Asian Journal of Technology Innovation 15, 2 (2007)

Strategy versus Practice in Innovation Systems Policy: the Case of Thailand

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Summary

The paper builds up on the pioneer work of Martin Bell, who started studying the Thai S&T policy already in the sixties. In one of his latest work (Bell, 2002) Martin strongly highlights the need to move from a traditional approach to science and technology policy to a broader system of innovation policy, that focuses on capability building and on the interactions between the different organizations responsible for the creation, acquisition and use of knowledge for innovation. The issue of the rationale for public intervention under the systems of innovation perspective has recently received an increasing attention among scholars and practitioners. However, with few exceptions, this literature has been based on the analysis of innovation policies and innovation systems in the industrialized countries neglecting almost completely the specific policy dilemmas arising from weak and fragmented innovation systems that characterize developing countries. In the last few years, a growing number of developing countries have adopted the system of innovation approach officially in their innovation policy.

Yet, there has not been an adequate attempt to systematically analyze how (and if) this has been done in practice. This paper attempts to shed some light on this issue by analyzing the innovation policy of Thailand. Right after Bell's latest report on S&T policy in Thailand and the Thai Innovation System was launched (Bell, 2002), the Thai government made official a new S&T five-year Plan (2001-2006) in which the system of innovation approach was officially adopted. This paper enquires the extent to which the IS has been applied in practice. The paper suggests that while innovation system approach might have been officially adopted by a government, the practice follows old innovation paradigms and hardly addresses the profound systemic problems of the Thai innovation system.

Keywords: Innovation policies, systems of innovation approach, latecomer countries, public intervention, Thailand

[1] Acknowledgements: the authors would like to thank Prof. Mike Hobday and an anonymous referee for their valuable suggestions for our revision of this paper. We would also like to thank Charles Edquist, CIRCLE, Sweden and Koson Sapprasert, TIK, Oslo for comments received to an earlier version. We would like to thank also Jan Vang, Copenhagen Institute of Technology, Denmark for bringing us together in the first place.

1. Introduction

Martin Bell's insights into policies for capability building have been admired by scholars and analysts around the world for past 20-30 years. In the core of most of his analysis of innovation policies is the question of why, when and how should public actors intervene in the innovation process. The discussions on the rationales for public policy intervention, that were dominant in the traditional neoclassical approach (Arrow, 1962; Nelson, 1959), have only very recently received attention by scholars and practitioners within the systems of innovation perspective (Chaminade and Edquist, forthcoming; Borras, et al., forthcoming; Kohlher-Koch, 2003; OECD, 2001; Smits and Kulhmann, 2004; Woolthuis, et al., 2005). The question of when should policy makers intervene in the system of innovation is currently emerging as a hot topic of debate, strongly related to our conception of the innovation process and its determinants (Edquist and Chaminade, 2006). As Martin Bell has always taught us, any discussion on policy options has to be rooted on a throughout analysis of the specific socio-economic context and trajectory of the country.

The extensive literature on systems of innovation (Freeman, 1987; Lundvall,1992, Nelson, 1993 and Edquist, 1997) has largely emphasized the role of organizations and institutions in shaping interactive learning. Formal and informal institutions such as rules, norms, routines, or informal social patterns of behaviour shape the interactions of the different organizations in the system of innovation (Nooteboom, 2000; North, 1990). And those institutions are highly context-specific. However, with meagre exceptions the literature on rationales for public intervention under the system of innovation perspective is rather abstract, and not attending to the context specific character of interactive learning in systems of innovation (Metcalfe, 1995; Borras, et al., forthcoming). This is particularly relevant when we consider the rapid dissemination of the innovation system concept from the industrialised context in which it was initially developed, to the less developed regions in the world (Lundvall, et al., 2006; Muchie, et al., 2005; Mytelka and Smith, 2002; UNIDO, 2007). Throughout this dissemination process, the concept of IS has been re-conceptualized to respond to the specificities of developing countries and regions (Chaminade and Vang, 2006a and b; Intarakumnerd, et. al., 2002; Intarakumnerd and Vang, 2006; Lundvall, et al., forthcoming; Lundvall, et al., 2006; Muchie, et al., 2005; Vang and Asheim, 2006; Vang, et al., forthcoming). But this contextualization and re-conceptualization has not yet pervade the discussion on rationales for public policy intervention within the system of innovation approach.

