Government Policies and Measures in Supporting Technological Capability Development of Latecomer Firms : A Tentative Taxonomy

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Summary

This paper focuses on the significant issues of technological capability development of latecomer firms, and government policies enabling such firms to attain certain level of technological capability. The survey and case studies of manufacturing firms in Thailand were conducted to substantiate and investigate the process of technological capability development of latecomer firms. The analysis portrays a dynamic view of technological capability development that comprises three key elements namely strategic capability, internal capability, and external linkage capability. The paper, subsequently, discusses and suggests a tentative taxonomy of government policies and measures to support firms' technological capability development.

Key words : latecomer firms, technological capability, technology policy, internal capability, external capability

1. Introduction

It has long been a commonly accepted rationale for governments to augment market mechanisms in order to ensure that investment by firms in creating or acquiring knowledge will be sufficient to maintain an innovative economy. For decades, various incentives and supports for promoting

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technology development in private sector have been practised by many industrialised and industrialising countries. These incentives and supports are expected to promote and enhance industrial technology development in the private sector. However, many studies (see, for example, Lall and Teubal, 1998; Arnold et al, 2000). pointed out that the effectiveness of existing measures and systems are not clearly visible especially in developing countries. In those countries, the central role of industrial firms, the importance of non-R&D activities, the significance of technology flows between firms, and the importance of people flows are not fully recognised by policy makers. Therefore, further studies should be undertaken to develop a much more systematic understanding of the nature and scale of industry's demands for different kinds of supporting mechanisms for technological capability development and the factors that influence differences and changes in those patterns of demand.

The purpose of this study is to investigate the process of technological capability development in latecomer firms, and its implications in developing effective measures for promoting a firm's technological capability development. Factors and conditions influencing the development of technological capabilities at firm level will be examined. This study will also recommend a tentative policy framework for industrial technology development support in a developing country. An example of manufacturing firms in Thailand is used to examine the technological capability development process.

The paper consists of four main sections. In section 2, we review the theoretical aspects of latecomer firms and government's policies supporting industrial technology development. In section 3, research methodology of the study is introduced and elaborated. Next, in section 4, an analysis of a firm's technological capability development process is conceptualised. Finally, section 5 will draw out policy implications for supporting firms' technological capability development.

2. Theoretical Aspects of Latecomer Firms and Supporting Government Policies

The concept of latecomer industrialisation was firstly introduced by Gerschenkron in 1962. He stresses that the crucial features of the latecomer countries' development are different from those of the forerunner countries' simply because they are late. Latecomer countries, he argues, have disadvantages to pursue their industrial development compared with the forerunner countries because of high degree of backwardness, especially in terms of institutions for development such as financial intermediaries. Nonetheless, they have advantages over the forerunner countries

since they can utilise technological and institutional backlogs already created by forerunners, without necessarily creating those prerequisites indigenously. After Gerschenkron, many authors have studied the industrialisation and catching up processes of latecomer countries, especially after World War II when several countries outside the North Atlantic such as South Korea, Taiwan, Singapore, Hong Kong, Thailand, Malaysia, China, India, Argentina, Brazil, Mexico, and Turkey rose to the ranks of world-class competitors in a wide range of mid-technology industries (see, for example, Abramovitz, 1986; Amsden, 1989; Wade, 1990; Chang, 1994; Lall, 1996; Shin, 1996; Amsden, 2001).

Hobday (1995) applies the concept of latecomer to the firm level. He defines a latecomer firm as a firm that faces two sets of competitive disadvantages in attempting to compete in export markets. The first disadvantage is technological in nature. Latecomer firms are behind technologically, lacking in research, development and engineering capability. Their surrounding industrial and technological infrastructure is poorly developed. It operates in isolation from the world centres of science and innovation. The second disadvantage concerns international markets and demanding users. Latecomer firms are dislocated from demanding international markets that help to stimulate technological advance and innovation. To succeed, these latecomer firms have to devise mechanisms to overcome these two disadvantages. He demonstrates at length how electronic firms in East Asian NIEs used OEM and ODM[1)] mechanism to advance their technological capabilities and access to demanding markets in advanced countries. Similar mechanism such as strategic alliances in various forms (such as joint venture, franchising, non-equipment cooperative agreement) have been used by many latecomer firms operating in various industries (see, for example, Taniura, 1989; Sato, 1993; Koike, 1993 and Kim, 1997).

