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Japanese Approaches to Technology Clusters: Implications for British Columbia

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Executive Summary

Japan is finding innovative ways to increase its economic performance and to address lingering concerns over the stagnation that set in after its 'bubble economy' came to an end in the early 1990s. In particular, universities are now seen as a key resource for innovation. This follows the widely acclaimed success of the US model of local economic development: Stanford University has played a significant role in the success of Silicon Valley, and Harvard University and the Massachusetts Institute of Technology in the triumph of Massachusetts' Route 128 high-technology cluster. By comparison, research in Japan has been concentrated traditionally in-house within large *keiretsu* companies, and this research declined throughout the slow-growth period. Consequently, there is now generally more dependence on university-based research. In addition, regional development policies in Japan stress innovation and the creation of strategic cluster programs involving networks linking local universities and researchers with local industry and local government support for science and technology.

This *Commentary* assesses how the Japanese government, universities and areas outside central Tokyo have responded to these developments by generating policies, strategies and reforms to promote university-industry links, regional cluster programs and local economic policies. Not all regions in Japan have achieved success through the new programs. Nonetheless, there are lessons for British Columbia, which has recently developed its own research and innovation strategy designed to improve competitiveness and promote growth in various technology sectors. What are these lessons? First, based on Japanese experience, cluster studies need to be carried out on the competitive strengths of each of B.C.'s regions and research universities. While local initiatives such as technology cluster developments are valuable, B.C.'s regions need to be well supported by the provincial and federal governments to increase their capacity for long-term sustainability. Second, while university-industry links are growing in B.C., the Japanese experience suggests that more could be done to encourage venture firms based on university research. Third, Japanese practice has shown the importance of local leadership in animating regional clusters and representing the collective interests of local firms. Fourth, Japan's new approach to high technology emphasizes social networks, consequently a 'place to call home' -- such as the proposed B.C. Technology Hub -- could be an important facility to showcase the province's technology, provide support to innovative start-up businesses and evolve into a network of regional technology centres for the province.

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The Commercialization Gap in Japan and British Columbia

The Asia Pacific Foundation of Canada has a long-term interest in benchmarking innovative policy making in Asian economies and exploring lessons for Canada. This *Commentary* builds upon earlier work published in this series[1] and derives from a two-day workshop held March 2007 by the Centre for Japanese Research (CJR), part of the Institute of Asian Research at the University of British Columbia.[2] The Workshop addressed recent approaches to stimulating research and innovation in Japan's localities and regions and whether there were lessons for the province of British Columbia. Key issues examined at the CJR Workshop included Japanese and B.C. comparisons of regional programs, innovation strategies and cluster policies.[3]

While at first glance Japan and British Columbia exhibit considerable differences -- especially in scale and economic structure -- both have committed to comprehensive science and innovation strategies, and both have concerns about the 'commercialization gap' – the challenges faced when trying to move a new and promising technology from academia into a marketable product. As noted by Carin Holroyd (in *Canada Asia Commentary No. 42*), the Japanese government in recent years has taken a major initiative to boost its science and technology policies, and to promote the marketing of university research -- in life sciences, medicine and pharmaceutical products, robotics, electronics and information technology (for a chronology of recent policy initiatives in Japan see Table 1). British Columbia is similarly concerned with the `commercialization gap'. It has top-notch universities with excellent capacity in creating research but overall has low capacity in building innovation and generating commercialization. Most high technology firms in B.C. are small and there is a problem of developing these to international scale. Indeed, the emphasis in Japan placed on encouraging a new generation of small 'start-up' companies in its hinterland is particularly relevant as B.C. is largely an economy built up of small-firms, so Japanese experience is relevant.[4]

The new direction in Japanese policy has seen for the first time the promotion of the commercialization of university research. There is also now support for science and technology in regions away from the capital city, Tokyo. In this respect the Industrial Cluster Project of the Ministry of Economy, Trade and Industry (METI) and the Knowledge Cluster Initiative of the Ministry of Education, Culture, Sports and Science and Technology (MEXT) are notable. They are both designed to overcome the perceived isolation of small firms in outlying regions following the decline of the *keiretsu* system (vertical integration within large enterprises). The general aim is to build up inter-firm networks and encourage universities, along with governments, to play a more active role in local economic development. In addition, national industrial and science and technology policies are directed at strengthening university-business linkages at the local level.

The importance of a regional or local approach to innovation is also supported by the research literature in this field and an increasing global interest in the role of technology clusters.[5] Although the initial work on innovation systems focused on the national level, an emerging body of studies has applied the concept to the regional and local level. The importance of Professor Michael Porter's ideas on cluster development and competitiveness has been influential in both Canada and Japan. In Japan, as elsewhere, the view has emerged that regions within countries should take on a greater significance in an increasingly globalized world. In particular, there is recognition that innovative capabilities are sustained through local and regional communities of firms and supporting networks of institutions that share a common knowledge base and benefit from their access to a unique set of skills and resources. Many of the factors critical to developing an innovative capacity remain embedded in local networks and communities of firms and supporting infrastructure operating in research and training institutions, financial intermediaries, government agencies, as well as community and business associations.

Improving productivity in Japan depended not only on making regulatory changes in its financial frameworks and labour markets -- reforms that tend to be the most discussed in national politics -- but also on the ability of local firms, supported by research institutions, to increase their level of innovation and technology development. In order to compete internationally, regions of Japan outside the core locations around Tokyo need to build and better harness the knowledge assets they possess. This *Commentary* examines the reasons behind the new focus in science and technology in Japan and the shift away from the link between 'large government and large firms' toward more regionally-based programs designed to support smaller firms and start-up ventures, and then details the new support programs themselves. It finishes with some ideas on how Japan's new approach can help policy-making in British Columbia.

Table 1: Chronology of Policies to Promote University-Industry Links, Regional Clusters

1983	Subsidies for joint university-industry research.
1987	Establishment of cooperative research centres at national universities.
1995	The Basic Law for Science and Technology Policy.
1996	The First Five Year Science and Technology Plan (1996-2000).
1997	Relaxation of restrictions on consulting and business activity by faculty (1997, 2000, 2002).
1998	Report on Innovation by a Research Group (MITI). Law for Promoting Technology Transfer from Universities (TLO Law). Reduction of patent fees for approved TLOs.
1999	Japanese version of Bayh-Dole Act. End of the Technopolis Law and the beginning of Local Platforms for regional development.
2000	Law to Strengthen Industrial Technology. TLOs allowed to use national university facilities free of charge.
2001	2nd Science and Technology Basic Plan (2001-2005). Hiranuma Plan for 1,000 university start-ups in three years. METI launched Industrial Clusters Initiative and MEXT launched Knowledge Cluster Initiative and City Area Program.
2004	National University Reformation Law.
2006	3rd Science and Technology Basic Plan (2006-2010).

