Prometheus, Vol. 26, No. 1, March 2008

Knowledge Clusters and the Revitalization of Regional Economies in Japan: A Case Study of the Biomedical Industry in Kobe

STEVEN W. COLLINS

Abstract *On a cold January morning in 1995, a powerful earthquake rocked Kobe, Japan, killing thousands and shattering the economy of one of Japan's most vibrant cities. Three years later, a small group of local leaders, realizing that much of the lost industrial output would never return, hatched a plan to develop the city as an international hub for biomedical research and innovation. Out of this was born the Kobe Medical Industry Development Project. Housed on part of an artificial island, the project integrates basic, applied, clinical, and translational research in regenerative medicine and biomedical equipment, providing a comprehensive platform for research, development, and commercialization of new medical therapies and technologies. This article reviews and assesses the achievements of this initiative in the context of the broader effort by central and regional governments to harness localized knowledge and resources as catalysts of sustainable economic development.*

Keywords: industrial clusters; Kobe; medical industry; regional development

Introduction

The purpose of this article is to report on the emergence of the Kobe biomedical industry—a case study of the application of Japan's new cluster-based approach to regional economic development, though one with some unusual twists. Since the 1990s, policies supporting cluster formation have become increasingly popular among policy makers eager to enhance the competitiveness of regions and states;[1] and Japan is no exception.[2] Typically defined as a geographically proximate collection of interdependent firms and other organizations in a particular industrial sector, industry clusters tend to form where sophisticated local demand, pooling of skilled labor, proximity to specialized suppliers, and supportive business environment lower the risk and cost of doing business in the local environment.[3] Sectors vary in the extent to which external economies make the embedding of operations

Prometheus ISSN 0810-9028 print/ISSN 1470-1030 online © 2008 Taylor & Francis
http://www.informaworld.com/journals
DOI: 10.1080/08109020701846066

in certain regions and formation of local interdependencies a strategically compelling if not unavoidable choice for firms: industries with long and divisible value chains, and ones reliant on knowledge created in universities and other external sources, are especially likely to be found in clusters.[4]

Among the latter are biotechnology firms, which tend to emerge near research universities and research institutes with prolific inventor-scientists working in medical and biomedical fields.[5] Regions also differ in their capacity to attract and sustain clusters that are self-reinforcing: these tend to be those with an abundance of venture capitalists, and those having research universities with an attached medical school, angel investors, specialized legal and other professional services, and associative organizations that facilitate networking which offer special appeal to firms in science-driven sectors such as biotechnology.[6] Philadelphia, San Diego, Boston, and San Francisco are at the top of most lists of regions rich in the supply of localized resources supporting thriving concentrations of biotechnology firms. Indeed, Kobe has not typically graced such lists. Although it is an industrial and commercial center of considerable historical importance to Japan's economy, Kobe has lacked most of the resources associated with success in commercial biotechnology. Its emergence, in short order, as a home to one of Japan's premier biomedical clusters thus presents something of a paradox. How did it happen, and why? What did policy makers do right, and wrong, in the process? Are Kobe's achievements sustainable? What lessons if any does Kobe's experience hold for other regions?

This article attributes Kobe's success to a rare combination of circumstances—a devastating earthquake, a handful of influential leaders with a powerful and compelling vision, generous public and private funding dedicated to reconstruction and revitalization, and far-sighted urban planning. The sheer destruction of much of the region's economic infrastructure created conditions not unlike that of the aftermath of a war, making possible the focusing of political resources and opening up a window of opportunity for policy entrepreneurship. At the same time, the central government's new framework for regionalizing science and technology policy and tying it to local economic development needs, aligned with and reinforced the proposals being made locally. This suggests that Kobe's approach may have limited applicability to other regions that have not experienced a natural disaster or other exogenous shock of similar magnitude. It also raises questions about the project's sustainability as public subsidies are ratcheted down and self-reinforcing processes are expected to take effect.

