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The Japanese Innovation System: University–Industry Linkages, Small Firms and Regional Technology Clusters[1]

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Abstract *This essay introduces the articles in a special edition on advances made in the Japanese innovation system. It sets the papers against a broad overview of traditional Japanese approaches to innovation and recent calls for change. An analysis is made of the geography of high-technology factories and recent job losses in the manufacturing sector. The new policies and their impact on Japan's national and regional innovation systems are then outlined and a synopsis given of the other papers in this special edition. The essay makes a number of concluding remarks on the appropriateness of Japan following the US-model of innovation.*

Keywords: industrial clusters; Japan; national innovation systems; regional innovation systems; university–industry links

Introduction

This special issue of *Prometheus* is dedicated to the theme of the Japanese innovation system and some noteworthy changes brought about over the past 15 years or so. These have involved new arrangements in science and technology policies that position university research and start-up companies as engines of economic innovation and competitiveness. In addition, Japan has recently made other efforts to increase its national standing in the global knowledge economy by tapping into local innovative capacity and establishing regional innovation systems. Against these ambitions, however, there is a popular perception shared both by Westerners and Japanese that the Japanese innovation system has distinct weaknesses: it is weak in giving birth to radical innovations and is strong only in giving birth to more incremental innovations.[2]

The efficacy of a country's innovation system can be assessed in a number of ways, for instance the number of persons awarded the Nobel Prize in natural science. The number from Japan—seven—lags far behind that of most other industrialized countries and reflects the country's relative shortcomings in basic research.[3] A country's education system and social values are also important and

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Japan's difficulties in this area may reflect its rigid high-school curriculum and university entrance examination system, with an emphasis on social conformity that does not encourage the development of creative talents. As well, it has been argued that the reason for the weakness of Japan's innovation system lies in many other institutional structures, which have been adapted for the needs of a 'catch-up' economy. These include, for example, the integral cooperation of corporate research departments with production and marketing departments, the low degree of internationalization in research laboratories, the education bias towards generalists, and the close and long-term relationships between buyers and suppliers. In addition, the closed labor market of major companies, an underdeveloped capital market and lack of venture finance for new start-up firms, an industrial policy that has neglected the importance of competition, and the low openness and mobility between firms and institutions are seen as central reasons for Japan's distinct drawbacks in innovation when compared to the USA and other Western countries.[4]

In the international sphere, Japan has relied historically on the imports of foreign technology for its industrial development. Such imports have often far exceeded Japan's technology exports, resulting in large deficits in its technology or royalty balance of payments. Yet, after the mid-1990s there was a small but growing technology trade surplus.[5] Nonetheless, during the 1990s Japan lost markets in leading-edge fields—such as semiconductors and other information technology products—to American, European and Asian countries. In international rankings of competitiveness Japan places low when compared to other OECD members. For instance, according to the Global Information Technology Report of the World Economic Forum of 2006–07, Japan ranked only number 14 in terms of 'networked readiness'—an index that purports to measure the degree of preparation of a nation or community to participate in and benefit from ICT (information and communications technology) developments.[6]

Even if one admits that particular companies, such as Sony, have brought out successful innovations in niche markets, the Japanese innovation system in general does not seem to be suitable for radical, risky innovations. By way of illustration, Japanese firms have not counted for much in software, the Internet, biotechnology and high-growth industries over the past decade or so. Japan can boast no equivalent of fast-growth companies such as Microsoft, Google, Amazon or eBay. Still, Japan's lack of success in the innovative sector is not for want of trying. The country has increased its R&D spending over the past 20 years and continues to lead the world in research and development, investing 3.35% of its gross national product (GDP) in research and development (R&D) in the fiscal year 2003, compared with 2.61% in the USA and 1.93% in the European Union (see Figure 1). Instead, the country's failures to generate new businesses have much to do with its method of management and organization. There has been what Anchordoguy calls a 'crisis of communitarian capitalism'.[7]

