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National innovation system in less successful developing countries: the case of Thailand

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Abstract

This paper, using Thailand as a case study, aims at understanding the national innovation system (NIS) in developing countries which are less successful in technological catching-up. In contrast to developed countries, the development level of Thailand's NIS does not link to its economic structural development level. As Thailand moves from agricultural to an increasingly industrial economy, its NIS remains weak and fragmented. The mismatch between the two affected Thailand's competitiveness and partially contributed to the recent economic crisis. Studies of NIS in countries like Thailand should focus on factors contributing to the long-running perpetuation of weak and fragmented NIS.

Keywords: Innovation; National innovation system; Developing countries; Thailand; Catching-up

1. Introduction

Since the 1980s (see Freeman, 1982; Dosi et al., 1988; Lundvall, 1992; Nelson, 1993), the concept of the national innovation system (NIS) has been gaining popularity as a core conceptual framework for analysing technological change, which is considered to be an indispensable foundation of the long-term economic development of a nation. Most of the literature concentrates on analysing the NIS in developed countries. Even though, many scholars from different academic disciplines have made a contribution to developing the NIS concept through various approaches, but only few studies focus on the NIS in developing countries. Their main focuses were on countries, such as Korea, Taiwan, Singapore, that have more aggressive policies and 'intensive technological learning', hence, to a certain extent, successfully catching-up with developed countries, (see Kim, 1993; Hou and Gee, 1993; Wong, 1996; Wong et al., 1999).

This paper tries to supplement the studies of the NIS in developing countries by exploring Thailand as a case study. It argues that the specific nature of the NIS and related problems in developing countries, which are less successful in terms of technological catching-up are different both from developed countries and 'learning intensive' developing countries. It highlights why the actors and linkages between them fail to produce 'learning intensive' catching-up. With a richer understanding, it may then be possible to develop policy recommendations that help to produce more systemic and effective NIS in such developing countries.

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2. NIS in developing countries

The emergence of the NIS concepts, particularly in the industrialised countries in the northern hemisphere, can be traced back to the work of Lundvall, the National System of Innovation or National Policies of Innovation and other works (see Freeman, 1987, 1988; Nelson, 1988) started in the mid 1980s.[2] NIS is the interactive system of existing institutions, private and public firms (either large or small), universities and government agencies, aiming at the production of science and technology (S&T) within national borders. Interaction among these units may be technical, commercial, legal, social and financial as much as the goal of the interaction may be development, protection, financing or regulation of new S&T (Niosi et al., 1993, p. 139).

While the study on NIS concept as a whole is still at the early stage, the study on NIS in developing countries is at an even more primitive stage. Most of research concentrate on how institutions and systems were built and shaped to produce 'intensive learning' which facilitated technological catching-up processes in newly industrialising economies in Asia, namely, Korea, Taiwan and Singapore (see Kim, 1993; Hou and Gee, 1993; Wong, 1996; Wong et al., 1999). One of the most important factors behind the successes of these countries is embedded autonomy of their governments. These governments can formulate and implement economic policies that do not simply reflects of individual firms. However, they have sufficient and positive linkages with other actors, especially the private sector (see Evans, 1989, 1998; Chang, 1997).

Surprisingly, there are only a few studies focusing on countries, which are less technologically successful in catching-up (see Dahlman and Frischtak, 1993; Katz and Bercovice, 1993). Dahlman and Nelson (1995) use empirical data, such as S&T manpower, R&D expenditure and educational figures, to analyse the relationships among social absorptive capability, NIS and economic performance by measuring and comparing 14 developing countries' technological capability. They concluded that most critical element of any successful development strategy is the development of human resource. Only the social absorptive capability by itself, as measured by high technical human capital, is not sufficient to explain why some economies have performed much better than others (Dahlman and Nelson, 1995, p. 117). The macro and incentive environments, including the importance of a strong outward orientation of private sector on the innovation system, also affected the NIS in the latecomer economies. The effective utilisation of foreign technology is more important than doing a lot of R&D in some east Asian NIEs such as Hong Kong and Singapore. Sripaipan et al. (1999), analysed Thailand's NIS by following the Oslo manual basis. The result illustrated that the Thailand innovation system is not well organised, especially with respect to the macro-environment, innovation infrastructure, R&D and technology transfer and innovativeness and technology capability in the industrial sector. The study does not directly indicate or highlight the uniqueness of Thailand NIS.

Other more applicable and conceptualised studies on NIS are Arocena and Sutz (1999) and Gu (1999). They provide 'comprehensive' understanding and insights on NIS in developing countries. Both studies share the views that the NIS concept for developing countries is 'ex ante', which opposed to an 'ex post' concept suitable for developed countries whose institutions are working in a system-like manner. This is because micro-innovative strengths that exist in developing countries remain isolated and encapsulated and many of institutions relevant to the innovativeness do not exist.

