BENCHMARKING EVALUATION OF NATIONAL INNOVATION POLICY IMPLEMENTATION

Grace Tyng Ruu Lin, Yung-Chi Shen, Hsiao-Cheng Yu, and Chia-Chi Sun

ABSTRACT

As small island countries, both Taiwan and Ireland have been regarded as locations that have performed economic miracles. Growing from agricultural economies to major regional players, both have often been studied as examples of national development and innovation. Therefore, this study seeks to compare the innovation policy in national contexts. The comparison of respective innovation policies on supply, environmental, and demand sides with a more elaborated classification base shows that the Taiwanese government adopts a more active top-down approach, making use of substantial levels of government research funding and resources to develop target industries. In contrast to this is the bottom-up approach of the Irish government that focuses more on creating an innovation environment and lifting firm-level research and development (R&D). Policy implications and suggestions are also given based on a number of similarities and contrasts identified in this research.

Grace Tyng Ruu Lin has been a faculty member (Assistant Professor) of Institute of Management of Technology, National Chiao Tung University, Taiwan since 2005. She earned her PhD from Judge Business School, Cambridge University in the end of 2003 and has some publication in Journal of Business Ethics, Sustainable Development, the Developing Economies, and Technovation. Her research interests involve innovation policy, development studies, value based management, and technology management.

Yung-Chi Shen is currently a Ph.D. candidate at the Institute of Management of Technology, National Chiao Tung University, Taiwan. He received his B.S. degree in international business management from National Chi Nan University, Taiwan, in 2004, and his MS degree in industrial education and technology from National Changhua University of Education, Taiwan, in 2007. His current research interests involve innovation policy, patent analysis, technology management, and industrial marketing.

Hsiao-Cheng Yu received his B.S. degree in electronic engineering from Chung-Yuan University, Taiwan, in 1972, and his Ph.D. degree in Industrial & Systems Engineering from Georgia Institute of Technology, Atlanta, Georgia in 1981. He was a telecommunications consultant with Contel Information System from 1981 to 1985. He then joined AT&T Bell Labs as a system engineer from 1985 to 1992. He is currently a professor in the Institute of Technology Management, Chiao-Tung University, Taiwan. His current research interests include regulations, policies, and business strategies in Internet and telecommunications.

Chia-Chi Sun is currently a Ph. D. candidate at the Institute of Management of Technology, National Chiao Tung University, Taiwan. He received the B.S. degree in International Business Management from Da-Yeh University, Taiwan, in 2004 and the MBA degree in Business Administration from National ChungHua University of Education in 2006, respectively. His research interests include management of technology, innovation policy, industrial analysis.

INTRODUCTION

As small island countries[1], both Taiwan and Ireland have been regarded as locations that have performed economic miracles; one, Taiwan, was part of high growth "Asian Tiger" economies that included Hong Kong, Singapore, Taiwan, and Korea. The other gained the nickname the "Celtic Tiger" as its sudden economic rise during the 1990s mirrored the growth of the Asian Tigers during the 1980s. Growing from agricultural economies to major regional players in western and oriental worlds, both have been studied as examples of national development and innovation (Preston, 1997; Hu and Mathews, 2005; Hsu, 2005; Lodge, 2005). In particular, studies have documented the remarkable progress of Taiwan and cited government innovation policies as a major factor in this success (Kraemer et al., 1992).

National innovation policies are considered especially relevant for small developing economies as part of their adjustment to the changing international, economic, and technological order as well as improvements to their own economic and technological situation (Davenport and Bibby, 1999; Pack, 1992). According to the Global Competitiveness Report 2006-2007, published by the World Economic Forum (WEF), Taiwan ranks 9th and Ireland 19th in the field of innovation among the 125 countries included in the study worldwide. In Asia, Taiwan ranks second, behind only Japan (Porter et al., 2007).

It is usually agreed that innovation is the key driver of economic performance. Innovation as a driver of growth theory is derived from the economic theory of creative destruction put forward by Joseph Schumpeter (1942) that states that in a capitalist society, long-term economic growth is generated by the creation of the new and the displacement of the old. As nations achieve higher levels of gross domestic product (GDP) per person, the main source of this change becomes innovation. Porter and Stern (2001) thus describe changes in advanced countries: "The challenges of a decade ago, were to restructure, lower costs and raise quality. Today, continued operational improvement is a given advantage must come from the ability to create and then commercialize new products and processes, shifting the technological frontier as fast as their rivals can catch up." In addition, statistical comparisons of economic performance among countries show that the intensity of national innovative activity is correlated with higher rates of standards of living and productivity growth (Furman et al, 2002).

In 1986 the Irish GDP per capita stood at US$9,265 and Taiwanese GDP per capita was a close US$9,088. A decade later, strong economic growth in both countries had produced similar GDP figures of $15,481 and $14,092 in Ireland and Taiwan, respectively. However, by 2004, average annual working hours per employee in Ireland had dropped to almost 75% of their Taiwanese counterpart, the GDP gap had risen to nearly $7,000 (Taiwan $18,527 vs. Ireland $25,540), and Taiwan had experienced a period of very slow growth (Groningen Growth and Development Centre, 2006). This is probably why the Global Competitiveness Report placed Ireland in the category of innovation-driven economies and Taiwan in the process of transitioning to one (Porter et al., 2006).

Recognizing the relationship between innovation and economic performance, we then wish to explore how actual innovation-related factors drive the competitiveness of these two small but relatively fast-growing economies separately. The research effort is devoted to the main task of assessing and analyzing the innovation policies of Taiwan and Ireland, highlighting their specific strengths, weaknesses, and effectiveness in the specific economic and institutional contexts in which they operate. The underlying hypothesis is that the benefits of each country's science, technology, and innovation policies, including specific policy instruments, cannot be adequately assessed outside the specific national context for which they are designed. It is hoped the differences and similarities observed in national innovation policy will contribute to an understanding of how the two small island countries stimulate themselves and then achieve similarly outstanding innovation performance.

The following describes the organization of this paper. Section 2 observes how Taiwan and Ireland have developed their national innovation policies respectively from an evolutionary perspective. Section 3 reviews prior research into assessment of national innovation policy through different proposed models. Section 4 describes the differences in national innovation policies between Taiwan and Ireland. This section

seeks to compare innovation policy in the two countries on the supply side, environmental side, and demand side. We provide a holistic view of national innovation policy using a mixture of quantitative and qualitative evidence and indicators and demonstrate how this relates either to the current policy mix or to likely policy changes in the immediate future. The final sections are devoted to conclusions, policy implications, and suggestions.

INNOVATIVE DEVELOPMENT: TAIWAN AND IRELAND

Taiwan

During much of the 1950s, economic goals did not rank particularly high with the Taiwanese leadership. The government was preoccupied instead with the reconquest of mainland China. By the end of the decade, it had become clear that the communist regime on the mainland was firmly entrenched. Taiwan's party elders came to see that economic development could be a better guarantee of the party's survival (Wade, 1990). At this point, the government turned its energies to eliminating many investment-deterring distortions (such as multiple exchange rates and macroeconomic instability). Taiwan was well endowed with a highly skilled labor force but was capital poor, and it had a coordination problem that inhibited growth.

