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Understanding the Strategic Stance of Innovation-Driven Industrial Policy: An Ex Post Facto Study

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Abstract

Fierce competition has placed enormous pressure on developing nations to rethink about their approach in industrial policy-making. Conventional approaches of industrial policy, centred on the traditional macro-economic strategy of producing high-value goods and services for international trade, have propelled developing nations to embrace the imperatives of science and technology. Yet, the basic pragmatic question lingers: do these approaches of industrial policy yield the desired economic pay-offs for developing nations? Whilst the answer(s) may be multi-faceted, complex and even country-specific, several lessons may be drawn from the experience of developed nations which have enacted industrial policy to address firms' concerns in innovation pursuits. This paper sheds light, based on an empirical study of *ex post facto* information collected from Singaporean firms, to put in perspective how developing economies could leverage on the strategic role of innovation-driven industry policy.

Keywords: Industrial policy, innovation, technology development, innovation-driven industrial policy, developing nations, developed world and economic competitiveness

Introduction

Economic Progress through Technology Development

Around the world, nations are facing new challenges of economic development due to changes in export trend, international trade and industry restructuring. These new challenges have resulted in greater demands that place unprecedented strain on industries to remain fiercely competitive for survival. In Asia alone, intense competition posed by large nations with vast hinterlands, such as China and India who are competing for foreign direct investments and an increased share of export markets, has exerted enormous pressure on developing nations to rethink about their approach to industrial policy-making. The nations once hailed as Asia's four tigers: Hong Kong SAR, Singapore, South Korea and Taiwan are now experiencing a period of moderate economic growth since the collapse of investor confidence after the Asian financial crisis in 1997. Together with an economic environment plagued by political instability, security threats and public health crises, the economies of these nations have been inevitably affected. To most bureaucrats, it seemed that the market economies of these nations were not, in general, optimally efficient and that there was a role for the government to play in industrial policy-making (Adler, 1989; Padmanabhan, 1993). Thus, as a form of centralised public planning, industrial policy is seen as providing a catalytic impetus to economic development in these developing nations. Even though governments are convinced that new industrial policy can boost economic growth, business leaders at large are sceptical as to whether industry policy-making alone can actually accelerate the economic recovery process (Legge, 1993; Padmanabhan, 1993). Given that past solutions of industrial policy centred on fiscal measures and the avoidance of excessive external imbalances have become less effective, some technocrats believe that high-tech industries will enable developing nations to scale the ladder of economic progress through technology development (Giget, 1997; Grossman and Helpman, 1992).

The MNC Strategy

For many years now, conventional approaches of industrial policy, based on the traditional macro-economic strategy of producing high-value goods and services for international trade, have propelled developing nations to embrace the imperatives of

science and technology. However, economic survival mandates industrial policy-making to ultimately address the overriding motivation of enhancing economic competitiveness and industry growth, which in turn lead to venture creation and employment opportunities. Why, then, are developing nations still pursuing industrial policy through technology development to aid economic progress? The reasons are primarily historical tinged with socio-economic and socio-political influences of nation building.

For almost half a century, multinational corporations (MNCs) from European Union (EU) nations, North America and Japan provided the much needed capital and technology, while developing nations supplied low-cost labour and offered untapped natural resources to be exploited in extensive quantities for commercial gains. This inadvertently led to the pursuit of industrial policies that favour the inflow of foreign direct investments from developed nations. This was crucial because, in the absence of large indigenous firms capable of producing exports on a global scale, developing countries can achieve rapid economic growth by increasing productive outputs beyond domestic demand through the export markets served by MNCs. In the case of Singapore, due to the constraint of a small domestic market, the government was convinced of not embarking on import substituting industrialisation (Kim and Lau, 1995). Thus, about 75 percent of Singapore's manufacturing output and 80 percent of exports are from foreign MNCs. Accordingly, large parts of its service sector such as financial services, hospitality sectors are also foreign owned. As a result, its economic development since independence in 1965 has been remarkable, with an average annual economic growth rate of around 8 percent and this high growth rate was largely attributed to the inflow of MNCs.

Industrial policies of developing nations has thus unwittingly attracted enormous foreign imports of technology; and industrial policy-makers are now concerned about the need to address the over-reliance on these imports (Wong, 1995; Tan, 1995). While MNCs have vast expertise in technology development, one must admit that the indigenous firms of most developing nations, in comparison, have limited training, exposure and experience in science and technology. There are plenty of examples of firms that have actively developed technology but failed to capitalise on the benefits of innovation. In fact, innovation is concerned not about pursuing technology leadership through big research and development investments, but through redefining "marketplace competition" or "changing the dynamics of competition".