Arocena and Sutz (1999) point out further that industrial innovation in developing countries is highly informal, i.e. not products of formally articulated R&D activities. In addition, dominant cultural patterns of these countries undervalue scientific knowledge and technological innovation.

Gu (1999) elaborates more that NIS in developing countries has the following distinctive characteristics:

(a) NIS in developing countries is less developed by order. Historically, the technological and institutional properties necessary for modern growth were not developed within their systems. NIS in

[2] The concepts of NIS trace back to the initial idea first seen in the book of Friedrich List, Das Nationale System der Politischen Oekonomie (1841/1859). In the second half of the 1980s, economists began to develop this idea as a new paradigm. 'The innovative capability of national production systems' was introduced by Lundvall in 1985.

developing countries should be studied in the context of economic development, i.e. it is important to ask how did innovation related activities start, and how they continued to improve once started in relation to their local conditions and changing internal and external environment.

(b) NIS in a developing country is specifically related to the country's development level. Therefore, it is important to connect level of NIS development with level of economic structural and institutional development.

(c) Extraordinary 'intensive learning' of the countries like Korea and Taiwan was the crucial factor for their successful catching-up, which required and was supported by the rapid development of their NIS. Studies on NIS in developing countries should pay high attention to purposeful strategic management for catching-up.

(d) As market mechanisms in developing countries are still under-developed, the role of the market in developing countries in terms of promoting learning needs to be perceived differently from that of developed countries.

(e) Unlike developed countries, capital accumulation, rather than intangible assets (such as knowledge) and learning, is the main contribution to technical progress in developing countries.

3. Thailand as a laggard in technological catching-up

Apparently, Thailand looks like a successful country in terms of economic development. The World Bank once categorised Thailand with other seven high-performing economies to be studied by the other developing countries. It praised Thailand for its macro economic management, poverty reduction, export push strategy, and high literacy rate (see World Bank, 1993). We will examine the characteristics of Thai economy and, then, its NIS in details.

3.1. Characteristics of the Thai economy

Economic performance of Thailand during the past 40 years has been rather impressive. During the industrialisation period, the growth rates of GDP of Thailand have been more or less similar to those of the east Asian NIEs (Korea, Taiwan, Singapore and Hong Kong). In particular, the manufacturing sector has grown considerably both in terms of growth of production and share of total export once dominated by agriculture commodities such as rice, rubber, teak, and tapioca.

On the whole, Thailand is similar to the east Asian NIEs by having its economic structure change from an agriculture-based economy to an economy in which the industrial (manufacturing in particular) sector has gain distinctive significance. Share of the agriculture sector in GDP has reduced remarkably from almost 40% in the 1960s to approximately 10% in the late-1990s, while that of the industry sector experienced exactly the reverse situation. Interestingly, there was a change in the composition of Thai exports along the line of NIEs. The share of once-dominated resource-based and labour-intensive exports has gone down while that of science-based and differentiated exports has gone up especially in the 1990s (see Table 1). Nonetheless, one cannot argue that Thai exports have turned to be more technological intensive, as the dividing categories do not reflect the sophistication of technological activities requiring to produce goods, for example, those categorised as science-based exports might be only assembled locally, while their technologically sophisticated and high-value-added components are imported. However, this trend suggests a general change in the structure of the Thai economy. Regardless of manufacturing share in the GDP, Thailand, with 42% total land is used for agriculture purposes, still keeps its role of being the rice bowl of the region and positions itself as a key player in the global food and agriculture market.

3.2. Characteristics of Thai NIS

According to the research triangle context, private firms, government and universities have the main roles in shaping Thailand's NIS. We shall describe the features of Thailand's NIS by examining both its actors and linkages. The description is based on the R&D/Innovation Survey 2000 (including top 200 largest firms), recently commissioned by the National Science and Technology Development Agency (NSTDA). One important characteristic of this survey is that although it focuses mainly on R&D and innovation, it asks about other important technological

Table 1
Distribution of manufactured export by technological categories (%)

Sector	Korea			Singapore			Taiwan			Thailand		
	1980	1990	1999	1980	1990	1999	1980	1990	1999	1980	1990	1999
Resource-based	9.0	6.8	11.6	44.4	26.9	13.2	9.8	8.2	9.2	21.7	13.8	10.7
Labour-intensive	49.2	40.8	23.2	10.6	10.3	7.6	54.3	41.2	31.0	47.0	45.5	35.8
Scale-intensive	23.6	19.3	21.0	9.3	5.9	5.5	9.1	10.3	10.6	7.8	6.3	7.7
Differentiated	11.3	15.6	18.7	20.5	22.3	21.2	12.4	20.6	20.4	22.2	14.1	19.5
Science-based	6.9	17.4	25.5	15.1	34.6	52.5	14.5	19.8	28.9	1.2	20.2	26.4

Source: calculated from UN Comtrade database.

activities of firms, which might be more important in developing country context, such as technology adaptation, engineering and design. Previous literature on S&T development in Thailand will be reviewed to enrich the findings from the survey.

