

A Survey of Innovation Policies in Developing Countries: Lessons and Case Studies

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Introduction

The purpose of this paper is to review literature on policies that target innovation performance in developing countries. Ideally, innovation policies should be based on empirically supported theories of innovation. However, the innovation process is still not well understood, Edquist (2005). In particular, its systemic character, which points to the importance of strong linkages among actors, remains unclear. Notwithstanding the recognized importance of innovation, this lacuna in literature has resulted in two competing views with regard to policy prescription in developing countries. One approach advocates accumulation by obtaining superior technology without further effort (Krugman 1994; Young 1995). The other stresses learning through engagement in innovative activities that provide a basis for knowledge absorption (Hobday 1995; Stiglitz 1996; Kim 1997; Nelson and Pack 1999).

Although both the accumulation and absorption views agree on the relevance of a suitable macroeconomic environment (fiscal, monetary, and exchange rate policies), the latter view argues that getting the prices right is not the *sine qua non* of economic performance: successful entrepreneurship requires policy intervention that nurtures learning with the aim of upgrading technological capabilities and infrastructure (Katz 1987; Lall and Pietrobelli 2002). The absorption view embraces the systemic character of innovation, despite the fuzziness that surrounds it, contrary to the stance of altogether obfuscating the innovation process in favour of crisp mathematical models. This literature review is based on the absorption view.

Innovation literature argues that the central concern of developing countries is the absorption and adaptation of the backlog of existing knowledge with the long-term goal of gaining technological independence by developing their own path of technological development (path-creating catching-up) (Gerschenkron 1962; Fagerberg and Godhino 2005). This has remained a daunting challenge for the vast majority of developing countries (Abramovitz 1986). However, the outstanding innovation performance of a few developing countries suggests that policy plays a central role in the innovation process (Nelson and Pack 1999; Chang 2002).

Although an inadequate understanding of the innovation process may blur vision in innovation-policy prescription, innovation literature recognizes the central role of feedback mechanisms that underlie the dynamics of innovation. It emphasizes that policy plays a significant role because it may either facilitate or inhibit innovative activities through its impact on learning and innovation. The finding that the innovation performance of firms strongly depends on the synergies and linkages in the local environment — firms do not learn and innovate in isolation — offers insight into the importance of interactions among firms, governments, and research institutes in the innovation process.¹

Interactions among firms, governments, and research institutes provide feedback mechanisms that involve learning, which determines the level of innovative activities (Rosenberg 1982; Lundvall 1992). Emphasis is placed on enhancing the learning process rather than on providing the “right” economic incentives (notably patents). Learning within the context of an innovation process consists of an interactive process that reflects the strength of the interrelationships

¹ The idea of local knowledge production and diffusion can be traced back to Marshall (1923) who recognized the local character of knowledge as being at the core of understanding economic dynamics, because it involves strong feedback mechanisms.

among different sectors, institutions, and agents, including firms, training institutes, universities, customers, and supplier. Indeed, it is the interconnectedness among sectors, institutions, and agents that facilitates innovative activities: it allows firms to learn about new opportunities and to engage in the innovation process.

Innovation leads to improved competitiveness and is a major explanation of why growth rates at the firm, regional, or national level differ (Fagerberg and Verspagen 2002). This view is progressively gaining favour from researchers of innovation in developing countries, particularly with the increased though patchy recognition that innovation is not an exclusively industrialized country affair. Innovation takes place mainly in firms, and their ability to learn provides them with the capacity to cope with change and remain competitive. The competitive advantage of a firm lies in the ease and speed with which it adjusts to rapid changes, through its ability to create, manage, distribute, and exploit knowledge (Cohen and Levinthal 1989). Competence building is a central element in the use of “new” technology because it is to a large extent composed of tacit knowledge. At the economy-wide level this translates into the capacity of an economy to shift into a knowledge-based economy and to continuously adjust so as to remain competitive. The importance of an innovation policy underpins the fact that an economy cannot stimulate competitiveness if innovation is lacking. Innovation is concerned with enhancing the competitive performance of economies.