Background

Kobe's population of 1.523 million people in 2005 makes it Japan's sixth largest city. Long one of Japan's leading ports, the city's gross product in 2001 amounted to 6.183 trillion yen, or about 1.2% of the national total. With only 1.2% of the country's population, firms in the city produce 0.86% of the country's manufactured output, which is consistent with the city's history as one of the major urban nodes in the manufacturing belt extending from Tokyo in the east to Hiroshima in the west.[7] Hyogo Prefecture, of which Kobe is the capital, is the country's leading producer of sake (Japanese rice wine), pearl jewelry, handsaws, and baseball-related products. The city prospered in the prewar period, its population rising from 25,000 at the time of the country's opening in 1868 to more than half a

million in 1914 and to one million in 1939. Massive aerial bombardment during World War II reduced the population to below 380,000 in 1945. Rapid recovery commenced after the war as the city resumed its role as the country's portal to the rest of the world. By 1950, a massive 42% of Japan's international trade was being funneled through the port of Kobe, an historical high for the city. The population once again exceeded one million in 1956, reaching 1.5 million in 1992.[8]

At 5:46 AM on 17 January 1995, an earthquake measuring 7.2 on the Richter scale shattered Kobe's morning calm, toppling buildings and spreading fires across a dazed city not accustomed to experiencing tremors of any magnitude. More than 122,000 structures collapsed fully or partially, and 6,965 structures were consumed in flames. More than 6,400 people perished, 4,571 of whom were city residents; 14,678 were injured.[9] In an instant, an estimated 6.8 trillion yen of capital stock, more than the city's entire gross domestic product, was erased, crippling the economy.[10] So extensive was the devastation that four years later, 24% of the infrastructure lost in the quake had yet to be replaced and only 64% of homes had been rebuilt.[11] Clearly, a long and painful path of recovery lay ahead.

Even by 2004 the Kobe economy was still struggling to recover to its pre-earthquake strength. In the late 1990s, employment levels fell in absolute terms at a rate of more than 3% per year, while the increase in businesses shuttering operations were at rates in the double digits (see Figures 1–3, which provide data on changes in employment, establishments and output in Kobe). Contraction was especially pronounced in construction, finance and insurance, and manufacturing of textiles, apparel, and rubber. Granted, most of the rest of the country was also affected by the recession of the late-1990s, but only Kobe had to rebuild a quake-damaged infrastructure amid falling demand and prices as the 'post-bubble' period of stagnation dragged on in Japan. Apart from chemical and petrochemical manufacturing, and parts of the service sector, output and employment in Kobe also declined. Amid the gloom of the immediate aftermath of the quake, the World Health Organization opened its Center for Health Development in Kobe in 1996. One of two WHO global research institutes, the Kobe center focuses on research related to health and urbanization. Its opening was significant as it signaled a new opportunity for the city in the expanding field of global health and health care for a rapidly aging population. It was an opportunity that would quickly be seized.

Figure 1. Trend in number of business establishments and employment in Kobe. *Source*: *Kobe no jigyosho 2004*, Table I-1.

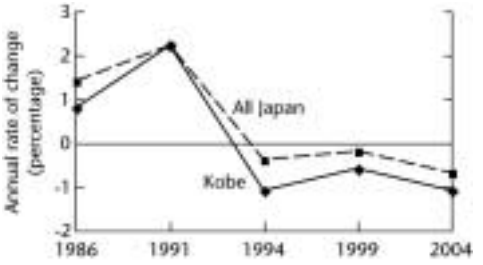

Figure 2. Annual rate of change in enterprise employment in Kobe and all Japan. *Source*: *Kobe no jigyosho 2004*, Table I-1.

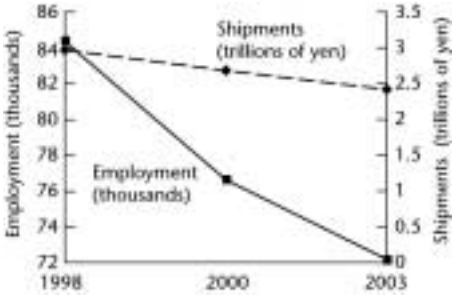

Figure 3. Trend in manufacturing employment and shipments for Kobe. *Source*: *Kobe no keizai 2006*, Table 42.