3.2.1. Actors of NIS

3.2.1.1. Firms. Several studies of Thai firms conducted since the 1980s state that most firms have grown without deepening their technological capabilities in the long run, and their technological learning has been very slow and passive (see Bell and Scott-Kemmis, 1985; Chantramonklasri, 1985; TDRI, 1989; Dahlman and Brimble, 1990; Tiralap, 1990; Mukdapitak, 1994; Lall, 1998). The recently commissioned by the World Bank's study (see Arnold et al., 2000) also confirms this long-standing feature of Thai firms. Only a small minority of large subsidiaries of transnational corporations (TNCs), large domestic firms and SMEs have capability in R&D, while the majority are still struggling with increasing their design and engineering capability. For a very large number of SMEs, the key issue is much more concerned with building up more basic operational capabilities, together with craft and technician capabilities for efficient acquisition, assimilation and incremental upgrading of fairly standard technology (see Fig. 1).

The findings of the R&D/Innovation Survey point out in the same direction. Most sampled firms conduct activities requiring shallow level of technological capabilities such as simple quality control and testing. Less than half of them have capability in design. Only one-third have reverse engineering capability. Less than 15% of them have done R&D.

Results of the survey show that the figure for the number of firms performing innovations (20%), albeit small, exceeds that of performing R&D (15%). Almost half of sampled firms (48%) that carry out product or process innovation do not conduct R&D formally. This confirms Arocena and Sutz's (1999) assertion that formal R&D, unlike in developed world, is not an illustrative and complete indicator of innovativeness in developing countries. They rather want to rely on off-the-shelf imported technology mostly in the forms of machinery, and turn-key technology transfer from abroad or joint venture with foreign partners (see, for example, Intarakumnerd, 2000). This is partly because they have tended to be short-term, very commercially oriented (Dahlman and Brimble, 1990, p. 31). Many of them historically developed from a trading background (see Suehiro, 1992), paying attention to quick return rather than the long-term issue of development of technology capability.

3.2.1.2. Government. We will first examine government policies on development of S&T in general and then we will investigate in more detail public research technology organisations (RTOs) responsible directly for developing the country's S&T capabilities.

Contrary to several OECD countries where innovation have been given high priority in national policy making and the concept of NIS has been well perceived and implemented (see OECD, 1999), there is no explicit and coherent national innovation policy in Thailand. 'Innovation', though mentioned in the present (Eighth) National Economic and Social Development Plan (1997–2001), is not well understood conceptually, let alone NIS. It is only a 'buzz word' fashionably spoken among Thai policy makers.

Policies to promote technology development came out on the agenda quite late in Thailand. In the period of first four development plans (1958–1981), S&T issue was not given separate treatment. As late as 1979,

