

Interaction between Host Countries' Innovation Systems and Investment Strategies of Transnational Corporations: A Case Study of a US-based Conglomerate

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Abstract: Though the roles of transnational corporations (TNCs) in host countries have been extensively studied, there is not enough empirical research on the interactions between corporate strategies of transnational corporations and innovation systems of host countries. This research is based on a single case study of a US-based Conglomerate investing in several countries around the globe. We paid particular attention to their investments in Singapore and Thailand and investigated how strategies of this TNC interact with national innovation systems of these two countries. The findings illustrate that Singapore's National Innovation System is much stronger and more proactive in inducing new investment from the TNC. Over time, it incentivised and pressured the company to move up the global value chain by investing in activities requiring higher technological and innovative capabilities. There is a strong relationship between Singapore's national innovation system and investment by the TNC. This is not the case for Thailand.

Keywords: innovation systems, investment strategies, Singapore, Thailand, transnational corporations

JEL classifications: F 23, 031

1. Introduction

There is an increasing concern about the roles of transnational corporations (TNCs) in the host countries' innovation systems. Several studies explore factors that could influence investment from TNCs (Tsai, 1994; Kumar, 2001; Nunnenkamp and Spatz, 2002) and the significant contributions from foreign investment to the host countries (Blalock and Gertler, 2003; Narula and Marin,

2003; Marin and Bell, 2006; Giroud, 2007). Others reveal the close linkages observed between TNCs and local networks in the host countries and determine that TNCs could possibly contribute to the development of the host country innovation systems due to their advanced technology and capabilities (van Beers, 2003; Boehe, 2004). The extent of such contributions depends on the strength of innovation systems themselves. A national system of innovation with a strong science base and the existence of innovative, competitive and often large national firms has many attractions (Patel and Pavitt, 1998). Similarly, an impact on the innovation system is considered to be positive if it supports or improves the conditions for industrial renewal, creates new areas of specialisation and contributes to economic growth in the country (Johansson and Lööf, 2006).

Nonetheless, previous studies have not extensively examined the interaction between national innovation systems of the host countries and TNCs' investment strategies. Therefore, studying this issue will have theoretical contribution. It will also be useful for devising better policy interventions from governments of host countries to induce more technologically sophisticated activities of TNCs and maximise their spillover impacts on the local economy, especially in terms of enhancing capabilities of local firms. To achieve this objective, we use a case study of a US-based conglomerate investing in several countries around the globe with special reference to its water technology business.

The outline of this paper is as follow. Section 2 provides literature review on Strategies of Transnational Corporations and Host Countries' Innovation Systems. Section 3 describes methodology and background of the case study. Section 4 examines the case study. Finally, Section 5 draws conclusion and policy implications.

2. Strategies of Transnational Corporations and Host Countries' Innovation Systems

The concept of national innovation systems (NIS) rests on the assumption that understanding the linkages among the actors involved in innovation is a key to improving technology performance (OECD, 1997). There is no single accepted definition of a national system of innovation, but a group of researchers has developed some concepts of innovation since the mid-1980s (Freeman, 1987; Lundvall, 1992; Nelson, 1993). For example, Metcalfe (1995) stated that a national innovation system (NIS) is a set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provide the framework within which governments form and implement policies to influence the innovation system. This definition makes explicit reference to institutions, governments and innovation policies and implies the existence of linkages among the actors in the systems such as

governments (their policies and actions), local universities, public research institutes, local suppliers and customers. Innovation and technical progress is the result of a complex set of relationships among actors producing, distributing and applying various kinds of knowledge (OECD, 1997). Hence, a national innovation system can be perceived as a historically grown system in which various organisations and institutions interact and influence each other in engaging in innovative activity (Balzat and Hanusch, 2004).

The national innovation system concept has been used in several ways. Oviatt and McDougall, (2005) observed that firms, even in their early phases, have increasingly adopted 'international entrepreneurship' i.e., the discovery, enactment, evaluation, and exploitation of opportunities across national borders to create future goods and services. As a result, some scholars in the area of innovation systems pay attention to the interaction between TNCs and different actors within national innovation systems at both home and host countries. Narula (2002), for instance, explains that firms are embedded in various systems of innovation in their home countries and systemic lock-in may prevent formal and informal networks between customers, suppliers, competitors, consultancies, universities and research institutes, government agencies, funding organisations, and so forth. Accordingly, integrating into a new location may be prohibitive even in the cases where the host locations are superior to the home. Nonetheless, firms may seek to acquire the technology they need from abroad through R&D investments (Johansson and Lööf, 2006).