Like many developing nations, Singapore was fortunate to embark on the strategy of attracting foreign MNCs during an opportune time since it coincided with an increased interest amongst electronic firms to locate their labour-intensive parts of production outside their home countries. However, in the last few years, there was a greater emphasis on efforts to transform developing economies into "knowledge economies". To meet the new challenges of economic development, developing nations including Singapore realised that they must undergo structural changes to strengthen the ability of indigenous firms to innovate (Collins and Bosworth, 1996; Young, 1995). While indigenous firms have increasingly begun to establish strategic alliances with MNCs to advance innovation pursuits, these alliances tend to be in the form of low-end manufacturing, product improvements and adaptations to assimilate home-grown innovations to new market conditions (Yap, 1997; Tan, 1995). In addition, the popularly held view was that the demand for new innovations should be met by foreign imports of MNCs.

Primary Focus of Industrial Policy

With the rapid changes occurring in the external environment, namely: the global economy, the Asian continent and South East Asia, what should the focus of industrial policy in developing nations be? Amongst the world's three major economies: the United States (US), European Union (EU) and Japan, the US has been Singapore's main engine of growth for more than a decade. By comparison, the EU economy has been far less vibrant than the US and Japan's post bubble economy has been stagnant for many years. Given the Asian economic crisis and the current state of the South East Asian economies, Singapore's reliance on the United States has also deepened considerably (Lee, 2002). Economic analysts are of the opinion that the United States will outperform both the EU and Japan over the medium term. It is also a known fact that the US economy has remarkable resilience and ruthless market-driven efficiency. Also, Japan will take some time to fully sort out its banking and corporate problems even after they have reached a consensus on how to tackle them. To prepare themselves for the challenges arising from the developments in the United States and to ride on the wave of economic recovery, it appears that the developing nations need to rapidly create industries that foster entrepreneurship, high-tech venture creation and global technology development. However, it must be recognised that no single universal industrial policy works perfectly for all countries. As aptly enunciated by Michael Porter's cluster theory, he said: "all regions are different with different competencies and require different strategies for success" (Porter, 1998). One should thus never expect all regions or nations of the world to be identical "silicon valleys" based on the same industrial policy model. Instead, industrial policies adopted for any region or nation must be tailored to a country's socio-economic and geo-political conditions. Therefore, for a small country like Singapore, the need for a primary focus in terms of industrial policy is critical, vital and deliberate; otherwise catalytic economic growth is unlikely to be realised if efforts of industrial policy-making are spread 'too thin'. Only when a strategic focus is attained could industrial policy bear fruits.

Technology Development versus Innovation

While research and development (R&D) may result in cost-effective industrial production, it is well understood that science and technology does not by itself guarantee that an economy may remain competitive. Several questions come to mind: is the impact of technology development on economic progress really significant? Does it improve economic competitiveness considerably for developing nations? Should developing nations place emphasis on technology development as a primary focus of industrial policy? As the questions remain unanswered, another key area of industrial policy-making lies in leveraging the strategic role of innovation as a form of human capital to continuously maintain national economic competitiveness (Geroski, Machin and Van Reenan, 1993; Rothwell, 1992; Grossman and Helpman, 1992). But one ponders, as the two terms are sometimes used interchangeably, what is the key distinction between technology development and innovation? To better understand the differences and similarities between the two, one should examine the accurate usage of these two terms. In the case of technology development, it is stated as follows:

> "Technology development" is concerned with the development of science and technological capabilities to pre-position industries for new emerging and high value-added clusters. It provides a competitive edge for technology-based industries to maintain a leading technological advantage over rivals, but has

> to commit heavy investments to sustain the edge as an entry barrier (Goh, 2002, p. 89).

Put simply, technology development is concerned with "state-of-the-art" issues in science or technology or both; and thereby is primarily associated with technology-based competition occurring in industrial development. As a result, it centres on the supply side of economic development to enable industries to preserve competitive advantages arising from technological imperatives. In other words, by itself, technology development does not fully address the issue of market-based competition. On the other hand, in the case of innovation, it typifies the essence of economic competition as described in the following:

> An "innovation" is the market introduction of a new product or process whose design departs radically from past practice. It may be derived from advances in science, and its introduction makes existing knowledge in that application obsolete. It creates new markets, supports freshly articulated user needs in the new functions it offers, and in practice, demands new channels of distribution and aftermarket support. In its wake, it leaves obsolete firms, practices and factors of production, while creating a new industry. (Abernathy and Clark, 1985, p. 23)

Therefore, in contrast, innovation addresses directly the demand side of economic development. If one analyses how the sources of value creation shift and migrate over time, signs are evident that the value pioneering of economic development has migrated from technology towards innovation. This is because innovation is concerned with the holistic use of scientific, technical, organisational and managerial assets that are key to economic survival and success, especially in a knowledge economy. However, to develop new perspectives along the line of thought that questions the strategic role of industrial policy-making, the economic impact of technology should not be ignored. For instance, as witnessed at the Lisbon Summit in 2000 where the European Union (EU) has placed innovation as a top strategy for the first time, all areas of technology are hailed as potential winners. The positional stance of innovation-driven industrial policy implies that industries which innovate will eventually prevail, regardless of the state of a country's technological advancement (Goh, 2002; Giget, 1997). After all, policy analysts argue that whether an industry remains competitive would be judged by its ability to innovate continuously, and technology development has considerable significance if utilised as innovation inputs. Industrial activists and public policy critics alike have thus maintained that innovation must be the prime consideration of industrial policy-making if nations aim to bolster economic recovery, preserve economic competitiveness and improve venture growth (Porter, 1998; Geroski, Machin and Van Reenan, 1993). These arguments supported the role of innovation-driven industrial policy in economic development; and suggested that technology development must be tailored to aid innovation pursuits.

