1. Introduction and overview

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East Asia is by practically any measure the most competitive and dynamic industrial region in the developing world. This is universally acknowledged but it is not fully understood, despite the industry that has grown up around the analysis of East Asian competitiveness. It is widely known that the successful countries used very different strategies to build their industrial competitiveness, but the ingredients of these strategies still need further analysis. In particular, the means that the ‘Tiger’ economies used to access and absorb new foreign technologies over time – this process is the very lifeblood of industrial success – have useful lessons for other countries. As the intensity of international competition mounts and as developing countries open their economies more widely to global market forces, all policymakers and analysts need to know how the most dynamic countries ‘did it’.

This book deals with one aspect of competitiveness strategies in East Asia: the interaction between foreign direct investment (FDI) and local technological activity in building export competitiveness. It highlights different strategic approaches at the national level and looks at capability development within industrial enterprises.

ISSUES

These differences in the strategies adopted by countries to promote technology development pose important questions. How, for instance, are foreign technologies most efficiently transferred from industrial to developing countries? Does the mode of technology transfer matter for subsequent technology development? What is the need for local technological effort in developing countries that are ‘latecomers’ to the industrial scene and can draw upon the vast cornucopia of technological knowledge in the developed world? Are TNCs essential for export competitiveness in technology-intensive industries today? And so on. Not all these questions can be addressed in this book but many are.

Some of the points that emerge in the analysis of country experiences are as follows.

- The transfer of technology and market information from foreign companies can take several forms. These include 'internalized' modes like inward FDI (where transfers take place within the company), or 'externalized' modes like licensing, subcontracting, original equipment manufacturing arrangements (where transfers take place across companies). While all countries use both methods to access foreign technologies, the balance between them varies greatly.
- Having accessed foreign technology, the developing country has to learn to use it effectively, adapt it to local conditions and improve it over time to keep up with competition and the international technology frontier. Simply importing new technology does not mean that it can be used competitively: there is always a need for local effort to create the capabilities to use new knowledge.
- The mode of technology transfer affects the need for, and the extent of, domestic effort.
- Reliance on internalized technology transfer reduces the need for independent local effort (though *some* learning is always involved). It also often provides access to state-of-the-art technologies along with established brand names and entry into global markets. FDI is thus a very effective way to transfer and operationalize new technologies for export competitiveness.
- Externalized technology transfer entails greater effort and risk on the part of the recipient country, and may not allow access to the most valuable new technologies (which are closely held by the innovators). Exploiting externalized technologies in world markets is also more difficult because of the need to build export marketing capabilities and channels. Where externalized transfers are not managed effectively, with the considerable local investment in capability development, they can result in technological inefficiencies, lags and subsequent uncompetitiveness.
- Yet there may be sound reasons for encouraging the development of local technological capabilities. In most medium to large sized economies, local enterprises account for the bulk of industrial activity, and their competitiveness depends on externalized technology transfers. Externalized transfers involve greater effort – and yield greater learning benefits. With industrial diversification and deepening, countries have to undertake more advanced technological functions, such as design, development and research. Internalized modes of technology transfer may not lead to the same pace of upgrading as externalized modes: there are good economic reasons for multinational companies to keep advanced technological effort centralized in a few industrialized countries.

- Technology development strategies have a large element of cumulativeness and path-dependence: once launched, they tend to persist along particular trajectories for long periods. At the same time, there are forces making for greater convergence. The international 'rules of the game' are changing, constraining the use of certain government interventions (such as protection, subsidies, local content rules and exclusion of FDI) in promoting technology development. The external environment is also changing, making externalized modes more costly and risky. At the same time, countries relying heavily on internalized modes are seeing the need for greater domestic capability development to sustain export competitiveness.

The East Asian countries have chosen different combinations of internalized and externalized modes of technology transfer, and are converging towards a more uniform set of policies at different rates. Korea, for instance, has taken the path of building domestic R&D capabilities instead of relying on FDI for its technological growth. Taiwan is rather similar, but has been slightly more open to FDI and less interventionist in building domestic industrial champions. Both are now more open to inward FDI while becoming major direct investors on their own.