Innovation performance in developing countries

Existing literature on innovation performance in developing offers some understanding of policy requirements for promoting the innovation process. Policies vary depending on the level of innovation performance across economies and time. Innovation policies in developing countries are generally geared toward incremental knowledge rather than innovating at the technology frontier: they target the acquisition of technological capabilities that allow developing economies to benefit from the existing backlog of knowledge. Nevertheless, the long-term goal is to progressively move up the technology ladder through a virtuous interactive and cumulative process that links foreign knowledge to domestic knowledge production.

To a large extent, differences in economic performance reflect differences in innovation performance. They mirror the more or less dynamic capabilities of an economy to provide an economic environment that allows entrepreneurs to identify and take full advantage of opportunities that arise from technological transformations. In Asia, for example, developing economies have been grouped in first tier (Hong Kong, Singapore, South Korea, and Taiwan) and second tier (Indonesia, Malaysia, and Thailand) newly industrializing economies, and a group of followers (China, India, Philippines, and Vietnam). These categories mirror the innovation dynamism of the economies. Innovation opportunities are important because they boost innovative activities that lead to improved competitiveness. However, innovative activities bear an inherent component of unpredictability. Innovation policy, therefore, is required to promote awareness of innovation investment opportunities, and ensures the existence of complementary assets for successful innovation. In an environment that is clouded by strong uncertainty, it is the capacity of an entrepreneur to identify opportunities and to make accurate evaluations that determines whether the entrepreneur will remain competitive or be forced out of the market. This capacity is strongly embedded in the learning process: it depends on capabilities for identification and realization. Innovation policy supports entrepreneurship by targeting

competence building (both in training institutes and firms) and the introduction and diffusion of innovation (Edquist 2005).

Innovation policies may be categorized with regard to whether they are general or specific (targeting sectors, technologies, firms, or projects) or horizontal or vertical policies (Lall and Teubal 1998; Metcalfe 2000). Vertical policies may be seen as efforts to steer an economy into technologically progressive sectors, i.e., sectors with higher growth potential. Horizontal policies encourage the realization of technological benefits through the creation of innovation systems that enhance learning and innovation. They address system failures that arise when competence building along with identification, use, and diffusion of knowledge is hindered by the absence of appropriate technological capabilities and networks. The importance of this systems perspective lies in the recognition of the role of networks to enhance feedback effects in the innovation process (Lundvall 1992; Nelson 1993). From a general perspective, innovation policies are government efforts to encourage the generation, use, and diffusion of new knowledge. It is noteworthy that innovation policies require clear coordination with science, technology, competition, and industrial policies if they are expected to enhance the innovation performance.

Figure 1 plots the average annual GDP per capita growth for 1990–2004 against average GDP per capita income over the same period for a sample of 77 developing countries. The figure depicts variance in economic performance — with poorer countries experiencing greater variance. The immediate question then is: why do growth rates of some groups of countries vary so much? This simple analysis, which uses averages over 15 years, is not intended to mask the great variation that occurs over shorter periods, particularly for the poorer countries (Table 1).

Figure 1: GDP per capita growth (% annual) against GDP per capita, PPP (constant 2000 international dollars) (World Development Indicators 2002).

