Innovation policy for developing Taiwan's competitive advantages

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Innovation is a prerequisite for every nation and business facing the emergence of a knowledge-based economy and globalization. For small and medium firms in developing countries with limited resources and relatively low national advantage innovation is much more difficult. Government innovation policy, stemming from three sides – supply, demand, and environment, has been shown to play a major role in assisting firms to conduct innovation activities, especially in developing countries. This paper first summarizes recent tends and issues relevant to Taiwan's innovation structure and policy. Then, considering the present situation of Taiwan, analyzes the effect of government policy and current problems. Recommendations are presented systematically, based upon innovation policy.

1. Introduction

Knowledge is becoming the main resource for economic development, and the application of technology and innovation are the fundamental means of creating knowledge. Indeed, science and technology are the very foundation for industry's competitiveness. Many countries around the world adopt innovation policy to improve people's livelihood and promote economic prosperity. All leading countries strive for technological innovation and new product development to ensure their competitiveness and continuous economic growth.

Theoretically, innovation is the engine for national technological development. However, innovation has excessively high risk and the return is uncertain, especially for large-scale integrated systems and high technology products. In this regard, government intervention is essential. Experiences of advanced countries show that the most favorable conditions for innovation include an open and democratic society, a superior national innovation system, and appropriate government intervention.

Taiwan's economy has prospered in the past four decades, but Taiwan is now faced with wage increases, appreciating currency value, and increase in international protectionism, and thus is losing its competitive advantages. Consequently, a number of industries are moving out of Taiwan, and industry growth and exports have slowed down. To break through these post-growth bottlenecks and open up new space for industry growth, Taiwan needs to adjust its industry structure, upgrade the technical level, and develop high technology industries to promote industrial competitiveness. The most effective approach to achieve this goal is to assist the private sector's capability for innovation and utilize manpower to build up the business competency, and thereby create the industry profits.

The purpose of this paper is to evaluate the current innovation infrastructure and policy of Taiwan and is organized as follows. Section 2 describes the background of the concept of innovation and innovation policy. Section 3 evaluates innovation infrastructure and policy. Recommendations for Taiwan innovation policy are in Section 4. Section 5 is the conclusion.

2. Innovation and innovation policy background

Schumpeter (1934) defines innovation as the activity of developing an invented element into a commercially useful element that becomes accepted in a social system.

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Peter Drucker (1985) wrote: 'Business has only two basic functions: marketing and innovation. Marketing and innovation produce results. All the rest are costs'. Innovation is the use of new knowledge to offer a new product or service that customers want (Afuah, 1998). It is 'invention + commercialization' (Freeman and Soet, 1977). It is, according to Porter, 'a new way of doing things (termed invention by some authors) that is commercialized. The process of innovation cannot be separated from a firm's strategic and competitive context, (Porter, 1990). Therefore, innovation includes a series of activities: science, technology, organization, finance and commerce.

Theories have been elaborated according to Schumpeterian vision of technological and economic change, stressing the role of increasing returns, learning processes and non-maximizing behaviors. From this approach, a theory of the economic process characterized by disequilibrium, nonlinearity, cumulativity and path dependency has been elaborated. As a consequence, in the field of technological change, certain hypotheses have been increasingly regarded as crucial. That is, innovation is not the product of the atomistic behavior of maximizing agents, but is the result of particular dynamics determined either at the sectoral or global (national) level (Leoncini *et al*., 1996).

2.1. Policy perspectives on innovation

Innovation policy can be classified as demand-side oriented or supply-side oriented (Edquist and Hommens, 1999). Similarly, theories on innovation process can be classified as linear or systems-oriented. Important parallels and logical connections can be drawn between these two classifications. On the other hand, linear views of the innovation process support a supply-side orientation in innovation policies. Conversely, systems perspectives on innovation yield a much more fruitful perspective from the demand side, in terms of both theoretical and policy relevance.

2.2. Innovation policy

Innovation policy, oriented at appropriate new product ideas, production processes and marketing concepts, can produce at minimum temporary competitive advantages (Jacob, 1998). Innovation policy includes science and technology (S&T) policy and industry policy. The aim of the S&T policy, basically supply-side oriented, is to enhance the basic and applied research capacities of nations. Additionally, the latter one enhances the industry competitiveness. The making of industry policy is based upon demand-side consideration. A list of possible kinds of innovation policies given by Rothwell and Zegveld (1981) is summarized in Table 1. These policies can be grouped under three main headings.

(a) *Supply*: provision of financial, manpower and technical assistance, including the establishment of scientific and technological infrastructure.