Regional and Local Approaches to Innovation in Japan

Unlike Canada, Japan has a unitary national government with control over regional development with an aim of equalizing and balancing development. Over the past 40 years Japan has pursued active and consistent centrally directed regional programs aimed at dispersing growth away from Tokyo and other large cities. The aim of these policies, which combined with a complex revenue-sharing system (the Local Allocation Tax accounts for about 30% of local government revenue), has been to establish balanced development across the nation. Regional policies have had a significant impact on patterns of economic activity and employment, counteracting polarizing pressures favoring its Pacific industrial zone (Tokyo-Nagoya-Osaka/Kobe) by rapid post-war economic growth as well as large-scale internal migration flows. It has contributed to relatively low levels of disparity in income per capita.[6] On the other hand, there has been much less success in fostering dynamism and creative capabilities in Japanese localities outside Tokyo-Nagoya-Osaka, especially in creating successful new high technology complexes. For instance, the much-touted 'Technopolis' program was designed to supply infrastructure projects (such as science and technology parks) and associated institutions in peripheral locations to assist high-technology manufacturing locate away from the core Pacific industrial belt. Evaluations of the Technopolis program, however, revealed that its limited success at decentralizing high-technology production lay for the most part in promoting branch-plant operations.

Economic changes over the 1990s to some extent overtook Japan's traditional approach to industrial and regional policies. The prolonged economic slowdown and deteriorating fiscal situation during the decade called into question many of the programs involving the direct support of local governments and intergovernmental transfers around which territorial policy was previously built. Moreover, during the past few years the pace of 'off-shoring' mass production operations to China and the deindustrialization of many mature Japanese industries has increased; many local areas have seen manufacturing employment decline and plant closures. This has been combined with population slowdown and loss in many regions. In addition, an increasing emphasis on decentralization to cities and prefectures by the national government has suggested the need for a new approach that balanced centrally driven territorial policies with the assignment of a greater voice to regional and local actors. The trend has been away from measures based on supporting the relocation of factories and other functions away from large cities to policies that emphasize innovation-led and cluster-based regional competitiveness policies and which utilize local resources and deregulation to foster development in targeted regions.

The result of this evolution is that regions are now seen from the perspective of 'innovation systems' and capacities embedded in each locality -- such as labour skills, local knowledge and access to materials and education -- rather than the factories themselves (many of which have downsized or even relocated off-shore). These innovation assets -- involving sector specializations, skilled labour, research facilities, networks and supply chains -- are now

▲ With a declining workforce and concerns over stagnation, Japan sees innovation as the way to increase its economic performance.

viewed in economic policy circles as key drivers in the revival of Japan's competitiveness. Besides physical proximity itself, the shared regional culture that often comes with physical proximity -- i.e. collective practices, attitudes, expectations that facilitate the flow and communication of tacit and other forms of proprietary knowledge -- has become the cornerstone of an implicitly 'regional' system of innovation.

The main policy issue therefore has been how to generate policies that will allow regions to develop innovation systems to better seize emerging opportunities as well as to confront their current challenges. These programs to generate sustainable growth will be fundamentally different from those that were implemented in the past. The following sections look at different aspects of developing an innovation regional policy in Japan:

-development and support for technology clusters[7]
-linking university research and industry
-local government initiatives

(a) Development and Support for Technology Clusters

METI's Industrial Clusters

The policy of developing symbiotic clusters of small and medium-sized enterprises (SMEs) where expertise and skill could accumulate commenced in Japan during 2001. At this time METI established an Industrial Clusters Program designed to upgrade existing industrial complexes and to help Japan's regions develop technological strengths. The aim was to encourage existing SMEs to emphasize innovation and to stimulate the start-up of new technology-based businesses. Typically, new technology-based ventures in Japan in emerging fields, such as life sciences or information technology, lack cash flow and reputation, require further product development support, and need to obtain intellectual property protection. During the first stage of this program (up to 2005) much effort was spent by the nine Regional Bureaus of METI in establishing networks of local SMEs, universities and public research institutions according to local industrial strengths, and setting common objectives for each cluster project.

The semi-rural fringe beyond the eastern suburbs of Tokyo (known as the Tama region) became industrialized as enterprises moved out of the inner city and coastal areas around Tokyo Bay during the 1960s and even before -- due partly to high land costs, environmental regulations and factory restriction laws -- to find less congested areas for industrial location. The area developed through the growth of the transportation equipment industry, precision machinery and other technologically advanced sectors. Despite being sub-contractors for large firms, the SMEs that came to the Tama region cultivated strong product development capacities. But as Japan's large firms moved their own assembly factories overseas or contracted their operations during the 1990s, the smaller firms located in Tama lost a considerable part of their customer base. However, a 1996 White Paper on SMEs noted that firms with the characteristics of those in the Tama region could maintain their competitiveness through networking with other similar producers and also with research generators, such as universities and laboratories. The Tama region, which stretches over three prefectures and 74 municipalities, contains more than 300,000 small businesses and about 40 universities. Of these, about 300 area companies and 34 universities are members of the TAMA association supported by METI's industrial cluster project.

METI has also encouraged cluster development organizations elsewhere in Japan. In the northern island of Hokkaido, a Super Cluster Project has been formed to promote biotechnology and information technology (IT) industries. Whereas TAMA is focused around parts of a huge and industrially dense metropolitan region, the Hokkaido project has a wider area and networked character involving 16 universities, five public research institutes, and nearly 300 companies in four non-contiguous locations within the prefecture (See Box 1).

Box 1 : The Hokkaido Super Cluster Promotion Project

Hokkaido is the northernmost of Japan's four main islands. It has a population of around 5.6 million (about 4.6% of Japan's total) and, like British Columbia, is rich in natural resources and agriculture. Livestock, marine products and the pulp industry are major sectors of the economy. Hokkaido University, which is a national government university, has helped the development of these industries through its research on biotechnology and agriculture. Since 2001, METI has worked to form and expand science and technology networks in Hokkaido focusing on the potential of both biotechnology and IT.

The development of the biotechnology cluster has been led mainly by university ventures and SMEs as there are few large firms in Hokkaido. METI built on an existing research support organization founded in the 1980s that already initiated inter-company exchanges. These were deepened and developed after 2002 when full-scale implementation of the Industrial Cluster Project was commenced, leading to an expansion of interactions between firms in agriculture, food processing, research support, cosmetics, pharmaceutical and medical industries, and equipment manufacturing. In 2005 this network consisted of some 96 companies, 21 universities and public research institutes, two local government organizations and 82 financial institutions and other bodies throughout Hokkaido.