The globalisation of corporate R&D occurred in phases. As TNCs gain more confidence in the capabilities of their affiliates abroad and the host countries, increasingly 'higher-order' R&D is being assigned to them. Before the mid-1970s, R&D investment by TNCs in developing countries was mainly related to adaptation of products and processes to the local conditions. Since the mid-1970s, as the need for increased sensitivity to local conditions became more important, some R&D activities of TNCs were established abroad to develop products exclusively for local markets. Subsequently, from the mid-1980s, TNCs started carrying out higher-order R&D, namely developing products for regional/global markets or mission-oriented basic research for long-term corporate use, in developing countries. This happened mainly because TNCs want to access the pool of talents, especially researchers in some large developed countries like China and India and some newly industrialising economies (Reddy, 2000). Nonetheless, several empirical studies (Amsden and Tschang, 2003; Rasiah, 2003, 2004, 2007, 2008, 2010, 2011; UNCTAD, 2005) illustrated that TNCs, though recently trying to invest in higher-order R&D, did not relocate from home to host sites in East Asia, the furthestmost frontiers in R&D.

Rasiah (2010) analysed taxonomy and technological capability trajectories of firms (see Table 1). His studies, including those already cited above, depicted low but moderately increasing participation of TNCs in electronics and automotive industries in Southeast Asia, Brazil and India in early and mature R&D (levels 5 and 6 of Table 1).

Table 1: Taxonomy and Trajectory of Firms

Knowledge Depth	Human Resource	Process	Product
(1) Simple activities	On the job and in-house training	Dated machinery with simple inventory control techniques	Assembly or processing of component, CKD and CBU using foreign technology
(2) Minor improvements	In-house training and performance rewards	Advanced machinery, layouts and problem solving	Precision engineering
(3) Major improvements	Extensive focus on training and retraining; staff with training responsibility	Cutting-edge inventory control techniques, SPC, TQM, TPM	Cutting-edge quality control systems (QCC and TQC) with OEM capability
(4) Engineering	Hiring engineers for adaptation activities; separate training department	Process adaptation: layouts, equipment and techniques	Product adaptation
(5) Early R&D	Hiring engineers for product development activities; separate specialized training activities	Process development: layouts, machinery and equipment, materials and processes	Product development capability. Some firms take on ODM capability
(6) Mature R&D	Hiring specialized R&D scientists and engineers wholly engaged in new product research	Process R&D to devise new layouts, machinery and equipment prototypes, materials and processes	New product development capability, with some taking on OBM capability

Source: Rasiah (2010)

Assessing R&D activities only, Amsden and Tschang (2003) classified R&D into five categories:

- pure science: creating intrinsic knowledge
- basic research: producing new knowledge for radically new marketable products

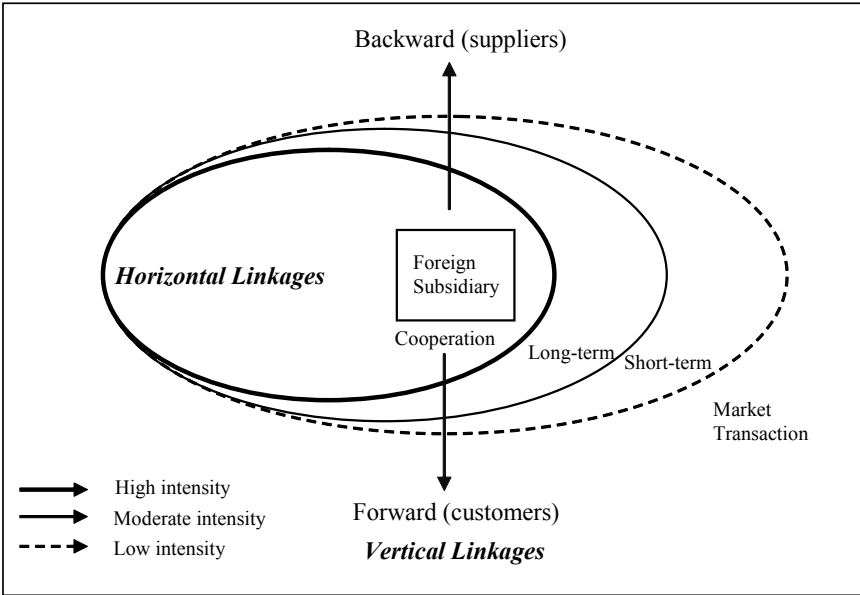
- applied research: creating differentiated products 'on paper'
- exploratory development: creating prototypes in a system
- advanced development: developing prototypes for manufacture.

They found that TNCs in Singapore attempted, with difficulties, to upgrade their activities to advanced or exploratory development from applied research.