High-Technology Interventionist Industrial Policy

Interventionist industrial policies are nothing new. One of the most prominent and outspoken proponents of an interventionist industrial policy is MIT's Lester Thurow. At a time when centralised economic planning has been thoroughly discredited, Thurow together with other intellectuals, industrialists and policy makers, continue to argue fervently for greater governmental planning of the economy. Interventionist industrial policies, as they are deemed to be allegedly successful in the United States, are viewed as models for economic development. As a result, the cause of US central planners is to "bureaucratise" the high technology industries with a

government plan. But in reality, the government's record in the area of high technology industrial policies is abysmal. In fact, the Wall Street Journal (1992) characterised the industrial policy of government subsidies for high technology industries as "a 40-year history of commercial technology projects turning into 'pork barrel' embarrassments". As reported in a Brookings Institution study, the findings showed that subsidised technology development programmes were "almost unqualified failures" (Cohen and Noll, 1991). Even when moderate successes may be evident in some areas, it becomes debatable when one considers the opportunity cost – the value of alternative uses of the resources involved. Based on the same study, it was also concluded that the "failure of virtually all high-technology industrial policies is inherent and that governmental institutions introduce predictable and systematic biases into technology development programmes so that, on balance, these projects will be susceptible to performance under-runs and cost overruns". Beneath these findings, notwithstanding the recognition of the growing influence of innovation-driven industrial policy, are there any lessons that developing nations could learn from the United States and the developed world? Given the tendency to adopt the normative rather than effective industrial policy-making, the next best thing is to avoid the "ineffectual approaches" and to understand the "proven claims" and fine-tune them as "feasible approaches" for industrial policy-making in developing countries.

Innovation-Driven Industrial Policy

Technocrats believe that proximity to MNCs is instrumental to the genesis of research and development (R&D); and yet, once resident in developing countries, MNCs tend to be involved in upstream product improvements or mere product adaptations to assimilate home-grown innovations to new markets. A sensible question is raised: is technology development, then, so critical to economic growth that industrial policy-making must particularly favour it or face industrial decline? Based on the experience of developed nations, opinions seem to point towards a common perspective along two main threads of thinking: First, successful industrial policy relating to technology development must be strategically positioned to enable innovation to be a primary driver of economic development; and second, an effective innovation-driven industrial policy does not necessarily have to be pro-technology all the time.

Although technology development provides competitive advantage in almost all aspects of business activities, firms do not need to engage in cutting-edge research and development (R&D) to compete effectively in the marketplace. Studies have shown that firms with virtually any form of skills, capabilities and knowledge can, through infusion of innovations, improve business concepts, systems and processes for commercial gains (Subramanian and Nilakanta, 1996; Rothwell, 1992; Pavitt, 1991). In fact, industrial policy that focuses exclusively on technology-centred endeavours may risk missing the limitless opportunities for improved competitiveness, and the never-ending prospects of new products and services in traditional and well-established industries. In contrast, innovation pursuits create potential opportunities for industrial growth by constantly improving existing products and services. Far from being exclusive to technology-based sectors only, new innovations not only invigorate traditional industries but also rewrite the "rules of the games" in industrial competition. In other words, an innovation-focused industrial development aided by technology development fuels the vibrancy of an enterprise ecosystem that in turn helps build a knowledge economy. While it may be acknowledged that there is currently a plethora of differing perspectives on the best industrial policy for developing nations, researchers are somehow purportedly in

growing support for innovation-driven industrial policy. This has received increasing endorsement in the context of the urgent need for developing nations to meet the demands of global competition and the exigency to transit to knowledge economies as summarised below:

> The significance of another prime candidate to economic competitiveness is dominating the industrial policy ecosystem: innovation. Industrialists have consistently backed opinions that advance the notion that long-term economic progress and industry growth depend almost entirely on innovation. Innovation is central to economic development and is one of the principal determinants of industry growth (Giget, 1997; Rothwell, 1992; Grossman and Helpman, 1992).

Conventionally, the perception of innovation maintains that it is basically technological. Yet, this popularly held, but partly flawed view about innovation is too narrow in today's economic environment shaped by volatile, unstable and revolutionary changes. Notable works of Drucker (1973) claimed that innovation is an economic and social activity, not a technological one, as asserted below:

> The criterion for innovation is neither science nor technology, but as a change in the economic or social environment, a change in the behaviour of people as consumers or producers, as citizens and so on. Innovation creates new wealth or new potential of action rather than just new knowledge in science and technology (Drucker, 1973, p. 62).