A major milestone early in Taiwan's development was the Nineteen Point Reform Program instituted in 1960. This contained a range of subsidies for investment and signaled a major shift in government attitudes toward investment (Lin, 1973). The most important direct subsidies in Taiwan came in the form of tax incentives. The Statute for Encouragement of Investment (enacted in 1960 in conjunction with the nineteen-point program mentioned above) represented a "sweeping extension" (Lin, 1973) of the prevailing tax credit system for investment. Among other things, the maximum business income tax paid by enterprises was reduced and tax holidays on new investments were increased. These investment incentives were further expanded in 1965, when business income tax was reduced in all priority sectors listed in the investment law, and specified manufacturing sectors (basic metals, electrical machinery and electronics, machinery, transportation equipment, chemical fertilizers, petrochemicals, and natural gas pipelines) were given complete exemption from import duties on plant equipment.

Various policy measures have also been designed to enhance firms' innovative activities, beginning first with the establishment of Hsinchu Science-based Industrial Park (HSIP) to provide an environment conducive to the development of the island's high-tech industry. Second, innovation alliances have been organized as a means of spreading the R&D risk between firms and securing first mover advantages. Third, the scope of the government-sponsored Industrial Technology Research Institute (ITRI) has been expanded to serve as a channel for technology transfer within the private sector; the majority of the budget for National Science and Technology Projects (NSTPs) has also been allocated to ITRI in an effort to boost the institute's innovative capacity. Fourth, tax incentives have been made available to absorb some of the R&D costs of firms and to encourage them to engage in R&D activities. Finally, a venture capital industry has been established, with the growth of this sector having already helped to speed the overall development of the high-tech sector (Tsai and Wang, 2005).

The Taiwanese government undertook a more direct role in the direction of the economy, taking steps to ensure that private entrepreneurs would invest in certain areas. The government helped establish industries, including plastics, textiles, fibers, steel, and electronics. For example, Wade (1990) provides an account of how Taiwan's plastics plant for PVC was built under government supervision and handed over to a private entrepreneur upon completion in 1957. More generally, it was common for the state to establish new upstream industries and then either hand the factories over to selected private entrepreneurs (as happened in the case of glass, plastics, steel, and cement) or run them as public enterprises (Wade, 1990).

On the other hand, a major distinction in policy regarding Taiwan's innovation development is in scale; Taiwanese production is marked by a large number of small and medium-sized firms (Park, 1990). In

view of this, its capital market was at a very early stage of development little more than ten years ago; i.e., there was an inherent phenomenon of market failure (Tsai and Wang, 2005).

The Taiwanese state was instrumental in the early stages of the development of the electronics industry. In 1974, the publicly-owned Electronic Research and Service Organization (ERSO) was formed to bring in foreign technology and disseminate it to local firms. ERSO built the country's first model shop for wafer fabrication and entered a technology transfer agreement with RCA. It trained engineers who later moved to private firms. The strategy led to many private-sector offshoots that commercialized the technology developed by ERSO (Wade, 1990).

However, other strategies were not successful. For example, a 1970s push by the Taiwanese government into the automotive industry via its public enterprises failed. When new opportunities arise, market failure can constrain their fruitful exploitation and, at firm level, such failure is seen as an entry barrier. Such is also the case in segments of the semiconductor and consumer electronics industries (Mody, 1991). Under such circumstances, government innovation policy measures can, to some extent, correct market failure problems and facilitate the pace of structural transformation. One example is the share of exports from the heavy chemical and technology-intensive industries, which was just 54.9% in 1986, but had grown to 80.6% by 2002. Such overall achievements demonstrate the effectiveness of the government's innovation policy measures (Tsai and Wang, 2005).

The basic philosophy underlying the Taiwanese government strategy is that an economy will undergo certain stages of development, and at each stage there are certain key industries (such as integrated steel mills, large shipyards, and petrochemical plants) that through various linkages will bring about development of the entire economy. This strategy also assumes that government officials know what those key industries are and what policy measures should be adopted to develop them (Hou, 1988). According to Rodrik (1994b), the available evidence strongly suggests that proactive government policy was directly responsible for the "miracles" of the Asian Tiger economies of Korea and Taiwan as well as that of Singapore. The governments of these countries essentially solved a coordination problem that permitted their economies to take off. Context is important for understanding why government intervention was successful. It was the initial conditions of these countries that provided government policy with such a high payoff.

Ireland

With the fastest growth rate of GDP per capita in OECD countries over the past decade, Ireland has largely caught up with leading countries in terms of productivity and, to a lesser extent, income levels (OECD, 2005). The economy of Ireland has been traditionally agricultural. Since the mid-1950s, however, the country's industrial base has expanded, and now mining, manufacturing, construction, and public utilities account for approximately 37% of the GDP and agriculture for only about 12%. Private enterprise operates in most sectors of the economy (Bradley, 2006). In Ireland nowadays, attention is often focused on the modern, high-technology sectors of computers, software, and pharmaceuticals; with the exception of the food processing sector, the remaining sectors are small and attract far less attention (Bradley, 2006).

In Ireland, for various reasons, little priority was given to the integration of scientific and technological research and industrial development until the 1980s. Yearly (1995) argues that, historically, this failure to integrate technology and industrial policy stems back to the pre-partition period. At this time, Yearly (1995) argues that scientific excellence in Ireland was "cultivated for an international audience. The work of the foremost scientists showed few signs of being significantly Irish. It dealt in abstract, would-be universal propositions. In other words science prior to partition was primarily practiced as a form of high culture (Yearly, 1995, p.173)." Following Irish partition in 1921 and the creation of the modern Irish state, this tendency was, if anything, exacerbated by the desire to distance the country from the British legacy and a concentration of public and academic resources on cultural and linguistic rather than scientific development (Lee, 1989). One consequence of lack of applied scientific research in Ireland was a relatively low level of innovative activity among indigenous Irish companies that persisted into the 1970s.

By 1985 the nation faced inflation averaging 11% per year, unemployment of 15% and a vast national debt. Between 1981 and 1990, 200,000 people emigrated (Dorgan, 2006) and, unlike previous waves of emigration, many of these were university graduates. In order to cope with the crisis, the government introduced a radical three-year national recovery plan, government spending was slashed, and national partnership agreements were put into place between the government and employers and unions. These agreements restricted pay raises and introduced tax incentives. While government spending was reduced in many sectors, investment was made in telecommunications infrastructure in order to target the financial services and software sectors. Import substitution and tariffs were used to protect and develop Irish manufacturing. Ohmae (2005) suggests that the previous industrial failure was at this point seen as a benefit: "It meant that there was no rusting industrial plants and no unemployed workforce born and bred to heavy industry…Ireland could start from scratch."

A reorientation of Irish industrial policy followed, toward a more balanced strategy involving the development of the export capacity of indigenous industry, alongside continued attempts to attract high-tech inward investment (National Board for Science and Technology, 1983). Implicit in the policy shift was the recognition, perhaps for the first time, that the international competitiveness of indigenous Irish industry depended on its technological development. The economy picked up, and by 1992 the concept of Ireland as the e-hub of Europe had been developed (BBC, 2006). While the economy has continued to prosper and significant FDI has been attracted, Ireland has become the European research base for a number of pharmaceutical companies; it is also the location of manufacturing plants for large international companies such as Dell and IBM. In addition, its beautiful scenery and unique history has led to the development of a strong tourist industry (Ohmae, 2005). However, large-scale inward investment has meant that 44.1% of manufacturing employment, 68.4% of net output, and 87.7% of manufacturing exports are now accounted for by foreign-owned enterprises (Ruane and Gorg, 1997). Moreover, only two Irish-owned firms appear in the list of Ireland's top 20 electronics companies (Roper and Frenkel, 2000), and only 2% of patent applications made in Ireland are now made by Irish residents.