Latecomer firms have different level of technological capabilities. Technological capabilities are classified differently by different people. The most comprehensive and well- accepted one is Bell and Pavitt (1995). They develop their technological capability framework based on Westphal *et al.* (1985) and Lall (1992). Firstly they differentiate "technological capabilities" from "production capacity". The latter incorporates the resources used to operate existing technological systems (i.e. to produce goods at given levels of efficiency and given input combinations). On the contrary, technological capabilities are resources needed to generate and manage technological change.

1) OEM and ODM are specific forms of subcontracting. Under Original Equipment Manufacture, a latecomer firm produces a finished product to the precise specification of a foreign transnational corporation, which will market under brand name via its own distribution channels. Under Own-Design Manufacturer (ODM), a latecomer firm carried out most or all product design (Hobday, 1995:37)

These include skills, knowledge, and experience as well as the particular kinds of institutional structures and linkages necessary to produce inputs for technical change. They also distinguish between "depths" of technological capabilities. A basic level of capabilities permit only minor and incremental technical change, whereas technological capabilities at the intermediate and advanced levels, may result in more substantial, novel and ambitious change. Functionally, they classify capabilities into types: facility user's decision- making and control, project preparation and implementation, process and production organisation, product-centre, developing linkage and capital good supply. Alternatively, Amsden (2001) develops more simplified classification of technological capabilities. She distinguishes capabilities into three generic type: *production* capabilities (the skills necessary to transform inputs into outputs); *project execution* capabilities (the skills necessary to expand capacity), and *innovation* capabilities (the skills necessary to design entirely new products and processes).

Various government policies and measures have been devised to help firms progress technologically. Several prominent scholars conceptualise these policies and measures. Martin and Scott (2000), for instance, outline mechanisms for public support of innovation according to types of innovation market failure in different industrial sectors. For example, in the sectors such as software, equipment and instrument where innovation market failure is risk associated with standards for new technology and limited appropriability of generic technologies, government policy instrument should be in terms of supporting venture capital markets, bridging institutions to facilitate standard adoption. In the light industry where the sources of innovation failure are small firm size, large external benefits and limited appropriability, government policies should focus on creating bridging institutions to facilitate technology transfer.

The most systematic framework for analysing technology policies in developing countries is proposed by Lall and Teubal (1998). According to their framework, there are three levels or phases of policies. At national level, the objective is to set national objectives and decide upon the trade-offs between them. At priority setting level, the direction of policies, and so interventions needed, have to be guided by a vision of future scientific, technological, and industrial development. Policies at this level can be divided broadly into two types of categories: horizontal policies aiming at stimulating generic technological activities and vertical policies aiming at targeting specific technologies, clusters and industries or regions. The last level is concerning specific programmes/ policies government has to design and implement to meet its priorities. A very interesting point illustrated by Lall and Teubal is that broad and generic policies are essential but not sufficient to strengthen firms' technological capabilities, and subsequently countries' competitiveness, policies addressing problems in specific industries, clusters and tech-

nologies are necessary supplements.

Nonetheless, the already existing concepts/frameworks advanced by these authors do not explain a very important aspect of government policies/measures, which is, policies/measures to help firms attaining different level of technological capabilities, i.e. acquiring and operating capability, absorbing and mastering capability, adapting and developing capability, and generating and innovating capability. Our study, aiming at addressing this crucial issue, tries to identify what types of policies/ measures are effective for in supporting firm to attain particular stage of technological capability. In order to do this, we initially have to study the process of technological capability development of latecomer firms in details.