Foster (1986) recognised that innovation, being a repeatable economic activity, is born from “individual ingenuity” and does not necessarily have any technological implications. Likewise, Pinchot (1985) reasoned that innovation originates from an underlying motivation to turn an idea into a business success, technological or otherwise, and is an act associated with creating new products or services for the marketplace. Since the “seeds” of innovation may germinate from all aspects of firm’s activities, with almost no confines in contrast to the limits of technology, industrial policy with a central theme on technology development alone is at best sub-optimal. On the contrary, industrial policy rooted with a primary focus on innovation with strong supporting technology development yields more positive results. Then, must an innovation-driven industrial policy be pro-technology to be effective? The answer is more a ‘no’ than ‘yes’.

Technological content does not constitute an elemental requirement for innovation. Many of today’s leading innovators such as Walmart, Starbucks coffee shops, Borders bookstores and Southwest Airlines are not trail blazers of new technology – instead, they seize every opportunity to innovate. Furthermore, technological developments usually do not necessarily create new innovations that market demands. On the contrary, activities that are purely technology-centred tend to produce “mere miracles of science” with low potential for commercial gains. That is why the success rate of high-tech innovations is much lower than that of innovations as a whole. Even though some successes may be achieved, the issue of optimal resource allocation remains unresolved when one considers the opportunity costs involved.

One cannot ignore the fact that the private sector is in the best position, due to its reliance on technology development for knowledge creation, to acquire its own sources of technology. In fact, within the developed world, there have always been collaborative efforts in technology development amongst businesses and interest groups, and the outcomes have always been overwhelmingly well guided by market

forces. One case in point was the American government's US$1 billion involvement to help military contractors develop high-speed integrated circuits (ICs) for military equipment only to find Intel getting there first on their own without federal funding. Hence the best the government can do in this regard is to eliminate potential barriers. As far as technology developmental efforts are concerned, less and certainly not more government interventionist measures would be the best approach to industrial policy-making. In summary, the sole pursuit of technology development constitutes fundamentally supply-centred thinking in economic development while innovation, in contrast, embraces a demand-led approach to catalyse economic development.

Methodology

To examine the strategic role of innovation-driven industrial policy, one cannot observe its impact directly and experiments cannot be conducted under controllable conditions. For this reason, it was ostensibly clear that extracting *ex post facto* information from firms would be particularly apt. To devise an appropriate methodology, trade-offs were made to strike a balance amongst factors with respect to speed, cost and control. Using the sampling techniques suggested by Kish (1965) and Tortora (1978), a three-stage sampling plan is designed to select suitable firms for analysis. The sampling plan comprises the following stages: (1) The first stage selects the industry sectors to implement a cross-sectional study, and (2) the second stage involves a randomized selection of firms to be studied, while (3) the third stage collects data from the selected firms.

The sample consists of firms operating in Singapore so that the contextual elements associated with industrial policy are principally similar since they are all subject to the same legal, political, social, cultural, economic and demographic environment within a single national economy. Ideally, data should be collected exclusively from those firms with sound knowledge of industrial policies. However, firm selection efforts were hindered by the difficulties associated with capturing solely these firms to the exclusion of others. Therefore, the study chose to concentrate on a few "domestic" industry sectors because the institutional conditions surrounding industrial policy differ significantly across nations.

The three chosen industry sectors are namely: (A) electronics and electrical equipment and components; (B) information technology and computer equipment; and (C) multimedia products, as these sectors are widely acknowledged to be experiencing a flourish of new innovations in the Singapore context. A minimum firm's age period is imposed to allow for the effects of industrial policy-making to be observed by firms and hence improve the overall reliability of the empirical data. Only firms with at least three years of innovation experience are analysed.

Random sampling is preferred as it enables the survey to be conducted at a single point of time so that respondents' opinions are comparable. The technique of stratified random sampling was used because it is less biased statistically and more reliable for drawing conclusions beyond the sampled data. Stratified random sampling is structured as a two-step process. One: (a) population firms were compiled from business directories, electronic company guides, industry contacts and networking referrals; and are subsequently short-listed and separated into non-overlapping sampling frames, consisting of potential subjects that represent the three industry sectors identified with an equal number of sampling units for each industry sector. Two: (b) units are randomly selected from the sampling frames to ensure the data sources are not unduly skewed towards certain groups of firms. This is considered to be generally adequate because the chances of being selected are

equal for each sampling unit; and it ensures that the differences in sampling probabilities from beginning to the end of sampling process are negligible.