Sales by firms in this network in fiscal year 2006 were estimated to be around ¥40 billion (about $360 million). One major spin-off has been research on the ecology of `Gagome Kelp' in the city of Hakodate, and the effective use of its healthy ingredient (Fucoidan). Local companies and university spin-off ventures produced many products utilizing Gagome Kelp with an economic benefit of over ¥1 billion. With similar venture businesses originating from universities, Hokkaido has suddenly become a new centre in this field within Japan. Above all, the number of bio venture businesses in Hokkaido more than doubled in the five years to 2006 and Hokkaido now has the largest number of such companies in Japan.

Hokkaido's IT cluster is the second dimension of cluster planning on the island. The sector emerged during the 1970s, mainly based in the main city, Sapporo, through the efforts of researchers at Hokkaido University and other universities in conjunction with entrepreneurial firms such as B.U.G., Hudson and DB-Soft Tomcat. These companies provided the core software for microcomputer games developed by leading manufacturers such as Sharp, Fujitsu and Sony during the first half of the 1980s. Numerous spin-offs from these entrepreneurial start-ups stimulated further cluster development over the next 20 years. The city of Sapporo constructed the Sapporo Technopark based on the growth in software companies and in 1988 large firms such as IBM Japan, Nihon Unisys and Matsushita Systems Engineering decided to locate branch offices in the park.

In the latter half of the 1990s the economy of Hokkaido was in a severe downturn, while the economy of Sapporo city was so stagnant that some local banks and food firms went into bankruptcy. During this period, however, the software industry showed a steady growth creating many jobs and the tag 'Sapporo Valley' emerged, mirroring the term 'Silicon Valley.' The national government took various measures to support Sapporo. METI established the Hokkaido Super Cluster Promotion Project in 2001 as an Industrial Cluster Plan. Since then, this local industry has continued to grow as a result of spin-offs from venture companies and new entries of major vendors into the software development business. However, a major weakness of the cluster is that while Sapporo's IT industry has become well known in Japan, most local firms operate by taking orders from larger 'hub' companies in Tokyo. For this reason many local IT enterprises have rarely dealt with other firms located in 'Sapporo Valley' – hence the need for METI intervention in order to strengthen local networks. Moreover, the repeated spinning-off of firms with an aggressive venture spirit has worked against the creation of any large-sized IT companies in Hokkaido. In addition, their relationship with overseas firms has generally been weak and the marketing of Sapporo's IT industry outside Japan is a challenge yet to be addressed, together with strengthening the marketing capability of each firm. Nonetheless, the Hokkaido IT Cluster Forum had 298 participating companies as of March 2006 in fields such as embedded technologies, open source software and geographic information systems. METI is now focusing on the international competitiveness of this cluster utilizing its underlying strengths.

Source: JETRO (2004) Anecdotal Survey of Regional Clusters in Japan; METI, The Industrial Cluster Program 2006, http://www/cluster.gr.jp/; MEXT, The Knowledge Cluster Initiative 2006, http://www.mext.go.jp/a_menu/kagaku/chiiki/cluster/h18_pamphlet_e.htm.

Apart from the Tama region and Hokkaido, the nine Regional Bureaus of METI have worked in cooperation with private networking assistance organizations -- such as existing industrial associations -- and local governments to set up an association of people from industries, academic communities and government agencies for cluster projects throughout the country. Often these cluster networks have had to be generated from scratch; consequently, much time was spent by METI bureaucrats in visits to individual companies and research laboratories, introducing businesses to local research facilities and finding matches of research and business opportunities. Private institutions were established to serve as centres for implementing each project, cluster leaders identified, and grants provided for various activities -- holding workshops and dispatching experts to small firms to assist in areas such as intellectual property management and business marketing.

R***esults and Evaluation***

By the end of 2005 regional officers of METI had started 19 industrial cluster projects (currently rationalized into 17 projects), with around 6,100 participating companies and around 250 universities. Starting from fiscal year 2005 (ending March 2006), cluster managers for each project were designated by METI from people having experience working at private businesses to serve as a one-stop points of contact to and from outside. METI also provided further grant programs for universities and firms taking part in each network. In addition, it has been able to help with finance for setting up companies and support measures for intellectual property management, research and development supporting cluster-based technologies, as well as marketing, training and business incubation. [8]

Parallel to the formation of cluster organizations, the first term of the program aimed at launching new businesses from member companies involved in the cluster networks. During the three years up to fiscal year 2003 the program overall initiated around 17,000 new businesses throughout Japan, and this number was expected to reach around 40,000 by the end of fiscal year 2005. As well, METI recorded 708 partnerships between researchers and private companies and 145 cases of successful technologies transferred to local industries. Presently, the efforts of METI's Regional Bureaus together with private-sector promotion organizations have built close cooperative relations with about 800 regional SMEs in the 17 cluster projects (close to 1% of the nation's total) taking on the challenge of generating new businesses, together with researchers from more than 290 universities.

The next phase of the Industrial Cluster Program is from 2005-2010 and builds on the results achieved and lessons learned from the first term of this program. Concrete plans and evaluation measures have been set for each of the 17 projects, such as how many new businesses should be established within the next five years as well as sales targets for the local networks. Priorities for new technology were set in fields designated for Japan as a whole, namely fuel cells, robots, environment/energy and other sectors. METI allocated around $575 million for these activities in fiscal 2006. As already noted, in the Second Term Industrial Cluster Plan a major target is the creation of 40,000 new businesses. It is hoped that the 17 Industrial Clusters will be self-supporting by the end of a 20-year assistance process.

MEXT's Knowledge Clusters

Whereas the METI Industrial Cluster Program concentrates on helping existing industrial complexes to develop technological strength, the Knowledge Cluster Initiative of MEXT focuses on universities. The aim is to encourage institutions to work with firms in local areas, as well as with financiers, to commercialize new technologies. MEXT will invest about $500 million over five years in 18 designated cluster areas (see Figure 1). In addition, 48 smaller areas were designated under the Cooperation for Innovative Technology and Advanced Research in Evolutional Area Project (also known as the 'City Area Project'). Taken as a whole, the intent of these

programs is to complement the more industry-focused cluster program of METI and to reform and upgrade the R & D systems in regions by improving the flow of research from and between universities, by networking other principal stakeholders and providing seed funding for joint activities. The emphasis is on encouraging stronger face-to-face interaction between the various actors who are likely inadequately connected at present.

Source: MEXT, *The Knowledge Cluster Initiative 2006*, http://www.mext.go.jp/a_menu/kagaku/chiiki/cluster/h18_pamphlet_e.htm l.