3. Research Methodology

The methodology for our study is twofold. At the more comprehensive level, the R&D/ innovation survey of 1000 manufacturing firms, including 200 largest firms, has been conducted under the supervision of National Science and Technology Development Agency (NSTDA) in the year 2000. Apart from surveying the magnitude and pattern of R&D and innovative activities of these firms, the survey will give a view on technological capability development of manufacturing firms in Thailand, and the relevancy of existing policy measures in supporting a firm's technological capability development. These include fiscal and financial incentives for supporting firms' technological development, incentives for training, technical and consultancy services. It also broadly assesses the role of government research institutes and universities in supporting technological development of private enterprises. Coupling with the survey, previous concerned literature has been examined.

At the more specific level, in-depth study of twenty local manufacturing firms has been carried out. These firms are in four industries, namely, electronics and components, automobile and parts, food processing, and supporting industries. The study will examine the processes of technological capability development of these firms, and influencing internal and external factors.

A dynamic view on the technological capability development process, which comprises three key elements of technological capabilities, is introduced to examine why industrial firms want to deepen their technological capability development, what are the key factors and conditions that trigger their decision-making, and to what extent existing policy measures in Thailand are effective in providing a set of incentives and supports mechanisms to reinforce industrial technology development activities and to cross the thresholds of capability development they currently face.

The Hypotheses of the Study are as Follow :

1) Technological capability development, with respect to the stage of industrial development in a newly industrialising country, is broader than R&D capability, and sometimes other capabilities are more important such as acquisition and absorptive capability, investment capability, and adaptive and design capability ;
2) Technological capability development is not only a matter of technology, but also closely related to other conducive factors such as business models and strategies, organisational culture and history, etc.;
3) Access to the sources of knowledge and flows of information and knowledge are important to support technological capability development, and mostly comes from external sources;
4) Technological needs come from external pressure, and depend on readiness of firms' internal capabilities to response to such a change

These hypotheses will be examined and substantiated by case studies, rather than tested statically.

4. An Analysis of Technological Capability Development of Latecomer Firms

4.1 A Broad View of Technological Capability Development of Latecomer Firms and Relevancy of Existing Supporting Government Measures

The findings of the survey in 2000 point out that most sampled manufacturing firms in Thailand 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. The figure for the number of firms performing innovations in terms of new commercialized products and processes (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 (1999)'s assertion that formal R&D, unlike in developed world, is not an illustrative and complete indicator of innovativeness in developing countries. These firms rather want to rely on off-the-shelf imported technology mostly in the forms of machinery, and turnkey 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: 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.

The survey's results also suggest that the links between industrial-oriented Research and Technology Organisations (RTOs) and industrial firms in Thailand are rather limited. Only a small number, at the very most 20% percent, of the 1,000 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.

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 subsidises the types and volume of training that would probably have been undertaken in any case without the tax deduction provision (Arnold, 2000: 114-115).

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 survey's results indicate that only 2-3 percent 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, 2000).

4.2 Process of Technological Capability Development of Latecomer Firms

The findings are synthesised from in-depth interviews and plant visits with 20 manufacturing firms in Thailand. These studied firms can be grouped according to main characteristics, especially their origination, into three identified business models which are categorised in Table 1.[2)]

2) These three business models do not include the TNC exporting subsidiary business model; however, this is the largest exporting sector in Thailand. Given the size and complexity of this particular business model, a further separate study will be undertaken. This paper concentrates on the three major *locally owned* business models.

Table 1 : Three Business Models of Studied Firms

Business Models	Main Characteristics
Group 1 (Locally Owned Own-Brand Manufacturers)	- Established by using its own brand and emphasised on domestic market - Mainly required high investment and supported by local large conglomerate as main investors - Cases : FP1, FP2, FP4, FP5, SP1, SP4, SP5
Group 2 (Locally Owned OEM suppliers)	- Established by manufacture as subcontracting or OEM for local TNCs, or export to international markets - Cases : EE1, EE2, AP1, AP2, AP3, FP3, SP2, SP3
Group 3 (Locally Owned Niche-focused Venture)	- Started from small businesses with local niche market - Emphasis on product design, less on production - Direction and business strategy mainly come from top executives - Cases : EE3, EE4, EE5, EE6, AP4

Notes : AP : Automotive parts, EE : Electrical and Electronic Components, FP : Food Processing, SP : Supporting Industries

Another key finding is the relationship between business models and technology capability development process of firms. Figure 1 illustrates differences in the technological capability development process of each identified business model.