A survey instrument, designed as a structured questionnaire comprising twenty questions, was employed for data collection. Overall, these questions cover three main areas: (1) profile of the firms, (2) lever of company performance and (3) ten critical points of concern, that industrial policy-making should address in order to develop an innovation-driven economy, using the experience and lessons of developed nations as identified in extant industrial policy literature. Being self-administered, the instrument enables a wider coverage of selected firms, is more cost-effective and efficient for soliciting answers. Extra consideration was paid to balance the need for reliable empirical measures and the potential complications that may arise due to sensitivities when releasing firms' information. Seven-point Likert scales were used for respondents to rate answers. To check the content validity of the survey instrument, a pre-test on "dummy respondents" was conducted. Accompanying the questionnaire was a cover letter addressed personally to heads of firms such as Chief Executive Officers, Managing Directors or General Managers since they typically possess the most comprehensive knowledge about their firms and the industry under which they operate and as such, would be able to furnish more reliable information about their opinions on industrial policy. The protocol for mail implementation, which was carried out over an eight-week period, involved three major mailings of questionnaires, thank-you cards and replacement surveys to a total of 300 firms. These mailings were conducted in succession to generate progressive encouragement to enable more respondents to participate in the survey.

Of the 300 survey instruments mailed to firms, a total of 105 questionnaires were returned. Hence the number of non-respondents from the pool of 300 potential subjects was 195, yielding an initial gross response rate of 35.0%. Despite conducting telephone checks prior to mailing, 12 survey instruments were returned as 'non-deliverables' mails. The reasons cited for non-delivery were 'change in mailing address', 'closure of business' and 'named person has left the firm'. Seven returned questionnaires were unusable because the respondents provided either incomplete answers with unfilled entries or unclear raw data that could be analysed. The two follow-up mailings to the 195 non-respondents yielded an additional 23 returned questionnaires, resulting in a total of returned 128 questionnaires. Because five of these 23 returned questionnaires were incomplete, only data from 104 firms were used for data analysis. To check for self-selection and non-response biases, the answers from the 86 completed questionnaires of the first mailing were compared to the answers from the 18 late respondents of the two subsequent mailings. The results indicated that the answers from both groups of respondents were not statistically different. Therefore the two types of data biases (that is, non-response and self-selection biases) were statistically insignificant and did not pose any problem to the analysis.

The two follow-up mailings improved the net and gross response rates by 6.0% and 7.7% to yield final net and gross response rates of 34.7% and 42.7% respectively. Given that the survey instrument solicited respondents' answers for confidential information about their firms, the response rates were reasonably high in comparison with similar studies. Table 1 provides a summary of the survey responses received from the three mailings across different industry sectors.

Table 1: Summary of Survey Responses

ITEM	INDUSTRY: ELECTRONICS & ELECTRICAL EQUIPMENT & COMPONENTS	INDUSTRY: INFORMATION TECHNOLOGY & COMPUTER EQUIPMENT	INDUSTRY: MULTIMEDIA PRODUCTS	TOTAL
Total Number of Subjects	400	400	400	1200
Stratified Random Sampling				
Number Surveyed	100	100	100	300
First Mailing				
Completed Questionnaires	31 (31.0%)	28 (28.0%)	27 (27.0%)	86 (28.7%)[a]
Non-Deliverable Packages	5	4	3	12
Unusable Questionnaires	4	2	1	7
Number of Respondents	40 (40.0%)	34 (34.0%)	31 (31.0%)	105 (35.0%)[b]
Second Mailing				
Completed Questionnaires	3 (+3.0%)	4 (+4.0%)	5 (+5.0%)	12 (+4.0%)
Non-Deliverable Packages	0	0	0	0
Unusable Questionnaires	1	1	1	3
Number of Respondents	4 (+4.0%)	5 (+5.0%)	6 (+6.0%)	15 (+5.0%)
Third Mailing				
Completed Questionnaires	2 (+2.0%)	3 (+3.0%)	1 (+1.0%)	6 (+2.0%)
Non-Deliverable Packages	0	0	0	0
Unusable Questionnaires	0	1	1	2
Number of Respondents	2 (+2.0%)	4 (+4.0%)	2 (+2.0%)	8 (+2.7%)
Total Responses				
Total Number of Usable Completed Questionnaires	36 (36.0%)	35 (35.0%)	33 (33.0%)	104 (34.7%)[c]
Total Number of Returned Questionnaires	46 (46.0%)	43 (43.0%)	39 (39.0%)	128 (42.7%)[d]

a: Initial Net Response Rate
b: Initial Gross Response Rate
c: Final Net Response Rate
d: Final Gross Response Rate

Profile of Surveyed Firms

From the empirical data collected from 104 respondents, the representative profile of the surveyed firms was determined based on the answers provided to five questions. With the three industry sectors A, B and C taken together as a whole, the mean age of the surveyed firms was 5.17 years old, or about 26 months in excess of the 3-year minimum period in innovation experience imposed under the sampling plan. On average, the surveyed firms accumulated 5.04 years of experience in innovation or almost 2 months less compared to the firm's age. This was to be expected since it takes time for any firm to prepare itself to pursue innovation activities as a company mission. Nonetheless, a large difference between a firm's age and its innovation experience means that the firm manifests a propensity to delay the adoption of innovation as part of the company's business plan. In contrast, the average length of managerial experience in innovation pursuits was shorter at 4.68 years or about 4 months less than that of firm's experience.