Interactions between R&D units of TNCs with partner organisations can have impacts on innovation dynamics in the host countries. Specifically, learning and innovation can be enhanced when TNCs interact with local partners, such as suppliers, customers, research institutions and universities. Nevertheless, the extent of their contribution depends on the strength of their technology and science related links with local and global partner organisations. As a consequence of this, it is necessary to offer an efficient national innovation system in order to attract such foreign investments. This requires continuous investments in high quality innovation centres, research parks and universities. Good physical and knowledge infrastructure allows specialisation in high technology niche markets (van Beers, 2003). Empirically, Berger and Revilla Diez (2006) identified several mechanisms by which TNCs foster the NIS development in late-industrialising countries which are ill-developed and fragmented, lacking crucial key resources and access to technology and knowledge. The study was based on qualitative research in 20 firms, of the automotive and hard disk drive industry in Thailand. They suggest that TNCs could contribute to the development of the host countries' innovation systems due to their advanced technology and capabilities.

Linkages between TNCs and actors in host countries' innovation systems can be classified into three main groups (Saggi, 2002; Murray *et al.*, 2005; Giroud and Scott-Kennel, 2006): vertical linkages with suppliers and customers; horizontal linkages with partners or competitors; and institutional linkages with governments, research institutes, industry organisations and universities. The intensities of such linkages can be different as well (see Figure 1). The interaction between subsidiaries and local sources of competence is one of a number of significant strategies to enhance a firm's capability. Nonetheless, this depends on location determinants, corporate level considerations, subsidiary-specific advantages and subsidiaries' ability to learn from their local business partners (Eng, 2007).

Figure 1: The Intensity of Different Types of Linkages



Source: Giroud and Scott-Kennel, 2006.

Several studies on linkages between TNCs' subsidiaries have been conducted. Different linkage types and objectives and findings of these studies are highlighted in Table 2.

Nonetheless, previous studies over-emphasising backward linkages restrict our understanding of the developmental potential of other linkages. There were also few studies examining the linkages and their impacts between a single transnational corporation and its local partners across different host countries. Therefore, longitudinal studying of linkages between a transnational corporation and local actors of host countries' innovation systems across different countries will provide significant theoretical and policy-wise insights for this very important issue.

3. Methodology and Background of the Case Study

The main research question in this study is to understand the interaction between national innovation systems of host countries and TNCs' investment strategies. Specifically, we will try to find answers to the following question: how do the roles of national innovation systems of host countries affect the TNCs' investment strategies. Based on the aforementioned literature review, we can summarise the conceptual framework of our study in Figure 2. In essence,

Table 2: Summary of Previous Studies on TNC's Linkages

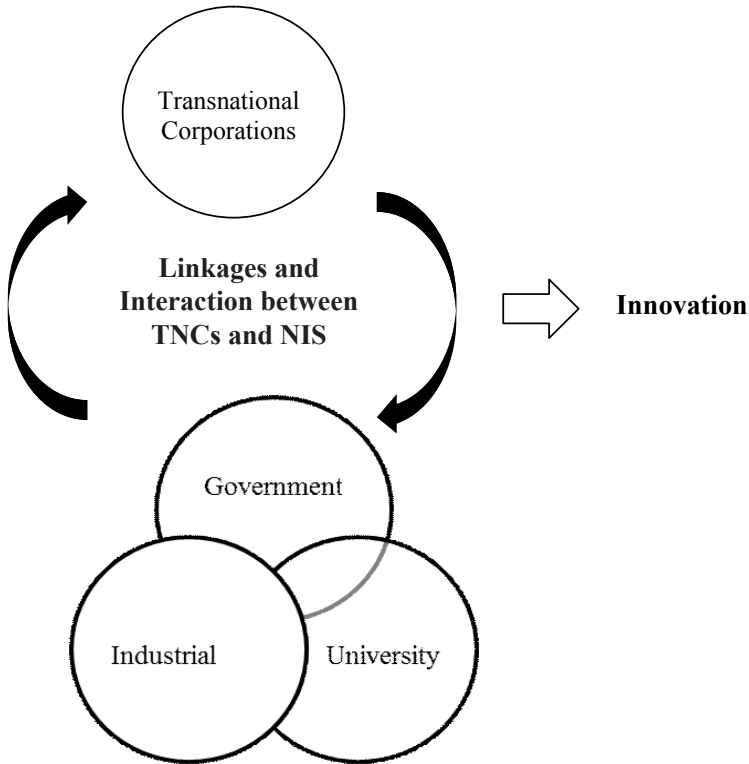
Linkage Types	Authors	Key Research Objectives	Findings
Vertical Linkages	Lim and Fong (1982)	Clarify the nature, extent, determinants and impact of vertical linkages.	A healthy investment climate and rapid economic growth are important driving forces in encouraging TNCs to lead in creating local vertical linkages.
	Jindra <i>et al.</i> (2009)	Analyse the effect of subsidiary roles and technological spillovers on the extent of vertical linkages.	The potential for technology diffusion via vertical linkages depends on the nature of subsidiary roles.
	Belderbos <i>et al.</i> (2001)	Examine the determinants of backward vertical linkages.	Host country factors promoting vertical linkages are the quality of infrastructure and the size of the local components supply industry, while restrictive trade policies have a detrimental effect.
Vertical Linkages	Giroud (2007)	Identify the potential for knowledge transfer between foreign firms and local suppliers to maximise the beneficial linkages from TNCs by investigating TNC-suppliers linkages in Malaysia and Vietnam.	Levels of backward linkages remain small and little knowledge is being shared by foreign firms to local suppliers. Economic and political systems need to be considered to design an effective promotion of vertical linkages programme.
	Iguchi (2008)	Explore evidence of significant inter-organisational linkages between TNCs' subsidiaries and local suppliers and to configure factors affecting provision of backward linkages by subsidiaries.	Firm-level factors such as a subsidiary's level of autonomy and local sourcing rate, as well as environmental factors such as location aspects, are all positively related to the intensity of backward linkages.
	Ivarsson (2002)	Analyse the extent to which TNCs in a developed host country have established technological linkages, leading to collective technology learning where both TNCs and their local business partners benefit.	A positive correlation with linkage formation between TNCs and local business partners especially customers.
	Miozzo and Grimshaw (2008)	Identify the effects for client firms in less developed countries, of outsourcing business functions.	The ability of customers to benefit from linkages is contingent on their absorptive capacity, especially their expertise.
Horizontal Linkages	Ray and Rahman (2006)	Examine linkages formed with domestic suppliers and contribute to the process of creating appropriate new technologies in developing countries.	Foreign affiliates foster beneficial horizontal linkages through cooperation with local suppliers of final goods but spend less effort than local enterprises to develop vertical linkages and to create suitable technologies.