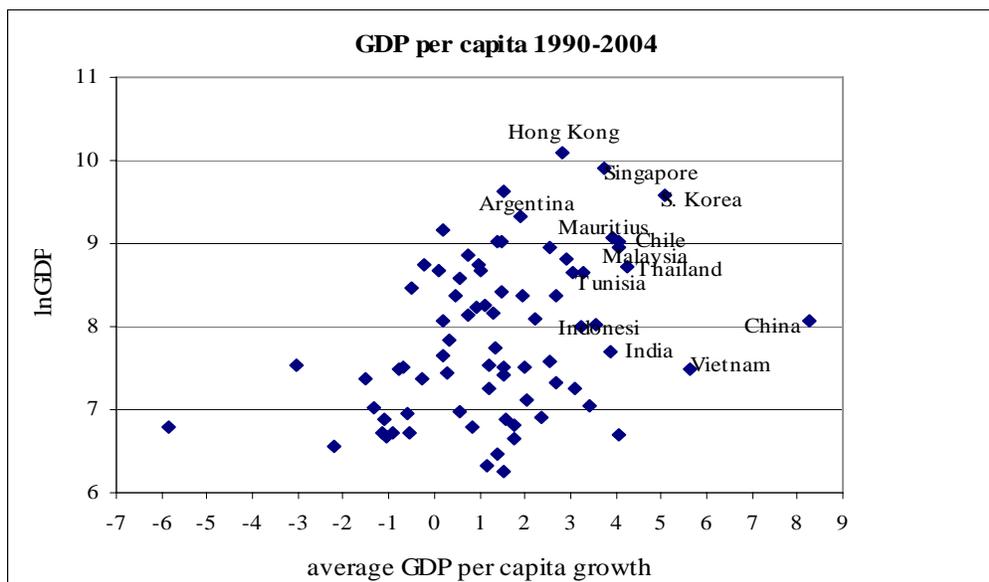


Table 1: Average GDP per capita growth rates (World Development Indicators 2002).

Country	1990–1994	1995–1999
Argentina	-8.48	5.13
Kenya	6.23	0.29
Senegal	-9.27	7.98
Togo	7.61	0.87
Tunisia	-3.22	3.18

The high variability of growth rates observed mainly in economies that perform poorly may be partly attributed to the innovation policies pursued in these countries or the sheer absence of innovation policies. Innovation policymaking is guided by indicators that may be termed “innovation indicators.” These include a selection of appropriate variables and the construction of data that reflect the innovation efforts of an economy. Table 2 compares some of the innovation indicators of a group of developing economies with relatively good innovation performance.

Table 2: Indicators of innovation (World Development Indicators 2002).

	Brazil	China	Hong Kong	India	Indonesia	South Korea	Malaysia	Singapore
R&D expenditure (% of GDP) 2000	1.04	1.00	0.48	0.85	n/a	2.39	0.49	1.91
R&D exp (% of GDP) 1996-2000 average	0.92	0.76	0.46	0.63	n/a	2.38	0.28	1.69
Researchers in R&D (per million people) 2000	324	550	1159	n/a	n/a	2305	276	4140
Total patents in 2000*	102	157	168	141	6	3332	44	226
Total patents 1996-2000 average*	80	97	133	88	5	2713	25	136
School enrolment, tertiary (% gross) 2002	20.57	15.79	30.79	11.92	16.39	84.73	29.26	n/a
Scientific and technical journal articles in 2000	6195	18142	n/a	1004	165	9386	470	2301
High-tech exports (% of manufacturing exports) 2000	18.61	18.58	23.28	5.01	16.16	34.82	59.53	62.56
ICT expenditure (% of GDP) 2000	5.55	4.10	7.18	3.62	2.52	6.84	7.47	9.86

* indicators from OECD database based on USPTO.

A comparison between South Korea on one hand, and Brazil and China on the other hand (countries whose data is available for all our variables) in table 2 above, reveals that although South Korea’s expenditure on R&D is relatively high, Brazil and China also spend a sizeable percentage of GDP on R&D. However, South Korea’s R&D efforts appear to be strongly supported by technological competences as indicated by the number of researchers in R&D, as well as the tertiary school enrolment. Arguably, the high-tech export performance coupled with the competitive performance of the countries provide a robust sign of the importance innovation policies in enhancing innovation performance, particularly with regard to creating policy coordination.

Case studies and lessons from developing countries

This section reviews case studies of economies based on a characterization of the technological trajectory. Kim and Dahlman (1992) refer to three stages of technology acquisition within a developing economy: in the early stage economies acquire mature foreign technologies that essentially involves assembly operations; the second stage is the consolidation of technology that takes place through a first step of duplicative imitation followed by creative imitation, which relies on enhanced local technological capabilities and infrastructure; the final stage involves generation of emerging technologies. The progressive advancement from one stage to the next involves building a competitive advantage.

The advantage of the technological trajectory approach is that it takes account of the evolutionary and path-dependent nature of technology acquisition. A different set of innovation policies is required for different stages of technological evolution. Innovation strategies vary across economies depending on a wide range of factors, including time, geography, natural endowments, and natural disasters, which go beyond a stage of development. Different strategies pursued by economies in the same stage of development have been shown to be equally efficient in propelling innovation performance. Although the approach may not explicitly depict innovation strategies, which are the central concern of this literature review, it may reveal the inevitability of designing environment specific policies that support the development of technological capabilities and infrastructure. The central role of economy tailored policies is indubitable as will be illustrated by a review of the development of selected developing economies that benefited from relatively good innovation performance. The aim is to trace technological progress through different stages in an attempt to capture aspects that have induced innovative activities, including capability building, enhancement of knowledge demand, specialization in targeted sectors, and creation of synergies and linkages.