In terms of firm size, the surveyed firms employed an average of about 48 persons or more than seven times larger than the mean firm size of 6.83 employees of a Singapore-registered firm. This appeared to suggest that Singapore-registered firms involved in innovation pursuits tend to be much bigger in firm size or the number of employees than the average firm. Undeniably, these firms require innovation competencies and hence more human resources to engage in innovation pursuits to bring about higher levels of business performance. To assess the value-added benefits derived from innovation pursuits, the survey results showed that the firms generated an average of about S$30.5m in annual sales gained principally from new innovations, reflecting its importance to the firms' overall profitability. According to the respondents' answers, the actual sales earnings come in the form of exports, foreign capital investments, equity shares and various forms of quantifiable economic spin-offs.

Survey Findings

To summarise the survey findings, it is beneficial to compare the results alongside with the lessons learnt from industrial policy-making of developed nations. In particular, the success stories of innovation pursuits amongst developed nations in the economic planning process bear testimony to the triumph of innovation-driven industrial policies (Branscomb, 1992; Grossman and Helpman, 1992; Giget, 1997). Based on *ex post facto* empirical data, the overall support for the role of innovation-driven industrial policy was statistically significant as revealed by respondents' scores to all questions. Furthermore, the scores to questions on the level of company performance attained by firms lent credence to the validity of findings. First, out of a maximum score of 7 on a seven-point Likert scale, the mean scores for all the questions ranged from 5.62 to 6.73, thereby indicating measurements varied from "strongly agree" to "absolutely agree". Second, the median scores for all the questions were from 5.51 to 6.42, representing a polar measurement at "strongly agree", which showed that the mean scores were relatively consistent. Third, the standard deviations were all greater than one, ranging from 1.03 to 1.42, confirming that the survey instrument was statistically sensitive for data measurement of the ranked readings provided by the respondents.

Clearly, this research required the reliability of variable statistics to be satisfactorily high to produce consistent data measurements. Hence, to ensure that the statistical means and standard deviations of sampled data did not differ significantly from that of the population beyond a tolerable error, the levels of reliability associated with

each measurement were calculated to determine whether they were indeed consistent within reasonable limits (more than 80%, for instance).

Table 2: Summary of Survey Findings

CRITICAL CONCERNS	MEAN (μ)	MEDIAN	STANDARD DEVIATION (σ)	RELIABILITY (%)
Point 1	6.12	6.15	1.10	92.3
Point 2	6.22	6.19	1.21	93.2
Point 3	6.32	6.31	1.24	94.1
Point 4	6.52	6.38	1.42	92.3
Point 5	6.73	6.42	1.30	91.7
Point 6	6.61	6.36	1.32	95.0
Point 7	6.65	6.38	1.37	94.3
Point 8	5.81	5.92	1.06	93.1
Point 9	5.76	5.67	1.09	92.8
Point 10	5.62	5.51	1.03	93.2
N.A.	6.30	6.17	1.23	94.0
N.A.	6.24	6.13	1.28	94.7
N.A.	6.21	6.10	1.27	91.0

N.A.: Not Applicable

Assuming that the tolerable error (ε) does not exceed 10% to 20%[1] of the standard deviation (σ) of the population, the reliability can be estimated by the probability, described mathematically by $P[|Z| < 0.10\sim0.20\sqrt{n(N-1)/(N-n)}]$, where N and n denote the population size and sample size respectively, and Z represents the normal statistical deviate[2] or simply, the random variable of the normal distribution with mean $\mu=0$ and variance $\sigma^2=1$. If N is very large compared to n, the reliability of each variable can be approximated by $P[|Z| < 0.10\sim0.20\sqrt{n}]$, with the estimation being perfectly accurate as N/n approaches ∞. Since the variables under study constituted those belonging to a small sample (n) from a large population (N), the latter estimation was used. As a general guideline, standard errors of 10% and 20% were used for the binary nominal and the 7-level ordinal scales respectively.

By assuming a standard error of 10%, the estimated computations showed that the levels of reliability for all the scores exceeded 91%, with several scores even attaining a reliability level of 95%. Judging by these levels of reliability for all the scores, the veracity of the survey findings was considered to be statistically high. From the findings on the ten critical points of concern on industrial policy-making, it was revealed that respondents were of the opinion that technology development was of lesser significance than innovation per se. Firms considered technology

[1] Based on the practical concerns of this study, the customary threshold level for a tolerable error (ε) of about 10% to 20% of the standard deviation of the population is considered to be appropriate to separate between insignificant errors from distinctly undesirable ones (Blank, 1984). In determining this level, it is acknowledged that all errors are undesirable but potential errors must be accepted as the price for using a sample instead of a census.