Against such as backdrop this special collection of articles on 'Advances in the Japanese Innovation System' brings attention to initiatives focusing on university–industry linkages, small firms and regional technology clusters. All of the research contained in this special edition was presented at a Workshop hosted by the Centre for Japanese Research, University of British Columbia in March 2007. This introductory essay proceeds in the following way. It first sets the shifts in national and regional policies against a broad overview that characterizes the strengths and weaknesses of Japan's traditional approaches, pressures for change, and a geographic analysis of high-technology factories and recent job losses in the manufacturing

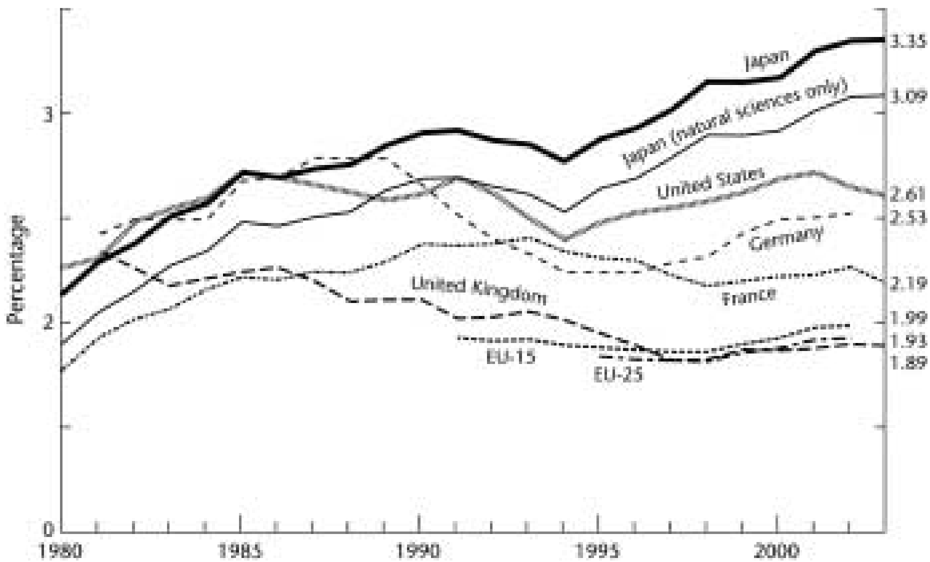

Figure 1. R&D expenditures as a percentage of GDP in selected countries.
Source: Ministry of Education, Culture, Sports, Science and Technology, Japan, 2005.

sector. The new programs are then introduced together with a synopsis of the other papers in this special edition.

Characteristics of the Japanese Innovation System

Systems of innovation are useful frameworks for understanding science and technology developments and have become popular among scholars and policy makers. The concept highlights the importance of linkages among the various actors involved in innovation—enterprises, universities, research institutions—and that understanding these relationships is the key to improving technology performance. Indeed, Freeman[8] first coined this expression in his 1988 study of Japan's successful economy. An allied concept has been provided by Etzkowitz and Leydesdorff[9] who propose a 'triple-helix' of academy–industry–government connections for promoting knowledge-based economic development, and many studies have affirmed the value of this idea. There is also an interest in 'regional innovation systems' and research on ways in which systemic learning and innovation enhance competitiveness at sub-national levels.[10] This level of examination has tended to be dominated by the work of Porter[11] on the significance of 'business clusters'. He and others have stressed the cooperative dimension of regional innovation arrangements and their potential for creating advantage for individual firms to engage in the competitive 'surplus' that arises from external economies of scope and scale. In the 1980s, the emergence of high-technology centers in the USA, such as Silicon Valley and Route 128, brought attention to the geographical basis of high technology development, leading to various kinds of regional technology policies in countries around the world.[12]

In Japan's case, many accounts of the birth of its innovation system point out that the establishment of national universities—starting with the University of Tokyo in 1877—helped the nation emerge economically from its centuries of isolation.[13] For a country without natural resources, policy makers considered that creating knowledge centers was necessary to develop the economy and society. Indeed, Odagiri[14] notes that investment in education was probably the single largest contribution of the government in the late 1800s, followed by its investment in communication and transportation networks and other infrastructure. At that time, Japanese professors and their universities played a central role in nation building by absorbing knowledge from Western economies. In the beginning of the Meiji period (1868–1912) imperial universities (later called national universities) and advanced high schools called 'Number Schools' were set up across Japan.[15] As shown in Figure 2, these institutions for advanced education were strategically positioned at the center of each major region.