This paper aims to contribute to this research gap by discussing the rationales for public intervention in innovation systems in the specific socio-economic and institutional context of latecomer countries. In developing countries, policies have traditionally relied on market based development strategies aiming at creating static efficiencies instead of dynamic capabilities. In the very few cases where there has been an innovation policy, it has frequently followed the linear model, particularly supporting research and capacity building in the public sector and, often neglecting capacity building in the private sector. This has been clearly the case of Thailand as illustrated by seminal works of Martin Bell (Bell, 1984; Bell and Scott-Kemmis, 1985, Bell; 2002).

Thailand is an interesting case study, since the country, unlike the East‐Asian Tigers, is one of a latecomer country particularly in relation to technological catching up with the forerunners. It has also been a latecomer in trying to adopt and implement the IS approach, despite suffering from very clear systemic problems highlighted by Martin Bell in his various analysis of the industrial technological development in Thailand (Bell, 2002; Intarakumnerd et. al., 2002; Lauridsen, 2002). The paper critically investigates if the rationales for public policy intervention in Thailand are indeed following such systemic perspective or if, on the contrary, they are falling on old paradigms, rationales and instruments that do not fit the existing systemic problems. This is critical as, as Bell acknowledges, Thai innovation system lags largely behind the efforts of regional competitors 10 or even 15 years ago and only a profound and real transformation in the scope of the S&T (and innovation) policy could contribute to narrowing this gap.

The remaining of the paper is organised as follows: the paper starts by discussing the main rationales for public intervention, particularly focusing on the discussion on systemic problems - often called systemic failures - (grounded in the evolutionary/systemic approach). In the last section of the paper the authors critically discuss the relevance of the framework to understand innovation policy in Thailand with the aim of suggesting extra set policies required as prerequisites to enhance ‘learning to learn’ capabilities of less successful countries before adopting a more standard system of innovation approach. The paper concludes with some open questions and issues for further research.

2. Rationales for Public Intervention, Systems of Innovation and Developing Countries

In the neoclassical tradition, the discussion on rationales for public intervention is strongly linked to the notion of optimality. According to the neoclassical theory public actors should

intervene to solve the market failures that prevent achieving the optimal investment in innovation (R&D). According to the neoclassicals, knowledge emanating from research has some specific properties: uncertainty, inappropriability and indivisibility (Arrow, 1962; Lipsey and Carlaw, 1998; Nelson, 1959) which will lead to an under‐investment in R&D activities by private actors. Policy makers have to intervene because of a market failure: economies will systematically under-invest in R&D not reaching the optimal allocation of resources for invention and this constitutes the primary rationale for public intervention in research activities (Chaminade and Edquist, forthcoming). The neoclassical tradition understands innovation in a rather narrow sense, more related to the process of research and discovery than on how that new knowledge is transformed into new products and services. The consequence is an (excessive) focus on the role of science and researchers in the innovation performance of a country or region. Whilst this might be relevant in advanced stages of development it is often not the case in developing countries. The transformation from knowledge users to knowledge producers is, as Martin has argued in many occasions a matter of capability building and on accumulation of engineering and design competences rather than purely scientific ones.

As opposed to the neoclassical theory, the notion of optimality is considered to be irrelevant by the IS approach. Rather the IS approach focuses on the evolutionary nature of innovation processes, on the transition from one stage to another, based on the accumulation of capabilities. Innovation processes are path dependent over time and it is not clear which path will be taken (Edquist and Chaminade, 2006). They have evolutionary characteristics (Metcalfe, 1995). The system never achieves equilibrium and the notion of optimality is irrelevant in an IS context. Hence, comparisons between an existing system and an ideal or optimal system are not possible. Thereby the notion of “failure” looses its meaning and applicability[2]. Instead one can talk about systemic problems (Chaminade and Edquist, forthcoming; Chaminade and Edquist, 2006; Edquist and Chaminade, 2006). The literature on systemic failures (Carlsson and Jacobsson, 1997; Norgren and Hauknes, 1999, Smith, 2000; Woolthuis, Lankhuizen, et al., 2005) refer to a variety of problems that the system might have and that require public intervention, such as infrastructure provision and investment problems, problems derived from the evolutionary nature of the system of innovation such as transition and lock‐in problems (Bruland and Mowery, 2005), problems with the different components of the system (institutions, networks, capabilities in organizations- including problems with