Launching of the Medical Industry Development Project

Kobe's biomedical industry has its immediate origins in two policy decisions made by the municipal government in the immediate wake of the earthquake. The first came in June 1995, five months after the quake, when the city announced a plan for economic revitalization targeting full recovery by 2005. A key element was a project to develop the southern part of Port Island, a small artificial island in Osaka Bay a short distance from Kobe's downtown and connected to it by train. Completed in 1980, the original part of the island had been developed to house the city's core steel, shipbuilding, and transport industries, sectors now in steep decline. The new Port Island Phase 2 serves as new industrial space on which to showcase the Kobe Enterprise Zone, a China–Asia Trade Zone, and a multimedia information and communication center known as the Kobe International Multimedia & Entertainment City (KIMEC). Both the City of Kobe and Hyogo Prefecture established tax incentives and subsidies for rent and loans to attract new business to the island. Four months later, Kobe unveiled its 4th Basic Plan, which called for leveraging the presence of the WTO research center, making it the core of a new health and welfare industry designed to support an aging population. Two years later came the 'Kobe Athlete Town Concept', designed to promote the city as a place where young and old alike can enjoy a vigorous, healthy life.[12]

At a press conference on 10 September 1998, Kobe's Mayor Kazutoshi Sasayama officially unveiled the Medical Industry Development Project, the city's comprehensive plan for creating a biomedical industry and making it into a pillar of the region's future economy. The strategic goal was to catalyze a shift of the city's industrial

structure, long reliant on heavy industry, to biomedical equipment and cutting edge medical therapies, and in so doing revitalize the small and medium-sized corporate sector and entice foreign firms to locate in Kobe.[13] Implementation proceeded by making firms in the biomedical field eligible for subsidies and other incentives associated with the development of Port Island Phase 2. At the same time, a New Industry Research Organization (NIRO), which had been established the year before to foster collaboration among the region's universities, industry and government, was encouraged to assist the city's small and medium-sized firms to enter the biomedical equipment and related fields. Finally, the mayor mentioned that he had established a working group, led by Dr Hiroo Imura, then-director of the Kobe City General Hospital and a former president of Kyoto University, and charged it with proposing a detailed plan by the end of the year. Represented on the group were directors of the medical teaching departments at Kyoto, Osaka, and Kobe universities, the head of the National Cardiovascular Research Center in Osaka, the head of the Kobe Medical Association, three officials from the Kobe City government, and one official from the Hyogo Prefectural government; officials from the Health and Welfare, and Trade and Industry ministries participated as observers. The group met three times and issued a final report the following March.

The working group's report presents a strikingly bold vision and detailed action plan for turning Kobe into a global leader in biomedical technology.[14] Far more than a scheme for revitalizing Kobe's economy, the project was framed as an endeavor to raise the quality and technological sophistication of Japan's entire medical system. Already large, the domestic market for biomedical and related products was expected to grow from 38 trillion yen in 1996 to 91 trillion yen in 2010. Domestic firms, however, were losing ground to foreign competitors. The report notes, for example, that Japan's domestic production of biomedical equipment grew slowly in the 1990s, even as overall demand was growing rapidly. In 1993 the value of imports exceeded exports by half; four years later, imports had soared to more than double the value of exports. Prices of PET (Positron Emission Tomography) scanners, which are designed to examine the human brain, and other high-end equipment, were two to four times that found in the USA and Europe due to the regulated and closed distribution and payments system for medical services in Japan. Finally, there was a precipitous drop in the number of drug candidates in late stage clinical trials, from more than 1,000 in 1991 to less than 200 in 1998.

The predominance of steel production and similar heavy industry in Kobe's economy raises questions about the appropriateness of a strategy targeting a sector that had virtually no presence within the city. Undeterred, the study group proposed tapping the potential of neighboring Osaka, the traditional center of Japan's drug industry, in addition to the world-renowned biomedical research at Osaka University, Kyoto University's capabilities in developmental biology and regenerative medicine, the large presence of foreign firms in Kobe, a highly skilled local workforce, and well developed trading links with Asia. Kobe itself is part of the larger Kansai region, containing around 20 million people and about one-sixth of the country's GDP. Together with these attributes is a new Spring-8 synchrotron radiation facility in nearby Harima and 53 kilometers of optical fiber and other advanced information technology capabilities in the KIMEC facility. Hence the advantages of locating a biomedical complex in Kobe begin to stand out.