Even so, the bringing together of Irish industrial and technology policy with the aim of developing the competitiveness of indigenously owned firms has been strongly supported by the EU through both the Structural Funds and the Framework programs (see, for example, Massey et al., 1992; Enterprise Panel, 1996). More generally, however, the effect of this uncoordinated decentralization of technology and innovation policy has been to exacerbate the lack of coordination within Ireland's innovation system, highlighted by Walker (1993). Although this was masked to some extent by significant flows of inward investment, particularly from the United States (e.g., O'Riain, 1997), it contributed to the development of a dual economy in Ireland: a technologically advanced, externally owned sector based largely on R&D conducted elsewhere and a technologically weaker, indigenously owned sector (Wrynn, 1997). Other continuing weaknesses cited by Walker (1993) relate to the lack of intermediate technology transfer institutions, the weakness of the Ireland skills base, and the distortionary effect of defense-related R&D. In terms of any assessment of the effectiveness of policy measures designed to increase the level of innovative activity by businesses, the central question is whether Ireland provides the most conducive environment for innovation.

ASSESSING NATIONAL INNOVATION POLICY

Traditional innovation policy has often focused on promoting science and technological policies. These policy models have typically believed in the science push effect in the radical innovation process. The new innovation environment then sets new demands for regional innovation policies and strategies. Therefore, innovation cannot be seen as a property of science or of technology-based firms; it is the basis of competitiveness in all kinds of economic activities (Pekkarinen and Harmaajorpi, 2006). Besides, the nature of innovation varies significantly across sectors, and differences between countries in the sectoral composition of output and the position of domestic firms in international supply chains can lead to significant differences in national patterns of innovation (OECD, 2005). In view of these, assessing national innovation in a

comprehensive mode is essential to country competitiveness enhancement. The following portrays how national innovation policy can be evaluated by various approaches.

In 1997, OECD proposed a National Innovation Systems (NIS) approach to attempt to offer an insightful analysis tool for national innovation states. The national innovation systems approach stresses that the flows of technology and information among people, enterprises, and institutions are key to the innovative process. The measurement and assessment of national innovation systems has centered on four types of knowledge or information flows: (1) *interactions among enterprises*, primarily joint research activities and other technical collaborations; (2) *interactions among enterprises, universities, and public research institutes*, including joint research, co-patenting, co-publications, and more informal linkages; (3) *diffusion of knowledge and technology to enterprises*, including industry adoption rates for new technologies and diffusion through machinery and equipment; and (4) *personnel mobility*, focusing on the movement of technical personnel within and between the public and private sectors. Attempts to link these flows to firm performance show that high levels of technical collaboration, technology diffusion, and personnel mobility contribute to the improved innovative capacity of enterprises in terms of products, patents, and productivity (Hadjimanolis and Dickson, 2001; Porter and Stern, 2002; Hsu, 2005; Hu and Mathews, 2005). However, the main problem with the NIS approach is that it is based more on robust indicators (such as R&D expenditures, patents, production, and trade in high-technology products) than on content analysis, so policy implications are limited. The other issue is that it is difficult to compare those indicators, particularly mobility of human resources and diffusion of knowledge through publications and patents, across countries.

Another fairly similar approach is taken by Kim and Dahlman (cited in Lee, 1998), who, using the innovation process as their starting point, classify policies as technology supply, technology demand, and technology supply-demand linkage policies. This approach has been adapted by Lee, who terms technology supply-demand linkage policies as technology diffusion policies. An alternative approach to analysis of innovation policy is used by Porter (2001; 2003) in a number of his presentations, making use of the Diamond Model first developed by Porter (1990) to explain the competitive advantage of nations and applying it to innovation policy assessment. In using this framework he examines innovation policy based on its effect on each of four interlinked factors: strategy and rivalry, demand conditions, factor conditions, and supporting industries. Nevertheless, one major criticism of this framework is its greater emphasis on the role of government in interfirm competition and strategy. In many countries with open markets and minimal government interference in market processes, policies are avoided that would affect firm rivalry as this would be seen as manipulating the free market.

A somewhat more complex approach is taken by Cheng and Lin (2006), who criticize the suitability of Porter's model for innovation policy analysis. They propose a matrix based on a triple helix model of three interactive driving forces: market, institute, and technology. These forces are combined into a matrix with a four-dimensional policy structure consisting of human resources, E-infrastructure, law and regulations, and public and private partnership. Although this framework may prove insightful, it is still rather newly developed and therefore little examination has been made of its suitability.

System perspectives on innovation performance by many academics have examined the classification and role of innovation policies. One of the most comprehensive classification systems for innovation policy employment is that developed by Rothwell and Zegveld (1981), who grouped innovation policy tools into supply side, demand side, and environmental side. Supply side tools are those that provide the basic resources for innovation, such as educational institutions or universities, trained technicians, information networks, and technical advice. In addition, they include direct innovation by government-owned agencies and state industries and research directly supported by government funds such as research grants. Environmental side tools regulate the operating environment of firms and include means by which the government impacts the financial aspect of innovation. This classification also includes not only the legal environment in which firms operate but also the legal environment for innovation. Demand side tools have an effect on the stimulation of invention by the demand for new products and services created by public spending and public services. These also include the stimulation or suppression of innovation by regulation of demand from overseas and the ability of overseas competitors to operate in the national market.

In this research we will make use mainly of these policy analysis denotations originally derived from Rothwell and Zegveld (1981) as a guideline facilitating a more insightful national innovation policy assessment. The reason we chose this framework as an analysis base is that this system rests on the premise that understanding the linkages among the policy actors involved in innovation is the key to improving technology performance (Shyu and Chiu, 2002). Furthermore, it is more feasible and applicable than other indicator systems from the perspective of comparability and comprehensiveness.

However, on the other hand, based on what we have argued above, we find the policy field of promoting network and entrepreneurship on the supply side may be a missing link in the innovation policy assessment framework first proposed by Rothwell and Zegveld (1981). Frenken (2000) contends that successful innovation depends on complementary competencies in networks of producers, users, and governmental bodies, and networks have become understood as an important organizational form for coordinating the efforts of heterogeneous actors without restricting their individual goals. More specifically, technological incubators have assumed a growing role in R&D research and innovation management, and their importance has not escaped researchers' attention (Lumpkin and Ireland, 1988; Mian, 1996, 1997). Science parks, like technology incubators, are property-based initiatives designed to provide a conductive environment in which high-tech businesses can be established and develop (Roper, 2000). Venture capital funds provide not only capital but also management assistance; once the enterprise has become a success, they sell off their holding in the company to make a profit. Support of it is rather beneficial for entrepreneurship promotion (Tsai and Wang, 2005). Importantly, interfirm collaboration and interorganizational learning are central to the innovation process (Roper, 2000).

Through the above discussions, to promote network and entrepreneurship, practice examples include establishing incubators and science parks, supporting start-ups, encouraging collaborations between firms, setting up venture capital associations, establishing grant-based measures to promote entrepreneurship, and so on. The revised innovation policy assessment model of general roles for each grouping is depicted in table 1.