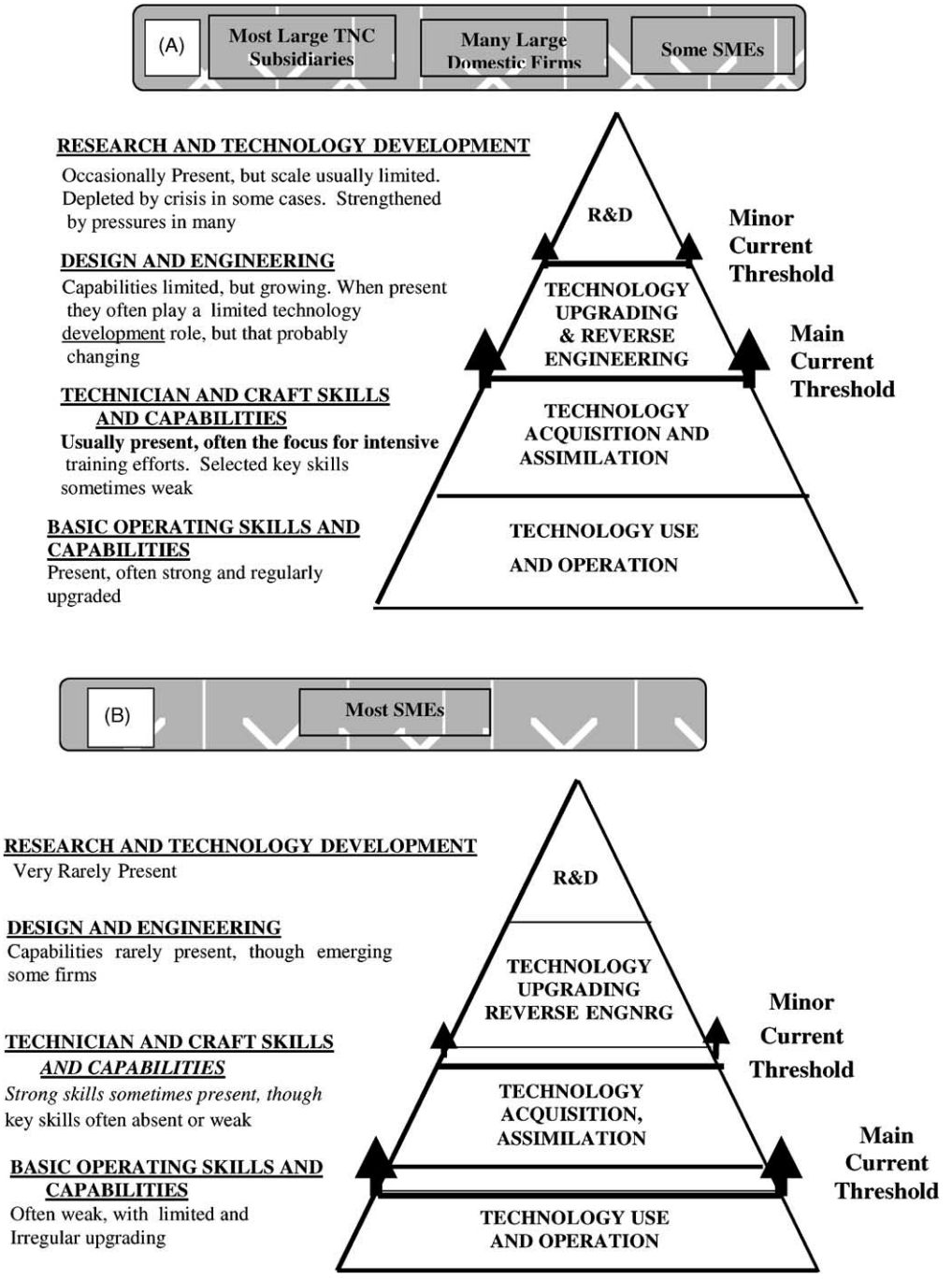

Fig. 1. Current stages of technological capabilities of firms locating in Thailand.

Ministry of Science, Technology and Energy (later Environment) was established, and the Fifth National Economic and Social Development Plan (1982–1986) began to highlight the importance of S&T (Lauridsen, 2000, p. 24).

Industrial policy of Thailand, which is also fragmented, has not paid attention to the development of indigenous technology capability as an integral factor in the process of industrialisation (Sripaipan et al., 1999, p. 37). Investment policy, especially the promotion of foreign direct investment (FDI), aims primarily at generating employment. Unlike Singapore where FDI is specifically used to upgrade local technological capability (see Wong et al., 1999), there is no explicit and pro-active link between promoting FDI and upgrading of local technological capability in Thailand. Trade policy, the most important instrument in Thailand being tariff, has not been used strategically to promote technological learning like in NIEs (see Amsden, 1989; Chang, 1994; Lall, 1996). Instead, trade policy was a part of fiscal policy to reduce domestic demand for imports in the case of balance of payment difficulty. The Ministry of Finance, the dominant agency which controlled the policy, had little knowledge or experience of industry and industrial restructuring (Lauridsen, 2000, pp. 16–20).

Industrial policies in Thailand have been limited to the so-called 'functional' intervention such as promoting infrastructure building, general education, export push in general. There have been virtually no selective policies, such as special credit allocation, special tariff protection, targeting particular industries or clusters. The exception was the local content requirement in automobile industry, which was rather successful in raising local contents of passenger vehicles to 54% in 1986 (see Doner, 1992). Interestingly, there has been no reciprocal performance-base criteria (such as export and local content and technological upgrading targets) set for providing state incentives like in Korea or Japan where governments had embedded autonomy (see Johnson, 1982; Amsden, 1989; Evans, 1989, 1998; Chang, 1994; Lall, 1996). Investment promotion privileges, for example, are given away once approved.

Moreover, in Japan (such as the case of synthetic fibre industry in the 1950s, see Ozawa, 1980) and Korea (such as the case of ship building industry in the 1960s, see Amsden, 1997), entries into restrictive sectors were based on technological capabilities of potential firms. In Thailand, on the contrary, such entries were decided by strength of political connections of prospective firms (see Intarakumnerd, 2000).