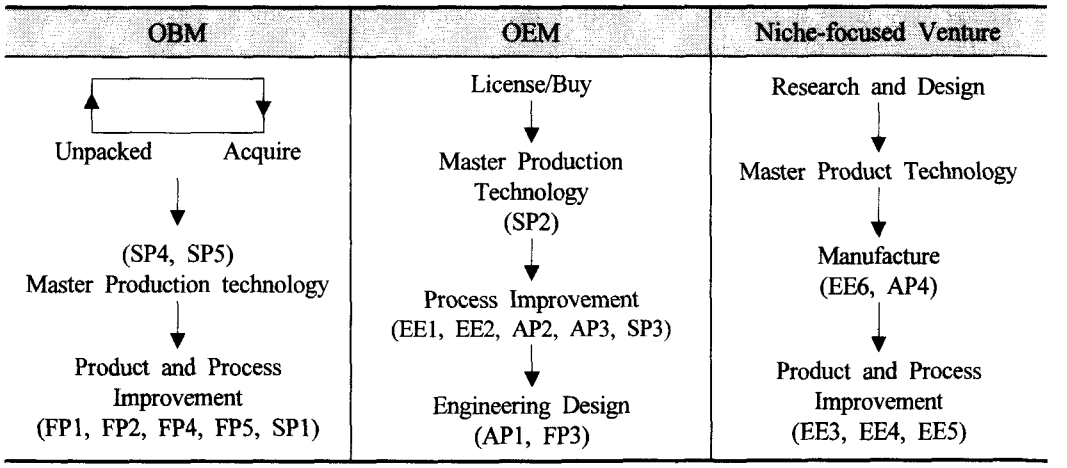

Fig. 1 : Process of Technological Capability Development of Each Business Model

The Locally-owned Own Brand group starts the process of technological capability development by considering both process and product technologies. In the beginning, to reduce the initial investment cost and to develop acquisitive capability, firms have two choices. They either a) attempt to unpack the process technology from the very beginning or b) acquire packaged technology and unpack

it later. They then learn to understand and be able to master engineering and maintenance works of the whole production system. Later, they are able to improve and adapt the process in order to increase production efficiency and product quality. R&D for product development of firms in this group, is not at advanced stage, and primarily lagging behind the international leaders.

The Locally-owned OEM group starts by licensing or buying production technology, and then tries to learn and understand these technologies. Later, at the stage of expansion, they themselves are able to determine the required specification, and master engineering and maintenance works of the whole system. They are also able to set up and ramp up the new production process. Later, they are able to improve and adapt the process in order to increase production efficiency and product quality.

The Locally-owned niche-focused venture group starts their process of technological capability development from product design capability. Their production scale is small and it emphasises on niche or specialised market, which is flexible to respond to customer's requirements. After getting more confidence, they are able to take orders of higher value and complicated products.

	Classification of Technological Capability			
Business Model	**Level 1** Able to acquire, select, and use	**Level 2** Able to understand, utilise and absorb	**Level 3** Able to adapt and improve own technologies	**Level 4** Able to do R&D and innovate
Own Brand	SP4 SP5 →	FP1 FP2 →	FP4 FP5 →	SP1
	→	EE1 →		
OEM		AP2 AP3 FP3 SP2 SP3	EE2 AP1	
Niche-focused Venture	EE6 →	AP4 →	EE3 EE4 EE5	

Fig. 2 : Classification of Technological Capability Grouped by Business Model

It can be noted that the above cases elucidate that technological capability development is not only a matter of technology, but also closely related to other conducive factors like business models. Here, three forms of business model and their processes of technological capability development can be observed. Dynamism of firm's business model tends to occur over time

with the influences of internal and external factors. This, in turn, affects the process of firms' technological capability development

4.3 Key Elements of Technological Capability of Latecomer Firms

Technological capability can be categorised in three elements: strategic capability, internal capability and external linkage capability. In relation to business models, development of the three elements of technological capabilities of sampled firms will be illustrated.