Table 1. Classification of government policy tools.

	Policy tool	Example
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.
	Scientific and technical development	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 consultancy services, data bases, liaison services.
Environmental side	Financial	Grant loans, subsidies, financial sharing arrangements, provision of equipment buildings or services, loan guarantees, export credits.
	Taxation	Company, persona, indirect and payroll taxation, tax allowances
	Legal regulatory	Patents, environmental and health regulations, inspectorates, monopoly regulations.
	Political	Planning, regional policies, honor or awards for innovation, encouragement of mergers of 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 service, public building, construction, transport, telecommunications.
	Commercial	Trade agreements, tariffs, currency regulations.
	Overseas agent	Defence sales organizations

Source: Rothwell and Zegveld (1981), pp. 59.

(b) *Demand*: central and local government purchases and contracts, notably for innovative products, process and services.
(c) *Environment*: taxation policy, patent policy and regulations, i.e. those measures that establish the legal and fiscal framework in which industry operates.

3. Innovation policy of Taiwan

The current innovation policy of Taiwan includes:

1. Alleviation of taxation

Companies can have exemption from import duties for 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.

2. Loan subsidy

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'.

3. Supply of information and technological assistance institutions

The government has set up some institutions, such as the Technological Information Center, the National Science Commission, the Standard and Patents Information Center of the Central Standard Bureau, the Institute of Industrial Technological Research, and the Industries Assistance Center of the Ministry of Economic Affairs for collecting and managing market and technology information. This information can assist companies to cope with a changeable environment.

4. Government procurement

Some rules and regulations have been drawn up to encourage government units to purchase products made in the local area.

5. Protection of research results

Regulations of the Patent Law concerning obtainment and protection of patents have been redrawn and carried out in earnest.

6. Cultivation of manpower

More training courses have employed to cultivate the manpower needed in R&D activities by government agencies and institutions. To encourage companies to build up manpower, 15–20% of expenditures on cultivation of manpower can be deducted from a firm's income tax.

Facing the highly changeable environment, the industrial circle needs various and adaptive innovation policies. Small and medium businesses with limited resources are the major components in Taiwan economy, therefore the government must be in a position to assist and guide these industries' technology development and to initiate some national strategic industries. Policy tools such as subsidy, loans, and financing are incentives that promote innovation capacity. The major tools include:

1. Scientific and technological fund of the National Science Commission: government prepares an annual budget to support academia for fundamental research.
2. Technological project of the Ministry of Economic Affairs: government initiates large-scale research plans and appoints research institutions or business entities to execute the plans.
3. Development fund: government sets up the budget to support strategic investment projects and establish major fundamental industries. Investment in TSMC (Taiwan Semiconductor Manufacturing Company) is a typical example.
4. Rules of new products development of the Industrial Bureau: government sets up annual budget as non-interest loans to support businesses to develop new products
5. Subsidy for R&D activities of high-tech companies located in the Science-based Industrial Park: government prepares an annual budget as relative expenses to support firms' research projects.

3.1. Critical Issues of Taiwan's innovation infrastructure

Under the government's guidance, Taiwan industries have built a solid foundation of industry development. However, their ability to innovate still falls behind advanced countries. Following are some major issues relevant to Taiwan's innovation infrastructure:

1. Insufficient laws and regulations regarding innovation
Taiwan has imposed too many restrictions that discourage the private sector's interests. Although there is a law called 'Technologies basic law', it still falls far behind liberalism, and thus lacks the incentives to encourage the private sector's investment in R&D.

2. Limited budgets and manpower for innovation
The R&D expenditures of Taiwan in 1998 were 5,495 million USD, far less than the US$227,934 million in the USA. Taiwan expenditures also fell behind Japan and Korea, based on the R&D expenditure in 1997 (US$1115,20 million for Japan, US$7,186 million for

Korea). In terms of R&D expenditures a percentage of GDP in the year of 1998, Taiwan was 1.98%, less than the 2.79% in the USA. Taiwan percentage is obviously much lower.

3. Some key technologies depend on other leading countries
According to statistics, 1,300 companies purchased technologies from foreign countries in 1994, for US$0.5 billion. About 150 companies sold technologies to foreign countries, for US$0.085 billion. Domestic industries with lower levels of technology are moving out. Taiwan must develop products with higher levels of technology. However, technology needed for high value-added products is also the key technology in advanced countries. They are reluctant to transfer these technologies to Taiwan for the welfare of their domestic industries. This is why the introduction of key technologies becomes increasingly difficult.