Table 1: A More Complete Innovation Policy Analysis Model

Grouping	Policy tools	Examples
Supply Side	Public enterprise	Innovation by publicly owned industries, setting up of new industries, pioneering use of new techniques by public corporations, participation in private enterprise
	Network and entrepreneurship	Supporting start-ups, establishing science parks and incubators, encouraging collaboration between firms and institutions, venture capital associations, measures to promote entrepreneurship
	Scientific and technical	Research laboratories, support for research associations, learned societies, professional associations, research grants
	Education	General education, universities, technical education, apprenticeship schemes, continuing and further education, retraining
	Information	Information networks and centers, libraries, advisory and constancy services, databases, liaison services
Environmental Side	Financial	Grants, loans, subsidies, financial sharing arrangements, provision of equipment, buildings, or services, loan guarantees, export credits, etc.
	Taxation	Company, personal, indirect and payroll taxation, allowances
	Legal and regulatory	Patents, environmental and health regulations, inspectorates, monopoly regulations
	Political	Planning, regional policies, honors or awards for innovation, encouragement of mergers or joint consortia, public consultation
Demand Side	Procurement	Central or local government purchases and contracts, public corporations, R&D contracts, prototype purchases
	Public services	Purchases, maintenance, supervision and innovation in health services, public building, construction, transport, telecommunications
	Commercial	Trade agreements, tariffs, currency regulations
	Overseas agent	Defense sales organizations

Source: adapted from Rothwell and Zegveld (1981), p.59.

SUPPLY SIDES OF INNOVATION POLICY: TAIWAN AND IRELAND

There are some similarities and major differences between Taiwan and Ireland in supply side policies (see Table 2). One common aspect is the creation of technical information networks that provide access to detailed technical information; this relatively low-cost service aids the research of companies and pools research knowledge (Advisory Science Council, 2006). Another policy utilized by both is the offering of grants to universities to undertake research (see Table 2).The Irish version of this policy is more specific in targeting advanced research, whereas Taiwanese policy is more focused on application research.

The key difference in supply-side innovation policies between Taiwan and Ireland lies in the role that universities play in their association with industry in the process of innovation development. The Global Competitiveness Report 2006-2007 published by the WEF cites Taiwan's seventh-place world ranking in "higher education and training pillar," with both quantity and quality of higher education reflecting the government's efforts to promote education and the development of elite personnel. On the other hand, while both systems try to improve links, the Irish system places a far greater emphasis on the role of industry in association with universities, with polices such as University/Firm Joint Research and University/Firm/Graduate Knowledge Transfer being driven by the needs of firms. Another indicator of the Irish focus is the setting up of industry groups for research; this policy seems to be open to failure, since it requires competitors to cooperate for the good of the group and essentially to reveal their research activities to each other. In the Taiwanese policies we can see that the role of government as a direct provider (as opposed to facilitator) is emphasized; for example, it establishes research institutes to directly conduct a range of research that then becomes available to local industry. These institutes, such as the Industrial Technology Research Institute (ITRI), Technological Information Center, and National Science Council (NSC), conduct research on a large scale and undertake studies into the feasibility of industrializing new technology. Although it tries to link universities via conferences, in effect the Taiwanese government is focused on providing the tools of innovation, i.e., technically educated students, government funded research, training, and information. One criticism of the approach by Shyu (2006), however, is that the needs of industry are not always served by the supply policy system; this is the result of the separation of education, industry, and government and to the political nature of such a government focused system.

Table 2: Comparison of Supply-Side Policies between Taiwan and Ireland

Ireland		Taiwan	
(a)	University/Firm Joint Research	(a)	Government Training
(b)	Advanced Technologies Research Grants	(b)	Development of Innovation Information Research Networks
(c)	University/Firm/ Graduate Knowledge Transfer	(c)	Industry and Research Conferences
(d)	Industry Led Collaboration Groups	(d)	Higher Education Development
(e)	The Provision of Technical Information and Support	(e)	Support of University Research
(f)	Support for Start-ups	(f)	Establishment of Research Institutes
(g)	Incubator Networks	(g)	Innovation Alliances
		(h)	Incubator Establishment
		(i)	Setting up of VC Associations

In contrast, the Irish government is focused on linkage of existing tools, i.e., joining firms into research groups, taking trained students into firms, bringing firms into the university research lab. For its success this policy is dependent on the strength of existing tools and on the strength of the firms to which those tools are linked. This is of concern as the higher institutions that are integral to these supply policies have been criticized by the OECD for their low levels of funding, despite recent increases in funding (primarily through changes in government policy and EU funds). Unlike many universities in Taiwan (e.g., National Chiao Tung University, National Tsing Hua University), Irish universities (e.g., Trinity College Dublin, University College Dublin) have had a strong focus on the humanities (Pontikakis et al., 2006), particularly Irish history and

literature. This has resulted in a lack of experienced researchers in universities and limited research facilities. The situation is now improving; "after years of neglect universities have only recently had the resources to carry out high-quality research" (OECD, 2006).

In addition, the governments of both Taiwan and Ireland have engaged in activities promoting collaboration and mutual learning between firms. In Taiwan, from the late 1980s through the early 1990s, in order to promote industrial upgrading, the government directed a considerable number of innovation alliances in the areas of notebook computers, high-definition televisions, fax and communications equipment, and so on, working through research institutions such as the ITRI. The most successful of these was the Notebook PC Joint Development Alliance (Tsai and Wang, 2005). In Ireland, national initiatives are now in place to promote collaboration in pre-competitive or basic research between firms, universities, and other research bodies. For example, Programs in Advanced Technologies (PATS), funded through Measure 2 of the EC Support Framework, have aimed to stimulate basic research in universities and technology transfer to companies in specific areas of new technology (Roper, 2000). On the other hand, Taiwan's venture capital (VC) has made a considerable contribution to the growth of Small and Medium-Sized Enterprises (SMEs), particularly those in the emerging industries, and the government has set up many VC associations and offered financial support to help investors (Tsai and Wang, 2005). In addition, since 1996, the Small and Medium Enterprise Administration (SMEA) of Taiwan has continued to promote the establishment of incubators through the use of financial support available from the Small and Medium Enterprise Development Fund for office equipment, personnel, and related costs. After five years of continuous effort, the SMEA has promoted 63 incubators and attracted around 900 firms to move into these incubators (Tsai and Wang, 2005). As for Ireland, new export-oriented businesses can receive employment grants and R&D grants (Roper, 2000). However, in Ireland, the business incubator network is relatively limited, although most Irish universities have small innovation centers, and EU-sponsored networks of business innovation centers and innovation relay centers support the relatively sparse innovation centers in Ireland that provide incubator-type facilities (Roper, 2000).

ENVIRONMENTAL SIDES OF INNOVATION POLICY: TAIWAN AND IRELAND

Strong similarities exist between the two countries with regard to the provision of grants and tax relief for R&D (see Table 3). A number of these policies have specific aims rather than general ones:

- Patent Royalty Tax Exemption (Ireland): To increase levels of Irish patenting and patent licensing (Roper, 2000).
- High Risk R&D Support Program (Ireland): To reduce the financial risks involved in undertaking high-risk research2 (Roper, 2000).
- Tax Relief on Training (Taiwan): To encourage the further training of technical and managerial staff (Tsai and Wang, 2005).