Figure 1: Knowledge Cluster Initiatives

1 - Sapporo IT Carrozzeria cluster (IT)

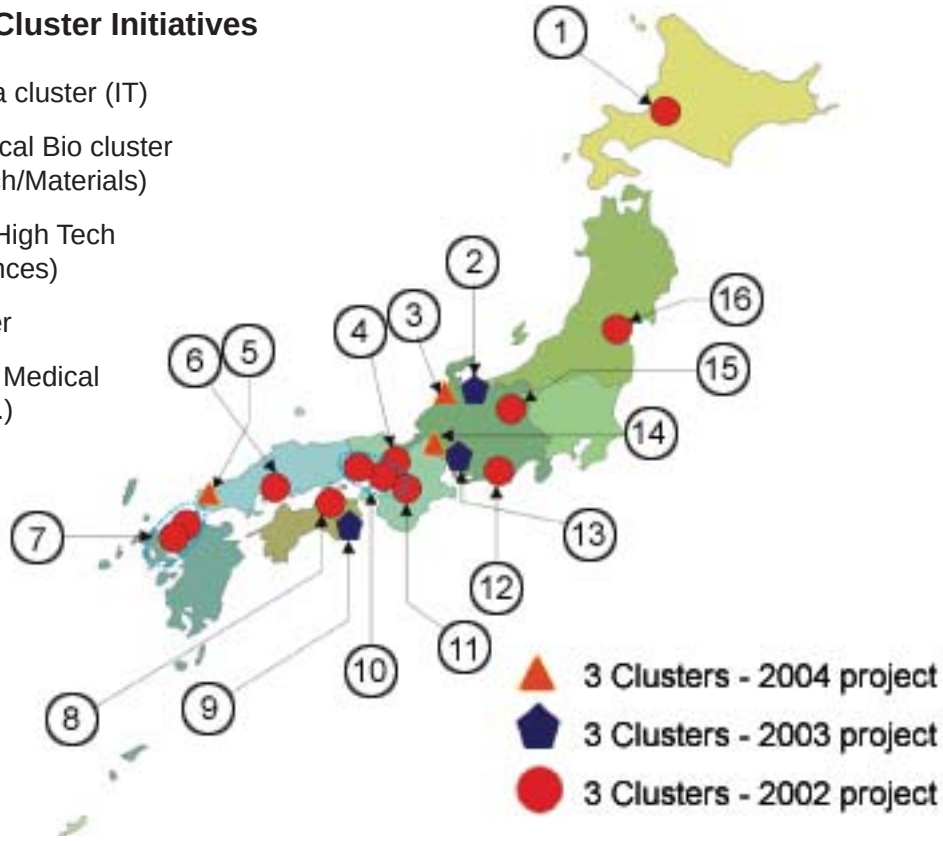
2 - Toyama/Takaoka Medical Bio cluster (Life Sciences, IT, Nanotech/Materials)

3 - Kanazawa – Ishikawa High Tech Sensing Cluster (Life Sciences)

4 - Kyoto Nanotech Cluster

5 - UBE – Yamaguchi Ube Medical Innovation Cluster (Life Sc.)

6 - Hiroshima BioCluster (Life Sciences)



7 - Kyushu Wide Area Cluster Fukuoka System LSI design and Development Cluster (IT)
Kitakyushu Human Technology Cluster (IT, Environment)

8 - Takamatsu Rare Sugar Biocluster

9 - Tokushima Health and Medical Cluster (Life Sciences)

10 - Kansai Wide Area Cluster Northern Osaka – Saito Biomedical Cluster (Life Sciences)
Kobe Transnational Research Cluster (Life Sciences)

11 - Kansai Science City (Life Sciences, Environment, IT)

12 - Hamamatsu Optronics Cluster (Life Sciences, IT)

13 - Nagoya Nano-Technology Manufacturing Cluster (Environment, Nanotech Materials)

14 - Gifu/Ogaki Robotics Advanced Medical Cluster (Life Sc.)

15 - Nagano/Uedo Smart Device Cluster (Nanotech Materials)

16 - Sendai Cyber-Forest Cluster (IT)

The organizational structure for each Knowledge Cluster is similar although each has its own specialized technology base. The MEXT program was designed so that local governments could initiate the start of each Knowledge Cluster project by filing an application for support with the national government. Local governments were then required to designate a 'core organization' -- usually a science and technology foundation -- to oversee implementation of the project. Eighteen core organizations have been set up as Knowledge Cluster Headquarters and staffed with a Project Director, a Chief Scientist, Science and Technology Coordinators and other experts to manage intellectual property research as well as to promote university and local business linkages. A team of science and technology coordinators and experts, such as patent lawyers, animate the cluster by bringing the various groups into contact with each other through seminars, forums and so on. The science and technology coordinators also assist participants in establishing research priorities, identifying areas for collaborative work and identifying possible commercial and patent related activities aimed at supporting R&D needs. The general objective is to fuse technology with regional development.

▲ The Japanese government has made a major initiative to promote the marketing of university research in robotics.

Four key scientific fields were identified in the Second Science and Technology Basic Plan which was established by the Japanese Cabinet in March 2001 – life sciences, IT, environmental technologies, nanotechnology and new materials.[9] At present there are nine life science Knowledge Clusters, including the Hiroshima Biocluster based on the national government's Hiroshima University, where yogurt and soap have been manufactured from the residue of Japanese rice wine or sake production. There are five information technology clusters in this program (counting one in Sapporo based on developing IT for manufactured products), one cluster based upon environmental technologies, and four in nanotechnology and new materials.

MEXT funds cover the operating expenses of network associations established under both the Knowledge Cluster and City Area Programs. About $100 million was allocated in fiscal year 2005 for this program, amounting to around $5 million per year for each Knowledge Cluster, with most of the funds allocated to the establishment of 'core organizations,' staffing these with science and technology coordinators and advisers such as patent attorneys. Funds also went to conducting industry-academe-government joint research at university joint research centres or other institutions, patenting research results, and conducting R&D relating to business incubation for new ventures. The 48 City Area Programs each attracted roughly $1 million per year for establishing the initial stages of urban-based research and business networks.

Clearly the two cluster programs have different emphases. METI focuses on industry and MEXT focuses on universities and public research institutes, with MEXT supporting research and technology development and METI supporting downstream commercialization.