With the above considerations in mind, the working group proposed a set of interlinked organizations and operating principles that would form the backbone of a next-generation medical system with a strategic focus on 'translational

research', defined as research that leads to the smooth and timely transfer of new medical treatments and technology from the laboratory, where the basic ideas and discoveries originate, to the bedside, where they directly benefit patients. The research and clinical emphasis would be regenerative medicine and medical devices associated with diagnosing and treating cancer, cardiovascular disease, and other disorders amenable to regenerative technologies. The choice of technologies made strategic sense given the aging of the population, well endowed basic research centers at Osaka and Kyoto universities, and existing national projects aimed at fusing the country's strong knowledge base in materials and micro-machines with medical applications. A set of organizations was mapped out to cover three core functions: research, business development to commercialize the research results in new and existing businesses, and training of human resources required to perform translational research and commercialize the results. The organizations performing these functions would be located in Port Island Phase 2, and efforts made to forge links with similar initiatives across the Kansai region. To manage the project, the Foundation for Biomedical Research and Innovation (FBRI) was established in March 2000 with total assets of 137.5 million yen, 50 million yen of which came from Kobe, 25 million yen from Hyogo Prefecture, and the remainder from private sources; tapped to serve as chair was Dr Hiroo Imura.[15]

Over the next three to five years a storm of construction activity engulfed the southern half of Port Island. Construction commenced on the core research facility, the Institute of Biomedical Research and Innovation (IBRI), in early 2000; it was completed in April 2003. Construction was budgeted at 13.2 billion yen, with four billion yen from Kobe City, three billion yen from the central government, 500 million yen from Hyogo Prefecture, and the balance from private sources.[16] It houses research in three primary areas: medical devices, clinical research for new drugs, and clinical application of regenerative medicine. IBRI scientists perform research on bone marrow and chord blood stem cell transplants, regeneration of peripheral blood vessels, cancer chemotherapy, and other areas. Equipped with some of the most complex and expensive medical imaging technologies, such as PET, CT-Linac, 4-D radiotherapy, and ultra-high magnetic field MRI equipment, IBRI specializes in research that peers directly but non-invasively into the cells of organs to identify and characterize disease agents at the molecular level, then disables or destroys the agent with a targeted dose of radiation or other therapeutic intervention; diagnosis and therapy are rolled into a single package. A germ-free facility for transferring hematopoietic stem cells, a 60-bed hospital for the care of in-patients receiving treatment, out-patient examination room, high-sterility operating room, and informed consent room with clinical research coordination staff round out IBRI's main facilities. Closely connected to the IBRI is the Translational Research and Informatics Center (TRI), which began operating in July 2003. The TRI provides planning, administrative, data management, and analytical support for clinical trials to the researchers at IBRI and firms associated with the project. The City of Kobe and Ministry of Education, Culture, Sports, Science and Technology (MEXT) shared the five billion yen costs of this centre, which is managed by the City of Kobe.

The remaining facilities support the business development and training functions of the project. In the training area, the Kobe Biotechnology Research and Human Resource Development Center, co-located with the Kobe University Business Incubation Center, sponsors programs for training medical personnel and researchers in the conduct and management of clinical research and development. The Kobe Medical Device and Development Center (MEDDEC), which

houses an MRI laboratory, operating room, and rental lab space for small firms, provides training in the use of catheters, endoscopes, and imaging technologies and is especially geared to the needs of small and medium sized enterprises. Regarding business development, the core institute is the Business Support Center for Biomedical Activities (BMA), which offers its tenant firms working in regenerative medicine a cell processing center and animal research facility. The BMA proved highly attractive to large drug and device companies expanding into regenerative medicine; among its earliest tenants are Hitachi Medical, Shimadzu, Sysmex, Nihon Schering, and Teijin. Several other facilities, including the original KIMEC building, provide offices, laboratory, advisory, and other business support services to the growing number of firms populating the project.

The Kobe Medical Industry Development Project received a major boost when, in February 2000, the prestigious Institute of Chemical and Physical Research (RIKEN) formally announced its decision to locate its new Center for Developmental Biology (CDB) in Kobe's Port Island Phase 2. The three billion yen facility, home to more than 240 researchers, was constructed along side of and at the same time as the IBRI. Since it opened in April 2002, the CDB has earned a world-class reputation for its work in stem cell research and developmental biology. Proximity to IBRI—indeed, the two institutes are physically connected—is intended to encourage collaboration, with IBRI providing translational research needed to render CDB's scientific achievements into products and therapies for patients. Opportunities for collaboration jumped in fall 2006, when RIKEN opened the Molecular Imaging Research and Development Center. The facility offers researchers in IBRI and companies participating in the project access to imaging devices and techniques that can enhance the ability to detect very small early-stage cancers and speed up characterization of drug activity in the body. These techniques offer the promise of dramatic increases in yields of successful drug candidates as well as speedier completion of phase 1 clinical trials.