It is important to note that the government emphasized practical education at a time when European and American universities tended to regard such practices as inferior to pure science. Universities were also expected to spread their knowledge to industry. For instance, one of the higher education institutions built by the government was a technical college called *Kogakuryo*, founded in 1873. This college, which later become the Engineering Department of the University of Tokyo, actively collaborated with engineers in the manufacturing sector. Following this, elites at universities urged a government role in promoting science and technology and achieved Diet (the Japanese parliament) approval in 1932 for establishing the Japan Society for the Promotion of Science (JSPS). In 1933 this agency launched a University–Industry Cooperative Research Committee, comprising groups of the leading industrial interests at the time as well as prominent academics and militarists. Early subcommittees addressed themes such as metal processing,

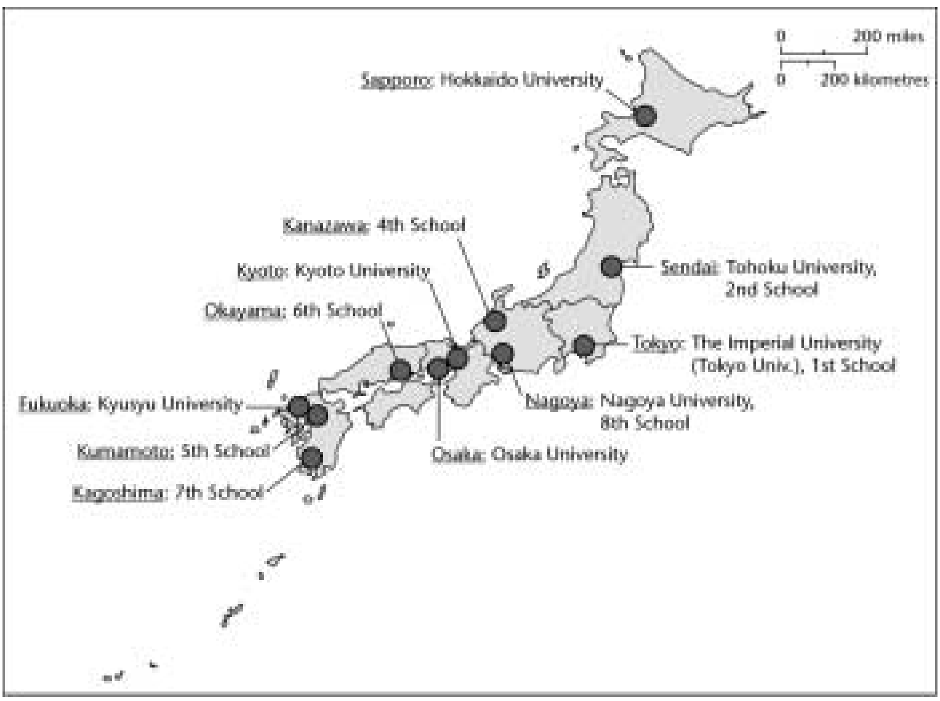

Figure 2. Distribution of imperial universities and 'Number Schools'.
Source: adapted from Ishii, 2007.

electrical storage, wireless communications, wear-resistant materials, and rice processing.[16]