[2] It is important to note that the absence of an optimum implies that there is no clear “gap” that policy makers need to target as in the neoclassical theory. That is, policies can not be objectively defined against a clear (and measurable) target.

complementarity or diversity of capabilities), or, in general, with the functioning of the system like unbalanced exploration and exploitation mechanisms (March, 1991; Cyeter and March, 1963). Systemic problems can only be identified through the empirical analysis of the system, its specific trajectories and capabilities (Bell, 2002)[3].

Although most systemic problems can be found in both developed and developing countries, the scope and extent of the problems are rather different in both contexts. In developing countries, the vast majority of firms lack the minimum capabilities to engage in interactive learning and innovation (capability problems) and even when those capabilities exists, the linkages within the actors in the system of innovation are weak (network problems) and the institutional frameworks are ill developed (institutional problems) (Chaminade and Vang, 2006; Vang and Chaminade, 2006). Overall, in developing countries, the systems of innovation are often fragmented (Intarakumnerd, et al., 2002; Chaminade and Vang, 2006a and b; Vang, et al., forthcoming), with some parts of the system well developed but with most firms and other organizations with low capabilities and weak linkages with the strong elements of the system. In some countries and regions one can even talk about two separate and coexisting systems of innovation. One dominated by TNCs, indigenous global firms and world class universities, coexisting with a second one with a majority of firms with low absorptive capacity, weak linkages with other organizations in the system of innovation and low quality educational institutions (Vang, et al., forthcoming). The key issue is how to transform and develop those systems of innovation, targeting to the particular problems identified in the system but consistent with the resources, capabilities and opportunities available in the country. In this sense, as Martin has strongly argued, innovation system policies based on the right portfolio of instruments, play a fundamental role (Bell, 2002; Arnold, et al., 2002)

3. From Rationales to Instruments - Making the Right Choices

It follows from the previous discussion that taking a neoclassical stand to innovation policy as opposed to a system of innovation approach has important implications in terms of the rationales for public intervention in innovation policy. Following the neoclassical rationale, the emphasis of policy has been on promoting science (that is invention). Research policies

[3] For doing this, one can look at the functions or activities of the system of innovation (Carlsson and Jacobsson, 1997, Edquist, 2005)

are the policy paradigm for neoclassical rationales (Lundvall and Borras, 2004) while innovation policies would be the policy paradigm most closely related to the innovation system approach.

Taking one or the other approach to innovation policy has also important implications for the choices of instruments to be used in innovation policy. Metcalfe and Georghiou (1998) propose to distinguish between two large groups of instruments:

- those instruments focused on research capabilities, aimed at reducing the cost of R&D to encourage the exploitation of technological opportunities.
- those aimed at improving or increasing other capabilities of different organizations, such as technical, engineering or design and thus open up for the exploration of new technological opportunities.

The first group of instruments is clearly linked to the neoclassical approach, focusing on the incentives for research. By reducing the costs of R&D, policy makers might create incentives for research in firms (that otherwise, will underinvest in R&D due to the rival nature of knowledge). The second group is clearly closer to the system of innovation approach. It emphasizes not only the importance of capability building and the accumulation of other competences that are necessary to gradually move from a system of production to a system of innovation, but also the social nature of the innovative process, and focus the intervention in both increasing the capabilities of firms and creating the conditions for acquiring, adapting, using and exploiting knowledge (i.e. learning) within firms but also between firms and other organizations. If firms are at the core of the development of a system of innovation, the accumulation of engineering, technological and design capabilities is the key engine in this transformation, as Martin has repeatedly shown in all his seminal work. Table 1 summarizes the two approaches. It includes some examples of paradigmatic instruments under each of the two rationales for innovation policy[4].