Strategic Capability

This is the capability of a firm to set strategic technological direction. This capability does not only involve technological aspect alone. It encompasses non-technological aspects such as marketing, management and finance, which in many cases are even more important in shaping technological and strategic direction of firms than technology per se. The study result finds that there are dynamism of business models (as shown in Figure 3) i.e., business model of an individual firm can change over time depending upon several internal and external conditions, especially for firms in OEM and niched-focused groupings. For example, foreign customers (transnational corporations), which adopted global sourcing strategy, pressured AP1 and FP3 to lower prices of their OEM products. For survival and long-term profitability, these two companies had to change their business models from being only OEM suppliers to developing their own brands. SP3 also moved up the value chain to produce composite for rubber part maker and mould for other companies. Changes in business model of these three companies forced them to develop new types of technological capability, viz., strengthening their design and R&D capabilities. Another example is EE3, which started its business from detailed designing and engineering works without having its own factory. After gaining a certain level of confidence and capability, it moved upward to participating with customers in the earlier phase of product concept design. Subsequently, after getting bigger orders from customers, EE3 also expanded its business downward to build its own factory, like OEM suppliers, and started learning how to improve technological capabilities in production process. Again, change in business model determines change in the direction of technological capability development. It should be noted that exposure of firms toward the global market helped them reshape their business direction, as they can realise external pressure and market conditions in advance. These findings support our hypothesis that needs for technological change, to a large extent, come from external pressure, and depend on readiness of firms' internal capabilities to response to such a change.

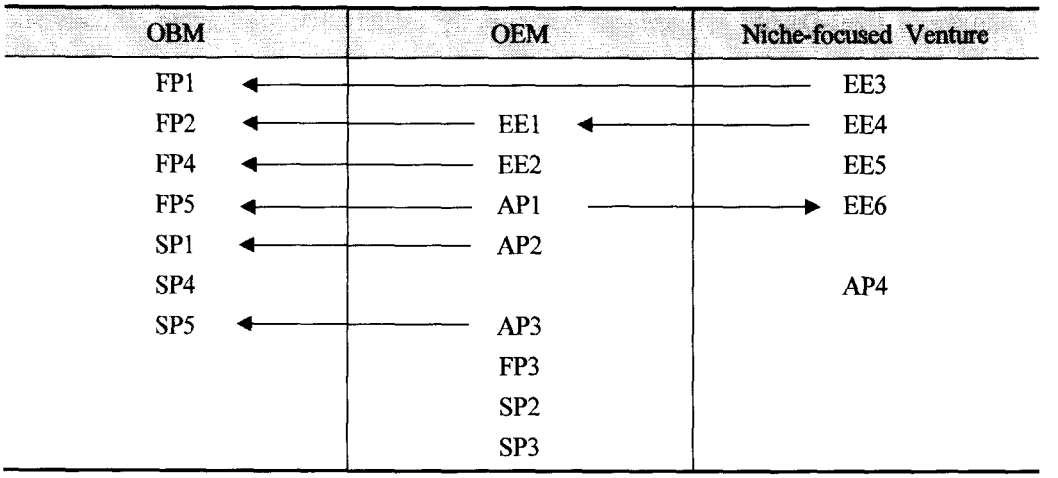

Fig. 3 : An Illustration of Firms' Dynamism of Business Model

Internal Capability

Here internal capability is defined as intra-firm technological and other factors (such as marketing, finance, management) affecting technological development of firms. From our study, critical internal factors affecting studied firms' technological development can be summarised as follow:

1) Absorptive capability of personnel and organisation: The success of upgrading technological capabilities in every firm significantly depends on the capability in absorbing and understanding the using technologies of its personnel responsible in technology development activities. This confirms our hypothesis that technological capability development is broader than R&D capability, and sometimes other capabilities are more important such as acquisition and absorptive capability. To succeed, close and concerted involvement top management, the engineering team working in the period of start-up phase, and new engineering teams is required. Moreover, organisation routine and culture such as management practices, flow of knowledge and personnel within firms, ability to accept changes and failure, and so on.