More specifically, in Taiwan, companies can be exempt from import duties on instruments and equipment for experiments in R&D. Equipment for R&D with a life of longer than two years can adopt two-year accelerated depreciation. Expenditures in R&D of 15–20% can be business income tax deductible (Shyu and Chiu, 2002). On the other hand, the Ministry of Economic Affairs also took action in promoting traditional industries' technology capacity with "Rules of encouragement for the private sector's development of new products" and the "'Law governing development for directive new products" (Shyu and Chiu, 2002). In addition, subsidy for R&D activities of high-tech companies located in the Science-based Industrial Park is offered by the Taiwanese government, which usually prepares an annual budget of relative expenses to support firms' research projects (Tsai and Wang, 2005). In Ireland, R&D support is offered on a discretionary basis, with a maximum grant of 50% of the eligible *non-capital* element of R&D project costs. Similar levels of support are available for feasibility studies and licensing of new manufacturing technologies (Roper, 2000). Tax relief is available in Ireland on all R&D expenditure, patenting costs, and costs of acquiring manufacturing licenses, etc., with expenditure being written off against profits in the year in which the expenditure is incurred. In addition, royalties and other income received from the use of patents are also exempt from income and

corporation tax. The impact of EU support for R&D and innovation capability development has been important for Ireland. The Operational Program for Industrial Development, 1989-93, for example, provided continuing funding for capability development, which in all probability could not otherwise have taken place given the state of public finances at the time (Hewitt-Dundas and Lenihan, 2002).

Ireland's policy to attract foreign FDI from the end of the 1950s was particularly successful. Initially, job maximization was a driver in attracting FDI, with large multinational enterprises (MNEs) concentrated in traditional and labor-intensive sectors. By the late 1970s and 1980s, however, policy began to adopt a more selective approach to the FDI sought, focusing more on high-tech and higher value added firms. Over the same period, the motivation for MNEs to invest in Ireland shifted, from tax and grant incentives along with low-labor costs in the 1960s, to access to major markets in 1973 with accession to the EU, and access to a skilled labor force that the Irish government had actively tried to develop, particularly in the areas of computers and other electronic products, pharmaceuticals, medical and scientific instruments, and software (Hewitt-Dundas and Lenihan, 2002). In Ireland, international firms have been attracted by the 10% corporation tax for all manufacturing companies that is due to continue until 2010 (Yuill et al., 1997). As for Taiwan, two main policy instruments were developed to attract FDI: direct taxation incentives and export processing zones (EPZs). To consolidate these incentives, between 1966 and 1971 a number of EPZs were established that enjoyed the benefits of simplified official procedures and duty-free imports of machinery, equipment, raw materials, and finished goods (Chen and Sewell, 1993). Currently, preferential tax measures, R&D assistance, and low-interest loans are being offered to encourage foreign investment, with the goal of further developing Taiwan as a hub of R&D and high-tech manufacturing. These measures, along with the establishment of modern science parks, have led to an increase in the amount of foreign investment dedicated to electronics and electrical appliances, a sector that now accounts for 33.45% of foreign investment (Department of Investment Services, 2006).

In Ireland, as with R&D support, capital grant support is offered on a selective basis. Capital grant support has been ubiquitous, but higher maximum grant rates have been on offer in less developed western regions (Yuill et al., 1997). However, a number of studies have suggested that capital grant support is particularly prone to deadweight and may lead to substantial distortion in the type and extent of firms' investments (Roper, 2000).

In financial support for R&D another common policy is the setting up of incubators. In Ireland, implementation has been undertaken at a national level by Enterprise Ireland (OECD, 2006) and all third-level institutes now have incubators; institutes have been in charge of establishing their own incubators and are supported by grants from the Small and Medium Enterprise Administration. While incubators in Taiwan have been successful at attracting firms, quality of support has varied, and firms coming out of the incubators have tended to be of a similar nature, with similar products and little to distinguish them in the marketplace (Tsai and Wang, 2005). In Ireland, the more centralized policy has resulted in the development of incubators specializing in a number of target industries and more consistent support levels (Advisory Science Council, 2006).

The role of the legal system in innovation is highlighted by the efforts taken by each country in addressing perceived weaknesses in their intellectual property rights (IPR) laws. For Ireland this involves the strengthening of copyright rules regarding software and the Internet. However, many small companies believe that they do not own any intellectual property because they do not recognize it, but all companies have at least one trademark—their name—even if it is not registered as a trademark. It is very much in the interests of even the smallest company or individual innovator or entrepreneur to make the best use of their intangible assets by investigating the opportunities offered by the intellectual property system (Irish Patents Office, 2007). In Taiwan's case the changes undertaken were of a more substantial nature, addressing the weaknesses in patent enforcement and prosecution (based on US government criticism). It is also interesting to note the integration of the Taiwan Intellectual Property Office into the National Innovation System (NIS) administration structure. The above Taiwanese laws and regulations include the Patent Act, Integrated Circuit Layout, Copyright Act, Trade Secrets Act, and so on. As for market competition law, Ireland has no limitation on FDI and relies on it to stimulate economic growth. However, most companies in Ireland are small and medium-size enterprises. Hence, to promote competition, Ireland's Competition Act also focuses on mergers and acquisitions from foreign investment as well as on supervision of cartel organizations and monopolies (The Competition

Authority, 2002). Although most of Taiwan's companies are small and medium-sized enterprises as well, Taiwan's competition law, the Fair Trade Law, does not emphasize mergers and acquisitions. The Fair Trade Law focuses on preventing cartels, monopolies, limited competition, and other behaviors hindering fair competition (Fair Trade Commission, 2000).

The political situation with China has resulted in visa restrictions for mainland Chinese engineers and researchers. Although few visa restrictions are in place for other nationalities, the restrictions are of particular significance as the two countries share the same language (a significant number of research labs in Taiwan use Chinese as their main form of communication), China is a major recipient of Taiwanese FDI, and to some extent their cultures are similar (Wu and Huang, 2003). This restriction contrasts with the liberal visa and immigration policy that Ireland offers as part of its EU membership and its growth strategy. In a similar vein, the use of technology export restrictions against China reflects the current situation of Taiwan These rules prevent the export of advanced technology to China and Chinese subsidies even for research purposes, and like the visa policy reduce access of Taiwanese companies to Chinese engineers. However, there is some evidence that this restriction is being circumvented.

Table 3: Comparison of Environmental Side Policies between Taiwan and Ireland

	Ireland		Taiwan
(a)	Financial Introduction Services	(a)	R&D Equipment/Expenditure Tax Alleviation
(b)	R&D Expenditure Tax Credits/Relief	(b)	Tax Relief for Training
(c)	Equipment/ Firm Infrastructure Grants (Capital Grant)	(c)	Loan Subsidies
		(d)	Tax Incentives and EPZs for Attracting FDI
(d)	Commercialization Fund	(e)	Patent and Copyright Acts
(e)	EU Support for R&D	(f)	Visa Restrictions (negative effect)
(f)	EU Membership	(g)	Technology Export Restrictions (negative effect)
(g)	Tax Incentives for Inward Investment		
(h)	Grants for Incubators	(h)	Research Facilities
(i)	Patent Royalty Tax Exemption	(i)	Grants for Incubators
(j)	Patent/Copyright/Trademark Law	(j)	Subsidies for Firms Located in Science Parks
(k)	High Risk R&D Support Program	(k)	Development Fund
(l)	Strengthening of Copyright	(l)	Fair Trade Law Focusing on Preventing Cartel and Monopoly
(m)	Competition Act Focusing on FDI Supervision		

DEMAND SIDES OF INNOVATION POLICY: TAIWAN AND IRELAND

To comply with the Agreement on Government Procurement of the World Trade Organization (WTO), Taiwan's government procurement law was legislated in 1999 and aims to clarify procurement information, complete procurement evaluation, and internationalize the procurement market (Public Construction Commission, Taiwan, 1999). Since then, the most advantageous tendering method has been adopted as a major legitimate contract award mechanism instead of the lowest bid tendering method (Tzeng et al., 2006). On the other hand, Taiwan uses government procurement as one of the most important sources of technological development, especially weapons systems procurement (Tien and Yang, 2005), though it faces a predicament in weapons systems procurement. The Sixth National Science and Technology Conference, for instance, proposed a strategy to strive for industrial/military cooperation in opportunities for defense weapons systems purchasing from abroad and introducing key defensive technology (National Science Council, 2001). Such industrial cooperation policy is one of the main sources of key technologies.