South Korea

Initially South Korea's strategies consisted of promoting import substitution industries. It then progressively shifted to export-oriented industries in the 1960s and 1970s. The domestic market was protected from foreign competition by a range of protective measures including export subsidies of capital intensive goods. Large industrial conglomerates (chaebols) were supported by the government to pursue targeted industries to secure export products and expand production capacities. Acquisition of foreign technology was essentially through imports of high-technology capital goods for efficient assembly of final export products. At this point, learning took place mainly through reverse engineering that was supported by existing high levels of education and posting of nationals overseas. Demand for domestic knowledge did not exist and domestic research was not pursued before it became necessary to move from the low road to the high road.

The next stage of development ushered in aggressive measures to boost the knowledge demanded by shifting focus to knowledge-intensive intermediate technologies. The large corporations (chaebols) were encouraged to engage in domestic R&D to further develop domestic technological capabilities. The government steered firms to targeted technology sectors through preferential arrangements and created demand for indigenous technological innovations through public procurement. This involved the creation of specialized public R&D institutes, and tapped into international human resources and expanded and deepened research institutes. Acquisition of foreign knowledge took place through FDI, licensing, and outward R&D. The

development of strong OEM (original equipment manufacturing) relationships established synergies and linkages with foreign firms that provided an important source of learning and access to foreign markets. Although aggressive competition among chaebol groups existed, mainly due to the cross-financing mechanisms among chaebol affiliated companies, it encouraged expansion rather than technology deepening, and therefore delayed progress in the development of technological capabilities (Sakakibara and Cho 2002).

Taiwan

Taiwan's industry is made up of a large number of small and medium-sized enterprises (SMEs) that began to develop rapidly during the import substitution period of the 1950s, and served mainly the domestic market. These enterprises exploited and benefited from low-cost labour advantages that were initially based on the agricultural industry before engaging in original equipment manufacturing (OEM). The SMEs relied on the cheap and high-quality skills that were complemented by managerial skills of Taiwanese working abroad. Tight networks based on family and personal connection characterize the SMEs, and these strong links played a significant role in accessing foreign markets and benefiting from foreign skills and capabilities.

The indigenous technological learning process was propelled by high-quality skills: Taiwan's relatively small pool of talent and the high ratio of scientific and technical skills encouraged the economy to progress into higher-value added activities. However, one of the main limitations of SMEs is their inability to engage in R&D activities particularly in high-tech industries. Technological deepening in Taiwan called for aggressive government intervention in the 1980s. Joint university–industry research was encouraged through various measures that include the creation of the Hsinchu Science-Based Industrial Park (HSIP), the leveraging of foreign technology in government-sponsored research institutes (Industrial Technology Research Institute — ITRI), tax incentives for R&D activities, and access to venture capital. Personnel training and mobility between research institutes and enterprises was strongly promoted to counter the problem of a small pool of talent.

Collaborative innovation efforts in the form of R&D alliances are driven by technological learning and upgrading, which has tapped into the flexibility and adaptability of the SMEs and the tight networks that connect them to foreign markets. Successes of the public–private innovation alliances that include personal computers, data switches, and automotive engines are based on the strong links between the SMEs and ITRI, which facilitate rapid assimilation, development, and diffusion of core technologies from abroad in an increasingly focused manner. Figure 2 describes the origins R&D alliances in Taiwan.

Figure 2: Taiwan's R&D consortia (Mathews 2002).

“Like Taiwan's industrial upgrading efforts more generally, the R&D alliances are the fruit of experimentation and some early failures... The new crop of R&D consortia trace their origins to a series of “multi-client projects” initiated by ITRI in the early 1980s, oriented towards stimulating a personal computer (PC) industry in Taiwan. Taiwan had missed out completely in mainframe and mini-computers. But in the early 1980s, computer engineers in ITRI's electronics laboratory (ERSO) were highly aware of the possibilities in the new PC sector, based on the emergence of firms in Taiwan in microprocessor-based product areas... The catalyst was IBM's introduction of its successful PC based on an open architecture, paving the way to “IBM-compatible” machines. This created an opportunity which Taiwan firms, led by the youthful Acer, were quick to seize.