4. Recommendations for Taiwan innovation policy

In order to maintain Taiwan's economic growth, an innovation policy of increasing incentives, based on supply side, demand side, and environment side, is essential. Supply side policy enhances capabilities for building technologies, and demand side policy aims at improving the demands for indigenous technologies and products. Environment side policy fortifies the national innovation systems.

1. Supply side policy

Supply side policy includes assisting firms to perform R&D activities, strengthening the function of public research institutions or foundations, setting up the open-labs, promoting the cooperation between industries and academics, revising of relevant laws to speed up technology transfer, and promoting technology cooperation between both sides of the China Strait.

(1) Assisting firms' R&D activities:
Even though the government has a number of incentives to encourage innovation, the accompanying red tape is time consuming and sometimes disputes regarding the ownership of intellectual properties arises. Firms find it difficult to adjust. We believe that a more practical method is to encourage cooperation among firms, research institutes and universities. Promote the positive benefits of innovation, on the other hand, and on the other revise laws, thereby increasing the incentives for the private sector to carry out R&D.

(2) Enhancing the innovation capabilities of research institutions
Research institutions such as the Industrial Technologies Research Institute, and China Technologies Research Institute are the main force in industrial R&D. Restricted by laws and regulations, the results of their R&D function is not fully utilized. A channel for technology diffusion is still not available and, as a result, creates the waste of R&D resources.

(3) Upgrade of Industries through cooperation between industries and academics
As competition grows fiercer and global specialization becomes a trend, how to make Taiwan become a 'Technological Island' is the focus of the Taiwan government. The Triple Helix thesis states that the university can play an enhanced role in innovation in increasingly knowledge-based societies. The Triple Helix denotes not only the relationship of university, industry and government, but also internal transformation within each of these spheres (Etzkowitz and Leydesdorff, 2000). In recent years, government budgets for education and public research have been reduced. Universities have adopted the strategy to work actively with industries, thus can get some funding from industries and the research results can be commercialized. Many incubator centers have also been set up in the university campus to bring a new mode of interaction between academia and industry. Basically, such cooperation mode is a supply side strategy.

Another type of cooperation between industries and academic institutions is the demand side strategy. Businesses set up independent research centers in and make use of technological experts and public facilities for R&D activities for commercialization. There are at least six advantages for demand side strategy of cooperation:

(a) Businesses have lower risk in innovation.
(b) Businesses guide the direction of innovation and cans integrate their marketing, finance, and manufacturing departments more effectively.
(c) With businesses guiding the direction of innovation, timing and external opportunities can be more leveraged.
(d) Disputes regarding intellectual properties are less likely.
(e) Businesses have more choices on strategies, such as technology cooperation and strategic alliances.
(f) University resources are fully utilized and trained, thus upgrade national capability in innovation

(4) Establishment of open-style research institute
Private firms are reluctant to conduct innovation activities due to the huge capital required to buy equipment and unknowing risks and returns. If the government can provide assistance to private firms for their R&D, such as setting up regional innovation service center, professional and open-style research institute, even opening up university labs to facilitate the private firms' research and allowing small and medium businesses to conduct projects pertinent to

upgrading manufacturing techniques and cultivation of R&D personnel with minimum expenses, this action, in effect, will upgrade the industries' manufacturing techniques and R&D capability.

(5) Leverage mainland China's technology resources and market
The technological resources on mainland China are owned and controlled by the government. Traditionally, innovation activities are mission-oriented under a planned economic model and lack considering of market demand that is very common to a capitalist society. Although mainland China has adopted an 'openness' policy, yet it is still unable to utilize technology resources to upgrade its industrial innovation capability. In Taiwan, the economy mainly consists of small and medium businesses which have leveraged returned students and comparative advantages of labor and land to create a vigorous economy. However, due to limited resources, small and medium businesses have neglected innovation. Consequently, promotion of industry has become a main issue for Taiwan innovation policy. Companies that depend upon cost advantage but have failed to promote themselves have elected to use cheap labor force in countries such as mainland China, Vietnam, e.g. and have made them their production centers to continue leveraging the labor cost advantage. A cross-strait technological system and innovation infrastructure built by both countries is the most promising method for 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.

2. Demand side policy

The purpose of demand side policy is to stimulate market potential and assure the purchase power of customers. The government plays the role of setting up a mechanism for firms to find proper markets with export incentives or deregulation in some specific markets.

(1) Procurement
Due to limited market side, most Taiwan companies adopt export as their major method to enlarge their market. However, government procurement strategy also plays a fundamental role in enlarging their market. Contracts assigned to local businesses can provide them with a suitable and stable market, which are very crucial for an emerging business.