Institutional linkages	Boehe (2004)	Explore to what extent subsidiaries with global R&D roles maintain different types of cooperative links with host country partner organisations.	Interactions or links between R&D units of TNCs' subsidiaries with host country partner organisations can influence innovation dynamics in the host country.
Institutional linkages	Marin and Giuliani (2007)	Explore the role of TNCs' subsidiaries in the generation of technological spillovers in industrialising countries.	There appears to be a higher potential for generating spillover effects.

Source: Compiled by authors.

the study will focus on the evolution of horizontal, vertical and institutional linkages between TNCs' strategies and activities and host countries' innovation systems comprising three main types of actors: local firms, universities and public research institutes and government agencies.

Figure 2: Conceptual Framework



Source: Authors

To answer the aforementioned research question, the selected company must provide detailed information about the characteristics of investment on different national borders and the integration of innovative activities in host countries. In this case the nominated organisation is a US-based conglomerate, one of the largest transnational technology and service corporations with dedication to innovation and built leadership franchises in a wide range of industries including energy, oil and gas, healthcare, aviation, transportation, water and consumer products. The company has a competitive advantage in technology based on robust investment and the ability to create a low-cost position while spending about 6 per cent of industrial revenue on R&D. It has been conducting business internationally for about 119 years, since 1892. More than 150 core technologies are created across the company. It also shares technologies and innovation across multiple platforms to create significant impacts worldwide. This implies that the company has a good integration of knowledge and technologies among its subsidiaries and host countries.

In addition, the case study is focused on one business segment, Water and Process Technologies, located in subsidiaries in Thailand and Singapore. This business unit was selected because its world-wide operations and different types and depth of activities in Thailand and Singapore could demonstrate how host countries' innovation systems interacted and co-evolved differently with the transnational corporation's strategies, the main research question of this study. To address the research question, multiple sources of evidence used in this study were primary data and secondary data. The primary data was obtained through in-depth interviews of top and middle managers of subsidiaries mainly in Thailand, Singapore, and other key locations in Asia such as China and Korea in the year 2011. They were responsible for sales, supply chain management and R&D activities. Moreover, information was collected by directly participating in subsidiaries' meetings, and observing the interaction between subsidiaries and local actors, especially in Singapore and Thailand. In addition, secondary data namely, company annual reports, information from intranet, internet, publications and news were added to achieve data triangulation. We will use the taxonomy of technological and R&D capabilities developed by Rasiah (2010) and Amsden and Tschang (2003) to differentiate activities of the firm in various geographical locations.

The strength of the study is its focus on capturing interactions between the TNC's corporate strategies and national innovation systems of host countries by providing evidence of the actual interactions, flows of knowledge and the link between these relationships and the development of firm-level technological capabilities. This has not been achieved by previous studies, as reviewed earlier, which aimed at providing general pictures of such relationships mostly by econometric analysis. Nonetheless, the limitation of this study is that it is based

on a single case. There are of course limitations in terms of generalisation and providing solid policy recommendations. Future studies based on other similar cases are very much anticipated.