However, the Taiwan firms lacked basic PC technology, and turned to ITRI for support. At that time the norm was for ITRI to develop new technologies and then advertise their availability to existing firms; or to develop the technology and then spin it off into a new firm (as done with the first semiconductor firm, UMC, in 1980). An alternative was to perform contract work for individual companies, sometimes merging into co-development work. A standard contractual agreement for the development of a PC was signed between the company Acer (then Multitech) and ITRI/ERSO—but at the insistence of the Ministry of Economic Affairs, which saw the potential for many Taiwan firms to become involved in this emerging industry, the project was extended to become a “multi-client project” thereby bringing in other firms as well. This was the organizational prototype of the R&D consortium. The idea was to seed an industry rather than provide assistance to a single firm. This initial effort had partial success, in developing a generic product standardized around certain core components—but it was too late for the market, and was plagued at the time by intellectual property rights disputes.

The next chance came with IBM’s announcement of the powerful new PC AT system in August 1984, which again featured open architecture and by now standardized components, such as DOS operating system and Intel 286 microprocessor. This was a technological leap that was eminently suited for Taiwan’s fledgling PC firms, and for technological imitation through the institutional vehicle of ERSO’s multi-client project. No sooner was IBM’s new machine announced than ERSO moved to establish a new multi-client project to develop a Taiwan version of the PC AT, in October 1984. Three companies were enrolled as participants... Formal contracts were signed in December 1984. A prototype machine was transferred to the companies by July 1985, less than a year after IBM’s announcement, and brought to market by the firms involved shortly thereafter. This project was considered a great success, in terms of the technology development and transfer, in terms of compliance with all intellectual property requirements (an important development for the Taiwan PC industry), and in terms of the business subsequently generated for the participant firms, all of which became leaders in the Taiwan IT industry.

The stage was now set for ITRI, and its newly established Computing and Communications Laboratory (CCL), to take the next step in upgrading Taiwan’s technological capabilities beyond the simplest PCs. Formal consortia were established in product areas such as laptop PCs, workstations and high-end servers. But the experience which was decisive in shaping the organizational form of future consortia was that of the Notebook PC consortium, which ran for a year and a half, from 1990 to 1991.”

Brazil

Brazil started off in the 1950s with strong inward looking policies that were aimed at the development of internal markets for domestically developed technologies. The government policies based on import substitution led to the development of considerable industrial potential in the 1950s and 60s. The Brazilian National Research Council (CNPq) was set up in 1951 to promote research. Nevertheless, the domestically developed technologies depended on second-rate complementary foreign technology and resulted in adverse effects: the economy became increasingly dependent on foreign technology and stood no chance of developing competitive technologies.

The first basic plan of science and technology development (1973–1974) increased the volume of resources attributed to technological development, and although industrial growth accelerated in the 1970s, the plan lacked niche strategies and did not focus on developing learning capabilities. In fact, Brazil’s capability building strategies lacked coherency and alternated between “populist” and “elitist” aspirations. The second plan (1975–1979) attempted to fill the gaps by setting priority areas and focusing on competence building. However, the considerable domestic industrial potential continued to erode as an increasing proportion of the industrial sectors, particularly the more sophisticated ones, shifted to the hands of foreign owners. The third plan (1980–1985) attempted to strengthen technological capabilities of domestic firms despite the difficulties that resulted from deep financial problems. Technology policies of the 1990s have attempted to develop indigenous technological capabilities by, for example, encouraging private firms to benefit from privatized telecoms R&D institute (CPqD).

Although, on the whole, innovation policies in Brazil have been tainted by the view that targeting specific industries would be insufficient because of the linkages and feedback effects of firms and industries, a few targeted sectors have been rather successful. A case in point is the telecom research institute that has been able to develop and export fibre optic and digital exchange related technologies. Brazil is the most technologically advanced economy in the region and is an interesting case, particularly with regard to the diversity of its industrial arrangements: small- and medium-sized enterprises specializing mainly in footwear and apparel, large firms in the automobile and aircraft industry, and public companies in activities such as telecoms. Figure 3 summarizes university–industry relations in Brazil.

Figure 3: University–industry relations in Brazil (Etzkowitz and Brisolla 1999).