In contrast to Taiwan's procurement with the objective of introducing key technologies, Ireland's public procurement law regime focuses on generating competition and promoting the free movement of goods, skills, and labor within Ireland and Europe. The regime applies to the procurement of works, services, and

supplies by government departments, local authorities, and regional public sector bodies and entities financed in whole or in part by public funds and certain utilities (Arthur Cox and Davis Langdon PKS, 2003), which enlarges the market to enterprises in Ireland and EU.

The main difference on the environmental side between Taiwan and Ireland is the policy tools adopted by the two countries facilitating public services. The Taiwanese and Irish governments mainly use build-operate-transfer (BOT) and public-private partnership (PPP), respectively, in this aspect. In Taiwan, BOT is applied to lower government expenditures, share risks with contractors, and introduce advanced technologies. The Taiwan High Speed Railroad, electronic toll collection on the two freeways, and construction of Kaohsiung Mass Rapid Transit are the major BOT examples in recent years (Kang, et al., 2007). On the other hand, infrastructural investment projects in Ireland have been funded by the Exchequer or EU transfers. However, since the successful transition of the Irish economy to the standards of the core EU economies, EU transfers are unlikely to play an important role in the future financing of Irish infrastructure (Scally, 2004). Public-private partnerships are partnerships between public sector organizations and private sector investors and businesses for designing, planning, financing, constructing, and operating of infrastructure projects. PPPs are being used increasingly in Ireland to deliver both major and minor infrastructural projects in the transport, environment, education, and health sectors that have been essential to support its economic growth and population changes (Scally, 2004).

Regarding trade policies, both countries are striving to join international or regional trade organizations for improving their industries' competitiveness and now have become members of important economic integration organizations. Taiwan accessed the WTO at the end of 2001 after twelve years of effort (Cho, 2004). To comply with the regulations of WTO, Taiwan has to reduce tariff duties on agricultural and industrial products, remove import quotas, decrease exporting subsidies, and so on. In compliance with Taiwan's accession commitments to the WTO, there will be positive and negative influences on different industries (Huang et al., 2003; Hsu and Chang, 2004; Weng et al., 2005; Dent and Chuang, 2005). In addition to joining the WTO, Taiwan also joined a multilateral regional trade organization, Asia-Pacific Economic Cooperation (APEC), in 1991 together with China and Hong Kong (Chou, 1999). Experts believe that enlisting a free trade area of Asia-Pacific would be a hope for Taiwan to surmount its trade barrier.

Ireland relied on trade protection to stimulate industrial development after independence in 1937. The Irish government opened up its market for free trade instead of a "block policy" at the end of the 1950s. Because of its small domestic market, export promotion is Ireland's basic trade policy. In contrast to Taiwan's difficult trade position, Ireland not only is a member of WTO and European Union (EU), but also signed an Anglo-Irish Free Trade Agreement in 1965 and comprehensive double taxation agreements with 44 countries. Ireland's close trade relationship with other EU members has led to a high growth rate in medicine and information industries.

Concerning foreign exchange controls, Ireland's policy is looser than that of Taiwan. Multinational corporations are permitted outward remittance without timing or amount limitations in Ireland, enabling the country to successfully attract FDI (Industrial Development and Investment Center, Taiwan, 2004). In contrast, companies in Taiwan have to report to the Central Bank when they to make outward currency exchanges worth more than US$1 million (Yu, 2003). Table 4 summarizes the above dynamics.

Table 4: Comparison of Demand Side Policies between Ireland and Taiwan

	Ireland		Taiwan
(a)	National, Regional, and Local Government Procurement	(a)	Government Procurement and Industrial Cooperation
(b)	Public Private Partnership	(b)	Build-operate-transfer
(c)	Access multilateral trade organizations such as WTO	(c)	Access multilateral trade organization such as WTO
(d)	Participate in regional trade organizations such as EU	(d)	Participate in regional trade organization such as APEC
(e)	Sign the FTA with England and Comprehensive Double Taxation Agreements with 44 Countries	(e)	Sign the FTA with Panama and Guatemala
(f)	Lessened Foreign Exchange Controls	(f)	Intensified Foreign Exchange Controls

CONCLUSIONS: POLICY IMPLICATIONS

International variation in innovation policy presents an opportunity to examine various influences on the pace of technological change. Understanding international differences in the intensity of innovation also informs public policy. While most studies of innovation are set in a given public policy environment (Griliches, 1995), policy analysis requires an evaluation of variations in innovation with country-level policy differences.

As a "higher education and training pillar", Taiwan's higher education reflects the government's efforts to promote education and the development of elite personnel. Taiwanese innovation policy emphasizes the development of innovation by research institutes and through universities. The most important direct subsidies in Taiwan are in the form of tax incentives. Among other things, the maximum business income tax paid by enterprises has been reduced and tax holidays on new investments increased as time has gone by. Generally speaking, the Taiwanese government takes an active role in innovation/R&D and focuses policies on specific industries. One of the clear differences exhibited in innovation policy in Taiwan is the importance attached to policies targeting specific industries and providing financial, research, and informational support to these industries. The results of this are seen in the specializations of science parks and strong cluster formations. This contrasts with the more generalized approach taken by the Irish government, which provides general benefits for all firms wishing to innovate. The Taiwanese policy accords with the nationalist history of planned economic development and state-owned industries, which has been successful in transforming Taiwan from an agricultural to heavy manufacturing to high-tech economy. However, on the other hand, heavy dependence on the government to control the direction of Taiwanese innovation creates a number of risks:

- Political factors may affect direct investment and policies,
- The government may incorrectly judge changes in technology and market developments
- Significant support may be perceived as dumping, subsidization, or other unfair business practices to competing countries which then seek restitution or institute punitive tariffs (as happened to the Taiwanese DRAM industry in the late 1990s).

The Irish government prefers not to be involved directly in R&D or in controlling the type of innovation that firms undertake. Irish innovation policy emphasizes innovation at the firm level and the interaction between firms and universities. Funding for universities is low, as is the level of government research. In particular, public support for R&D and innovation in Ireland accounts for a lower proportion of costs. Being minimized in Ireland, levels of R&D grant support are typically lower and public assistance is given on a more selective basis. Lower grant rates also mean, however, that a higher proportion of the risk of any R&D will be borne by the private sector. Thus, the need to provide up-front evidence of the commercial validity of R&D or innovation projects to satisfy selection criteria, and the unwillingness of the Irish government to support near-market developments, is likely to reduce the contribution of Irish innovation policy to diversity. On the other hand, the fact that Ireland's policy to attract inward FDI is quite successful also

implies a high level of R&D globalization for the country, helping to gain more international mobility of R&D and innovative activities. In international terms, substantial inward FDI in Ireland for the last three decades has created the potential for substantial learning by indigenously owned enterprises (Roper, 2000). However, one criticism leveled at Irish innovation is that too much focus on FDI policies results in failure to address some of the weaknesses in the indigenous technology sectors (Walker, 1993; Hewitt-Dundas and Lenihan, 2002).