Finally, it should be pointed out that the architects of Kobe's biomedical industry benefited from generous subsidies and other support from the central government. The advent of the project fortuitously coincided with the launch of a new science and technology policy framework under the government's Second Basic Plan, which covered the period 2001–06. Under this plan, spending on science and technology increased from 17 trillion yen under the first plan (1996–2001) to 21 trillion yen, which was enough to boost the government's R&D budget from 0.7 to 0.8% of GDP.[17] In addition to continuing the commitment to increase funding in the four priority areas of life sciences, information technology, nanotechnology and materials, and the environment, the new policy framework gave greater attention to the regional context, using investments in science and technology as explicit drivers of economic revitalization of regions through the fostering of collaborative ties among local governments, industry, and universities. Four points were stressed: increasing the mobility of researchers between universities, industry, and government; improving the environment for technology transfer from universities to industry; promoting commercialization of publicly funded R&D; and strengthening support for the formation of start-up companies.[18]

Underpinning it all were commitments to expand the proportion of funding awarded on a competitive basis and spur the bubbling up of ideas and initiatives from the regions themselves. Among the programs most directly connected to regional revitalization were the Industrial Cluster Project, launched by the Ministry of Economy, Trade and Industry (METI) in 2001, and the Knowledge Cluster

Initiative launched a year later by MEXT. The METI project fosters networking among universities, regional government bodies, and industry within each of nine regional districts covered by a regional branch of METI; proposals emanate from the regional bureaus. The MEXT program targets the formation of clusters that have universities and public research institutes at their core; the goal is to integrate these research institutions more tightly into the local economies that surround them. Neither project involves large subsidies: MEXT, for example, promises only 500 million yen to each of 18 clusters over a period of five years. Rather the value is in networking and coordination of activities across organizations and sectors that have historically been isolated from each other.

The Kobe Biomedical Industry Development Project received designation from MEXT as the Kobe Translational Research Cluster in April 2002. The coordinating organization is the FBRI and its president Dr Imura; participating organizations include all the key players in the project.[19] Also receiving the cluster designation was the Northern Osaka Biomedical Cluster, under the leadership of the Senri Life Science Foundation, with Osaka University as the core research institution. Osaka's strengths in pharmaceutical manufacturing and drug development complement those of Kobe, which has branded itself as a center for translational medicine with specialized competencies in therapeutic use of medical imaging. The two clusters are expected to forge collaborative ties under the auspices of the 'Kinki Wide-Area Cluster', whose objective is to link the capabilities of the two smaller clusters into a comprehensive regional innovation system in medical and pharmaceutical technology. Both these clusters in turn are embedded in an even larger ecology of medical, drug, and biotechnology institutions in the Kansai area. Support for this super-cluster comes from METI, which awarded an industry cluster designation to the roughly 450 companies and 35 universities that comprise it. Whether these nested clusters manage to define a common identity and organize themselves into a coherent larger innovation system remains to be seen.

Assessment

Nearly a decade has passed since the Kobe Biomedical Industry Development Project was conceived in the late 1990s. Measured against the decades normally required for regions to develop self-sustaining agglomerations of industrial activity, the Kobe project is still in its infancy. Yet already it has received a great deal of attention within Japan: the respected news magazine *Nikkei Biotechnology* named it Japan's best overall biotechnology cluster in December 2004 on the basis of the number of research institutes and star researchers, ease of performing clinical trials, technology transfer, tax incentives, and other criteria. As anyone who has regularly visited Port Island over the past five or six years can attest, the changes have been astounding: an entire biomedical research, development, and commercial complex has emerged from what was less than a decade ago little more than land reclaimed from the waters of Osaka Bay. In addition, in early 2006 the new Kobe airport opened for business on another artificial island just to the south of Port Island Phase 2, making it possible to transport patients and researchers from across Japan literally to the doorstep of one of the world's most advanced medical facilities.

Is the Kobe project achieving its objectives? Is it returning value to its stakeholders and constituents at least as great as the costs that have been invested in it to date? Has it reached a point where it can be self-sustaining, without further

injection of public funds? The answers are, in order, an unequivocal yes, probably, and probably not but becoming close.