[Under the second basic plan for S&T a science park was established at Campinas close to the State University of Campinas (UNICAMP). The initial challenge was to induce existing R&D laboratories to relocate to the park.]

“The R&D centre of Telebras (Brazilian Telecommunications) was established neabyr UNICAMP and the university developed both optic fibre technology and semiconductor lasers for telecommunications development by the CPqD (R&D centre of telebras). Brazilian S&T policy focused on the supply side, linking research universities to the government effort in building national capability in some strategic technologies such as telecommunications.

In 1978 UNICAMP was the first Brazilian academic institution to establish an incubator project, the Technological Development Company (CODETEC). CODETEC was to act as an intermediary between university and industry; translating academic research into new products... By the end of the 1970s and beginning of the 1980s, however, the Brazilian economy was in deep recession. Despite the difficulty in obtaining support for research in these difficult financial circumstances, certain specific initiatives have been successful at UNICAMP. The most successful joint efforts both inside and outside CODETEC involved long-term collaboration between the university and state-owned companies, since projects with private industry tended to be less costly shorter term projects.” [Deep financial problems forced CODETEC to find a niche in the chemicals and pharmaceutical industries that consisted in developing products for firms through reverse engineering. After the economy was opened up CODETEC was forced to focus on specific areas and pay more attention to innovation to remain competitive.]

Chile

The Chilean economy focuses mainly on traditional activities including forestry (pulp and paper industry), aquaculture (salmon production), and agriculture (wine industry). It has to a large extent benefited from the highly skilled labour that was created during the import substitution period that began in the 1940s. It was also supported by the government mainly though the Corporacion de Fomento de la Produccion (CORFO), which was established in 1939 to promote production. In the mid-1970s the government engaged in massive efforts to expand and diversify exports: in 1971, Chilean National Council for Science and Technology (CONICYT) was made responsible for promoting scientific and technological research in Chile. The government also made major investments in acquiring information on foreign markets and creating networks between domestic and foreign firms and research institutes.

Chile has been very successful in production expansion and export promotion, particularly in salmon farming. However, the main challenge is now that of developing indigenous technologies. The level of innovation is low and depends mainly on government funds, but the

Chilean government has thus far supported mainly broad science policies. Chile is dominated by small- and medium-size firms that have focused on adaptation of superior technologies rather than innovation. In addition, SMEs engaged in industry are a minority — most of them are in the commercial sector. The increasing need to innovate has led to an increase in large enterprises, particularly in the 1990s, mainly due to the difficulty of securing innovation related credit. CORFO launched a programme in 1991 (Proyectos de Fomento) to support SMEs through credit facilities for technology upgrading and to encourage collaboration among firms. A more recent initiative, Innova Chile (2005) promotes private-innovation business start-ups in identified areas such as biotechnology, ICTs, and agribusiness.

Shortage of skilled labour is increasingly hampering innovation, although there are efforts to increase tertiary education — universities and technology institutes benefit from government funding. An example of such a technology institution is the Fundacion Chile, a private and not-for-profit institute, established in 1976 to improve competitiveness through enhanced innovation by an agreement between the government of Chile and the International Telephone and the U.S Telegraph Corporation (ITT). The institute has been successful in developing new technologies for export products and launching new firms, particularly in the salmon export industry that was underdeveloped in the early 1970s, although it has also experienced failures. The weak linkages between business and research institutes also pose a major challenge in the development of indigenous technology for the production of more sophisticated goods. Figure 4 summarizes the case of salmon farming in Chile.

Figure 4: Salmon farming in Chile (Katz 2004).

“The case of Salmon farming industry in Chile has shown that dynamic trajectories of [an industry from inception to maturity as a result of new product introduction, imitation, entry of new firms, learning processes and an eventual plateau of technological obsolescence, with a significant fall in profit margins] are not restricted to high-tech sectors and developed economies, as the early product cycle literature assumed. These evolutionary trajectories can also play a major role in shaping up dynamic comparative advantages of natural resource based sectors of the developing nations.

In the early 1970s, Chilean salmon industry was small and essentially underdeveloped. Chile was not a player in the international salmon market... In the foundation stage, the industry was dominated by public sector firms, foreign companies and a number of small and medium size local firms. The Government had a catalytic role in the industry’s development. However, as more firms began to enter the market, the Government assumed the role of regulator and coordinator.