As we argued in the previous section, the extent and scope of the systemic problems in less developed countries is rather different than those in developed countries. In LDCs the issue of capabilities is absolutely crucial and so are the linkages with external sources of knowledge due to the limited availability of resources domestically (Bell, 2002; Lundvall, et al., 2006). It follows that systemic policies, aiming at creating capabilities are more adequate than other policies targeting at exploiting existing capabilities (that is, R&D grants or R&D tax breaks) in this less developed countries (Intarakumnerd, et al., 2002).

[4] The list of instruments is only illustrative and by no means exhaustive.

Table 1: Examples of Paradigmatic Instruments under Each of the Two Rationales for Innovation Policy

	Neoclassical	Systems of Innovation
Problem/Rationale	Market failure rationale: Due to the non-rival nature of knowledge, firms will under-invest in innovation (invention)	System problems rationale: The system of innovation might not work effectively due to problems in the components of the system (organizations, institutions or relationships) or in its functioning (exploration/exploitation, lock-in, transition)
Policy Paradigm	Science and technology P policy	Science, technology and innovation policy
Focus	Research activities	Innovation activities, capabilities and networking
Solution	Policy makers should lower the costs of innovation (invention), facilitate the exploitation of existing knowledge, and strengthen capacities of knowledge creators (universities, public R&D institutes, human resource development)	Policy makers should intervene to solve those systemic problems, particularly supporting capability building of concerned actors, networking especially enhancing knowledge flows, and creating an adequate institutional framework facilitating collective learning of those actors.
Instruments	- R&D subsidies - R&D tax breaks - Technology demonstrators - Establishing government R&D institutes/centrescenters of excellence - Subsidies for production Science and technology manpower (e.g. scholarship of postgraduates in sciences)	- Training – active engagement in capacity building in firms - Networking programs (e.g. cluster policies, facilitating access to partners with complementary assets) - Facilitating access to foreign sources of technology and knowledge (e.g. coupling with TNCs) - Business services - StrenghteningStrengthening user-producer Interaction

Source: Based on Bell (2002), Metcalfe and Georghiu (1998) and Chaminade (1998).

However, consistent with Martin's findings, LDCs have traditionally been imitating policies from the developed world and focused much more on R&D incentives than on the capability building and networking policies that would be derived from the system of innovation approach. In the last years, we have witnessed the adoption of the IS approach in several less developed countries. One of the last ones to join this approach is been Thailand, in an attempt to move gradually from a strong research policy, focusing in investment in

research in universities and public research institutes (Bell, 2002) to a stronger focus on firms and firm capability building. Next section critically discusses the extent to which the innovation system approach has been adopted in practice and the problems of colliding rationales.

3. Towards Innovation System Policies in Ddeveloping Ccountries?: an Experience of Thailand

Thailand is a lower‐middle‐income country with the GNP per capital of approximately 2700 US$ in the year 2005 (‘Bank of Thailand’, n.d.). Economic performance of Thailand during the past 40 years has been moderately impressive with the growth rate of GDP around 7%. Like other Asian Newly Industrialised Economies (NIEs), namely Korea, Taiwan, Singapore and Hong Kong, Thai economic structure has also changed from an agriculture-based economy to an economy in which the industrial (manufacturing in particular) and service sectors have gained distinctive significance. Also, there was a change in the composition of Thai exports along the line of NIEs. The share of once-dominating resource-based and labour-intensive exports has gone down while that of science-based and differentiated exports have gone up especially in the 1990s (Intarakumnerd, 2006a).

3.1 Rationales for Government Intervention in Iinnovation in Thailand

Systemic innovation policy brings together a variety of policies that have traditionally been separated (education policy, industrial policy, etc). In this sense, innovation policy can be seen as a policy system itself, integrating traditionally individual and independent policies into a new systemic policy with new rationales, new instruments and new governance bodies. Adopting the IS approach implies the adoption of new rationales that might collide with former rationales. In other words, policy makers might adopt the system of innovation approach in their discourse while still using “market failure” arguments for allocating resources for innovation (Chaminade and Edquist, forthcoming). This is clearly the case of Thailand.