The project has undeniably turned Kobe into Japan's leading center for research and translational medicine in the fields of regenerative medicine and combined diagnostic and therapeutic use of medical equipment. From a starting base in 2000, the project had managed to attract 35 firms to Port Island Phase 2 by the fall of 2003, 75 in March 2006, and 101 in February 2007. Of the 101 firms at the time of writing (mid-2007), 49 are start-ups, 25 are local operations of large firms, and 27 are medium-sized firms.[20] A study conducted by Nomura Research Institute in fall 2006 estimated the total economic impact of the project on the city of Kobe at 40.9 billion yen in 2005, prompting the project's founder and still-current leader Dr Hiro to declare the project was proceeding smoothly in its seventh year.[21] A total of 2,690 jobs have been created, including 593 in the 75 biomedical-related firms with a presence at that time in Port Island Phase 2, and 610 in the three core research institutes. The resulting economic activity added between 1.24 and 1.32 billion yen in new tax revenues to the City of Kobe.[22] Going forward on the current track, the number of firms will grow to 203 in 2010 and 311 in 2015; a total of 9,700 jobs will have been created in the city by 2015.

Also noteworthy has been the extent to which the city's small and medium-sized firms have been integrated into the project. From the very beginning of the project in late 1999, the Kobe Machinery and Metal Firms Association, many of whose member firms were struggling under the combined weight of earthquake damage and the national economic slowdown, mobilized in support of the project. Thirty-two firms from the association's ranks formed the Medical Equipment Research & Development Committee; it now boasts 70 members. Its members visited life sciences clusters in the US and Europe to see how they were organized first hand. In 2003, they pooled resources to form a development and sales company, Kobe Biomedics, to assist members with diversifying into medical equipment and developing products that meet market needs. As of early 2007, these firms had commercialized 59 products, including stents, catheters, probes, and other surgical tools, many of which are used in clinical testing and in conjunction with imaging. The path from research to market is especially difficult for small firms to traverse because of the time and expense required to meet regulatory requirements.

Has the project generated a satisfactory return on investment? Has it created value for taxpayers in excess of opportunity costs? Here the evidence is somewhat mixed. The project has consumed vast amounts of public funding from both central and local governments. One source notes that the combination of capital costs (hard funds) and research costs (soft funding) had reached 60 billion yen (about US$600 million) by fall 2003.[23] The study group formed to produce a new vision and strategic plan put the capital costs of the core institutes at 32 billion yen (as of 2005), not including land, which compares favorably with the 49 billion yen in economic impact on the city.[24] On the other hand, the City of Kobe and Hyogo Prefecture have also offered generous subsidies to attract firms to Port Island Phase 2, including an office rent subsidy of up to 1,500 yen per square meter for three years (down from 2,500 yen which had been in effect through March 2005) to a maximum annual amount of two million yen. In addition, firms receive a 50% tax reduction on property, business office, and urban planning taxes for three years. While many regions around the world offer such inducements, the danger in Kobe is that they may breed a culture of dependence and an expectation they will continue in perpetuity. This hazard was in evidence at a focus group meeting in

summer 2005, in which I was a participant, where phase-out of public subsidies was one of the greatest concerns in evidence among the participating executives from life science firms involved with the project.

On the other hand, internal surveys show a generally high level of satisfaction among companies and research institutes. One such survey was undertaken in 2006 for the Kobe Life Sciences Promotion Council. A total of 93 firms and research institutes (including 13 non-medical companies in Port Island Phase 2 and four medical-related firms in Kobe but not on Port Island) were asked to rate their satisfaction with 17 items, using a scale from one to four (four being highest). The average score on nine items came in above 2.75, with the highest being airport and transportation access (3.3), the lowest being access to food and shopping, and access to capital, both of which came in around 2.4.[25] Dissatisfaction with the lack of amenities, food, and services is not surprising; their absence is striking to the visitor from outside, especially given the importance researchers and other talented people tend to attach to them in making decisions about employment.

Finally, there is the question of sustainability. Has the Kobe biomedical cluster achieved a critical mass that would allow the phase-out of public funding? In some respects it is still too early to tell; regional industry clusters tend to form over periods of many decades. Based on my research there in 2005, and my participation as a member of the advisory board that performed the fifth year evaluation of FBRI, my conclusion then was that firms were overly dependent on public support and continued to look to the national and local governments for subsidies. FBRI, moreover, had been operating in the red, and it was not clear when it would break even. However, much has changed in two years. The number of firms has grown by around 25% during this period. A new Molecular Imaging Research and Development Center had added a new dimension to the translational research emphasis with its focus on boosting the efficiency of clinical trials. The world's fastest supercomputer is being built at the time of writing, sponsored by the national government's RIKEN's Center for Developmental Biology, which outbid 15 other sites in the competition to host the supercomputer facility. In addition, three universities have opened campuses on Port Island Phase 2.