2) Confidence level of firms in committing in technological capability development: After absorption and understanding of technology from continuous practices, firms will gain more confidence in receiving customer orders that require higher specifications, which, in return, will put pressure to firm's learning to produce higher quality products.

3) Awareness of top management in the importance of technological capability development: FP2 sent the engineering team to be trained before investment and plant construction. SP3

introduced Total Quality Management system in the organisation much more seriously and in detailed than other firms of the same size. EE3 have decided not to be only an OEM supplier since the first date of business.

4) Long-term planning and business strategy: Unlike its competitors, SP3 diversified to be a mould maker and produced composite for rubber parts, the market which has only a few players. FP3 needed to build up their own brand name after over many years of OEM operation because of cost pressure and international trade. FP1 relocated its old production facilities to neighbouring countries in Asia and replaced with the new ones. EE3 relies on its core technology to diversify into potential markets in the future.

External Linkage Capability

This is capability that enables firms to search and access external technological knowledge, and to identify the suitable technological choices for their projects. External linkage capability is very important especially these days, as no firms perform technological activities in isolation. Linkages can be developed with suppliers, customers, competitors, various types of strategic partners (such as franchising, technological licensing, technological assistant agreement, and joint venture) and public institutions like universities and research technology organisations (RTOs). Case studies of FP4, FP5, AP1, EE3, EE4 show that firms with higher external linkages can advance technologically than others. For example, AP1 has developed its own internal capability in aluminium die-casting technology and improved the quality of products up to the market standard. This helps AP1 to move across a threshold toward design capability, and enable it to adopt its own design and develop the relationships with their key customers. Recently, it sent its staff to work as a member of the design team with its customers as guest engineers. This implies that it can set the market standard and be ahead of its competitors.

The relationship between top management and their business partners, customers, and suppliers also helps firms to access and acquire external sources of knowledge and experts. The access can broaden perspectives of executives and personnel, and bring in the idea for firms' technical improvement and adaptation. For example, FP1's engineering team visited two noodle plants in Japan, and subsequently use this experience to change its existing technologies. Excellent relationship with Japanese customers allowed AP1 to participate in up-stream customers' conceptual product design. EE2 established joint ventures in overseas market. Being able to visit factories of its suppliers, SP2 can gain access to state-of-the art technologies that help broadening and increasing its capability continuously. These findings confirm our hypothesis that access to sources

of knowledge, especially external ones, is important for supporting technological capability development of firms.

4.4 A Framework of Technological Capability Development of Latecomer Firms

From the analysis of three key elements of technological capability in case studies, we found that these capabilities are related to each other and the pattern of demands for capability has changed over time. This can be illustrated by a framework as shown in Table 2. The changes over time of key elements of needs of technological capability and capability improvements can be identified. In Thailand, most of manufacturing firms belong to the 1st and 2nd level where firms do not know what they do not know and have minimum capability to move across the development staircase. They emphasise on tangible technology base and depend on technology suppliers rather than their own internal capability. At the 3rd level, firms have enough capability to do significant development work. The aim of a firm is to move toward an 'unboxed' understanding of technologies. At the highest level, firms have enough capability to do research and development and innovation.[3)]

A dynamic view of technolgical capabilities has suggested a better understanding on firm's capability needs. For example, awareness on business and technology development is the most important measure at the 1st level. Technology infrastructure such as technical information, testing services is the most important support for the 2nd level, while internal capability is for the 3rd level. External linkages and R&D supports are very important at the higher level of capability development in order to create product and process innovation and sustain firms' competitiveness.

However, this staircase models does not imply that firms typically (or should) progress incrementally, step by step, towards higher levels (this is sometimes called 'managed incrementalism'). In some cases, if the firm is mature or lacking in capability, then it may need to bring in a *radically different* kind of capability (involving knowledge of new markets and technologies and internal leadership which challenges 'the way we do things around here') from the outside. These special capabilities can unlock the capabilities lying dormant inside the firm.