These early beginnings geared to university–industry links and regional development were lost however in the period after World War II. In particular, there was an intellectual backlash among leaders of the academic community against working with industry as this sector was considered to have been a central contributor to armaments and the war effort. An anti-war and anti-industry atmosphere prevailed throughout the 1960s and played a major role in delaying the re-emergence of university–industry cooperation.[17] Japanese industry for its part typically did not regard research cooperation with universities as particularly advantageous. Throughout the 1970s and 1980s, the strategy adopted by Japanese technology-based companies for attaining and maintaining a strong international competitive position was based on making incremental improvements to imported expertise and this sector saw little need to seek potentially promising research results by working with universities. Most firms preferred to carry out whatever research they required in their corporate laboratories and to train personnel for company-specific R&D. Despite the barriers involved, Japanese corporations did not entirely ignore university research. Although direct cooperation was relatively rare, where it did occur it remained largely informal and consultative, based on personal links with particular faculty. In a labor market that was short of skilled labor, ties to university professors were also important to firms for their success in recruiting. In exchange for access to students at the time of graduation, industry contributed human and physical resources to university laboratories. Nonetheless, it was only since 1983 that faculty in national universities were legally able to undertake research with private companies, and only in 1989 could they openly accept donations from private industry.[18]

The post-war period also saw the Japanese central government support many technology programs and approve national science and technology budgets funneled to so-called 'big science' research agendas, such as space and nuclear research. These occurred mainly through its 16 national industrial laboratories (*kogyo gijutsuin*) operating under the supervision of the then Agency of Industrial Science and Technology, an external branch agency of the former Ministry of International Trade and Industry (MITI).[19] In certain high-technology industries, such as semiconductors and computers, MITI played a major role in their successful development. It identified core technologies, pushed firms into collaborative research projects, and at the same time bullied some companies into compliance.[20]

Accordingly, at the end of the 1980s the Japanese system of innovation was characterized largely by large companies, many of which had emerged as powerful competitors in technology-intensive goods. Ministry of Education, Science, Sports, Culture and Technology data show that they have been responsible for around 75% of R&D spending compared with just 25% from the government and universities or public research institutions.[21] An irony here is that while small firms hardly feature in most formulations of the 'Japanese model', Japan has the highest proportion of small and medium-sized enterprises (SMEs) and employment of any major industrialized country. Provision of SME support was until recently provided under the Small and Medium Enterprise Law of 1983, which tended to concentrate on the growth and development of existing firms, endeavoring to improve their performance, innovation and competitiveness. A regional focus to these efforts has been maintained by *Kohsetsushi* centers, which comprise public research institutes funded by local authorities in each of Japan's 47 prefecture and large cities, such as Yokohama and Osaka. These usually concentrate on practical technical issues for SMEs, including adopting new techniques and often specialize in particular sectors, e.g. ceramics, textiles, metals and machinery.[22]

The important point to note here is the sharp contrast to the patterns of, say, the Silicon Valley style of innovation characterized largely by a sizeable array of start-up firms and mobility of researchers between companies.[23] The heavy concentration of Japanese R&D in large corporations was also bolstered by long-term guaranteed employment that encouraged firms to transfer researchers and engineers between their research and manufacturing divisions. This has tended to increase the horizontal communication between laboratory and shop floor in Japan, as well as between different corporate departments. The scheme of remuneration, based on seniority, allowed researchers and engineers to reap returns on human investment only when and if they were promoted to higher ranks—making it hard for personnel in mid-career, who possess substantial company-specific knowledge, to quit the firm. As noted by Goto[24] Japan's manufacturing industry became very successful by using the tacit knowledge that was embodied in production workers and sales forces. However, with the increasing importance of scientific knowledge for innovation, the challenge has been to create a management system and organization structure that enables both types of knowledge to be used.

Yet another feature of post-war circumstances was the concentration of industrial production in the Kanto region (centered on Tokyo and the surrounding Keihin industrial district) together with Chubu (focused on Nagoya and Aichi prefecture) and the Kansai region (Osaka and Kobe). Hall[25] notes that the initial location of the electronics industry in the Kanto region benefited from close proximity to the national government in Tokyo at the beginning of the twentieth century. After 1945, easy access to information and the availability of research personnel in Tokyo explained the growing number of research institutions in the capital region. Castells and Hall[26] assert that by the 1980s the densely urbanized 700 km Tokaido corridor between Tokyo and Osaka/Kobe held almost 80% of all corporate laboratories, 70% of all scientists and 60% of all university professors.