The Philippines and Thailand have chosen to rely heavily on the import of internalized technology and have invested relatively little in domestic R&D effort. This has not prevented them from entering highly sophisticated and dynamic areas of export activity, but it is seen as a constraint on sustaining competitiveness in the longer term. Singapore has relied on FDI but has made strong efforts to induce foreign investors to deepen into local design and development. China combines the Korean and Singaporean strategies. Its total R&D budget as a percentage of GDP has been quite high. And so on.

The choice of strategy has, of course, depended on many country-specific factors. These include, *inter alia*, the prevailing policy environment (in turn reflecting history, culture and political economy), domestic technological and human capital, development objectives and the institutional framework. As noted, however, there is considerable policy convergence between Asian economies. Countries that have built competitiveness by specializing in labour-intensive segment of MNC activities are finding that they can sustain export growth only by deepening local content, skills and technological activity. Those with strong indigenous technological bases are realizing that innovation is becoming expensive and specialized, and that production is being increasingly organized in internalized MNC systems spanning several countries. It thus becomes necessary to form alliances with technology leaders and participate more fully in global production systems.

This is a highly simplified picture of a complex and dynamic scene, with many variations within and across East Asian countries. The chapters that follow adopt different approaches to the analysis of technology strategy and competitiveness. We have not sought to impose a uniform format or approach on the studies, encouraging authors to explore aspects of technology development and FDI from their own perspectives.

CHAPTERS IN THIS BOOK

Lall (Chapter 2) sets the scene for the country studies by analysing the general relations between technology transfer, FDI and local technology development. He describes the nature of technological learning and effort in developing countries, and the possibility of a divergence between the private interests of the multinational company and the social interests of the host economy in terms of long-term technology development. He goes on to trace recent patterns of export growth and competitiveness in manufactured products, noting the rising share of technology-intensive products and the growing competitiveness of East Asia. The advantage of East Asia over other developing regions is greatest in technology-intensive products, and the most dynamic exporters (including China) have rapidly moved up the technology ladder as they have expanded exports.

The burgeoning competitiveness of East Asian economies draws upon quite distinct strategies. Lall distinguishes between four broad approaches. The first is 'autonomous' (the building of domestic technological capabilities, restricting FDI entry and investing heavily in domestic skills and capabilities), as in Korea and Taiwan. The second is 'strategic FDI dependent' (relying heavily on FDI but using industrial policy extensively to induce it to deepen into advanced activities and functions), as in Singapore. The third is 'passive FDI dependent' (also heavily FDI reliant but without the use of industrial policy to deepen the technological structure). The fourth is 'ISI restructuring' (inducing domestic market-oriented activities to restructure for export markets), as in China.

Each of these policies has been successful in its own way in boosting export competitiveness, though each faces different strategic challenges. Lall shows with some comparative data the varying implications or consequences of the strategies in terms of skills, R&D and FDI. Cluster analysis is used to supplement the descriptive statistics and illustrate graphically the differences in FDI dependent and autonomous strategies.

Kawai and Urata (Chapter 3) examine the performance of East Asian economies in terms of per capita GDP and total factor productivity (TFP) growth for 1970–97. They also investigate statistically the determinants of

per capita GDP and TFP growth for 137 countries with a focus on domestic technological capability and inflows of foreign technologies.

They find that East Asian economies as a group perform better than other developing countries (despite some variations among the individual Asian economies). Improvements in domestic technological capability and greater inflows of foreign technology both contribute to increases in per capita GDP and TFP in East Asia. High educational attainment plays an important role in improving domestic technological capability while capital goods imports and FDI inflows are the main sources of foreign technologies. In some cases, foreign technologies are used most effectively when combined with high domestic technological capability.

Though East Asian economies in general perform better than do other developing economies, there are wide variations among them. Many are facing difficult challenges in upgrading technological levels because of increased competition and rapid technological progress. Kawai and Urata argue for a business-friendly environment for foreign and domestic firms by pursuing open policies, improving hard and soft infrastructure, and maintaining stable macroeconomic performance.

Goto and Odagiri (Chapter 4) analyse how Japan acquired foreign technologies in the manufacturing sector during the period from 1945 to the early 1970s. The most striking feature of Japan's strategy was the limited use of FDI and the reliance on technology licensing and purchase of capital goods for the acquisition of foreign technologies. The reasons for its competitive success lie in accumulated technological capability, a rapidly growing market, intense competition from domestic rivals and potential foreign entrants and government policies. There was a 'virtuous circle' between the import of foreign technology and domestic R&D, resulting in the development of technological capability. The measures used by the Japanese government included the protection of domestic industries and promotion of R&D.