(2) Deregulation
A free market and deregulation have brought economic prosperity to the United States. Deregulation of the transportation, telecommunication, and finance market are considered the fundamental reasons of the emergence of a new economy (Ohmae, K., 2000). Compared to other leading countries, Taiwan's economy is still very conservative. With the coming of a new economy and globalization, deregulation and free market should be considered in Taiwan policy formulation process.

3. Environment side policy

A complete and well-established national innovation system is the best safeguard for industrial innovation. Government policy should be focused on building up the innovation system. In the industry environment, cultivation of superior production factors, encouragement of suitable industrial competition and demand, as well as the creation of relevant industries are the key tasks. In addition, the completeness of the technological system, especially the fortification of environment side policy, will accelerate the speed of knowledge diffusion.

Environment side policy includes encouragement of the emerging of venture capital, establishment of Technomart, supply of favorable financing measures and fortification of the capability of industrial and information supply center.

(1) Development of venture capital
Taiwan government has implemented 'Administration Rules on Venture Capital' since 1983 and provided a number of incentives for investments. However, the subjects of these capitals are concentrated on the matured industries. The capital invested into the emerging industries only represents 10% of total capital. That is against the requirement of investment in the hi-tech industries with high-risk and high-profits. The investment in information, semi-conductor, consumer electronics and communications represents 70% of total fund, showing a tendency of over-concentration. Therefore, the government needs to evaluate the current investment policy.

(2) Establishment of Technomart
The government should set up, or assist private sector to set up technologies trade center. This center will provide a marketplace where the firms with the intention to sell technologies and the buyers for technologies can exchange efficiently. This very kind of mechanism also will accrue to the diffusion of technology and knowledge.

(3) Provide preferential financing measures
The government has a number of incentives to encourage the businesses. However, these measures are not fully implemented thoroughly, so the effects are not satisfactory. Such as tax break designed to encourage the investment in R&D, the criteria for R&D expenses is too loose, some businesses would fill R&D expenses includes irrelevant expenses, thus this policy is not working satisfactorily. The government needs to re-examine the incentives and gradually

abolish the necessity of incentives in order to resume the essence of free competition.

(4) Augment the capability of the industrial information center

There are as many as 1 million small and medium businesses in Taiwan, representing 98% of the total number of businesses. Their abilities to collect, summarize, and apply information are relatively weak. In this regard, the government should assist the establishment of an industrial information system to increase their competitiveness. In recent years, the government set up, either by itself or assisted the private sector to set up, a number of industrial information centers, such as the the China External Trade Development Council, the Industrial Technology Information Service center, and associations for all industries. However, all these centers are not integrated, and thus are unable to provide really useful information or intelligence to users. Meanwhile, the government should reinforce the performance of all existing centers, especially in assisting them to establish a complete industrial database and intelligence, which can become the reference in decision-making.

5. Conclusion

During the first quarter of 2001, Taiwan has witnessed massive layoffs and restructuring of major corporations. A global economic depression seems imminent and is causing concern for corporate and national leaders. It looks as if globalization and cyber-space based movements of goods and capital are the first to blame. While globalization and cyber-space based activities continue to take the stance, development of common international practices and legal infrastructure are still burgeoning. Interdependence in a global economy will continue to move ahead at full steam, and only those who learn quickly to embrace the new world will prevail. Those who fail to do so will be left behind and isolated from the prosperity of the world.

The recent slow down in the global economy and the plunge of global capital markets reflect a continuous restructuring of the global economy. By no means, these trends are a result of a burst or overheating of a 'bubble economy'. Rather, this restructuring will lead to an outcome where those companies, or nations, that have the greatest efficiency and nichmanship, are the most deregulated and most flexible, and that have the most adaptable infrastructure will gain a greater advantage over the long run. Cost-cutting and restructuring will represent an important complementary weapon for staying healthy in bad times for firms operating in the new economy. Investment in public works and controlling cross-border capital flow (into the Mainland) cannot guarantee success. (Look what has happened to the Japanese!) Economic prosperity and better quality should be the prevailing goals for the government and corporate leaders. Knowledge-intensive industries should be the focus. In this arena, flexibility, and non-standardized, externalized operations with an emphasis on dynamic thinking and global manipulation are all prerequisites. Development of knowledge-intensive service industries with a deregulated infrastructure that allows Taiwanese businesses to fully take advantage of their flexibility, pragmatism, and dynamic thinking, should be encouraged. Moreover, construction of needed infrastructure and bylaws is also very urgent.

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