Cluster Program Challenges and Overall Appraisal

There are at least three dilemmas that cluster projects will need to address and which must be overcome to ensure that these projects make a substantial contribution to the revitalization of local economies. First, there is the difficulty of evaluating what essentially are long-term programs. Not all projects have made good progress over the first five or so years, but it is hoped that some are destined to lead to the revitalization of regional Japan and assist the revival of the entire country. Realistically, a 20-year time horizon is necessary before these clusters will be self-sustaining, although a number of spin-off firms and new products are expected before then. During this period it will be hard to separate the effect of policy intervention from other variables, such as the state of the national economy. The progress of various projects and target setting in terms of scale of new firm creation, as well as other goals such as cluster group sales, depends on particular technology fields and the context of individual region themselves. In other words, different clusters evolve in different ways depending on particular technologies and local contexts. It is problematic for bureaucrats and even experts to evaluate the prospects for new technology before the stage of commercialization.

Second, it is necessary to expand cooperation in implementing regional clusters between Japan's various national ministries, including MEXT and METI. Ideally, MEXT's knowledge clusters must be market and industry driven, and METI's industrial clusters must find 'research seeds' for new products and processes from local universities and research institutes. So there is a need for greater coordination between their operations. The network-based approach is similar in both types of cluster programs and there is the obvious potential for participants and beneficiaries of the two programs to overlap constructively. Indeed, channels of cooperation between the two programs have already been established and the functional complementarities between them are also becoming more apparent. For instance, the Sapporo IT Creation Project in Hokkaido (one of the METI projects mentioned in Box 1) and the MEXT-supported Hokkaido IT industry Carozzeria Cluster Initiative have both been active in developing new technologies and helping firms to incorporate these new processes respectively. In the Japanese context, national regulations under the control of other ministries are also sometimes a constraint -- for instance, various controls imposed by the Ministry of Health on the production of pharmaceuticals. Other challenges for the Japanese government include trying to find a balance between successful clusters in the major cities of the Kanto (Tokyo) and Kansai (Osaka/Kyoto/Kobe) regions and those in more peripheral areas of Japan, such as Hokkaido and Shikoku.

Third, a strong commitment by local governments and other local stakeholders is important. Clusters cannot be merely imposed in the outlying regions of Japan by central government ministries alone. Local players must be involved and increase both their national and global connections. It is particularly important that inter-cluster exchanges are promoted. In this regards, some clusters have already made exchanges with overseas partners. For example, the Kinki bio-business project supported by METI has signed a memorandum for information exchange on regenerative medicine with Pittsburgh in the United States and Berlin in Germany. Also, the MEXT Knowledge Cluster projects must be more than just a compilation of local scientists, especially as some university researchers involved are rather unresponsive to market needs. This leads to consideration of new policy initiatives designed to foster the link between research and innovation and commercialization in Japan more generally.

(b) Linking University Research and Industry

In the fields of science and technology, Japan has been a late-comer in the attempt to make university research an engine of economic innovation and

competitiveness. Traditionally, Japanese universities have been criticized for their poor quality and lack of international competitiveness in higher education and basic research. Nonetheless, over the last few years, the Japanese government has introduced a number of changes to the organization of its national universities, the flagship of the country's higher education system.[10] In particular, universities in Japan are rapidly establishing Technology Licensing Offices (TLOs), venture business incubators, collaborative industry-research centres and other programs to promote research commercialization. The 1999 Industry Revitalization Law (also known as the Japanese Bayh-Dole Act after its US predecessor with similar objectives) reduced obstacles to collaboration between universities and private enterprises and also allowed private firms to acquire intellectual property rights from publicly-funded research. In 2004, the national universities' role changed substantially and they are now incorporated as agencies independent from the government. Previously, national universities had no self-determining corporate status and so, for instance, they could not be a patent agency and manage intellectual property. Following the reforms, universities can own intellectual property and private firms can deal directly with universities to negotiate over patents and royalty fees. This has stimulated the growth of TLOs, of which there were 41 as of 2005. As a result, the number of joint research projects between universities and industry has grown together with the number of patents granted, royalties from industry and the number of university-led start-up firms.

By way of illustration, there is a novel 'support triangle' to champion industry-cooperation at the University of Tokyo. This involves, first, the University Corporation Relations of the University of Tokyo, which is the managing entity for intellectual property management; it supports joint research with industry through its 'Proprius21' scheme. Second, 'Toudai TLO' is the operating entity for creating intellectual property and it is involved in marketing licences to companies. Finally, the University of Tokyo Edge Capital (UTEC) Fund supports the start-up of university-oriented venture businesses, both in terms of finance and also human resources. Together, these facilities support the flow of intellectual property from researchers to industry.

While the University of Tokyo is nationally or internationally oriented and of sufficient size to create new technologies for use throughout the country, other universities have a smaller and more regional or local focus. Ritsumeikan University's Shiga prefecture campus is a good example. The Ritsumeikan Trust is the legal entity that operates the entire Ritsumeikan Academy, which is composed of two private universities located on four campuses. Ritsumeikan University operates a medium-scale science and engineering campus in Kusatsu city, Shiga Prefecture, in western Japan. It receives support from regional partners and plays a role in local economic development by interacting with Shiga-based manufacturing firms. It cooperates with other stakeholders in the region including the Shiga University of Medical Science, local governments and Ryukoku University. In turn, Ritsumeikan University is supported by local small companies that dot the Shiga landscape. Indeed, the number of commissioned and joint research projects with industry almost quadrupled after Ritsumeikan University opened its second campus in the heart of the Shiga industrial area south of Lake Biwa in 1994. Joint research with local industry covers wireless transceiver equipment, illumination systems for elderly persons, intelligent robots and sensor equipment, and 3-D imaging equipment. Ritsumeikan faculty research is particularly strong in the area of robotics. In 2007, Ritsumeikan University had 22 firms operating in its Kusatsu campus incubator where there is a five-year limit on occupying a laboratory and office. The goal is the commercialization of products to IPO stage. Other Ritsumeikan University programs foster local entrepreneurs, through special classes and a student venture enterprise competition.

(c) Local Government Initiatives

Finally, there is a strong interest by Japanese local governments in linking local enterprises into national and regional government policies, and generating local approaches to research, technology development, diffusion and innovation. Indeed, the 1995 Science and Technology Law mandated this task for local governments for the first time. Many local authorities have subsequently taken a proactive role based on their own circumstances, which, as noted earlier, is revolutionary as regional economic policy in Japan has traditionally been centrally directed. As a result, regions and smaller cities had little experience in driving their own regional policy agendas. Nevertheless, prefectural governments and cities outside Tokyo are becoming more active in the innovation field in response to the extensive incentives offered by the national government. Many prefectures and cities have established councils to discuss science and technology promotion policies, and have taken other measures that include the formation of guidelines for their own science and technology policies. As of 2003, about 50 local governments had set up science and technology councils as well as formulated science and technology promotion guidelines.