The dominant orientation of policy and resource allocation for building industrial technology development capabilities since the 1960s has been on the capabilities and resources of scientific, technological and training institutions that were intended to undertake technological activities on behalf of firms. Conversely, policy measures and resource allocations designed to strengthen the technological learning, technological capabilities and innovative activities of firms themselves was rather minimal and ineffective (Arnold et al., 2000, p. ix).

Ministry of Science Technology and Environment has much more roles in promoting technology development than economic agencies such as Ministry of Industry (Arnold et al., 2000, p. vii). This imbalance is very different from NIEs and Japan where economic organisations like Ministry of International Trade and Industry (MITI) of Japan (see Johnson, 1982), Economic Development Board (EDB) of Singapore (see Wong et al., 1999), Economic Planning Board (EPB) of Korea (see Chang, 1997) have significant roles in the array of policy and institutional support for industrial technology development.

As for public RTOs which have direct responsibility for developing S&T capability of the countries. Common characteristics can be generalised as follows.

Technological activities of public RTOs mainly focus on R&D, not on building lower level capability such as technology assimilation and adaptation, designing and engineering, which are the technological thresholds faced by most Thai firms (see Fig. 1). In this aspect, Thai RTOs behave differently from those of NIEs in the 1970s and 1980s, when their level of development was more or less at the same level of Thailand. Korean Institute of Science and Technology (KIST) or Industrial Technology Research Institute (ITRI), for example, emphasised institutional and technical supports for industrial technological capability development within firms, such as helping to solve their operational problems (see Hobday, 1990).

Though the industry sector has become more and more important in terms of contribution to GDP and

export, as already mentioned earlier, government budget for research and development has been allocated to development of agriculture technologies much more than industrial technologies. In the year 1997, R&D expenditure for agriculture sciences was 42%, while that for engineering and applied sciences was only 6.94% of total government expenditure on R&D.

Different from developed countries and NIEs, development of Thai RTOs since the 1950s has not resulted in progressive specialisation. The structural feature of public RTOs exhibits high degree of multiplicity and limited specialisation. There are several institutions doing a number of similar duties, namely, providing technical support services, carrying out applied technology development and transfer, and undertaking strategic/basic research, and funding R&D. This feature reflects the inability of government over 40–50 years to abolish or reorganise existing institutions when new ones are founded (Arnold et al., 2000, p. 140).

3.2.1.3. University. At present, there are 24 public universities and 50 private universities. Altogether Thailand has capacity of educating 1.1 million students, most are concentrated on social science and humanities areas. The quality of universities themselves and their graduates are not high compared to other universities in Asia. Their research capabilities are generally unsatisfactory. Relevancy of research to the industry is rather low.

3.2.2. Linkages between actors

Linkages among the three actors of the Thai NIS are generally weak and fragmented.

3.2.2.1. Weak users–producers linkages. Different from NIS in developed countries where the linkages between user and producers (see Lundvall, 1985) have been emphasised as common basis for innovation, the R&D/Innovation Survey shows that the intensity of links between producers and users and between producers and suppliers are relatively weak. The result from the survey confirms the study of Arnold et al. (2000), which describes customer–supplier links in Thailand as short and fragmented ones. Also, as the intra-firm technological capabilities themselves are weak, as already mentioned, the innovation–centre interaction generated from such links is, therefore, limited.

3.2.2.2. Weak co-operation between firms in the same and related industries. Not only is the vertical interaction along the value chain weak, the horizontal relationship between firms in the same or related industries is viewed as rather unimportant by the surveyed firms. Co-operative consortiums among firms, as occur in Japan or Taiwan, to research particular technology or products are very rare in Thailand.

3.2.2.3. Low technological spill-overs from TNCs. Thailand is a major recipient of FDI in the region, the amount being US$ 7 billions in 1998. Nonetheless, unlike Singapore where the strong links between TNCs and local firms has been consistently upgraded to help strengthening local technological capability (see Wong, 2000), the links for technological development between TNCs and their subsidiaries in Thailand are rather limited and trivial. Previous studies (see, for example, Sribunruang, 1986; Kaosa-Ard, 1991) found that the transfer of technology has tended to be limited to the operational level, i.e. TNCs tended to train their workers just so that they can efficiently produce goods. There has not been sufficient transfer of technology at higher levels such as designing and engineering. Little investment from TNCs in Thailand has been made in R&D. From 1990 to October 1998, only 41 R&D projects, of which 22 were foreign firms, were granted investment promotion privilege (Brimble et al., 1999, p. 28).

Similarly, TNCs have not been active in developing subcontractors or giving technical assistance to local suppliers. The reason behind this is inefficiency and backwardness of local supporting industries. Equally important, TNCs lack willingness and effort to devote the resources and time to upgrade local suppliers (see Dahlman et al., 1991).