Up to the year 2001 before the government of Prime Minister Thaksin Shinawatra (January 2001-September 2006), Science and Technology policy in Thailand had three main characteristics: a) scope of S&T policies in Thailand was rather narrow and did not include the aspect of innovation, b) there was a dichotomy between S&T policy and economic policies, c) policies were mainly constrained by the neoclassical economic framework, that is,

government intervention was only allowed in the case of market failures. During the Thaksin Government, there were major changes. These will be discussed below in detail.

3.2 Scope of S&T Policies before the Thaksin Government: the Neoclassical Rationales

Policies to support innovation before Thaksin Government, in general, had a clear research bias. It covered only four conventional functions, namely, research and development, mainly in universities and public research institutes, human resource development in general (not targeting specific industrial needs), technology transfer from public research institutes to private companies , and general S&T infrastructure development. This narrow scope of S&T was very much based on the linear model of innovation concept that put research at the core of the innovation process. As Martin has acknowledged, private firms were almost absent from the policy (Bell, 2002) and regarded as only "users" of S&T knowledge mainly produced by government agencies and universities (Arnold, et al., 2000). Therefore, policy attention was paid on enhancing research capability of government R&D institutes and universities, whose outputs were believed to be easily transferred to private firms. There was no articulate national innovation policy, not to mention the incorporation of the system of innovation concept in policy content and process.

Though the word "innovation" was mentioned in several national plans, it was not whole‐heartedly incorporated into the scope of S&T policies (Lauridsen, 2002). In this regard, as Bell indicates, (2002) Thailand S&T policy had been almost unchanged since the 1960s and the linear model of innovation still predominately influenced the country's S&T policy formulation even up to the 1990s. One of the main reasons is that policy makers and opinion leaders who had major influences in S&T policy formulation were scientists (most of them being educated by prestigious universities in the West), who subscribed to the supply-push idea that gave highest priorities to research excellence (especially basic research) and S&T human resource development.

Scientists had their own 'science' agenda, and, given their societal respect and self esteem, they were, to a considerable extent, articulate and influential in 'high' policy making circle. They had very strong belief that the country needs strong scientific foundation, especially in research, to be able to progressively develop. As a consequence, the Thai S&T policy has traditionally given universities and research institutes a predominant role. This is obviously contrasting to Martin's long-standing defense of the role of firms in technological change and catch up and opposition for developing countries to use R&D as an indicator for technological progress in general. For him, technician, engineering and design skills are far more important

for catching up, technological progress and innovating from 'behind' the technology/R&D frontiers.

Outside the 'narrow' scope of S&T policy controlled by scientists, powerful neoclassical economists, many having Ph.D. from the US, in key economic ministries, especially Ministry of Finance and National Economic and Social Development Board, did not pay attention to policies aiming at increasing indigenous technological and innovative capabilities of firms in Thailand. For them, this would be automatically attained once the country's market reached an equilibrium, the so-called 'getting the price right'. They also opposed targeted industrial policies for specific industrial sectors because, in their view, this would lead to market distortion and rent-seeking behaviors.

3.3 Innovation Policy under the Thaksin Government- towards a System of Innovation Policy?

The major change in policy came recently under the Thaksin government. Media and academics in Thailand and the Southeast Asia labeled this government distinctive policy as "Thaksinomics" (Thaksin's Economics). Dual track policy was the main thrust of Thaksinomics. The government tried to enhance international competitiveness of the nation by strengthening 'external' side of the Thai economy, namely, export, foreign direct investment and tourism. At the same time, it attempted to increase capabilities of domestic and grass-root economies by implementing projects like Village Fund (one million Baht to increase local capabilities of each village), a three - year debt moratorium on farmers' debt, One Tambon3 One Product Project (supporting each Tambon to have product champion), and People Bank (giving loans to underprivileged people with no requirement of collateral). Some academics and politicians from opposition parties, however, branded these new grass - root supporting policies as 'populist policies' aiming at winning votes from the rural poor (Intarakumnerd, 2006a).

Furthermore, during the Thaksin government, the gap between science, technology and innovation policies and economic policies was reduced. Unlike its predecessors which paid most attention to macro-economic stability, this government focused more on enhancing meso- and micro-level foundations for international competitiveness. The high priority of 'competitiveness' issue on the government's agenda was illustrated by the establishment of National Competitiveness Committee chaired by the Prime Minister. Investment policy, for example, has substantially changed. The main trust of new investment policy was on the issues underlying long-term competitiveness of the country, namely, development of indigenous technological capability and human resources.