4. The Case Study: A US-based Conglomerate in the Water and Process Technologies Business

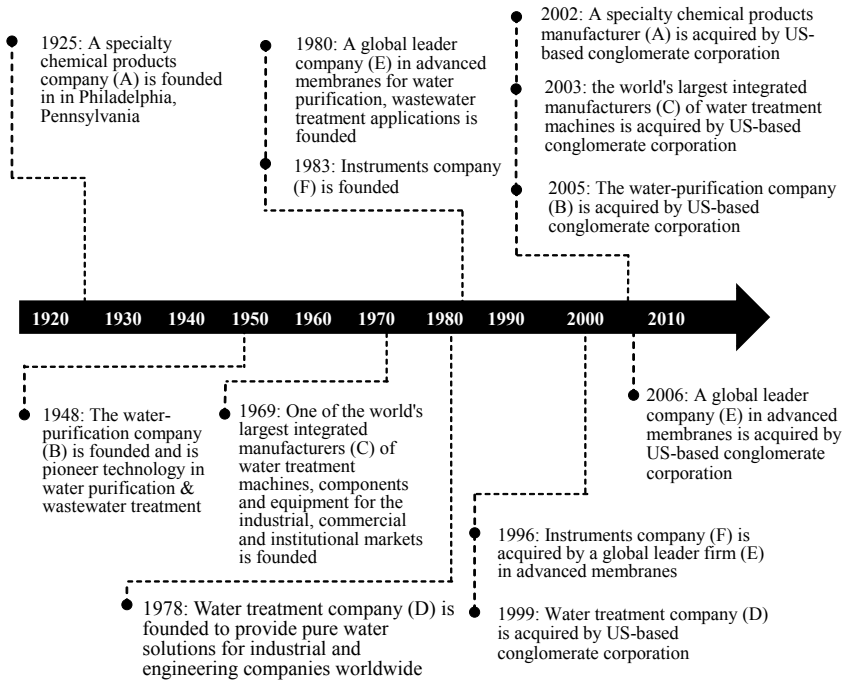
We will explore the overall historical evolution of the case-study firm in the sub-section 4.1. Then we will pay specific attention to interactions between the firm's investment strategies and host countries' innovation systems in sub-section 4.2.

4.1 Evolution of the Conglomerate's Water Technologies Business

As abovementioned, the case study is a very long-established conglomerate with headquarters in the US. The company entered the water business in 1999 by acquiring an industry leader, established since 1925 in the US. The company had provided innovative pure water solutions for industrial and engineering companies worldwide. Subsequently the conglomerate invested more than \$4 billion in acquiring another four companies during 2002-2006 to expand its products portfolio and water treatment and services capabilities. These expansions were within the US and the company was in the mode of merger and acquisition, therefore relationships with other actors (apart from acquired firms) at these sites were limited (see the history of the conglomerate's water business in Figure 3).

Previously, the advanced molecular research, developing treatment programs, and simulating water and process systems were only carried out in the US headquarters and then chemical products and equipment were developed in main manufacturing plants in the US before distributing products to customers globally. With a rapid increase in cross-border movement of goods, services, technology and capital, regional R&D centres were subsequently established. At present, the conglomerate's water business has a product portfolio of chemical and monitoring instruments and engineering systems such as membrane, mobile water, reverse osmosis, and so on. There are approximately 7,900 employees in 130 countries. It has five regional centres in the US, Singapore, Belgium, Brazil and United Arab Emirates (UAE), and seven R&D centres outside the US including India, China, Germany, Brazil, UAE, Singapore, and Qatar. Researchers in the headquarters and these R&D centres work together as a global research team. For instance, the R&D centre in India has grown from a 275-employee facility to one with over 4,000 employees. The global value chain and production network of the conglomerate is depicted in Figure 4.

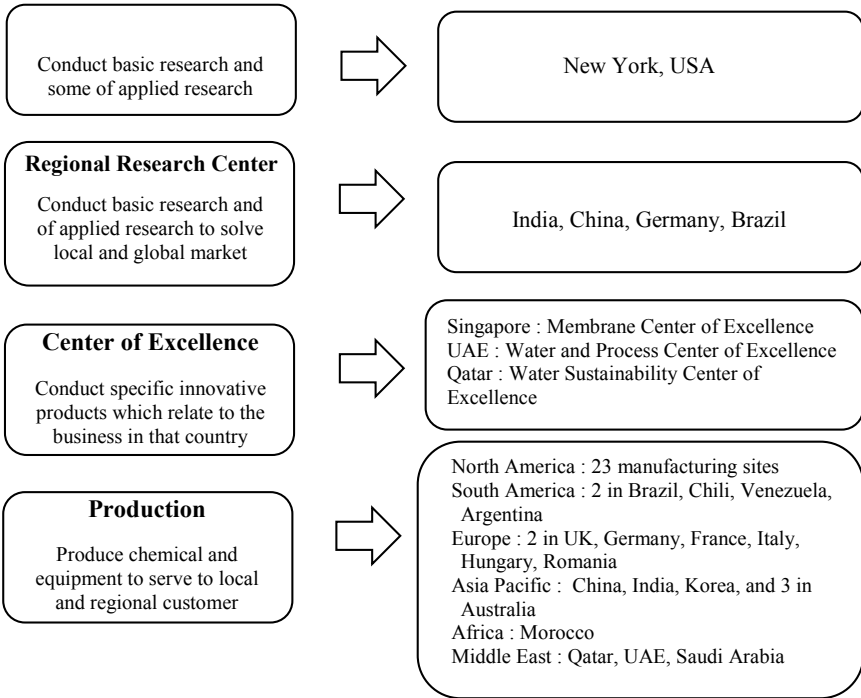
Figure 3: History of the Conglomerate's Water Technologies Business