We may note that an early manifestation of policies designed to address this concentration and link regional development to technology was the 1964 decision by the Japanese government to establish a new academic and research city in Tsukuba, some 60 km north-east of Tokyo in rural Ibaraki prefecture.[27] After then, the flow of investment in high-technology towards Tokyo accelerated and during the late 1970s and early 1980s regional disparities increased. In order to rescue Japan's regional economies MITI devised the Technopolis program in 1983 and designated 26 sites for high-technology production decentralized throughout Japan based on new legislation. In each case, local governments were asked to build upon their strengths and mobilize local resources as far as possible to attract new industries and develop high-technology manufacturing complexes. Most of these were based around local universities or research institutes, *Kohsetsushi* centers and new industrial and residential infrastructure established by public authorities. In this regard, the Technopolis program incorporated the conceptual model of 'triple-helix' between university–industry–government links by strategically tying technology development goals into policies aimed at promoting the expansion of Japan's peripheral regions (e.g. Hokkaido and Kyushu).[28]

Economic Stagnation and 'Hollowing Out' in the 1990s

From August 1971 through to April 1995, the Japanese yen's value ratcheted up from 360 yen to the US dollar to 80 yen to the dollar. This had the impact of diminishing the nation's traditional exports (textiles, ships and steel) and accelerating the process of industrial transformation initiated by technological innovation.[29] In recent times, the most significant economic change has been the long period of stagnation that began in the early 1990s and which ended only around 2004. The dramatic decline in industrial growth could be ascribed at first to fallout from the bursting of the country's massive asset 'bubble' in both land and stock markets, and subsequently to woes in the financial sector. But by the second half of the decade serious problems were emerging in hitherto competitive manufacturing industries. Most immediately there were challenges associated with falling profits and declining market share, and in some major cases, especially among the large electronics makers, much red ink. From top position in 1989–93, Japan began to slide rapidly down the IMD Business School's World Competitive Survey rankings to 24th position in 2007.[30] Yet as noted earlier, this was not due to a lack of R&D investment as Japan ranked at or near the top. Still, many companies were having difficulties in capturing the benefits of this investment.

Whittaker has examined the case of the Hitachi Corporation in the late 1990s as an example of a giant *keiretsu* (industrial conglomerate) firm that ceased to innovate and allowed North American, European and other Asian firms to catch up with Japanese productivity. Commenting on the company's massive losses incurred in 1998–99 of over $2 billion, the *Nikkei Shinbun* newspaper remarked that:

> Japan's economic woes have now reached the major electronic machine companies which support the nation's very economic foundations. The picture of battleship Hitachi, losing its way, unable to take effective measures before this massive loss materialized is the very picture of Japan today.[31]

Diminished opportunities for 'catch-up' development required the government to place greater emphasis on basic science and technology development. The many difficulties in this transition have been revealed by Callon, who showed the increasing jurisdictional conflict between MITI and the former Ministry of Education over science and technology budgets, intensified by bureaucratic rigidities and technological change itself.[32] During this period academic capability for basic research and technological innovation began to gain attention. But as suggested earlier, Japanese firms were often disappointed at the problems involved in forging closer ties with Japanese universities; they complained that domestic universities were not motivated to collaborate, did not fully commit to protecting intellectual property, and lacked interest in putting research to practical use. Consequently, Japanese firms' R&D funding to foreign research institutes (e.g. prestigious American universities) was more than double that granted to domestic universities.[33]

Another serious problem was that the number of new companies being established lagged the number of firms being shut down. Not surprisingly, Japan's financial crisis in the 1990s affected small firms most, especially from late 1997 onwards, when city banks and regional banks reduced their SME loans sharply to improve their own financial health. New firm growth had been about 7% in the 1960s and 1970s but this fell to around 4% by the early 1990s, its lowest rate in around 25 years. This state of affairs contrasts sharply with the United States where bright young engineers, sometimes working at first in large corporations, started their own spin-off venture businesses, riding the wave of the 'dot.com' boom of the late-1990s.[34]

