little is known about the activities or capabilities of Thai firms. Consequently it is hard for firms and industries to benchmark themselves against their competitors in Thailand or elsewhere, or for the government to formulate policies and measures to improve the technological capacity of local firms. So an important first step has been to gather such information through surveys and case studies.

Three out of four Thai firms do *not* engage in any activities to improve their technological capability. In 2000, the National Science and Technology Development Agency (NSTDA) and the Brooker Group PLC carried out the first R&D/Innovation Survey of Thailand's manufacturing industry. The survey covered both R&D

[21] Tan and Middleton, op. cit., p. 4.
[22] Alice H. Amsden, *The Rise of 'The Rest': Challenges to the West from Late-Industrializing Economies* (New York: Oxford University Press, 2001), Table 1.2, p. 4.
[23] S. Lall, *Learning from the Asian Tigers*, London, Macmillan, 1996, p. 29.

Box 4-2
Innovation clusters

Industrial innovation clusters exist where there is a loose *geographic* concentration or association of *firms* and *other organizations* involved in a value chain, producing goods and services and *innovating*. Innovation clusters, particularly in the knowledge services sector, can be 'virtual' rather than geographically based.

The *innovation cluster* concept goes beyond traditional ideas on industry clusters, which involve horizontal networks of firms focusing on the same product lines in the same industry sector. It stresses the advantages of producers, suppliers and support services from a variety of industries being close to each other. Thus, innovation clusters are cross-sectoral, involving dissimilar firms that collaborate with each other and with public 'knowledge institutions' such as universities and research laboratories.

Michael Porter uses the term 'cluster' in a similar although more restricted sense to describe formal cooperative linkages among firms - and between firms and technology organizations - that result in business 'clusters' that are globally competitive. The concept of 'supply chains' is closer to the traditional 'industry cluster' model (i.e. focused on a particular product and sector), but incorporates vertical relationships and, increasingly, an acknowledgment of the importance of sharing knowledge and learning.

Where innovation clusters have developed their financial, learning and productivity 'cultures' to a level that supports systemic innovation they can be regarded as constituting a 'regional innovation system'. An analysis of innovation clusters will usually reveal the extent to which such collaborative action has developed in funding, learning and the production of innovative goods and services, and the level of support for these goals in the commercial and public sectors.

and other innovation activities, including training and market research, for the three years 1997-1999. A total of 1,019 firms responded to the survey (including the 200 largest firms in Thailand). Of these 154 (or 15.1 percent) reported carrying out R&D, while 223 (21.9 percent) reported carrying out other innovation activities. In other words, more than three out of four firms responding had *not* engaged in any activities to improve their technological capability in the preceding three years[24] (not even employee training or the acquisition of machinery to improve production processes). Most of the firms carried out only simple testing and quality control, fewer than half had a design capability and only one-third a capacity for reverse engineering.[25]

R & D is concentrated in a few sectors. Research is perhaps the most skill-intensive driver of innovation and the survey showed it was clearly a minority activity. Fewer than one in six firms said they had carried out R&D in the last three years. Firms spent Baht 1,350 million on R&D in 1999, with companies in the food, beverages and tobacco industry carrying out around 48 percent of the total, and firms in the fabricated metals, machinery and equipment sector performing a further 35 percent. Nearly 1,100 research personnel were employed. The survey shows that R&D activities are concentrated in a few sectors but, at least in the case of the food industry, ones not regarded internationally as sectors of 'high R&D intensity'.

Strong linkages between local and foreign firms support innovation. Expenditure by firms on innovation activities other than R&D totalled Baht 2,084 million in 1999, or about 1.5 times the expenditure on R&D, again concentrated in the same two industry sectors. Acquisition of machinery and equipment was the most common activity and buying external technology the least common. The main reasons for innovation were reported as a) to improve product quality; b) to reduce production costs/ improve yield and c) to expand product ranges and markets. Factors limiting innovation were also canvassed. The survey also found that innovating firms saw it as important to use their parent and associated overseas companies and their foreign-owned suppliers as collaborators and sources of information on innovation.