Goto and Odagiri draw two policy implications from Japan's experience. The first is that the acquisition of foreign technology requires strong technological capabilities and enormous efforts on the part of the acquiring country. The government played two important roles in technology acquisition. First, it nurtured technological absorptive capabilities by promoting general education and R&D spending. Second, it opened the economy to trade and FDI gradually and with careful preparation. It announced liberalization in advance and in a policy environment in which Japanese firms could raise technological levels in order to compete effectively with anticipated competition from foreign countries.

The second implication concerns FDI policy. While accepting the potential benefits of FDI for technology transfer, they identify some potential

drawbacks, such as the domination of domestic industries by foreign firms. Goto and Odagiri argue that restrictive FDI policy contributed to the development of local firms by providing high profits and so allowing them to invest in capacity and capabilities. However, they warn that such restrictions have to be short term: domestic firms must face a potential entry threat. In the globalized economic environment and taking account of the wide technological gap between developed and developing economies, Goto and Odagiri question the advisability of restrictive FDI policy for developing economies today.

Urata and Kawai (Chapter 5) deal with overseas R&D and intra-firm technology transfer by Japanese MNCs. They distinguish between two types of MNC technology transfers: intra-firm (from the parent to overseas affiliates) and spillovers (from affiliates to local firms). Both can contribute to upgrading technological capability in host economies. Urata and Kawai find that Japanese affiliates transfer technology to affiliates and also undertake R&D in host developing economies (mainly to support production). The determinants of affiliate R&D include strong dependence on local sources for intermediate inputs and long operational history in a given location. The determinants of successful intra-firm technology transfer are the availability of educated personnel and R&D resources, the size and development of the local manufacturing sector and accumulated Japanese FDI.

Urata and Kawai draw the implications of their analysis for developing host economies. First, it is important to build strong supplier industries to promote R&D by foreign firms. Second, developing economies should improve the quality of human capital, on the shop-floor, in engineering and in research activity, in order successfully to assimilate technology from foreign firms. Finally, developing economies should provide the economic environment, legal system, infrastructure and so on that attracts FDI.

Kim (Chapter 6) argues that rapid technological learning by Korean firms was the most important factor in its phenomenal industrial and export growth. Korea relied heavily on the inflow of new technology via licences, capital goods and original equipment manufacture (OEM) contracts rather than FDI. Domestic efforts and capabilities were essential in assimilating foreign technology in these externalized forms, since foreign firms were reluctant to transfer key technologies and capabilities. Kim warns that FDI reduces the efforts on the part of domestic firms and increases their dependence on foreign firms. In Korea domestic technological capability was nurtured by both supply and demand factors. The main supply-side factors were the availability of strong human resources, active R&D by private firms and the creation of large firms, supplemented by credit provided on favourable terms. The main demand-side factor was the

very competitive environment facing Korean firms, engendered by the strong emphasis on exports which offset the protection offered on the domestic market in terms of providing incentives for capability building.

Kim derives four policy implications for developing countries. The first is the importance of skill building. The second is the role of strong export orientation in creating an intensely competitive environment. The third is the use of the 'brain drain' as an input into domestic capability building: high calibre nationals abroad can be important sources of technical knowledge and skills. The fourth is the role of government research institutes (GRIs) in providing a supply of capable researchers and engineers.

The Korean experience is, however, difficult to emulate, in part because of the new international environment. For example, tightened intellectual property right protection has made it difficult for developing economies to 'reverse engineer' foreign products, one of the main methods of acquiring foreign technologies by Korean firms. Restrictions on FDI are more difficult, and the protection of infant industries is now impossible.

Bee-Yan Aw (Chapter 7) analyses econometrically the effect of different modes of technology acquisition on total factor productivity growth in Taiwan, using firm-level data for the electronics industry in 1986 and 1991. She distinguishes between the following modes: exporting, FDI, R&D, employee training, subcontracting and technical cooperation. The results suggest that exporting, R&D and FDI had positive effects on TFP. In terms of technology spillovers (the acquisition of technology through informal interaction between firms) FDI and exports have a significant impact in the same geographical region and in the same industry. This points to the importance of contacts with foreign firms through exports and FDI, particularly in the electronics industry, where the technology frontier shifts rapidly.