[2] This implies an assumption that the scores on the variables are clustered around the statistical mean in a symmetrical, unimodal pattern known as the bell-shaped curve.

development as initiatives in support of innovation; and preferred to focus on those that would produce innovation spin-offs with direct economic benefits to their firms or industry as a whole. Overall, the survey findings seemed to re-affirm the normative industrial policy model adopted by developed nations. Notwithstanding the limitations of a single-country study, the findings lay the groundwork for future research in similar themes. To develop an innovation-driven economy, the ten critical points of concern that industrial policy-making should address are summarised below:

1. Nurture firms to be innovation-driven in all business endeavours;
2. Promote innovation pursuits to create value-added products and services;
3. Encourage an increase of income generated from innovation pursuits;
4. Foster a culture-based spirit of innovation amongst industries;
5. Forge an innovation-conducive climate to generate commercial opportunities;
6. Champion innovation-friendly rules, regulations and legislation;
7. Push for industries to re-invent economically through innovation initiatives;
8. Build innovation-driven industries in favour of pro-technology industries;
9. Select technology development initiative(s) to support innovation initiatives;
10. Focus on technology development with innovation spin-offs.

Lessons From The Developed World

Even as the survey findings implied that governments should be more proactive, responsive and adaptive in industrial policy formulation, three lessons can be drawn from the experiences of developed nations.

Firstly, the governments of developed nations have recognised, for some decades now, that industrial policy bent on maintaining trade surpluses with heavy reliance on exports make countries economically dependent, vulnerable and susceptible to the rise and fall of demand for export markets. Such industrial policy works less effectively, at times inadequately, in a world of intense global competition. For developing nations to remain internationally competitive in an economic environment whose export trends are ever fluctuating due to forces of globalisation, industrial policy aimed at moderating long-term over-dependence on key export markets and promoting innovation-driven industries stand a far better chance of steering clear of economic stagnation.

Secondly, the outcomes of large-scale technology development plans in developed economies have shown to be abysmal in resource requirements and oftentimes, produce low returns for industry growth. In terms of “economic competitiveness” considerations, effective industrial policy-making must be inextricably embedded with innovation-centred imperatives. Indeed, as supported by Porter’s (1998) four-phase evolutionary model of national competitive development: factor-driven, investment-driven, innovation-driven and wealth-driven categories, the overriding consensus is that if a country aspires to become a developed economy, it must transit to the innovation-driven category.

Thirdly, developing nations should emulate the appropriate features of the industrial policies of the United States, the United Kingdom, Japan, France, Germany, the Netherlands, Canada, and Sweden. These countries were amongst the first developed economies in the world to enact industrial policy that took into consideration firms' concerns of innovation, to replace the more general industrial policies of earlier years after the Second World War. The common thread of thinking surrounding industrial policy-making across these developed nations, who constantly braze new trails in almost all forms of innovation, seeks to build vibrant innovation-

driven industries that consider technology development as only an ancillary economic planning measure. Developing nations can ill-afford to neglect this vital underpinning in today's industrial policy-making if they wish to succeed in the new globalised world.

In gist, the more firms are free to innovate, in terms of creating new products and services, the more vibrant the competition will be, and the more likely industries will grow. While technology development may help to position an economy for future growth, it does not always result in increases of savings, investments and industrial productivity. From the point of view of the developing nations, however, economic competitiveness is dependent largely on institutional capacity and human capital (the ability to innovate, for instance) rather than on the abundance of technological resources. Also, the complex processes involved in innovation pursuits are undermining the effectiveness of traditional pro-technology industrial policy, which places a heavy focus on fundamental research and development (R&D). Clearly, innovation should not be just about research, or science and technology alone, but depends increasingly on organizational, social, economic and other non-technology skills and know-how. Only by understanding innovation behaviour at the firm level and the human complexities associated with it, can governments hope to formulate effective industrial policies that will spur national economies to be competitive.

In the case of industrialisation for Singapore at the national level, with innovations fast becoming sought-after assets for industry competitiveness, industrial policy-making has been centred on innovation. Undoubtedly, a shift in primary focus for industrial policy-making in support of innovation is thus critical, as articulated by the Singapore's Innovation Manifesto, for economic development. Stated as a six-point declaration, industrial policy-making of developing nations should be approached with like-minded ideology as summarised below in Figure 1.

Under the Innovation Manifesto, the Singapore's Public Service elaborated five points for the ingredients of innovation. They are summarised as follows:

1. Innovation takes many forms. Innovation can be a process, product, service, or anything that helps firms to perform better.
2. Innovation can originate from anyone. Anyone can innovate, as innovation requires a mindset that probes perceived boundaries to bring ideas to fruition.
3. Innovation is not creativity alone. Innovation is more than creativity as it begins with an idea and subsequent implementation to produce new value.
4. Innovation is more than improvement. Improvement is the refinement of existing methods to get more output from the same input while innovation breaks new ground, giving new outputs from less or different inputs.
5. Innovation pays in quantum amounts. The impact of innovation results in quantum leaps in value that encompasses effective results.