3.2.2.4. Weak industry–university link. As already said, Thai universities have rather poor research capability and most of their research has a low level of industrial relevance. Linkages between university and industry are based on personal connections between individual researchers and companies rather than organisational commitments. Development of long-term and formal links is still at early stage.

Most industry–university links represent short-term training or ad-hoc use of consulting or research activities rather than longer-term, more extensive relationship. The range of activities and mechanisms remains rather limited both in terms of nature and depth of activities, and institutional sophistication of mechanisms (Brooker Group, 1995, p. 19).

3.2.2.5. Weak links between public research technology organisations (RTOs) and industrial firms. The Innovation Survey suggests that the links between industrial-oriented RTOs and industrial firms in Thailand are rather limited. Only a small number, at the very most 20% of the 1000 firms surveyed have used the services of any of those RTOs. Moreover, these firms generally view RTOs as relatively unimportant sources of information to their innovation activities. These findings are not so surprising, since most RTOs still believe in 'linear model of innovation'. Unlike RTOs in NIEs such as ITRI of Taiwan (see Hobday, 1995), Thai RTOs have been concentrating on developing technologies for industry and, then, transferring them to private firms, rather than promoting transferring of people from RTOs to private firms, which is important for deepening technological development capabilities in industry (see Arnold et al., 2000, pp. 142–133).

3.2.2.6. Training by government institutions fails to upgrade technical expertise of firms' employees to higher end. There are very limited policy measures designed to stimulate firms' investment in training and skill development. The only incentive mechanism that is intended to influence firms to invest more in training is the facility permitting 150% tax deduction for eligible training expenditure. From the Innovation Survey, less than 5% of firms are aware of the existence of this incentive. More importantly, this incentive subsidise the types and volume of training that would probably have been undertaken in any case without the tax deduction provision (Arnold et al., 2000, pp. 114–115). It does not target on skills necessary for crossing the thresholds of technological capabilities shown in Fig. 1. The fact that many vocational students are unemployed suggests a disconnection between firm needs and supply of human resources (Ritchie, 2000, p. 25). Although the Skill Development Department invested heavily to upgrade its vocational training programme, its main concern is employment, not technological development of Thailand. Therefore, it targets rather low-end skills like carpentry, not demanded by large Thai firms and TNCs. This is in sharp contrast with training programmes in Korea and Singapore where higher level, specialised and 'pioneering' type of training are the main focus (Arnold et al., 2000, pp. 111–112).

3.2.2.7. Government fiscal and financial incentives are ineffective in stimulating private sector's demand for investment in technology development. Not many firms have used government fiscal and financial incentives because of the three main reasons. Firstly, most firms do not recognise the availability of such incentives. The Innovation Survey indicates that only 2–3% of sampled firms knew about the existence of the fiscal and financial incentives. Secondly, those incentives tend to focus on narrowly-defined R&D, excluding very large proportion of activities that contribute to technology development such as engineering and design. Therefore, such incentives are not demanded by many Thai firms which have no capabilities and interest in R&D. Lastly, these incentive schemes have highly restrictive operation procedure due to concerns about corruption and misuse of public funds. For example, financing organisations demand conventional types of collateral from borrowing firms (see TDRI, 1998; Arnold et al., 2000).

4. Discussion

From what has been described in the previous section, similar to the east Asian NIEs, the GDP growth of Thailand has been remarkably impressive, and the Thai economy has been moving towards an economy that relies heavily on production and export of industrial products, especially those classified as differentiated and science-based ones.

In contrast, the NIS to support industrial technology development remains weak and fragmented. Therefore, there is a mismatch between level of economic structural development and development level of NIS. In this respect, the Thai case differs not only from the experience of NIEs, but also from Gu's general proposition, that is, there is a link between the level of eco-