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3) However, this does not mean that R&D is necessarily the most important or at the apex of firm's technological capability development. First, many large firms now outsource R&D relying instead on a less vertically integrated positioning along the value chain (see, Hamel and Prahalad, 1994). Second, in a catch up context, other technological activities such as product design and process improvement can be more important. Third, most R&D is not (and perhaps) should not be performed by SMEs, except the knowledge-intensive start-ups (the third group of studied firms here). Formal R&D belongs mostly in large companies while SMEs perform other important roles.

Key Elements of A Firm's Technological Capability	Development 'Staircase' of A Firm's Technological Capability			
	STAIR 1 No Perceived Need for Technological Capability	STAIR 2 Basic/Minimum Capability to Make Applications-based Adaptations	STAIR 3 Sector or Technology-Specific (Ability to make incremental improvements to the technology itself as well as its applications)	STAIR 4 R&D Performing(Able to develop significantly new variants or innovation)
Strategic and Business-related Capability	Technology as 'Black Box' Lack of resources and desire to monitor and assimilate external technology	Technology as 'Grey Box' Able to search for market opportunity	Technology as 'White Box' Able to understand and manage the fit between the firm's capabilities and market needs	'Unboxed' Able to take long run view of technological capabilities Have the vision to understand when organisation needs to change
Internal Capability	Emphasise on usage of tangible technology base such as plant and equipment, routine operation, and basic maintenance of given facilities	Able to manage the tangible technology base Able to identify and invest in the right and appropriate plant and equipment	Able to manage intangible resources Emphasise on design, technology, and engineering	Able to manage tangible and intangible resources such as R&D facilities, codified intellectual capital and tacit knowledge
External Linkage Capability	Heavily rely on suggestions of technology suppliers	Able to access external knowledge such as know-how, techniques, information resources	Able to manage producer/user relations	Access other partners with needed complementary assets and capabilities

Fig. 4: An Analysis of Firm's Technological Capability Development

5. A Tentative Policy Framework for Firm'S Technological Capability Development

From the analysis of firms' technological capability development processes and key elements of technological capability, we can observe some implications to government supporting measures that help firms attain specific technological capabilities. The result from the analysis implies that different supporting measures need to be applied for different levels and elements of firms' technological capabilities development as shown in Table 3. This illustrates a tentative policy framework for firm's technological capability development. The framework tentatively suggests which sets of government policies and measures should 'focus' on strengthening capability at which type and level (some measures can be used at different levels but with different weight) rather than provide clear-cut policy/measure boxes totally separable from each other as the table appears.

5.1 Encouraging Strategic and Business-Related Technological Capability

The study found that one of the difficult problems to be overcome in helping latecomer firms develop capabilities is caused by the 'learning paradox'. That is that until you have learnt something you cannot properly specify what you need to learn. (Arnold, and Thuriaux, 1997) Awareness programs such as government-sponsored overseas company or exhibition visits helps to broaden perspectives of firms' executives and raise their awareness in the importance of technological capability development. These government-supporting measures can help to speed up the technological development process of firms as clearly illustrated by the case of SP2. To raise firms' competence, not only in technology but also in the basic of business, there need to be sources of practical help and training close at hand. When they moved up capability, what firms of this type want are market opportunities for its own-designed products provided by government procurement. Joint ventures and business alliances are also needed when business models' change, and may lead to new ventures for capturing new business opportunities.

5.2 Encouraging Internal Capability

To induce positive changes in aforementioned internal critical factors influencing firms' technological capability development process, various training programs such as technology management course (on simple management of firm's production process), quality programs, and more advanced course such as technology and innovation management course (on how to manage firms' resources to create new products and processes) and knowledge management course (on how to manage intangible technological knowledge and create knowledge networks)

is needed. Similar to experiences of East Asian newly industrialising countries (see Lall and Teubal, 1998), the higher the capability that firms aim for, the more targeted training services for attaining critical skills are needed. Issues such as quality, simple manufacturing strategy, and use of IT are generic areas where latecomer firms need for minimum capability.