Technology and innovative capabilities in Thailand lag behind comparable Asian countries. The government policies and institutional framework supporting technological development in Thai firms have recently been

Box 4-3
Scope of innovation activities

- Research and development (R&D).
- Acquisition of machinery, equipment and software for product and process innovation (i.e. new or significantly improved products or processes).
- Acquisition of external technology (e.g., patents and licenses) linked to product and process innovation.
- Industrial design and engineering, market research and marketing linked to product and process innovation.
- Training linked directly to product and process innovation.

Source: Thailand R&D/Innovation Survey 2000

Box 4-4
Factors limiting innovation

Factors limiting innovation (1 – not important, 5 – very important)	
Lack of government support	3.6
Perceived cost too high	3.6
Lack of qualified personnel	3.5
Inadequate support services	3.4

Source: Thailand R&D/Innovation Survey 2000

[24] Technical Information Access Center, National S&T Development Agency (2000). Thailand R&D/Innovation Survey – 2000, (Questionnaire); The Brooker Group plc (2001). Technological Innovation of Industrial Enterprises in Thailand: Project Synthesis prepared for the Workshop on 'Innovation and R&D in Thailand's Private Sector: *Information and New Findings, June 21, 2001'.*

[25] Patarapong Intarakumnerd, Pun-arj Chairatana and Tipiwan Tanchipiboon, 'National Innovation System in Less Successful Developing Countries: The Case of Thailand', m/s submitted to *Research Policy*, Sept. 2001.

reviewed with the support of the World Bank.[26] The study found that technology and innovative capabilities in Thailand lagged far behind comparable Asian countries. For example, the current level of R&D among business enterprises in Thailand is around 10-15 years behind the level in Korea in the early 1980s when that country had a level of industrial and manufacturing development similar to that in Thailand today. The intensity of R&D in business in Thailand would need to increase to around 20 times its present level in order to 'catch up' with the level in Korea at its corresponding earlier stage of industrial development.

The most important thresholds of technological capability that firms need to cross are *not* concerned with formally organized R&D but with other technological development and learning activities:

- For larger firms, they are about building design and engineering capabilities as a starting point for significant technology development activities.

- For the majority of SMEs, especially in traditional industries, they are about increasing the efficiency with which existing technologies are acquired, used and operated.

Public policy and institutional framework for innovation must change

The common finding of recent studies is that most Thai firms do not have the resources they need to upgrade their process and product technologies. In particular SMEs (the backbone of most economies, whether developing or developed) lack both the knowledge required to make informed decisions and the financial resources to acquire that knowledge and to invest in new technologies once they have decided on a reasonable strategy. In countries with relatively low per capita incomes, governments offer the best (and perhaps the most equitable) prospects for providing the funds needed to surmount these barriers.

Public institutions are viewed as weak and ineffective by firms. In the 2001 innovation survey companies were also asked about their knowledge and use of government support and funding and which services and incentives they had used. Firms rated the availability of government incentives for innovation as weak and requested the provision of better information on innovation, better human resource development and financial incentives for R&D and innovation. Firms that used public services valued the information, technical and training services provided by the government more highly than the monetary incentives, which were not used extensively by the firms sampled. University laboratory services were also well used.

Supply side driven technology development will need to be changed. The Technopolis study was strongly critical of a 'supply side' approach to technology development in Thailand and argued for giving end-users more influence over government sponsored technology development. It saw current policy and institutional arrangements as 'mono-structural', favoring public and semi-public institutions at the expense of building up technology development capabilities within industrial firms. This finding has clear implications for future policy.

The nexus between universities and the private sector. In 2002 Thai public universities are expected to achieve greater management autonomy while being required to generate more income from the business sector. This should prompt growth in university-industry collaborative R&D, training and service activities.

Policy reforms, funding arrangements and the organization of technical support institutes would build technological capability. There is a need for more specializa-

[26] E. Arnold, M. Bell, J. Bessant and P. Brimble. *Enhancing Policy and Institutional Support for Industrial Technology Development in Thailand: The Overall Policy Framework and the Development of an Industrial Innovation System*, Technopolis, SPRU, CENTRIM and Brooker Group plc, December 2000.