Aw also finds that R&D and training improve technological ability, allowing local firms to assimilate technology more effectively. In Taiwan, the role of the government and industry associations in linking foreign investors with local firms, and in establishing an efficient system of subcontracting, was vital to technology transfer and absorption. All this required human capital, and policies to improve education and R&D manpower were also critical. The impact of technological activity and spillovers greatly contributed to the competitiveness of the small and medium-sized enterprises which formed the bedrock of Taiwan's economic development.

Wong (Chapter 8) traces Singapore's rapid economic growth and structural transformation since independence in 1965. This remarkable economic performance was, according to him, made possible only by the upgrading of technological capability. Singapore underwent four distinctive phases in technology development. The first was the industrial take-off

phase, with high dependence on technology transfer by foreign firms. The second phase involved deepening local process technological capabilities, both within MNC affiliates and in supporting local firms. In the third phase foreign and local enterprises and research institutions expanded applied R&D activity. The fourth phase is that of high-tech entrepreneurship and basic R&D. This evolution has moved Singapore from being a technology user to becoming a technology creator.

The technology development of Singapore is to a large extent attributable to effective government policies. These include sound macroeconomic management, open trade and FDI policies (including effective promotion and targeting of MNCs), active science and technology policy and strong emphasis on education and training. One noteworthy feature of technology development in Singapore has been the willingness of MNCs to invest in R&D, partly in response to the strong incentives and enabling conditions offered by the government. Wong also notes the effectiveness of government measures in creating technological linkages between MNCs and local firms.

Wong draws several implications from this experience for other economies. First, it is important to combine a long-term commitment to upgrade technological capability with the institutional capability for flexible and rapid policy change in response to changes in the global environment and the changing needs of the national innovation system. Second, a proper sequencing should be followed in building and deepening technological capabilities: operational and adaptive capabilities should be built before investing in basic research. Third, success in technology development depends not only on effective science and technology policies but also on a variety of other factors, including an open trade and investment environment, sound macroeconomic performance, political and social stability, a corruption-free public service sector and good infrastructure. Fourth, there is no universal set of technology development policies that can be applied to all the countries. One country cannot copy the system that worked in another without modifying it to suit its own conditions. This modification itself needs significant government capabilities.

Yao (Chapter 9) describes China's remarkable industrial growth since the start of liberalization in the late 1970s. He attributes it partly to improvements in technological levels, revealed by rapid increase in total factor productivity and by a shift in the export structure from resource-based products to labour-intensive and simpler technology-intensive products. He describes several characteristics of the technology system in China, such as the dominance of central and local government and public research institutes in R&D activity and the important (even excessive) role of basic research. The acquisition of foreign technologies has shifted from licensing to FDI, particularly in the 1990s.

Yao assesses the effectiveness of the government, private firms and foreign firms in Chinese technology by descriptive and econometric analysis. He finds several interesting patterns. First, collective, private and foreign firms (excluding those from Hong Kong, Macao and Taiwan) are more efficient than state-owned enterprises. Second, foreign firms seem to be reluctant to transfer state-of-the-art technology, but they have beneficial spillovers by training personnel and stimulating competition. Third, R&D by public research institutes has no significant impact on firms' technological levels.

Yao draws policy implications for China and other developing economies. First, he argues for a shift in emphasis in technology development from the public to the private sector and for close ties between basic research in public laboratories and the private sector. Second, he notes the importance of technology development in labour-intensive industries, in which countries like China have a strong comparative advantage. This entails a shift away from the current emphasis on high-tech. Third, he remarks on the importance of integrating foreign firms into the domestic economy.

Abrenica and Tecson (Chapter 10) provide a provocative analysis of technology development in the Philippines. They contrast its very high-tech export specialization (the Philippines has one of the most technology-intensive export structures in the world) with its weak technology base. They describe the various channels of technology transfer – FDI was the most important – and go on to explain the sharp divergence between the export structure and the technology base. They note that the high-tech export structure is due solely to the predominance of the electronics industry, and within it to semiconductors. In this activity, the Philippines is confined to the labour-intensive end of assembly and testing, with very low local content and little upgrading over time. The apparently high endowment of human capital is also slightly misleading once the quality of education is taken into account.