In 2006, the City of Kobe announced that it would stop leasing land in Port Island Phase 2 for fixed terms but would instead encourage firms to purchase the land outright, a policy that is in response to rising land prices resulting from Japan's recent economic recovery. Boehringer Ingelheim, a mid-sized European drugs company, also announced lately that it will relocate a major research center from Kawanishi in Hyogo Prefecture to Port Island Phase 2, bringing with it around 100 researchers.[26] Finally, the FBRI, which had for so long been operating in the red, is expected to balance its budget in the 2007 fiscal year, the result of successful cost-cutting and a 12% increase in the number of patients being treated on an outpatient basis at the IBRI's hospital facility.[27] Though firms still appear to be anxious, the future of the medical industry project looks considerably brighter than it did two years ago.

Conclusion

The life sciences sector in Kobe has grown with extraordinary speed since the opening of Port Island Stage 2, and the inauguration of the Medical Industry Development Project. More than 100 firms have established a base on Port Island over the past seven years. To put this achievement into perspective, it took three

decades for Seattle, home to one of the premier biotechnology clusters in the US, to accumulate a comparable number of companies. Far from funding the region's universities and waiting for the start-up firms to spin out, policy makers started from scratch with a vision, strategy, and comprehensive plan to execute that strategy—which was to turn Port Island Stage 2 into one of the world's leading platforms for regenerative medicine and translational research. That vision, and much of the energy to implement it, has come from a single individual, Dr Hiroo Imura, who put his prestige and influence behind it. In this capacity, he was a change agent and policy entrepreneur. Yet the opportunity to remake the city came in the form of a great natural disaster, the earthquake of 1995, which wiped out large swaths of the region's core industries. With the economy mired in recession three years later, Kobe's leaders, and the country's, were open to bold new ideas, and—importantly—money was not especially an obstacle; the era of fiscal conservatism associated with Japan's prime minister Koizumi in the next decade (2001–06) had not yet arrived. Indeed, the decision to focus on regenerative medicine and medical equipment made good strategic and political sense: the first would appeal to scientists in a field in which the Kobe and surrounding Kansai region was especially prominent; the second promised near-term commercial results and opportunities for the region's many metal manufacturers to be involved.

Overall, Kobe's Medical Industry Development Project is an example of a top-down explicit approach to cluster formation like that described by Fromhold-Eisebith and Eisebith.[28] It was conceived and driven not by private entrepreneurs and firms but by a very small group of respected scientists who had the ear of public officials at the local and national levels. Kobe is unusual for the overwhelming influence of a single individual, who has remained at the helm of the project even as he was serving on the Council for Science and Technology, the highest-level advisory body in science policy. Yet also crucial was the openness of the city to his ideas and the willingness of its leaders to shift the city's economy in a whole new direction. And while it is too early to write the conclusion of the story, it is hard not to be optimistic. The medical, health, and welfare sector is among the fastest growing employers in a city where most sectors are still in decline. And Hyogo Prefecture led the nation in the number of new plant openings last year for the first time in 21 years—and most of these openings were on Port Island.[29] Fromhold-Eisebith and Eisebith argue that there is no one-size-fits-all approach, or best-practice, in developing a regional industry cluster; policies and approaches must rather be tailored to the specific institutional, historical, and cultural context. Kobe's approach cannot be understood as a rational response to market opportunities or self-organization of the economy. It is the result of a reaction to a remarkable confluence of events, personalities, and political context not likely to be found in many other places.

Notes and References

1. J. Cortright, *Making Sense of Clusters: Regional Competitiveness and Economic Development*, Brookings Institution Metropolitan Policy Program, March 2006.
2. National Institute of Science and Technology Policy, 3rd Policy Studies Group, *Chiiki Inobeshon No Seiko Yoin Oyobi Sokushin Seisaku Ni Kansuru Chosa Hokoku* [*Investigation of Success Factors in Regional Innovation and Promotion Policies*], Policy Study No. 9, March 2004; Ministry of Education, Culture, Sports, Science and Technology, *White Paper on Science and Technology 2006*, Part 3, 3.3.3, available at: http://www.mext.go.jp/english/news/2007/03/07022214/003/005.htm, accessed September 2007; Y. Ishikura *et al.*, *Nihon No Sangyo Kurasuta-Senryaku* [*Japan's Industrial Cluster Strategy*], Yuhikaku, Tokyo, 2003.