Overall, Japan's economic stagnation and corporate restructuring have had uneven sectoral and spatial outcomes. Thus, in the manufacturing sector there has been a massive reorganization of the country's productive capacity, with a large share of factory capacity moving overseas to cheaper locations in Asia and elsewhere, leading to a collapse of previously stable domestic production chains.[35] Some analysts argue that a new integrated economic system is developing in East Asia with a division of labor that fits with Japan's competitive strengths *vis-à-vis* the economies in the region.[36] The result of this rationalization has been that a large proportion of Japan's more labor-intensive assembly industries have almost disappeared. Moreover, under the previous *keiretsu* system of vertical integration, large corporations developed their own tightly woven networks of suppliers and subcontractors for whom a single major firm was the only customer or one of just a few. The collapse of this system has put many SMEs under significant pressure. As a result, the OECD noted that the machinery sector, for example, which had accounted for a large share of total exports, lost over 750,000 manufacturing jobs and around 12% of companies went out of business in the course of the 1990s.[37]

The 'hollowing out' of manufacturing jobs has been a general phenomenon across the country. Figure 3 shows the change in factory jobs from 1990 to 2005 from the Japanese Census of Manufacturing. The job declines for each region vary from 18.9% to 33.8% (excluding Okinawa). However, employment losses have affected locations outside the industrialized Tokyo–Nagoya–Osaka belt particularly hard due to the inability of these peripheral regions to generate alternative jobs in services or high-technology industries, leading to high unemployment and high enterprise closure rates. An interesting feature of Figure 3—especially in the context of the decline of the *keiretsu* system of assembly firms linked to SME suppliers—is the relatively smaller decline of 18.9% recorded by the Chubu region (mainly Aichi and Shizuoka prefectures) in which Toyota and Honda motor corporations opted to retain their main operation centers in Toyota City and Hamamatsu City, respectively. The low percentage decline of only 2.9% recorded from Okinawa (essentially a non-industrial prefecture) is an anomaly and this has occurred from a very small base level of manufacturing jobs.

A parallel geographical trend has been a renewed spatial concentration of economic activity within the Tokaido belt, particularly in the national capital region. In the growing high-technology manufacturing sector which produces high-end consumer goods for local markets or sophisticated parts and equipment for overseas factories, the most prominent geographical cluster of new investments has occurred in the core region surrounding metropolitan Tokyo (the Kanto region in Figure 4). This is confirmed by a spatial analysis of factories in selected technology-intensive sectors, taken from the Census of Manufacturing. The main reasons for this pattern include the presence of existing R&D laboratories in the corridor running from Tsukuba Science City through Tokyo down to Yokohama, together with numerous subsidiary and independent companies dealing in software and hardware. In total, this complex of high technology is now much stronger than those contained in the manufacturing regions focused on Osaka/Kobe (Kansai) and Nagoya (Chubu) (see Figure 4). Apart from sophisticated production facilities, the increasing dominance of the wider Tokyo region over information services and other white collar industries has also been striking. In particular, large