An important change triggering more local initiatives in Japan was a law enacted in 1999 (Law for Facilitating the Creation of New Business) that replaced the former 'Technopolis' program, which was designed to encourage the decentralization of high-tech industries. Its aim has been to utilize the initiative of local governments to establish 'local platform' projects. The local platform is a comprehensive support system to provide one-stop service in each local government and to support each step from research and development through to the establishment of business ventures. This is done by setting up networking and industry-assistance organizations and establishing a variety of support mechanisms for local entrepreneurs. In order to improve this system, the coordinators that comprise the regional platform organizations throughout Japan have set up the Japan Association of New Business Incubation Organization (JANBO) aimed at promoting new firm creation in local communities. This approach has given smaller cities and prefectures far more autonomy and responsibilities in the field of promoting innovation. Indeed, the geographical limitations that applied to the Technopolis program – mainly through preferences given to peripheral locations – no longer apply as every region in Japan now needs technology innovation for economic sustainability.

Kyoto Research Park, run by the private sector but with substantial local government input, is a successful example of the new law in practice (see Box 2). Another illustration is the Kobe Medical Industry Development Project, the core support organization of Kobe City's Local Platform Project. This project is located on the second stage of Kobe's Port Island jutting into Osaka Bay, where the city is trying to construct clusters focused on the medical and pharmaceutical industry, including medical equipment. Institutions supported by the city are the Centre for Developmental Biology and the Institute of Biomedical Research and Innovation, while another institute looks after basic research in clinical medicine. Other centres located on Port Island include the Kobe International Business Centre (KIBC) and the Business Support Centre for Biomedical Research Activities (BMA) -- established in 2003 as a major incubation institute for supporting bio-venture businesses. These and other public institutions have attracted 70 private firms to the Kobe area.

▲ Innovation extends even to controlling the human the environment. Ocean Dome, the world's largest indoor water park, defies the elements with a constant air temperature of 30 degrees C.

Box 2 : The Kyoto Innovation System and the Kyoto Research Park

Kyoto, 400 km south of Tokyo and one of Japan's oldest cities, was the national capital for over a thousand years from the 8th century. The unique traditional culture of Japan, focusing on precision, delicacy and refinement in fields such as flower arrangements, tea ceremony and dyed fabrics developed in Kyoto. Based on this tradition, research institutes, such as Kyoto University and Kyoto Institute of Technology, have developed advanced science, such as nano-technology. Amid the Buddhist temples, pottery artists and kimono weavers of this former capital are some of the country's most nimble companies. Among them are game-maker Nintendo, custom chip maker Rohm and electronic components leader Murata Manufacturing – all high-tech manufacturers that grew to global prominence in recent decades. Furthermore, triangular cooperation between private industries, governments and universities is very much alive in Kyoto. Now the city is trying to lead another wave of Internet, multimedia and software-based industries. In 2005, Kyoto was home to an estimated 300 high-tech start-ups, including Honya-san, which aims to be the Amazon.com of Japan.

The city of 1.3 million offers start-ups a number of services:

- Mentors: In 1997 Kyoto executives formed a committee to review the business plans of aspiring entrepreneurs. A grade of `A' can be taken to local banks for loans that the city will guarantee.
- Links to academia: Kyoto's 40 universities and colleges bring together faculty, entrepreneurs and bright minds.
- A place to call home: Many new companies are clustered in the Kyoto Research Park, considered to be among Japan's top company incubators. This privately run park supplies low-cost office space, high-speed data lines and a network of services for start-ups (see Figure 2). Included in the Park are a number of key support institutions for SMEs, including the Kyoto Prefecture Centre for Small and Medium Enterprises; the Advanced Software Technology and Mechtronics Research Institute; and the Kansai Technology Licensing Organization.

Kyoto is trying to shape younger minds, too. At the Centre for Entrepreneurial Education, materials are being developed to spur creativity in 12-15 year olds. Student interns are sent to start-ups, and local CEOs hold seminars. Japanese companies do not need obedient employees anymore. They need employees with ideas.

Source: D.W. Edgington (2008), `The Kyoto Research Park and Innovation in Japanese Cities'; and Kathryn Ibata-Arens, (2005) `Innovation and Entrepreneurs in Japan: Politics, Organizations, and High Technology Firms'.

Implications for Canada and British Columbia

How then do Canada and B.C. compare with Japan and what lessons might there be from these new approaches? In general, investment in R&D in Canada has been relatively high by government and universities but low in industry -- hence the concern over the 'commercialization gap.' Since the late 1990s the federal government has made a vigorous effort to fund research and innovation, and in 2002 it launched its own innovation strategy, *Achieving Excellence*, which aimed to move Canada to the front ranks of the world's most inventive countries. This policy document identified nascent technology clusters and recommended increased tax credits to try to resolve the commercialization gap.[11] In addition, a national study group is looking at Canadian technology clusters -- known as the Innovative Systems Research Network (ISRN). This is a collaborative Canadian initiative to undertake and disseminate research results concerning the diverse nature of regional and local innovation systems across the country. In related fields, federal government programs designed to strengthen university research and infrastructure in Canada have emerged including increased research capacity through the Canada Research Chairs (CRC) programs, increased funding to the three federal Research Councils, and support for Genome Canada. Nonetheless, as Carin Holroyd has pointed out in *Commentary* Number 42, compared with Japan the general intensity of R&D in Canada is still very low, in part due to the low absorptive capacity of local business and poorly coordinated federal and provincial programs.

In B.C., the technology industry comprises about 5.3% of the provincial gross domestic product (GDP) and employs somewhat less than 2% of the working population. The industry is dominated by relatively small companies that form a diverse group of clusters, including IT, alternative energy, biotechnology, new media, wireless and sustainable technologies. These sectors have dramatically outpaced the rest of the province's economy in recent years and now employ around 45,000 technology workers and 78,000 employees in total. B.C.'s biotechnology industry is one of the top in North America, and the fastest growing in Canada. More than 90 firms make up this cluster, employing more than 2,600 people and earning some $344 million revenue in 2004. These are primarily biopharmaceutical companies specializing in a multitude of research areas including infectious diseases, cardiovascular drugs and genomics. Nonetheless, about 70% of the 8,300 high-tech companies in B.C. have fewer than five employees and most are located in Greater Vancouver and Victoria, the core regions of the province. It is of concern that at present their size is small and their growth may not be fast enough or large enough to be self-sustaining. In other words B.C. is first-rate at creating research, but needs to be better at growing, technology companies for world level success.