To attain design and engineering capability, for example, special training programs for advanced computer-aided design and manufacturing (CAD/CAM) and high precision production have been set up. For a firm's near-market activities such as detailed design, engineering and improvement of production process, where benefits are perceivable, manufacturing consultancy and grants for design and engineering would help encourage firms to carry out such activities. When moving up to the high level, government grants, in several schemes, will help increase firms' confidence in investing in R&D, especially for firms which have not pursued this risky and costly activity before.

5.3 Encouraging External Linkage Capability

At the early stage of development, firms are willing to get tangible technologies rather than intangible technologies. This requires generic technology transfer and information supports. When firms move up to more technology- specific needs, they will require more external linkages to specific sources of intangible technology such as technology centres and networks. At the higher level, R&D services and bridging agents will be needed to support collaboration and partner search. Co-operations with universities are more effective for firms intending to develop R&D capabilities but less effective for firms intending to develop technological capabilities at lower level than R&D. Government subsidies for technical consultancy services are more effective in upgrading technological capabilities at this level. The higher technological capabilities firms want to achieve, the more preference (of firms) for foreign consultants to local ones, since foreign consultants have had much longer experiences in specific technical fields.

The role of the private sector in effective implementation of these policies is quite important. Private consultancies, domestic and/or foreign, can participate in several aforementioned government measures to strengthen the three types of firm's capabilities. Government can, therefore, use and stimulate private consultancies to deliver services rather than do it themselves- sometimes with small amounts of seed money.

	Development 'Staircase' of A Firm's Technological Capability			
Key Elements of A Firm's Technological Capability	STAIR 1 No perceived need for technological capability	STAIR 2 Basic/minimum capability to make applications-based adaptations	STAIR 3 Sector or technology-specific (ability to make incremental improvements to the technology itself as well as its applications)	STAIR 4 R&D performing (able to develop significantly new variants or innovation)
Strategic and Business-related Capability	Proactive mentoring in business and technology audits State-subsidised awareness programs such as visits and comparisons	Business capability development, especially marketing Feasibility assessment	Joint-venture programs Techno-Business programs	Business acquisition and strategic alliances New venture programs
Internal Capability	Technology management course	Quality programs Training needs analysis and training programs Technology management course	Manufacturing consultancy Product development assistance Grants for design and engineering Technology and innovation management course	R&D tax incentives Loans of research personnel R&D matching grants and soft loans Knowledge management course
External Linkage Capability	Technology transfer programs and brokerage	Technology information services	Technology centres Technology development networks Company supplier development	Science parks and incubation R&D collaboration Metrology services State procurement programs Partner-search programs Inter-company network programs

Fig. 5: A Policy Framework for Firm's Technological Capability Development

6. Conclusion

This paper addresses a very significant issue for latecomer countries, how government policies and measures can enhance technological capabilities of latecomer firms. In order to design and implement effective supporting measures, a better understanding of firms' technological capability development processes is necessary. This paper highlights an analysis of technological capability development process comprising three key elements. It leads to a tentative government policy framework for supporting latecomer firms' technological capability development in latecomer countries.

The study shows that different policy instruments need to be addressed at different level of technological capabilities. To help firms attain targeted technological capabilities, policy makers have to bear in mind and use these instruments selectively. Several instruments lead to positive changes, because they, in a way, affect firms' internal capability, for example, educating firms' executives on how important firms need to invest more in certain type of technology capability development activities. Hence, they can accelerate existing processes of technological capability development, and enable firms to cross their technological capability thresholds.

However, not all government agencies can provide these kinds of assistance to firms. Some agencies need to learn and strengthen their own capabilities before engaging in such activities. More importantly when countries develop, some of the aforementioned measures should be implemented by private consulting companies and government should take indirect roles by encouraging these consulting services.

The framework suggested here is a tentative one based on case studies of only one latecomer country, Thailand. In order to develop more solid framework, further studies on appraisal (or evaluation) of policy effectiveness, impact, gaps, and capabilities are needed, especially on 'what works' in other latecomer countries.

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