From an innovation policy perspective, importantly, the concept of system of innovation has been, to a certain degree, 'formally' adopted during this government. Building innovative capabilities of the nation was highly regarded as very important factor increasing and sustaining Thailand's international competitiveness. "Innovative nation with wisdom and learning base" was one of seven Thailand's Dreams projected by the government (Phasukavanich, 2003). The ten-year Science and Technology Strategic Plan (2004 - 2013) places the concept of national innovation system and industrial cluster at its heart. The scope of the plan is much broader than the aforementioned four functional areas. Measures to stimulate innovations and to strengthen national innovation system are explicitly highlighted. However, a closer look at the instruments that are being used, still shows that while there is a gradual move in the right direction, most of the instruments still respond to the old paradigm, focusing on giving incentives to research and focusing on the public sector rather than encouraging capability building and innovation in firms.

Table 2: Examples of Important Instruments of Thai Science, Technology and Innovation Policy

	Neoclassical	Systems of innovation
Instruments	• 200% tax concession for R&D expenditure • Accelerated depreciation for R&D machinery and equipment • Deduction/ exemption of R&D machinery import duties • Tax holidays for investment in R&D activities • Soft loans for Firms' R&D investment • Establishing seven centrescenters of excellence mainly for educating postgraduate research students	BOI's Skill, Technology, and Innovation Scheme[5] Industrial Technology Assistance Program (ITAP)[6] BOI's special tax concession scheme for hard disk drive and semiconductor clusters[7]

Sources: Derived from Turpin (2002) and National Science and Technology Policy Committee (2006).

Some measures aim at mitigating certain types of systemic problems. For example, to tackle infrastructure problems, more centers of excellence and better technical services such as testing, calibration, quality assurance and metrological system will be provided. To solve

[5] See details later in the text

[6] The ITAP program aims to find suitable consultants from aborad or domestic universities/research institutes to help firms' solves their production problems and enhance their internal technological and innovative capabilities. Up to fifty percent of the consultancy costs are publicly subsidised. The programme somewhat helps forging linkages between universities' professors and firms.

[7] This is a new scheme launched in 2004. It is for the first time that Thailand had incentive for particular clusters (beneficiaries being both final-good producers and components suppliers in the clusters)

the network problems, the Plan targets to establish knowledge intermediaries like science parks. To address institutional problems, the Plan focuses on expanding the scope of existing R&D tax incentives to cover design and engineering activities, improving intellectual property system and management, and reforming national science and technology management system (National Science and Technology Policy Committee, 2004). As a result, S&T policies were expanded to become Science, Technology and Innovation (STI) policies.

Special investment package promoting "Skill, Technology and Innovation" has been initiated. Firms can enjoy one or two years extra tax incentives if they perform the following activities in the first three years: spending on R&D or designing at least 1-2 percent of their sales, employing scientists or engineers with at least bachelors degree at least 5% of their workforce, spending on training of their employees at least one percent of their total payroll, and spending at least one percent of total payroll on training personnel of their local suppliers.

However, with the exception of these few cases, the implementation of changes initiated in the Thaksin era is far from being successful:

- Though there were introduction of new thinking paradigm in favour of system of innovation approach at the top level of policy making process, the middle and bottom levels were, to a large extent, locked in the old paradigm. Many senior policy makers in STI policies are still the same old group of scientists or their successors who strongly believe in the linear model of innovation. They might have been introduced to the new concept and start to use new terms like 'innovation systems', 'clusters', 'innovation networks', 'linkages' and so forth, nonetheless, when they involves in the STI policy making, they still put emphasis on research and development within public research institutes and universities and exploit 'existing' research capabilities and outputs to solve the problem of private firms, which are still mainly regarded as 'users' of knowledge and technologies (Intarakumnerd, 2006b).
- Policy measures to enhance technological and innovative capabilities of firms and to solve systemic failures such as creating intermediaries, linkages, and institutional context (for instance, conducive intellectual property regime, trust, entrepreneurship) were given much less priority and resources. For example, total R&D expenditure by the public sector (including government agencies, public research institutes and universities) was around 262 million US$ (NSTDA, 2006). On one project basis, investment to build seven centres of excellence mostly for providing S&T manpower at the postgraduate level was approximately 22 million US$ per year (Office of Higher Education Commission, 2006). On the other hand, the public subsidy for paying private firms' consultancy fees of the ITAP programme, one of the most outstanding programmes to enhance technological

capabilities of private firms and mitigating systemic failures, was only less than one million US$[8] per year (Suprattaraprateep, 2007).