While MNCs have transferred considerable production technology to the Philippines, they have not invested much in local R&D. Neither have local industrial firms. The bulk of R&D takes place within government laboratories, most of it de-linked from the productive sector. Technology strategy has not been coherent, and its implementation has been weak. The main science and technology body has a low status in the government. Trade liberalization has not stimulated a change in the technology culture in industry, and without this the country is exposed to considerable risk by its narrow specialization and low local content in export activity.

Rasiah (Chapter 11) deals with technology development in Malaysia, which was, to an even greater extent than Thailand, dependent on foreign

investors to drive industrial and export growth. As with Thailand, local technology development lagged; Rasiah notes the contrast between Malaysia's experience and those of Japan, Korea and Taiwan, where technology development and industrial competitiveness were largely driven by domestic effort. However, the government did play an important role in attracting FDI and providing good infrastructure and a conducive business environment for export-oriented industrialization.

FDI has provided considerable benefit to the Malaysian economy, going beyond its direct contribution to exports, employment and manufacturing production. It has raised local content over time, and so helped the growth of supplier industries. However, rising costs and the emergence of cheaper sites in China and Indonesia place Malaysia under increasing pressure to upgrade its production structure and capabilities to higher value activities. Rasiah finds that Malaysia has not been very successful in meeting this challenge, largely because of its failure to make the requisite institutional changes in such areas as tertiary education and technological activity. While the public sector has actively supported R&D activities, the private sector has not responded adequately. In addition, there is insufficient co-ordination between such technology support activities as finance, training, technical extension and R&D. Rasiah emphasizes the need for a comprehensive policy addressing all these issues.

Brimble, in his analysis of Thailand in Chapter 12, draws a rather different picture of technology development in another dynamic and competitive economy. Thailand's rapid economic growth was based on the growth of labour-intensive, low-tech industries, with foreign investors playing a very important role. However, the development and deepening of local technological capabilities lagged. Indeed, Thailand lags behind many other Asian economies in terms of technological development; this is borne out by international comparison of such things as the quality of technology, management and labour. It is also shown by low R&D spending, the small number of scientists and engineers and the small number of students specializing in science and technology.

Brimble attributes weak technology development in Thailand to a lack of awareness in the public and private sectors of the economic importance of science and technology. This is attributable to a tradition of passive reliance on off-the-shelf technology import, with little subsequent effort to absorb and improve upon it. Thai entrepreneurs tend to display a short-run commercial orientation, which deters them from investing in the long-term development of technological capability. Yet the phase based on low wages and skills is coming to an end, and Thailand's future growth and competitiveness depend on its ability to develop significant new technological capabilities. This calls for substantial changes in its science and technology

policies. Such changes extend well beyond the narrow scope of S&T, and cover manpower development, technological upgrading of small and medium-sized enterprises and the development of support industries.

Brimble stresses the need to allocate more resources to training, R&D and other innovation activities with a particular emphasis on applied technology. He also points to the importance of the creation and use of linkages – between the government and the private sector, between foreign firms and public intervention and between foreign and local firms – to improve technological capabilities. All this also needs greater awareness on the part of the Thai government, business and the population at large of the importance of technology development and the role of FDI in development.

Okamoto and Sjöholm (Chapter 13) treat the case of Indonesia, which made enormous economic strides before it was struck by the financial crisis in 1997. Despite rapid industrialization, however, Indonesia still lags behind other East Asian countries in technological development. Analysing the results of other studies of Indonesia's experience, Okamoto and Sjöholm draw four lessons for technology development. First, in the early stage of industrial development agents like foreign buyers, trading companies and experts are important sources of technology; thus, it is important to have an open trade and FDI regime. Second, FDI can contribute to development not only by introducing new technology but also by generating employment, expanding production and exports. However, the host economy has to build local skills and R&D capabilities if it is to benefit fully from MNC presence. Third, the government can play an effective role in acquiring, upgrading and disseminating technology, especially in an environment where private industrial linkages are deficient. Specifically, government can provide better education and training, and improve the technology infrastructure (standards, quality and testing). Fourth, technology policies targeting high-technology industries (like aircraft in Indonesia) can be wasteful, unless backed by the prior development of skills and a technological, managerial and institutional infrastructure.