Table 4-2
Financial Incentives for R&D and innovation activities in Thailand

Scheme	
BOI promotion for R&D activities	Promotion of R&D as: (a) R&D activities already included in a promoted investment project (b) R&D as an addition to an already promoted investment project. (c) activities separate from firm's other business activities
Depreciation allowances for machinery and equipment for R&D	Depreciation rate raised to 40% from 20%
200 percent tax concession	200% deduction for R&D expenditure
Deduction or exemption from R&D machinery import duties	
Research and Technology Development Fund (MOSTE)	R&D soft loans Baht 10-20 million per project
Company Directed Technology Development Program	
Innovation Development Fund	Grants and soft loans for business innovation and start-ups
Thai Research Fund R&D Grants	Science and technology for production, marketing and services Industrial R&D for production processes and product development
MOI Productivity Improvement Plan	Soft loans for improving productivity and upgrading machinery
NSTDA Industrial Consultancy Service	Provides up to 75% of consultancy costs
Support for Technology Acquisition and Mastery Program (STAMP)	Financial support and arrangement of factory visits
BOI Unit for Industrial Linkages Development	
Skills development: 150 percent tax concession for training expenditure	

Source: Garrett-Jones, Robertson, Turpin, and Charoenpanji (2002)

Objective	*Mechanism*	*Target*
Promote firm-based R&D	Taxation concessions	Firm located in any zone involved with R&D activities
Encourage firm-based R&D	Taxation concessions	Firms engaged with R&D
Encourage firm-based R&D	Taxation concessions	Firms conducting R&D or hired to do R&D. They must be approved by MOF. NSTDA is the certifying body.
Encourage technology acquisition	Taxation concessions	Firms importing specific types of machinery: esp. scientific tools, R&D testing equipment, electronics parts and computer parts
Soft loans to improve and develop production processes and invest in R&D results	Loans	General
Assist SMEs to invest in technology development	Loans and grants	SMEs
Grants and soft loans for strategic projects	Grants and loans	General
Raising levels of R&D to develop processes and products	Grant	SMEs
Improving firms' machinery and productivity	Loans	SMEs
Enhancing production capability in SMEs through the use of consultants	Subsidies	SMEs
Support for technology acquisition	Subsidies	SMEs
Improving linkages between manufacturers and local suppliers		
Encourage private sector to invest in training	Levies	Firms that don't conduct training themselves

Table 4-3

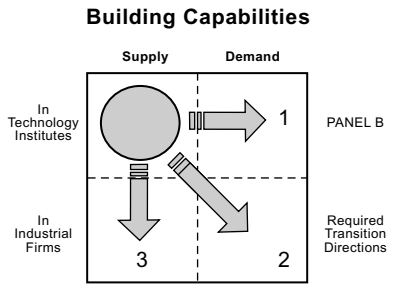
Administrative benefits and constraints on different forms of financial incentive for research and technology development

Assistance Measure	*Benefits*	*Possible Constraints*	*Budgetary/Administrative/Legal Issues*
Tax concessions	Non-discriminatory: open to all firms that meet stated criteria. Businesses more likely to be aware of taxation benefits. 'Arm's length' instrument: activities chosen by industry. Maintenance of firm confidentiality. Speedy processing (when approval 'automatic').	No benefit to unprofitable/start-up firms. Subsidizes 'existing' activities that would have occurred anyway (unless based on incremental performance, which is hard to police). Abuse (e.g., 'double dipping' when firms are also eligible for loans or grants). Selection criteria may encourage risk-averse activities to achieve short term repayment.	Cost is open-ended (difficult to control the level of revenue foregone). Relatively simple administration. Does not require annual approval of budget. Usually requires changes to taxation legislation. Requires careful accounting of eligible costs within the firm. Problems of definition and legal interpretation.
Repayable loans	Can be targeted widely or focused on specific activities. Priorities or scope (type, timing, size) set by govt., specific proposals made by firms.	Less likely to subsidize activities that would occur anyway. Formal application may be required. Cumbersome and lengthy selection procedure.	Maximum cost can be set but actual cost hard to determine. Requires annual budget. Requires formal procedure for application and selection. Difficult to decide what constitutes a successful outcome for the purpose of repayment – clear criteria required.
Grants	Generally for specific activities. Priorities or scope set by govt., specific proposals made by firms.	Less likely to subsidize activities that would occur anyway. Formal application required. Cumbersome and lengthy selection procedure.	Annual cost is set. Requires clear criteria for selection and the evaluation of outcomes. Requires formal procedure for application and selection.