Recognizing the need to introduce support for the commercialization of research the B.C. Government moved in 2005 to launch the B.C. Competition Council and B.C. Innovation Council to support economic development and to link it with technology sectors in the province.[12] Moreover, the B.C. Premier in the February 2006 Throne Speech promised to launch a 'B.C. Hub strategy' to transform the province's approach to technology, research, commercialization and capital expansion with new efforts to integrate science, technology and knowledge into the resource, agriculture and manufacturing industries. In 2007 the provincial government released a Research and Innovation Strategy for the province as well as recognizing B.C.'s opportunity as a gateway between Asia-Pacific and Canada -- a strategic advantage from which many industries in the province are likely to benefit. The goal of the Research and Innovation policy is to make B.C. the most productive province in Canada by 2015.[13] Its five pillars comprise: investing in people, the commercialization of technologies, strengthening research infrastructure, supporting venture investments, and building on the province's regional strengths.

B.C.'s regional strengths include wood products in coastal, central and northern areas of the province; food, beverages and wine in the Okanagan; energy and mining in the northeast, northwest and southeast regions; alternative energies and biotechnology in Greater Vancouver, the southern interior and Vancouver Island; and ocean sciences, fisheries and aquaculture in B.C.'s coastal communities.[14] These sectors form the basis of nascent regional clusters. Nevertheless, the most viable and highly regarded technology clusters in the province are in information and communications technology, wireless, new media, fuel cells and biotechnology sectors associated with the core Lower Mainland region. Also, unlike the classical definition of a cluster, B.C. technology clusters are not typically based on manufacturing and marketing of specific physical products, but rather on the development of intellectual property. Consequently, this process does not fit well with the traditional cluster model constructed by METI in Japan, derived largely from the strengths of a manufacturing-based economy with large domestically-based corporations.

At the centre of many of the B.C. clusters are two strong public sector research universities (University of British Columbia --UBC -- and Simon Fraser University --SFU) supported by smaller, more specialized technical training colleges. When compared to Japan there has been far less structural reform in Canadian post-secondary institutions as Canadian universities have had more autonomy to begin with to develop their own approaches to commercializing research. For instance, UBC is a recognized leader in technology licensing within Canada and North America and is well placed to expand local research and industry connections. It is oriented toward outreach and engagement with industry through its University-Industry Liaison Office (UILO). Long-term results from UBC regional innovation efforts include a considerable expansion of industry-research partnerships, the development of cutting-edge technology-based economic development programs, scores of new high-technology start-ups, ongoing technology and business support for numerous existing firms, specialized industry training for students each year, and the fostering of systems for entrepreneurial development.

The practices and partnerships of this innovative university emerge from the grass roots level and not from the federal government or through top-down standardized formulas which have been the norm in Japan. As with most innovative universities in North America, there are certainly common practices involved in the commercialization of locally generated technologies, but no one model or approach is followed by all. UBC is ranked 8th in North America and first in Canada in technology transfer and commercialization, especially in biotechnology. A notable enhancement of its commercialization program is the development of a small business incubator/ accelerator facility on campus since 2004. This facility, situated near the UILO, is part of a larger vision, which is to develop an environment that will foster the creation and growth of a stream of successful new ventures rooted at UBC. The Accelerator Centre provides the necessary infrastructure to support early stage start-up companies, and is a joint-venture between Discovery Parks and UILO. The Accelerator Centre has plans to engage the local technology community to assist in the provision of support for fledging spin-off companies. In addition, services related to research and commercialization, such as intellectual protection or business plan preparation, are to be linked through a network of approved partners. Educational seminars will also be organized to assist the tenants during the earlier stages of growth.

Four Ideas from Japan

Both Japan and British Columbia are taking steps to move toward the 'triple helix' model of linking university research with local business and government support policies. Japan now has a full range of government-supported regional cluster programs

to assist science and technology fuse with regional development. Furthermore, while Japan may have started further behind Canada and B.C. in terms of university-based technology transfer to local industry, it is catching up and recent reports show dramatic increases in both university-industry links and technology commercialization. Nonetheless, there are many challenges involved when comparing the province of B.C. to the nation of Japan and attempting to draw policy lessons. For example, Japanese prefectures have far less autonomy *vis a vis* their national government than Canadian provinces have in relation to the federal government. Conversely, in Canada there are also many political considerations and constraints in direct federal support for local regional cluster development, which constitutionally are the purview of provincial governments.

Even so, in the development of its own research and innovation strategies it is appropriate for B.C. to keep abreast of policy trends in other countries. How then can the Japanese model of upgrading research and technology in local areas assist the policy debates in B.C.? Clearly the two jurisdictions are at different stages in the commercialization of research and innovation and support for regional development. Japan's cluster programs, for instance, have a strong focus on the development of new technology (which obviously plays to an area where Japan is undoubtedly strong) and on university-industry links (an area where further strengthening needs to occur). B.C. has not yet committed to focusing on a local or regional approach to research and innovation even though most province-wide industry associations have a clear perspective on the current activity, strength and challenges faced by their membership. On the other hand, a locally-based approach building up the science and technology of all regions of B.C. might also be attractive.

The Japanese example shows that history and culturally specific factors have helped determine the trajectory of local industrial clusters (e.g. Hokkaido has gone from a resource periphery to biotechnology and IT and has many apparent similarities with the B.C. situation). Building on these insights, local cluster studies in B.C. would provide more in-depth analysis of data for the various regions of the province to support benchmarking, collaborative marketing and communication needs, R&D support, public policy initiatives and strategic targeting of anchor companies and world-class researchers and business leaders. The following ideas are relevant to B.C. or any province interested in upgrading its policies to support research and innovation.

(a) National and Provincial Backing for Local Clusters

Japan's cluster programs comprise a bold and distinct departure in policy emphasis, but with links to earlier approaches to regional economic development. The involvement of Japan's government -- such as the METI regional offices -- gives strong leadership in each of the cluster projects and provides a lesson for B.C. This is because the regions of B.C., including Greater Vancouver, presently lack strong coordinating organizations to support economic growth and technology. While there is often a willingness to generate and support bottom-up initiatives from local communities, B.C.'s regions are deficient in the capacity to plan and promote local clusters. This is especially so in Northern B.C.[15] By comparison, there has been a tradition of building capacity in the peripheral regions of Japan, beginning with planning for roads and other transportation infrastructure in the 1970s, Technopolis projects in the 1980s and now the 'soft' infrastructure of building networks between local firms, governments, regional universities and research institutions. The Japanese model suggests that there is a fine balance between local and central planning. Bottom-up initiatives will only be successful if allied with strong capacity-building in the regions provided by central governments -- in this case by the B.C. Government. B.C. should provide funds to regional planning agencies to mandate that science and technology become part of their planning function. As Greater Vancouver is a major Pacific Rim gateway city, the federal government should

be also become involved in funding its capacity to coordinate economic development and deliver an economic strategy that is technology-focused.