Source: compiled by authors from the company's reports 2008-2010

To a certain extent, each location of R&D centres has a different type and technology of research focus and advantages ranging from market size, availability of human resources, technological superiority, labour cost, strong intellectual property protection and supporting government policies (see details in Table 3). Some locational advantages were results of idiosyncratic characteristics of host countries' national innovation systems. For example, unlike many developing countries, China and India have had systems that educate qualified engineers and scientists in large numbers. Singapore has a system that encourages universities to closely collaborate in research with investing foreign companies (more details in section 4.2).

Figure 4: The Global Value Chain of a Water Business



Source: Company Annual Report 2010 and interviews with top managers.

We will then, carefully examine the conglomerate’s activities in Singapore and Thailand, the two leading bases of the company in Southeast Asia. This comparison will shed light on the relationship between host countries’ innovation systems and a company’s strategies.

4.2 Relationship between Host Countries’ National Innovation Systems and Corporate Strategies: Singapore vs. Thailand

The first subsidiary in the region was established in Singapore in 1978 and served as the regional headquarters. Since then, most chemical compounds were manufactured by the production plant in Singapore, and then subsequently sent to another subsidiary in Singapore and the one in Thailand to blend these compounds into products specific to the needs of local customers. The toll blending process, a not-so-sophisticated technological process, was mostly outsourced to local producers which could meet the company’s technical requirements. The final products were then sent to other subsidiaries, which

Table 3: Major Research Areas and Locational Advantages of Selected Regional Research Centres outside the US

R&D center (year of establishment)	Focus Research Area	Locational Advantages
India (2000)	<i>Basic research</i> : To conduct research and develop new materials and advance technologies for diverse businesses, including - Advanced material - Energy, water and process technologies - Consumer and industrial - Healthcare - Transportation	- The availability of high quality talents in broad areas of science and engineering - Labor cost - Market Size
China (2003)	<i>Applied research</i> : To develop leading-edge technologies for - Transportation, aviation - Energy, water and process - Healthcare - Consumer and industrial	- Market size - Labor cost
Germany (2004)	Basic and applied research - Renewable energy and power system for example smart grid and distributed power generation systems with renewable energy sources (new to the world) - High power electronics for example mini-grids (new to the world), high power drive control system (new to the world)	- Market size - The availability of high-quality talents in broad areas of science and engineering especially in renewable energy and electronics - Strong intellectual property rights protection
Singapore (2009)	<i>Applied research</i> focuses on water and process technology business - Membrane (new to regional market) - Low-energy seawater desalination systems and water reclamation systems (new to regional market) - Innovative analytical sensors and monitoring systems (new to the firm)	- Strong support and collaboration from government - The availability of high-quality talents in related fields - Strong intellectual property rights protection

Source: Data from interviews with top managers

mostly acted as sales and customer service offices in other countries in the region such as Malaysia, Indonesia, the Philippines, and Vietnam. In 2006, the production of chemical compounds was moved to China due to its sheer domestic market size. Since then, China became the most important production and R&D base of the company in Asia. Nonetheless, Singapore was still an important location for the company. In 2009, the company invested S\$130 million to establish a Water and Process Technology R&D Centre in the National University of Singapore. It comprised five centres of excellence and employs 100 top-tier researchers. As for Thailand, the company has been represented in the Thai market since 1996 and now employs over 300 people there. It opened a branch close to the industrial estate in Rayong. Thailand is particularly focused as one of the significant markets in the region with continuous growth and now the company continues to grow its business including healthcare, aviation, water and process technology, and energy. However, no research centre has been established there. The differences in the scope of activities between subsidiaries in Singapore and Thailand are illustrated in Table 4.

Table 4 Comparison of Activities in the Value Chains between Subsidiaries in Singapore and Thailand

Value Chain Activities	Thailand	Singapore
R&D	✗	✓
Supplier sourcing	✓	✓
Production (outsourcing to local firms)	✓	✓
Sales	✓	✓

Source: Data from interviews with top managers

For supplier sourcing, the main relationship was a vertical backward type between the company and its suppliers. The key criterion in selecting suppliers is normally competitive price whereas suppliers in this case had to be approved by a company committee in terms of policy congruency. The sourcing team based in Thailand had responsibility for providing the suppliers for the Singapore team and most suppliers were local firms. In both countries, the main interaction pattern was training by suppliers, regarding product specification for sales persons, service engineers, lab specialists and technicians. Classroom training was set up as requested and sometimes on-the job training was provided for specialty equipment such as chemical feeding pumps and instruments.