The Taiwanese government emphasized use of government procurement and industrial cooperation policies in the past to acquire advanced technologies such as aerospace technology, military technology, transportation technology, etc., establishing the foundation of the high-tech industry in Taiwan (Industrial Technology Research Institute, 2005). Along with introducing key technologies by use of policy tools, the Taiwanese government also takes a role in linking customers to manufacturers by holding trade shows. However, the Irish government intends to establish an environment to attract more foreign investments. Table 5 summarizes the main innovation policy contrasts between Taiwan and Ireland on the supply, environmental, and demand sides.

Table 5: Summary of Major Innovation Policy Differences between Taiwan and Ireland

	Ireland		Taiwan
Supply Side Policies – Both provide technical and research information.	Emphasis on knowledge transfer between universities and firms, role of industry highlighted. (Weak university funding)		Emphasis on research institutes, university development, and university research
Environmental Side Policies – Both have many financial incentives for firms to conduct research and incubators.	Mostly focused on the provision of finances including program to make access to private finances easier.		Very strong role for science parks. Research facilities are provided and the government directly funds key companies. (Restrictions because of China situation)
Demand Side Policies – Both have undertaken deregulation but more efforts need to be made.	Limited marketing initiatives		Government procurement is important. Trade shows link customers to manufactures.
General Policy Observations	General development polices benefit all industries	V.S.	Targeted development of innovation in chosen industries
	Bottom-Up Approach to Innovation	V.S.	Top-Down Approach to Innovation

Nevertheless, we also find a common shift in the nature of innovation and in response of innovation policy between these two small countries. This shift has been accompanied by a number of related changes reflected at various points in the following assessments:

(1) Enhancing industry-science linkages. There is a much greater need than in the past for strong links between firms and universities/public research organizations (PROs). Our research suggests that such links depend much more on the in-house capabilities and orientation of these two groups of organizations than on the creation of the linkages themselves. Technologically sophisticated firms will usually know how to access knowledge in the public sector research base, but firms in more traditional sectors with little need for interaction with the science base in the past will find it much more difficult. Hence, we find that enhancing industry-science linkages has become a common trend of innovation promotion and development in the two nations.

(2) Promoting collaboration among firms. Both Taiwan and Ireland proceed with industrial innovation from agricultural and traditional sectors. While firms tend to focus on fewer products, the number of technologies incorporated into any one product is increasing. This includes the increasing relevance of science-based technologies to more traditional sectors whose technology has hitherto been largely engineering based. Thus firms need in-house capability in or access to an increasing range of technologies. Outsourcing of technologies has increased, though even if a firm acquires a technology from elsewhere it will still require

some degree of understanding of the nature of that technology and what it can do. One consequence is that government support for collaborative research and similar public/private partnerships becomes ever more important.

(3) Fostering small and medium-sized enterprises (SMEs) and new technology based firms (NTBFs). In Ireland and Taiwan, outsourcing of the design and development of key components, the modulization of technology, and the difficulties of large established firms to adapt to the different business models/innovation modes required by new sectors create a much greater role for SMEs with advanced capabilities in science-based technologies. However, the framework conditions, financial institutions, and management needed to foster the creation, development, and growth of such SMEs are very vital while closely integrated in supply chains. Thus, the incubator networks or venture capital associations helping to promote entrepreneurship and SME management efficiency are rather important for Taiwan and Ireland, whose NIS was particularly well adapted for success in an SME environment.

(4) Rationalizing innovation policy. Both Taiwan and Ireland are concerned about the proliferation of innovation support measures over time and the need for rationalization and simplification. Both countries have taken steps to improve the situation. For example, Taiwan is implementing a structural reform of its system of public funding of R&D. Ireland, too, could benefit from a discussion of its policy mix, which is presently characterized by an almost exclusive prevalence of non-targeted measures based on bottom-up principles.

(5) Innovation in services. An increasing proportion of GDP is accounted for by service sectors, and technology/knowledge-based services have being growing rapidly. Encouraging innovation within services is therefore of increasing importance to policy makers in both nations.

(6) International cooperation. Taiwan and Ireland actively participate in multilateral and regional trade organizations such as WTO, EU, and APEC. Both of them also sign the Free Trade Agreements with amicable countries. These policies help to create a more suitable and stable market, which is crucial for an emerging industry (Rothwell and Zegveld, 1981; Shyu and Chiu, 2002).

RECOMMENDATIONS FOR TAIWAN'S AND IRELAND'S INNOVATION POLICIES

In the future, the innovation performance of a country is likely to be even more crucial to its economic and social progress (OECD, 2005). The following reviews and synthesizes the main findings of the study in an effort to identify key policy messages and recommendations that could inform further policy developments in Taiwan and Ireland.

Taiwan

(1) Fundamental research, long-term economics, and technology developments should be coordinated with each other. Taiwan's innovation performance in recent years, as mentioned above, has already become very competitive worldwide. However, why can't economic growth catch up with the speed of technology development? We suggest that fundamental research projects should be coordinated with long-term economics and technologies. Technology forecast may be one of the feasible strategies for the Taiwanese government, given the limited R&D resources. Moreover, the focal domain of development with technology forecast should still be complemented with industrial demands so as to contribute to the entire economic environment in the future. For instance, if technological demands brought on by industries cannot be realized, product quality can hardly be improved, and in the end firms remain without market competitiveness. Under such circumstances, there will be negative effects on national economic growth in the long run. Therefore, the government should inspect the demands of technology in the context of the market itself instead of distributing resources based simply on technology. Furthermore, it is advisable for the government to establish institutions such as technological trade centers where technologies can be more efficiently exchanged and extended into the market to benefit national economic growth.

(2) Integrating technology resources in China. Taiwan's economic growth performance is associated with its steady relationship with China's government in terms of politics, economics, and diplomacy. Because of increasing investments in China over the years, leveraging mainland China's technology resources and market should be a key point enabling the Taiwanese government to strengthen technological and economic developments in the future. The establishment of a "World Chinese Business Technological Research Center" can be a proper mechanism to coordinate and channel both sides' resources into innovation efforts (Shyu and Chiu, 2002).

(3) New aspects of intellectual property impetus. Intellectual property protection is an important policy of the Taiwanese government in recent years. However, in practice, more emphasis can be put on intellectual property in the world of the Internet as well as on setting up a series of standards for uses of Internet compilation. On the other hand, implementing regulations such as the IC Circuit Layout Protection Law not only represents technological advancement in Taiwan but also has some impacts on domestic industries. This is what Taiwan is facing as it becomes internationalized.

(4) Diffusing research results and technologies. In Taiwan, technological case projects are often administrated by public or private research institutions. As a result of the high flow rate of research elites in these institutions, technology accumulation is difficult. As a matter of fact, to accelerate information circulations, it is advisable to release intellectual properties to industries after a certain period of time. Moreover, government should establish derived companies through the technical transformation of several research projects, transferring elites to industries step by step in order to accelerate the process of diffusing techniques and strengthening the R&D power of civil firms. Finally, extending Taiwanese R&D and intellectual property activities to institutions other than research ones is the ultimate aim.

(5) Improving distributions of R&D human resource and managerial performance. Although Taiwan puts heavy emphasis on training of high-tech elites such as electronic information, it is not enough. Besides enhancing relationships between universities and conventional industries, government should strengthen human resource training and evaluate workers' quality in conventional industries. The other important issue is distribution of human resources. Hsinchu Science Park is just like a black hole, attracting elites from all over. This should be viewed as a severe warning to other industries. The managerial problem is another challenge when developing human resources. Therefore, training and retaining policy elites (or technological policy research elites) in organizations is also a human resource management difficulty that needs to be seriously confronted.