(b) The Importance of Local Leadership

While cluster-based development is highly decentralized in Japan, leadership is an important quality that differentiated one region from another. In the case of METI's industrial clusters, leadership was originally provided by government officials. In other cases it was a prefectural governor or a local business person. Clearly, 'civic entrepreneurs' are vital to catalyzing development of new industries in local regions. They help animate the local process of strategic visioning, galvanizing socially organized activities to upgrade the innovative capabilities of local firms, and represent the collective interests of their cluster and industry when required. In the B.C. context, non-urban areas that are still dependent on resource industries, and lack infrastructure and educational opportunities and leadership mechanisms. Leadership forums are necessary, involving stakeholders in order to coordinate local activities, particularly in changing mindsets to embrace innovation.

(c) Stronger Support for University-industry Links

The Japanese have recently increased their support of universities and their contribution to innovation and economic development. With changing contexts of knowledge production, the old division between pure research (carried out in universities) and applied R&D (in industry) has given way to new forms of partnerships and collaboration. While the B.C. Government has supported university-industry links, more can be done to ensure the development of new start-up firms in the province. Japan is taking steps to catch up to global norms in the commercialization of technology and B.C. must do the same. University TLO offices and on-campus start-up firm incubator facilities have received special funding and this should provide a trigger for further resources targeted at sectors where the province and its regions have clearly identified comparative strengths.

(d) A Place to Call Home

Japanese experience, such as the Kyoto Research Park, has shown that technology clusters grow and develop better when the people within them interact on a daily basis. Indeed, the lack of social interaction and need to welcome newcomers has been one of the biggest challenges for the two major Japanese science cities (Kansai Science City and Tsukuba Science City). Research on innovation more generally has also highlighted the importance of informal linkages and contacts. Cross-pollination of ideas and projects provides synergies and encourage serendipitous innovation. In this regard, a 'Technology Hub' in a central location in Vancouver would be an ideal facility for innovators to 'call home'. Such a facility should be designed not only provide a show-place for the province's technologies but to also contain incubator/accelerator space for small start-up companies and other support services, such as top-level mentors, tax and legal advice, angel funding, marketing and manufacturing advice. It would be an important centrepiece for B.C.'s technologies and by providing meeting spaces would allow for social interaction to encourage networks of integrated diverse technologies. Space should also be set aside for research institutes, industrial associations and government agencies. The first would be built in Greater Vancouver, but eventually there could be one for each of B.C.'s nine regions and networked in order to connect all the regions of the province.

Notes

[1.] See Carin Holroyd "Japan's 21st Century Innovation Economy: Lessons for Canada," *Canada Asia Commentary,* No 42, January 2007**.** http://www.asiapacific.ca/analysis/pubs/listing.cfm?ID_Publication=582. The author acknowledges the very helpful assistance provided by Carin Holroyd in preparation of this Commentary.

[2]. This Commentary draws from more than 20 presentations made at the CJR 8-9th March 2007 Workshop. For details on the Workshop see: http://www.iar.ubc.ca/centres/cjr/seminars/locecondev/index.html.

[3.] Technology-based clusters (and other types) are concentrations of firms and supporting institutions in proximate geographical regions. Often they share and benefit from a common knowledge base as well as various other resources ranging from raw materials to transportation infrastructure and a trained workforce. Clusters allow collaborative approaches to economic development, such as joint training and marketing, and a more focused approach to technology transfer. In Canada, the National Innovation System Research Network (2000-2005) has concentrated on studying 26 clusters - from biotechnology in Vancouver and multimedia in Ontario to wine producers and wood manufacturers in British Columbia (see M. Porter "Clusters and the New Economics of Competition," *Harvard Business Review***,** November-December, [1998], 77-90; J.A. Holbook and D.A. Wolfe, "The Innovation Systems Research Network: A Canadian Experiment in Knowledge Management," *Science and Public Policy*, 32, [2005],109-118.)

[4.] While Japan is well-known for its many giant firms such as Sony and Toyota, each with its own in-house R&D departments and training units, the nation is made up predominantly of small firms; over 90% have under 30 employees, and just under half of the workforce work in these types of small companies (source: Japanese Ministry of Labor, 2004 data).

[5.] See for example, P. Cooke, M. Heidenreich and H-J. Braczk, *Regional Innovation Systems: The Role of Governance in a Globalized World***,** London: Routledge, 2004.

[6.] See for example, D.W. Edgington, "Central-Local Government Fiscal Relationships and Regional Equalization," in L.T. Woods (ed.) *Understanding Japan: Essays Inspired by Frank Langdon*, Vancouver: Centre for International Relations, UBC, 2004, 59-87.

[7.] The Japanese government has also implemented a number of other important urban and regional programs in recent years, including the `Urban Rennaisance Program' comprising special zones for structural reform aimed at revitalizing Japan's cities and their economies by deregulation. However, as their focus is not related to science and technology *per se* they will not be considered here (see *OECD Territorial Reviews, Japan***, Paris** [2005]).

[8.] Source: METI, *The Industrial Cluster Program 2006*, http://www.cluster.gr.jp.

[9.] Nanotechnology is associated with the science of matter at the nano-scale, making possible novel applications and interesting materials.

[10.] See J. Chan, "Academic Capitalism: National University Incorporation and Special Zones for Structural Reform," forthcoming in J. Zajda (ed.) *Decentralization and Privatization in Education*, New York, Springer, 2007.

[11.] See *Canada's Innovation Strategy***,** http://www.innovationstrategy.gc.ca/.

[12.] See the reports of the B.C. Competition Council, http://www.bccompetitioncouncil.gov.bc.ca/ and of the B.C. Innovation Council, http://www.bcinnovationcouncil.com/.

[13.] See Ministry of Advanced Education and Ministry Responsible for Research and Technology, *BC Research and Innovation Strategy***,** Victoria: Ministry of Advanced Education and Ministry Responsible for Research and Technology, 2007. http://www.innovationstrategy.gc.ca/gol/innovation/site.nsf/en/in04135.html.

[14.] A useful approach to assessing B.C.'s non-metropolitan regional strengths and potential industrial clusters is provided in the reports of the British Columbia Regional Science and Technology (see http://www.bcrstn.com/bc/396/documents).

[15.] See G. Halseth et al. "The Connected North: Findings from the Northern BC Economic Vision and Strategy Project," *Journal of Rural and CommunityDevelopment*, 3, 2006, 1-27.

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