For production, the main relationship was a vertical backward type between the company and outsourced OEM producers in both countries. There appeared to be no differences in these relationships between the two countries. The company selected these outsourced producers based on their capabilities and

alignments with the company's policy. Outsourced producers were audited by a company corporate team in terms of their capabilities for chemical production, before doing business together. The company provided technical knowhow through technical assistance and training to those outsourced producers. Agreements for chemical production between company and outsourced producers were signed based on company policy such as the confidentiality of all chemical formulae.

Concerning sales, the company had a vertical forward relationship with customers, which in Thailand and Singapore were from many kinds of businesses such as food and beverage, energy and power, petrochemicals and refinery. The relationship with customers could take several forms and there were no significant differences between operations in Singapore and Thailand. First, annual, monthly and weekly meetings were set up based on the contract agreement between company and customers. They discussed treatment results and collaborative projects. Second, collaborative projects focusing on cost saving and environmental protection were carried out during the implementation of treatment programs. They could take between one to three years depending on requirements of customers. Finally, annual training was one of the most significant channels for maintaining good relationships between customers and company including delivery of good treatment results.

As for R&D, the key factor behind the strategic investment to set up an R&D centre in Singapore was the partnership between the company and Singapore's government. Singapore's Economic Development Board (EDB), in particular, had a strong intention for Singapore to become a "Global Hydro Hub" – a place where Singapore-based companies, both local and foreign, can create and provide innovative water technologies and solutions for global markets through R&D activities. Other government policies such as long-term commitment to building up S&T (Science and Technology) manpower, strong enforcement of protection of intellectual property rights, and generous and comprehensive research and innovation funding programmes, especially the schemes supporting companies to set up R&D centres in Singapore, are also significant factors. During the late 1980s to the late 1990s, the government launched the 'liberalised Research and Development Tax Deductions Program'. Unlike in other countries including Thailand, this deduction included R&D activities which took place outside of Singapore (but were related to and benefitting those in Singapore), though the deduction rate was lower than for local activities. It seems that Singapore's government officials have an understanding of how global R&D networks of TNCs operate and what constitutes an R&D hub (Intarakumnerd and Wonglimpiyarat, 2012). Further, an incentive Scheme for Companies (RISC) by the Economic Development Board was launched in 1993 as a key industry and capability development tool

for anchoring and building R&D capabilities in Singapore. This grant scheme provides subsidies for 50 per cent of manpower-related costs and 30 per cent of materials, software and intellectual property costs. A co-funding mechanism has also been used to attract R&D investments in Singapore, particularly in areas of economic importance to Singapore (Wong and Singh, 2012). In this case, apart from these general schemes, the Singaporean government also provided land and subsidies in terms of paying salaries of researchers working for the R&D centre. The following excerpt from an interview with the President and CEO of the Water and Process Technologies Business highlights the above points.

Our decision to invest in Singapore is due to the strong commitment from the government in developing the water industry. This, coupled with the easy availability of skilled manpower and the strong enforcement of intellectual property rights regulations makes Singapore the ideal platform to launch this R&D centre.

These policy initiatives and aforementioned characteristics of Singapore's national innovation system were not evident in Thailand (see comparisons of key features of national innovation systems of Singapore and Thailand in Table 5).

Table 5: Comparison Key Features of National Innovation Systems between Singapore and Thailand

Key Features	Singapore	Thailand
R&D intensity : R&D as % of GDP (GERD)	2.31% (High)	0.24% (Low)
R&D personnel per 1000 population	6.85 (High)	0.65 (Low)
Output – Granted US patents (cumulative number until 2011)	5783 (High)	425 (Low)
Business Enterprise Expenditure in R&D (% Total)	61.6% (High)	38.0% (Low)
Government' R&D innovation financing schemes	Many evolving grants, tax incentives and direct equity participation schemes tailored made for demand of different industrial sector and/ individual companies	Mostly limited to 'standardized' tax incentives. Grants and direct equity investment for specific needs of sector/and or companies are few.
Intellectual property rights regime	Strong enforcement of intellectual property rights laws	Weak enforcement

Source: Intarakumnerd and Wonglimpiyarat, (2012)

In fact, one of the most important factors attracting the R&D centre to Singapore is the presence of a world-class university, the National University of Singapore (NUS). Locating inside the university provides many opportunities for rich interactions between NUS's faculties and students, and the company's researchers working in the centre. NUS's research strengths in membranes, biological processes, nano-materials, catalysis and sensors related to water security are complemented by the company's technical expertise and industry experience in water and process technologies. This is a win-win collaboration well placed to leverage on the broader and more comprehensive set of expertise available in both the company and the NUS.