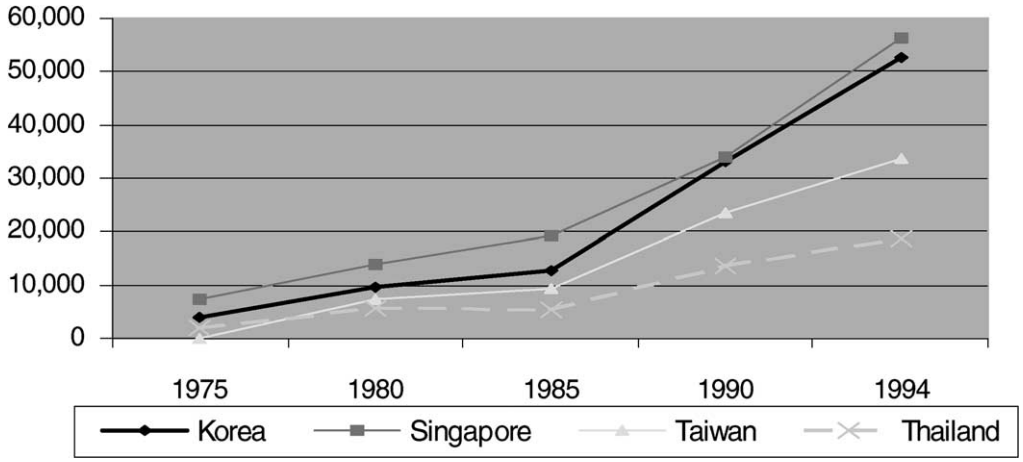

Fig. 2. Value-added per workers (dollars): Thailand vs. NIEs.

nomic development of a developing country and its development level of NIS.

It is the belief of these authors that this mismatch contributed significantly to the economic crisis which started in 1997, apart from other causes like untimely and under-regulated financial liberalisation, and the burst of bubble economy. In 1996, the growth of exports of Thailand was 0%, starkly different from double-digit growth in the past 30 years. This signifies that Thai exports lost competitiveness and aggravated current account deficit. In the period of increasing globalisation which intensifies competition in the world market, the weak and fragmented NIS could not sustain competitiveness of the country any more. After that, confidence of foreign investors, who started to realise the true situation of Thai economy, was dropped sharply, leading to heavy outflow of money and fiercely speculative attack on the Baht leading to the abandonment of the fixed exchange rate system in July 1997.

The fact that the Thai economy slumped more seriously and that the economic recovery has been much slower than the east Asian NIEs and that the growth of export was low after the crisis, notwithstanding heavy devaluation of its currency, all suggest that the Thai economy has much more structural and fundamental problem of inability to achieve technological deepening, a challenging question for future sustainability of Thailand's industrialisation. This problem can be manifested by two indicators.

(a) Much slower growth rate of manufacturing value-added per worker even in the period of high rate of GDP growth, as compared to NIEs (see Fig. 2). This indicates that even though the Thai economy experienced high growth of GDP and structural change, the ability of the country to create 'value-added' for its products, depending significantly on technological development capability, was rather poor. Her exports relied heavily on imported components and industrial materials.

(b) Indicator of the contribution of disembodied technical change to economic growth, in manufacturing and industry sectors. For example, in the period of 1978–1990, the growth rates of TFP in both sectors were −0.36 and −0.61, respectively (see Tinakorn and Sussangkarn). This is different from Korea and Taiwan where most of manufacturing branches shows positive TFP growth indicating significant technological catching-up trends (see Timmer, 1998).

5. Thai NIS in transition?

The crisis, the worst one for Thailand since the World War II, also has some positive, albeit inconclusive, effects on the Thai NIS. The main actors in the NIS (firms, government, and university) and linkages among them have started to change favourably.

5.1. Firms

Higher competition in the global market and the crisis has lead to changing behaviour of Thai firms. The Innovation Survey indicates that more than 80% of firms that have already invested in R&D, in spite of being a small part of technological activities of firms in developing countries, express strong interest in increasing their spending in R&D in the next 3 years. This finding is supported by a recent study of Thai firms after the economic crisis in 1997 (see TDRI, 1998). It showed a few interesting phenomenon as follows:

(a) Several large conglomerates such as the CP Group and Siam Cement Group recently increased their R&D activities. One large conglomerate alone invested 500 million Baht on R&D in 1999.
(b) A number of smaller companies recently increased their technological efforts by collaborating with university R&D groups in order to stay ahead in the market or to seize the most profitable market section.
(c) Several subcontracting suppliers in the automobile and electronics industries were forced by their TNCs customers/partner to strengthen their efforts lately to modify product design and improve efficiency and to be able to absorb the design and know-how from foreign experts.
(d) There were emerging new start-up firms (less than 50 employees) relying on their own design, engineering or development activities. These companies were managed by entrepreneurs having acquired a strong R&D background, while studying or working abroad. Many of them are "fabless" companies.

5.2. Government

There are also favourable signs from the government sector as well.

Firstly, the National Science and Technology Committee has been set up very recently. The committee, chaired by the Prime Minister, will oversee development of S&T and co-ordinate all used-to-be-unconnected government agencies, including economic ministries, responsible for increasing the country's competitiveness in S&T. It has a sub-committee on strengthening technological capabilities of the private sector. Key persons from the private sector (such as CEOs of large Thai conglomerates and TNCs and executives of industrial associations) are members of the committee and the sub- committee.

Secondly, public RTOs are under the pressure from the Budget Bureau to increase their revenue, hence, reducing their reliance on the national budget. They will be forced to be more relevant to industrial needs to earn extra income and try to promote technological development within firms.