Source: Garrett-Jones, Robertson, Turpin, and Charoenpanji (2002)

tion by institutions (including both integrating and separating current functions), more competition between institutions to encourage rationalization (e.g. between NSTDA's national institutes and the universities), greater stakeholder involvement (govemment and industry) in decision making and priority setting, and performance-linked financing. For example a key part of NSTDA's mandate is to foster industrial development. However industry plays a surprisingly small part in the govemance of NSTDA. NSTDA has a range of support instruments to help develop technological capabilities but these are not widely deployed and do not interact much with NSTDA's main research activities.

Figure 4-1
Industrial technology development policy in Thailand: alternative strategy – policy emphasis



Source: Arnold et al (2000)

Agencies like NSTDA could consider shifting the focus of their activities from developing public research capabilities to fostering technological capabilities in industry. This would require changes in governance, management and strategy development in NSTDA. Changes in focus would also be necessary. These include separating policy-making and policy/program implementation, adopting formal goal setting, performance measurement and reporting of achievements and increased mobility of personnel between NSTDA, the universities and industry.

There is a strong consensus among analysts that it is time for a change of direction on the part of NSTDA and other technology agencies. The important 10-year phase of building up the public research and technology infrastructure must now lead on to the crucial 'second step' – that of working directly with industrial 'customers' and with groups of players in the knowledge economy. This represents a significant change of emphasis in government programs.

Knowledge networking

There is a growing recognition of the important role of 'knowledge networks' in driving innovation (rather than the catalyst being technology alone). Other important factors are the importance of clustering in industries to support smaller firms in skill development and the collective acquisition and distribution of technology; a reliance on knowledge intensity rather than capital or labor intensity; the need to link local, national and international knowledge and innovation systems rather than focusing on developing an isolated national system. The implication is that future government policies should support knowledge networking as a means of improving the capability of firms in an equitable manner.

Linkages between the 'knowledge actors' (local and multi-national firms, technology institutes, universities) within Thailand's innovation system appear generally weak and fragmentary. The result of this is weak links between users and producers, limited intra-sectoral cooperation, limited technology spillover from MNCs and poorly developed, short-term relationships between firms, universities and technology institutes.[27] For example, in the 2000 innovation survey fewer than one in five firms reported having used the services of the government research and technology organizations.

Past studies have supported incentives that promote collaboration between universities and industry, with the dual aims of stimulating world

[27] Patarapong Intarakumnerd et al. op cit.

Box 4-5
Malaysia – the search for spillovers

Since Malaysia achieved independence in the 1960's the role of technology in development policy has evolved greatly. In particular in the mid-1980s the government embarked on a large-scale program to promote industrialization through technological development in targeted industries. As a result of dissatisfaction with the failure of investments by MNCs to provide substantial spillovers at that time, public R&D expenditures were centralized in the Fifth Malaysia Plan of 1986-90 and the Intensification of Research in Priority Areas program of 1986. Increased private sector input was provided as a result of the Action Plan for Industrial Technology Development (1990).