- At the same time, for many government officials in economic ministries, neo‐classical economic paradigm still primarily directs the rationales for government intervention. Initiatives to solved systemic failures, such as providing needed grants to help private firms increase their technological capabilities, were opposed on the ground of market distortion (and inducing corruption).

4. Conclusion and Policy Implications

In the last few years, a growing number of developing countries have adopted the system of innovation approach officially to formulate their innovation policies. This is the case even for the group of the so-called 'less-successful developing countries', with weak and fragmented innovation systems which, as Martin highlights, has lead to failures in technological catching up with forerunners countries (Arnold, et al., 2000; Bell, 2002). Thailand is one of them. By adopting this approach, it has been successful in broadening the scope of its science and technology policy to cover 'innovation' and started to have selective intervention policies for particular sectors/clusters. Nonetheless it faced several hurdles in carrying out policies into practice: deep-rooted weakness and fragmentation of its innovation system (e.g. poor linkages among government agencies and between them and other actors), lack of clear and shared vision of policies, lack of supporting institutions such as Shumpeterian entrepreneurship and trust, and, most importantly, path dependency and inertia in policy formulation process due to the problem of locking in old paradigms. The result is a policy that although is moving in the right direction and focusing on the right problems hardly addresses the identified systemic problems in practice. System of innovation approach is like an icing on the cake which main ingredients are neoclassical economics and linear model of innovation.

This paper, therefore, suggests that while IS might have been 'officially' adopted by less-successful developing countries, the practice still follows old innovation paradigms and barely addresses systemic problems. The situation at present has not changed much from what had been described in the pioneering works on Thailand's science, technology and innovation by Martin Bell. Policy implications are obvious. Less successful developing countries are

[8] The conversion to the US$ here is based on the historical data of exchange rates of the Bank of Thailand available at http://www.bot.or.th/bothomepage/databank/EconData/EconFinance/Download/Tab89.xls

facing two problems at the same time. Their innovation systems are weaker and more fragmented than those of the forerunner countries. There are greater systemic problems to be solved and much more effort is needed. At the same time, introducing system of innovation approach in these countries is also more problematic. The problems of uncertainty, selectivity, policy path dependency and inertia are much severe than those of the forerunners.

Here, we propose two-sided policy recommendations. On the one hand, there is an urgency to educate policy makers and mainstream academics about the limits of the old paradigms (for example, linear model of innovation and neo-classical economics approach in the Thai case). This will take quite a long time since, as Martin points out, their mindsets are very much preoccupied with deep-rooted old concepts (Arnold, et al., 2000). Training courses, lectures and seminars in system of innovation approach should be organised, not only for the high-level policy makers but also the middle- and lower-level policy practitioners as well as people who are key actors in the systems such as people from the private sector and academics. The educational activities should be carried out at national, sectoral and regional levels. One the other hand, after a 'certain degree' of capacity in formulating and implementing policy measures along the line of system of innovation approach has been achieved, attempts should be made to solve vivid systemic problems of certain national, sectoral and regional innovation systems. Selected small projects might be a good start. If they are successful, it will create demonstration effects and confidence among policy makers and concerned parties.

These two policy recommendations should not be totally stepwise, as developing countries have urgent problems to be addressed and they cannot wait until capacity in handing system of innovation approach is fully developed. Instead, implementation of the two recommendations should go hand in hand, as they would mutually strengthen each other. To carry out these two recommendations, an organisation similar to Sweden's VINNOVA specifically created to develop effective innovation systems, is needed (VINNOVA, 2001; 2002). This organisation might be a semi-governmental organisation with high flexibility and autonomy but well-equipped with high-calibre people capable enough to make this organisation a promoter of system of innovation approach.

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