3. M. Porter, 'Location, competition and economic development: local clusters in a global economy', *Economic Development Quarterly*, 14, 2000, pp. 15–34.
4. C. Steinle and H. Schiele, 'When do industries cluster?', *Research Policy*, 31, 2002, pp. 849–58.
5. L. G. Zucker, M. R. Darby and M. B. Brewer, 'Intellectual human capital and the birth of US biotechnology enterprises', *American Economic Review*, 88, 1, 1998, pp. 290–306.
6. P. Cooke, 'Regional innovation systems: general findings and some new evidence from biotechnology clusters', *Journal of Technology Transfer*, 27, 2002, pp. 133–45.
7. Keizai Sangyosho, Keizai Sangyo Seisakukyoku, Chosa Tokeibu, *Heisei 17 Nen Kogyo Tokeihyo (shikuchoson hen)* [*2005 Census of Manufactures, Municipalities, Towns and Villages Edition*], available at: http://www.meti.go.jp/statistics/tyo/kougyo/result-2/h17/kakuho/sichoson/index.html, accessed September 2007.
8. *Kobe No Keizai 2006 Kaitohen* [*Kobe's Economy in 2006, Revised*], Part 1, ch. 1.1, available at: http://www.city.kobe.jp/cityoffice/27/shomu/chousa_page/, accessed September 2007.
9. City of Kobe, *The Great Hanshin–Awaji Earthquake: Statistics and Restoration Progress*, 1 January 2007, available at: http://www.city.kobe.jp/cityoffice/06/013/report/January,%202007.pdf, accessed September 2007.
10. 'Port city seeks to nurture new enterprises', *Financial Times*, 27 April 2004, p. 3.
11. *Nihon Keizai Shimbun*, 25 January 1999, p. 2.
12. Kansai Toshi Seisaku Kenkyukai, *Kansai Keikaku Chizu* [*Map of Kansai Projects*], Kanki Shuppan, Tokyo, 1998, pp. 74–80.
13. *Nihon Keizai Shimbun*, 11 September 1998, p. 46.
14. This section is based on the text of the study group's report, *Kobe Iryo Sangyo Toshi Koso Kondankai Hokokusho* [*Report of the Medical Industry Development Project Working Group*], March 1999.
15. *Nihon Keizai Shimbun*, 20 February 2000, p. 46.
16. *Nihon Keizai Shimbun*, 1 March 2000, p. 46.
17. OECD, *Economic Surveys: Japan*, OECD, Paris, 2006, p. 140.
18. K. Tamai and Y. Miyata (eds), *Nihon No Sangaku Renkei* [*University–Industry Collaboration in Japan*], Tamagawa Daigaku Shuppanbu, Tokyo, 2007, pp. 49–57.
19. Ministry of Education, Culture, Sports, Science and Technology, *Knowledge Cluster Initiative 2006*, pamphlet (mimeo).
20. Personal communication with K. Uematsu, Director, Kobe Trade Information Office, Seattle, Washington, June 2007.
21. *Nihon Keizai Shimbun*, 21 February 2007, p. 46.
22. *Kobe Kenko Kagaku (Raifusaiensu) Shinko Bishion~kurasuta- No Shoraizo~* [*Kobe Health Sciences (Life Science) Promotion Vision: The Cluster's Future Image*], Kobe, Kenko Kagaku (Raifusaience) Shinko Kaigi, March 2007.
23. 'Baiocurasuta- No Kokusai Kyosoryoku' ['Biocluster's international competitiveness'], *Loop*, October 2003, p. 25.
24. *Kobe Kenko Kagaku*, *op. cit.*, p. 12.
25. *Ibid.*, p. 14.
26. *Nihon Keizai Shimbun*, 4 August 2007, p. 46.
27. *Nihon Keizai Shimbun*, 14 July 2007, p. 46.
28. M. Fromhold-Eisebith and G. Eisebith, 'How to institutionalize innovative clusters? Comparing explicit top-down and implicit bottom-up approaches', *Research Policy*, 34, 2005, pp. 1250–68.
29. *Nihon Keizai Shimbun*, evening edition, 20 June 2007, p. 13.