(6) Improving investment environments. Compared with that of Ireland, Taiwan's inward FDI is not as good as it appears. This indicates that Taiwan perhaps needs to improve its investment environment. We suggest that the primary remedies would be to provide a sound capital market, loosen foreign exchange controls, and then stabilize the political situation. As far as Taiwan's situation, remaining in ease monetary policy and a low interest rate should be the right policy trends for the government to stimulate business investments.

(7) Advancing build-operate-transfer mechanism. Although Taiwan has applied build-operate-transfer to introduce advanced transport systems in recent years, some cases suffered scandals benefiting specific contractors, reflecting the fact that Taiwan's BOT mechanism is immature. To prevent a financial predicament for contractors caused by over-optimistic financial prediction, government may adopt the least-present-value-of-revenue auction proposed by the World Bank (Engel et al., 1998). This way, the crucial market provided by government for innovation can be sounder.

Ireland

(1) Developing R&D capability in indigenous firms. Ireland's FDI policy has been successful; however, the government should try to create domestic conditions that gain as much as is lost from international mobility of R&D and innovative activities. For Ireland, a key challenge is not only to encourage foreign owned MNEs to increase their investment in R&D undertaken in Ireland, but also to ensure that the social benefits arising from this are maximized. This could be accomplished through greater partnerships and collaboration between universities and the MNEs as well as through vertical supply links with local suppliers. This will develop R&D capability in indigenous firms and increase the likelihood that they will subsequently undertake R&D.

(2) Upgrading higher education system. Current Irish innovation policy makes use only of general tools and fails to account for the weakness of the educational system. This problem with higher education in the innovation system needs to be addressed, either by significant investment and reorientation of the educational system or by depending less on the education system as an input. Given the importance of higher education in innovation, the former would likely be most beneficial. The Irish government may also wish to consider whether a more focused approach to innovation policy would be better suited to a country with such a small population.3 Targeting the creation of industrial clusters that complement the existing MNEs based clusters would both provide ready customers for those new clusters and aid in retaining MNEs within Ireland.
(3) Strengthening public sector engagement with industry. We also feel that encouraging universities to engage with business, removing legal impediments, and increasing their in-house interface with firms should be key objectives in policy for Ireland, as Ireland's publicly funded R&D seems below international good standards. In addition, encouraging mobility of researchers is a concern for Ireland as this is seen as the most effective means of knowledge transfer.
(4) Encouraging non-R&D active firms to invest in R&D. In Ireland, although efforts have been made to bridge links between industry and science, a large proportion of firms receiving grant support are in sectors where R&D is established in the organizational ethos of the industry, and many of these firms are large, foreign-owned plants with well-developed R&D capability. One explanation for this is that firms are unable to participate in huge R&D programs if the underlying capability to undertake R&D does not exist. Therefore, a continued focus on encouraging non-R&D active firms to invest in R&D is to be encouraged for Ireland. However, this aim will be achieved only where a holistic approach to business support and development is adopted in building R&D capability along with the provision of R&D support. In particular, the lack of intermediate technology transfer institutions should be leveraged.
(5) Liberalizing regulations. Transportation, electricity, and, to some extent, telecommunications suffer from unnecessary regulations in Ireland, including barriers to entry, price controls, and other rules limiting business operations that show up in high prices. Although liberalization of utilities has started in line with the EU agenda, our recommendation is that the Irish government pursue liberalization of network industries by ensuring that incumbents do not engage in business practices that prevent newcomers from entering the market. Ongoing regulatory reform and impact assessment should be carried out.
(6) Facilitating cluster development. As noted, the Irish government's interventions promoting networks as well as cluster development seem not so successful. We recommend that development agencies be formed and act collaboratively to encourage and facilitate cluster development. The agencies should be tasked with the identification and publicizing of specific clusters, and structures should be put in place to monitor the effectiveness of such actions. It is also vital that the legislative framework makes the delivery of relevant supports for clusters as efficiently as possible. The government should be more responsive to and supportive of industry needs, in terms of the provision of infrastructure and collective assets, as well as other tools (i.e., grants offering) designed to facilitate cluster development. In addition, government and agency supports for industry should be increasingly organized around clusters and sectors, and there is a need to more closely integrate FDI with indigenous industrial development. FDI should be used more strategically to support indigenous industry and to "fertilize" indigenous industrial clusters. This may require some degree of organizational innovation as agencies adopt the necessary structures to support changing enterprise policy.

Both Taiwan and Ireland

Both countries should look at methods by which they can expand their use of demand-based policies. Since both economies are export oriented, demand polices are particularly important with regard to customer-based innovation. In addition, as highlighted by OECD (2005), globalization has led to internationalization of demand for innovative products; this demand combined with demand-based policies such as government marketing initiatives overseas, would provide larger markets for innovative products, thus reducing the risk that research and commercialization of innovation would not produce economic returns for firms.

The other issue is that start-up SMEs (NTBFs) play an invaluable role in the economy of both Taiwan and Ireland; it is thus important for both nations to create conditions in which these SMEs can grow and

prosper over the longer term. Both have had policy initiatives to make progress in this regard; however, we make the following recommendations from the perspective of the findings of this paper.

(1) Public procurement. Start-up SMEs should be given full and fair opportunities to bid for public R&D contracts or contracts to buy technology-based products, The US Small Business Innovation Research (SBIR) program is one way of achieving this objective.
(2) Intellectual property protection. It is usually not very expensive for a small firm to take out a patent, but having that patent properly searched costs much more. Defending a patent in the courts is usually an expensive and protracted business. Making the intellectual property right (IPR) system user friendly for small businesses is important as is making them aware of how the IPR system can help them grow and develop. Effective IPR protection is often essential to enable a firm to raise finance, access new markets, and protect existing market positions.
(3) Tax policy. Start-up SMEs usually cannot afford to pay market salaries to experienced executives and can attract them only by giving them a share in the equity or profits of the growing business. Appropriate tax treatment of share options or profit-related bonuses are important if such firms are to attract the business expertise they vitally need. Favorable tax treatment of R&D can help to finance growth, particularly where tax credits are given even when the firm is not making sufficient profit to offset the value of the credits against its potential tax bill. Inability to capitalize R&D means that rapidly growing R&D-based businesses may appear to be incurring a loss when in fact they are making a profit from production and sale of current products.
(4) Competition regulation. Enforcing competition laws needs plenty of manpower. Both countries should invest more professional manpower in enforcing competition regulations in order to promote market security and fairness for the SMEs.

FUTURE RESEARCH

Additional researches can be conducted to evaluate the differences between the two nations in the production of visible innovative output and to investigate how variations in innovation policy matter to performance in small countries such as Taiwan and Ireland. Another focus of future studies should also be to explore how innovation performance directs policy as feedback. Consequently, more efficient policy implications and suggestions can be drawn from further findings.

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ENDNOTES

[1] An island country is a country that is wholly confined to an island, several islands, an island group, or several island groups, and has no territory on the mainland of a continent. Forty-seven of the world's countries are island countries (2007), including most of the smallest ones. Island countries can be divided in two approximate groups: large, relatively populous nations, such as Cuba and the United Kingdom, and smaller island countries such as Ireland and Taiwan. See "Island Country," Wikimedia Foundation, Inc., http://en.wikipedia.org/wiki/Island_nation, accessed on Nov. 19, 2007.
[2] High-risk research is often associated with radical innovation.
[3] Ireland's population was estimated in July 2007 at 4.1 million (CIA, The World Factbook, 2007).