Different types of linkages between the subsidiaries of the firms and local actors in Singapore and Thailand can be summarised in Table 6.

5. Conclusion

This paper has examined the relationship between investment strategies of transnational corporations and host countries' national innovation systems by using a case study of a US-based conglomerate in Asia, particularly in Singapore and Thailand. The main conclusions and possible implications can be summarised as follows.

First of all, the study clearly demonstrates that characteristics of a host country's innovation systems considerably influence investment strategies of the transnational corporations. There are strong relationships and a co-evolution pattern between the strength of host countries' innovation systems and technology strategies and capabilities of transnational corporations. More specifically, the R&D centre located in Singapore is important evidence supporting the notion that a company tends to locate technological and innovative activities in the locations having strong science and technological capabilities (Bas and Sierra, 2002; Kuemmerle, 1999; Cantwell and Janne, 1999). Furthermore, the availability of skilled manpower and strong protection of intellectual property rights are significant locational advantages of the host countries as argued by Luo and Wei (2008). In turn, the company invested in R&D in Singapore to exploit the country's competitive advantages, which would help it sustain or further their global competitiveness (Patel and Vega, 1999).

Second, the role of government is important in inducing technologically sophisticated investment from TNCs, especially R&D activities. Unlike Thailand, the Singapore government had clear vision in making Singapore a regional R&D hub in the Asia Pacific. Subsequently, it has implemented a number of financing policies aiming at attracting investment in R&D and innovation activities. Grants providing to private firms upfront were extensively used and proved that they were effective in inducing investment in R&D and sophisticated technological and innovation activities (Wong and Singh,

Table 6: Linkages between Subsidiaries and Local Actors in Thailand and Singapore

Activities	Country	Type of Linkages	Local Actors	Interaction Types	Outcome
R&D	Singapore	Institutional	University	Research collaboration	New product development (membrane, new technology (analytical sensors and monitoring systems).
		Vertical forward	Customers	Technical training	New businesses and opportunities ('low-energy' seawater desalination systems), knowledge and technology transfer.
	Thailand	No R&D			
Sourcing/ Logistics	Singapore	Vertical forward	Suppliers (done by the Thai team)	Training for product specification, meeting.	Enhanced capabilities in material selection and knowledge of regional and global markets of suppliers' engineers, lab specialists and technicians.
	Thailand	Vertical forward	Suppliers	Training for product specification, meeting.	Enhanced capabilities in material selection and knowledge of regional and global markets of suppliers' engineers, lab specialists and technicians
	Singapore	Vertical backward	Outsourced producers	Training for process improvement, regular meetings.	Outsourced producers enhanced their product quality and knowledge of treatment programme reliability was continuously updated.
Production	Thailand	Vertical backward	Outsourced producers	Training for process improvement, regular meetings.	Outsourced producers enhanced their product quality and knowledge of treatment programme reliability was updated
	Singapore	Vertical forward	Customers	Weekly/monthly/daily meetings, joint projects, annual training courses.	Improved quality of company's products (better treatment programme results), customer's cost saving, maintained good relationship.
	Thailand	Vertical forward	Customers	Weekly/monthly/daily meetings, joint projects, annual training courses.	Improved quality of company's products (better treatment programme results), customers' cost saving, maintained good relationship.

Source: Data from interviews with top managers.

2012). Importantly, a key government agency, the Economic Development Board (EDB), acted as an 'intermediary' linking the targeted TNCs with other concerned government agencies and other actors, especially, the National University of Singapore.

A few policy implications can be drawn from this study. First, foreign direct investment supporting policy ought to go beyond tax incentives. It should be corresponding to the type of targeted firms' activities and should be more comprehensive. For example, to attract R&D activities, governments should seriously create a strong domestic S&T manpower base and implement strong enforcement of IPR protection. Co-funding of R&D and related activities, providing subsidies in terms of land and salaries of any company's researchers, and brokering cooperation between TNCs and local sources of knowledge like universities and public research institutes should be carried out. For example, the Economic Development Board (EDB) not only provided financial and other incentives but also played a significant role in encouraging collaboration between the TNC and a leading university of Singapore.

Second, since the relationship between TNCs and host countries these days change very rapidly, therefore a *government's capability* to initiate new policies and adjust existing policies is very crucial. Policy makers must have a deep understanding of innovation processes, their own innovation systems, and how the relationship between TNCs' strategies and host countries' innovation systems evolve overtime. There is a sharp contrast between Thailand and Singapore in forming innovation financing measures. While the former narrowly focused on close R&D-led innovation, the latter broadened their incentives to other activities important within innovation processes, both in-house and outside of a single firm. Incentives can also cover innovations in services, business models, solutions and other types. The difference between Thai and Singaporean incentives to promote the countries as R&D hubs, as mentioned earlier, is also another good example of the different level of understanding of government officials in regards to the global R&D processes of transnational corporations.

Note:

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