Figure 1: The Innovation Manifesto

We see Singapore as an Innovative Society that is able to offers limitless opportunities for all in the Knowledge Based Society. The Public Service for the 21st century, as an integral component of society, has to continually re-invent itself to support the innovative and enterprise movement so as to better anticipate, welcome and execute change. In doing so, we will be guided by the following principles:

- People want challenge in their work and recognition for what they do. People want to contribute and know that their contributions matter. Hence, they are motivated to contribute to a worthwhile higher purpose and cause, beyond self-interest.
- Everyone has talent and ability. Each individual has something to contribute and diversity of views must be encouraged for non-linear thinking and analysis.
- People want to improve themselves and can do so. People have an inherent thirst to learn. They can improve given time, opportunity and training.
- Individuals best realise and maximise their creative value through collaboration with others. Collaboration may vary from a network of relations to an integrated organisation. Innovation thrives best in a vibrant environment as opposed to being in a vacuum.
- Everyone thinking and doing will achieve more than a few thinking and doing. This is especially critical for Singapore with our limited manpower, to succeed, we will need to leverage on the diverse knowledge, skills and expertise of every single individual.
- The manager's role is to facilitate and allow his staff to optimise their innovative capacity. By instilling a sense of purpose and creating the broad framework and safe environment in which the staff could operate - new ideas, experiments and change become the norm rather than the exception. Supervisors must move from "managing resources" to "leading and inspiring people". Leadership skills must be honed for the New Economy.

We challenge everyone to ask themselves:

HAVE YOU INNOVATED TODAY?

© Courtesy of the Singapore's Public Service

Hence the role of governments in innovation policy formulation should include a strong learning component as the inherent nature of innovation is about harnessing old and new sources of knowledge, albeit technological or otherwise. Industrial policy-makers must be consciously reminded that technology development, though may be of relevance to economic competitiveness, is only subordinate to innovation. One is related to reducing the costs of production and improving factors of efficiency, while the other is concerned with positioning, directing and overcoming global competition. To put it metaphorically, the former is an efficient tool predisposed to produce incremental changes in national economic performance, whilst the latter focuses squarely on enhancing the strategic competitiveness of industrial development that may achieve phenomenal improvements in national economic growth. It is the latter, which cannot be ignored, that has far-reaching impact on the competitive dynamics of industries and for firms to survive in the global marketplace.

Concluding Remarks

This paper has presented the catalytic role that the government could play in developing an innovation-driven economy. Yet, whether it is on the radar screen of a government's industrial policy map is another matter. Bearing in mind that industrial policy-making only creates the conditions but does not provide all the ingredients for innovation, one can understand why the lessons learnt from the developed nations in relation to an innovation-driven economic strategy are so critical. In the case of Singapore, which chose to industrialise through export orientation rather than import substitution, a focus on innovation-driven industrial policy is implicitly paramount. The intended objective is to promote a "permanent state of restlessness" in economic development – a stance to actively drive every aspect of business to be fiercely competitive. It is also noteworthy to acknowledge that any innovation-driven industrial policy is explicitly based on the effectiveness of a national innovation system. This implies that innovation capacity and thereby economic competitiveness is shaped by a number of economic factors apart from technology development. From the survey, the finings seemed to support the fact that economic growth is largely caused by factor accumulation like the pursuit of innovation. In terms of industrial policy-making to further enhance the national effort of promoting an environment for innovation pursuits, three points are worth highlighting.

Firstly, allegedly successful industrial policies tend to perform an important function in fostering firms to inculcate, internalise and entrench a culture-based spirit of innovation. Industrial policy-making should thus encourage an innovation-focused mindset to permeate all management structures at the human, organisational and societal levels.

Secondly, effective industrial policies must transform economic agencies, statutory bodies and public organisations to champion innovation-friendly rules, regulations and legislation. Industrial policy-making should thus address firms' concerns in enabling various forms of innovations to flourish in all facets of business, industrial or commercial endeavours.

Thirdly, industrial policy must forge an innovation-conducive climate for firms to thrive, and create a wealth of opportunities for industries to re-invent themselves through innovation pursuits. Firms must be encouraged to challenge assumptions about the business world and geared towards creating new market space that encompasses the entire value chain in all aspects of industrial and business activities. If not, the strategic intent of enhancing economic growth through innovation-driven imperatives is unlikely to bear much policy mileage.

In conclusion, with global competition sweeping the economic landscape of all nations, governments should refrain from being overly preoccupied with the constant debate on the economic pay-offs of a pro-technology industrial policy versus an innovation-driven industrial policy. Instead, industrial policy-making must transcend orthodox macro-economic perspectives to prepare developing nations to confront the economic challenges of a fiercely competitive world by: (a) firstly, selecting 'what' to innovate; (b) secondly, learning 'how' to innovate effectively; and (c) thirdly, constantly improving the 'ways' of innovating.

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