A large number of small and medium size Chilean salmon farming companies entered the salmon farming market in the 1980’s... The firms often pooled their resources and coordinated their activities to benefit from economies of scale. A majority of these firms were family undertakings. As the companies expanded, they developed new technology, intermediate inputs and production and marketing techniques.

In the second half of the 1990’s, the Chilean salmon farming sector evolved into a mature’ oligopoly... There was also considerable vertical and horizontal integration of firms... In other words, the search for economies of scale and unit cost reductions, brought about by stronger international competition, induced many Chilean salmon farming companies to introduce major changes in technology and production organization in the 1990’s. These developments brought the industry closer to the world standards for process technology and product quality... A significant number of small and medium size companies abandoned the industry during the 1990’s. Lack of adequate sources of finance as well as the production know how and technological expertise needed truly to become global competitors, induced many family owned firms either to exit the industry or to sell off their production facilities to large salmon farming MNCs in recent years. The number of Chilean salmon farming firms declined from 65 in 1994 to 35 in 1999... The new consolidated companies are still playing a

major role in the international market. Chilean salmon farming sector presently controls over 50% of installed capacity. An important outcome of this has been the development of ancillary industry. Intermediate inputs are available locally now. Firms providing services like transportation, software design, equipment maintenance, training, veterinarians and legal counsel have also developed locally.

The Government has acted as facilitator, coordinator, promoter, regulator and educator in different stages of development. In the beginning, Government acted as a catalyst by creating ideal condition for companies to enter the market. This was done through the contracts with US Peace Corps and the Japanese market. CORFO (Corporacion de Fomento) and Fundacion Chile started one of the first salmon farming firms in the country... In spite of its rapid recent expansion, and of its growing degree of technological sophistication, Chilean salmon farming activities still continue to be mostly based on imported machinery and equipment and 'disembodied' know how, marginally supplemented by ad hoc knowledge generation and adaptation efforts carried out locally by salmon farming salmon farming industry, but it has not so far developed a similarly strong domestic scientific and technological infrastructure, nor a strong capital goods industry, serving the sector."

Malaysia

Malaysia has pursued a policy that combines government intervention and foreign direct investment. In the initial phase the economy relied on exports of natural resources such as rubber and palm oil, while it focused on import substitution policies to develop an industrial base that mainly consisted of packaging and assembly. Aggressive government efforts to attract FDI in manufacturing during the import substitution policies went as far as not discriminating against foreign capital in all manufacturing industries. Manufacturing industries were subsequently dominated by FDI. The availability of cheap labour supported the production of manufactured products and the economy was able to make a rapid transition from agriculture to manufacturing.

During the 1970s to mid 1980s, policies based on social tension led to the creation of public enterprises that were aggressively supported by the government through finance and procurement policies. These efforts were pushed further and led to the creation of the Heavy Industries Corporations of Malaysia that targeted capital-intensive projects and were intended for the diversification of the manufacturing sector. This led to a further expansion of the industrial base. In addition, there have been efforts to create domestic and foreign linkages, encourage FDI into higher value-added activities, and promote SMEs through, for example, the creation of technology parks and development zones. However, the base of technical skills has not expanded sufficiently, and although one of the government's main aims from the late 1980s was to expand them, shortage of technical skills remains a major obstacle to technology upgrading.

Although FDI policies in Malaysia were instrumental in creating a vibrant electronics industry, which is the main driver of export-led growth, they have failed to create the possibility of technology acquisition in local enterprises. Reliance on FDI for structural upgrading is not visionary and the government is actively promoting other avenues of acquiring foreign technology, including encourage firms to engage in original equipment manufacture (OEM), joint ventures, and acquisition of foreign companies. There have been a few cases of indigenous firms such as Globtronics that have been successful in taking advantaged of government efforts, and have managed to upgrade technological capabilities through international alliances and joint ventures.

Concluding remarks

Notwithstanding the fuzzy understanding of the innovation process, the role of innovation in economic development is central. Coherent and well-design innovation policies that account for

specificities of an economy are necessary for the generation of innovation activities and opportunities that induce technological growth. The case studies have demonstrated the importance of flexible and anticipatory innovation policies that target up-grading of technological capabilities and capacities with the long-term goal of gaining technological independence.

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