Thirdly, long-standing investment strategy has recently been rearranged in accordance to a major economic structural adjustment. Priority has been given to increase in the support of industries that are knowledge-intensive. The new investment strategy of the country focuses on increasing value-added and indigenous technology capability of the industrial sector. This is a significant shift from the investment centred at employment generation.

5.3. University

In the year 2002, Thai public universities will attain autonomous status. They will be out of red-tape bureaucratic system and will enjoy more freedom financially. They will be subsidised by government but they are expected to generate more income from other sources, especially from the private sector. Therefore, they have to conduct research and other activities, which are more relevant to industry. Recently, universities have tried increasingly to increase industry sponsorships and to forge links with industry through collaborative R&D and training activities (TDRI, 1998, p. 107). King Mongkut's Institute of Technology North Bangkok, for instance, has a joint venture with Hi-tech Industrial Estate to establish Ayutthaya Technical Training Centre to provide training and facilitate recruitment of skilled workers of industries in the industrial estate. The centre received training equipment and new technology from a number of Japanese companies (Brimble et al., 1999, p. 25).

6. Conclusion

This paper has both theoretical and policy implications for developing countries which are less successful in technological catching-up.

6.1. Theoretical implications

'Developing countries' are not identical animals. The study of NIS in developing countries might have to differentiate between more successful 'intensive' technological learning countries like NIEs and the countries less successful in technological catching such as Thailand and other countries in Asia, Latin America and Africa. Basically characteristics of NIS in these countries are different from those of developed countries and NIEs in the several ways and one might need to study these countries from a different perspective.

1. Unlike Gu's argument, development level of NIS in a country like Thailand does not link to its economic structural development level. As Thailand has experienced structural change from an agriculture-dominated economy to an economy predominantly oriented on industry and service both in terms of production and export, its NIS does not develop satisfactorily, i.e. it remains weak and fragmented.
2. In the case of Thailand, the mismatch between the level of economic structural change and the development level of NIS led to the worst economic crisis in 50 years, and the transition of its institutional framework. The Thai experience is in line with Freeman and Perez's proposition on the mismatch between techno-economic paradigm and socio-institutional framework, which contribute to structural crisis and change (see Freeman and Parez, 1988). The interesting point is there can be a long time lag between when a country uses a 'window of opportunity' to enter new techno-economic system and when that country faced a structural crisis. A developing country such as Thailand could enter the manufacturing sector and prosper for as long as a few decades by exploiting natural resources and low wage before it faced a serious structural crisis triggered by fiercer international competition and external factors.
3. In opposition to Gu's proposition, studies of NIS in countries less successful in technological catching-up like Thailand should focus not only on how innovation related activities start and improve over time but also, and more importantly, on factors that contributing to stagnancy and factors contributing to the long-running perpetuation of weak and fragmented NIS system.
4. Focus of study on developing countries, which are less successful in catching-up or the so-called 'laggard', therefore, should also be on why and how 'intensive learning', as witnessed in NIEs, has not happened and what are the main obstacles to such type of learning.
5. The main problem preventing governments in many developing countries to play significant roles in developing NIS and inducing 'intensive learning', such as establishing performance-based criteria for government subsidies might be their lack of autonomy and competence. Different from NIEs, sound policy making is hindered by political interference from vested interest groups, and government agencies have insufficient organisational and individual competencies to initiate policies and co-ordinate with other actors of NIS.

6.2. Policy implications

A few policy implications can be drawn from experiences of Thailand. It might be useful for other developing countries, which face similar situation.

1. Governments in countries like Thailand should plan and implement policies that help to address the weakness and fragmentation of NIS. Particularly, they should target the factors that make the Thai NIS unchanged or perpetuating for such a long period of time, many years after it embarking on industrialisation process.
2. If governments in developing countries aspire to be important and effective players in the NIS, institutional reform of their bureaucracies is needed. Bureaucracies should be insulated enough from political pressure of vested interest groups, and, at the same time, be able to cultivate favourable co-operation with other actors of NIS. Also they should be run by capable and dedicated government officials committed to common goals. Recruitment and promotion based on meritocracy, like in Japan and east Asian NIEs, should be adopted. In addition, to attract bright people to bureaucracies, the packages of salary, intrinsic job satisfaction, perquisites, job security, and prestige have to be close enough to the packages of rewards given by the private sector.

3. To address the co-ordination problem within bureaucracies and between government and private firms, rotation of personnel among government agencies and between government and private firms should be encouraged.
4. The aforementioned government reform is not impossible. At the beginning, developing countries are not required to transform their whole bureaucratic system, but they can focus their efforts on economic ministries and agencies that would play significant roles (in terms of policies or effects on other actors) within their NIS.

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