Although government spending on R&D more than doubled between 1986 and 1995 and public sector technology institutes expanded greatly, a feeling arose that activities had become excessively centralized and bureaucratized and that, as a result, they were not sufficiently efficient in meeting industrial needs. To counteract these tendencies and to hamess technological dynamism in the private sector government policy followed a new direction after 1993. In order to encourage the creation of industrial clusters the Malaysian government increasingly sought spillovers from MNCs operating locally. In a policy similar to Singapore's, the government has tried to promote technological advances in indigenous firms that belong to subcontracting networks centered on foreign firms (largely from Japan or East Asian NICs) with manufacturing operations in Malaysia. Through *keitretsu*-like structures small local firms are meant to get the resources to upgrade their technological skills and reduce Malaysia's high level of dependence on labor-intensive operations. A cluster in Penang, built around disk-drive firms that had migrated from Singapore, has been viewed as especially successful. A more recent phenomenon, the Multimedia Super Corridor, is currently receiving a large amount of funding from the Malaysian government to create another private-public cluster. However despite this partial shift in emphasis to technology transfer within the private sector, two prominent observers (Felker with Jomo, 1999, 24) have argued that;

> *"In sum, though industrial and technology policies have gradually shifted from expansive aspirations to strategically direct structural change to a model more focused on private-sector dynamics and institutions, the Malaysian state retains its activist stance in fostering technological upgrading. It continues to emphasize strategic intervention, if increasingly in a supportive and facilitating role".*

Although it is too early to evaluate these initiatives fully, there are concerns that, in reality, the spillovers from MNCs to indigenous firms are less than had been hoped. Moreover, the lack of local skilled and educated labor may inhibit further rapid development if MNCs capture the bulk of the skilled workforce, so leaving locally-based firms that wish to participate in technological upgrading at a disadvantage. This situation had led to calls for immediate and substantial growth in the infrastructure devoted to training and education.

class research and doctoral level training and encouraging 'people-focused' (rather than equipment focused) technology link-ups between technology institutes and industrial enterprises.

Potential locations for such collaboration already exist. In the Chiang Mai area a number of service providers (government agencies, universities and technology institutes) cater to SMEs in the local ceramics industry. However their relationship appears to be short term and ad hoc rather than systematically supporting a strategy for building the technological capability required for higher quality and higher priced products. An effective example of collaboration is that between King Mongkut's Institute of Technology in Bangkok and the Hi-Tech Industrial Estate, which has led to the setting up of the Ayutthaya Technical Training Centre.

Potential collaborative dusters may also be found in the supply chains of manufacturing MNCs. In the automotive industry MNCs like Toyota have significant in-country R&D and technological skills which can be used to support their Tier 1 and Tier 2 (primarily local) suppliers. The activities of semi-public agencies like the Thailand Automotive Institute (in information, training, quality certification and testing) can also play an important role. However, a recent analysis of the Thai automotive industry identified a lack of collaborative mechanisms within the supply chain, in addition to the common problems of a shallow skills base and inadequate support services.[28] Communication within the supply chain was largely informal, making little use of ICT-based systems. The challenges facing the automotive sector at the Tier 2 level concern the interaction of technology/skills development, trade policy, investment policy and SME development. As is the case in other sectors these problems cut across several government. agencies, including NSTDA and the Ministries of Industry and Labor.

There is no single focal point within government with responsibility for producing a coherent sectoral strategy or coordinating the government's response to the technical and policy needs of the sector. In such industries the technological needs will be almost wholly determined by the MNCs. But public-private sector cooperation is also required to assist the local companies in building their capability to serve MNCs with technology-based products of the required quality and price.

Conclusion

Thailand ranks low in global rankings of technological and skills capability despite the large number of public institutes that have been established to support science, technology and labor skills. It is estimated that at least 17 public organizations or funds exist to support technology and innovations. Most of these programs suffer from a lack of targeting. There is a lack of coordination amongst agencies, and many of the programs are supply driven. The programs on technological development are not well coordinated with those for skills development. Along with institutional deficiencies the instruments used to deliver the services (e.g., taxes and subsidies) are also ineffective.

Thailand will need to consider the following to improve its technological and skills development.

- Improve targeting (e.g., by reaching out not only to firms but also to networks, targeting SMEs).
- Improve coordination across agencies.
- Improve governance of these agencies by giving a greater voice to SMEs on the boards of management.
- Increase awareness.
- Integrate technological and skills development.

[28] World Bank Group, SME Global Product Group/East Asia and Pacific Private Sector Development, *Supply Chain Deepening in the Thai Automotive Sector: Analysis of Key Issues-Pilot Program Design*, December 2001.