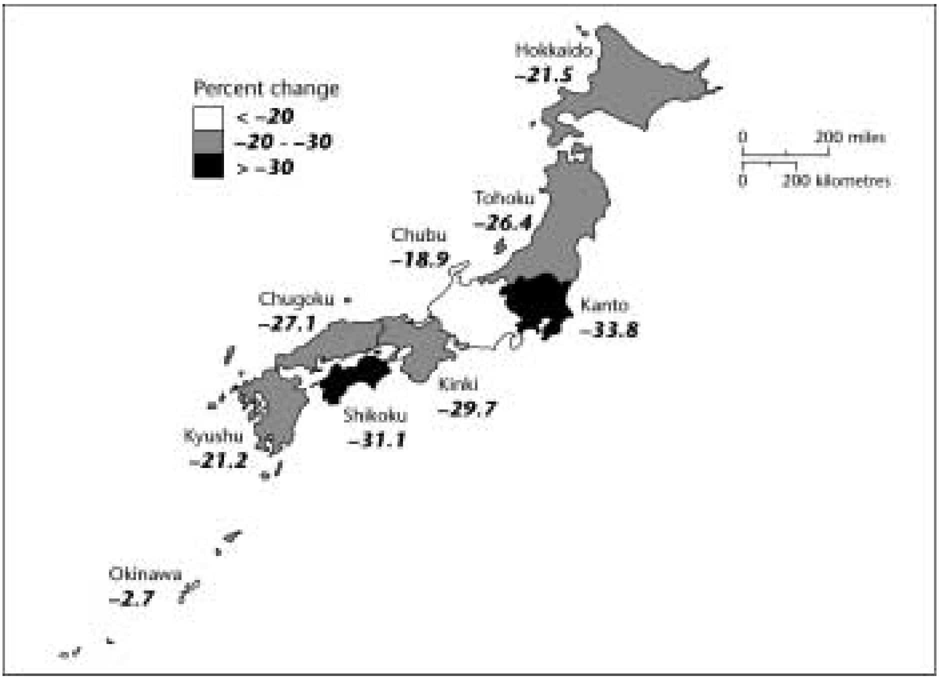

Figure 3. 1990–2005 manufacturing employment change in Japan's regions.
Source: derived from Census of Manufacturing, 2005.

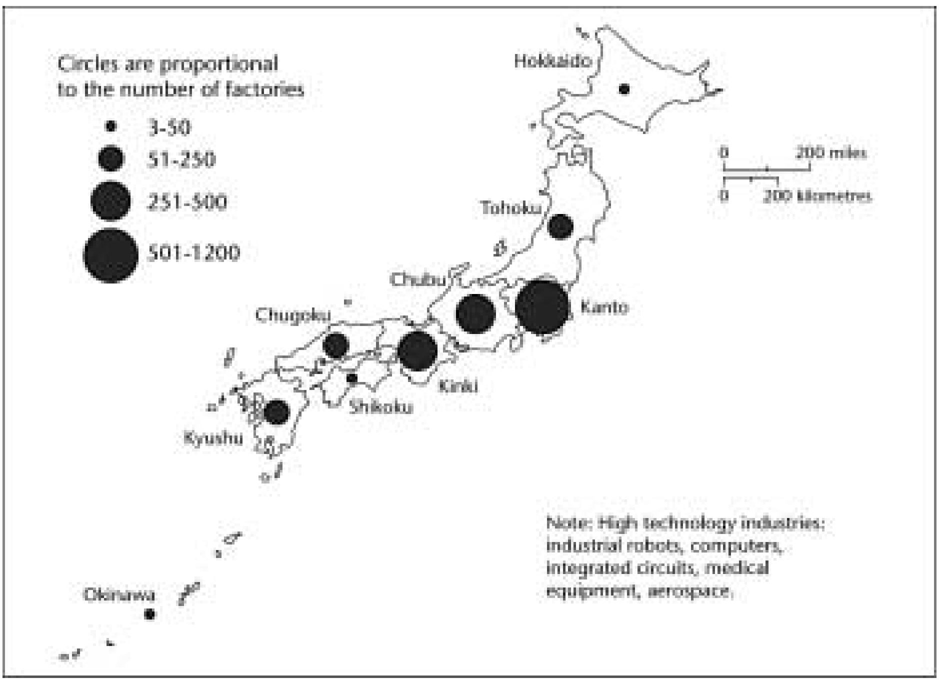

Figure 4. Number of high-technology factories per region, 2005.
Source: derived from Census of Manufacturing, 2005.

corporate head office functions expanded in Tokyo more than Osaka, Japan's second largest commercial city.[38]

Despite the need to provide further support for locations outside of Tokyo, the Technopolis program was unable to avert regional hollowing out in its 26 designated locations. In part this was because the main instruments of policy under this scheme were tax breaks, depreciation allowances and special loan rates. These types of government subsidy comprised policies that generally favored the attraction of large-scale corporations (or rather their branch factories) rather than development of an independent small firm base in Japan's localities. Indeed, the inherent bias towards large firms within the Technopolis program was very similar to MITI's other post-war industrial policies that contributed to a concentration of strategic decision-making and R&D within corporate Japan. A linked dimension was that even the limited success of certain peripheral regions in promoting branch plants led to very little innovation potential and was always threatened by the risk of off-shoring. During the 1980s many science and technology parks were created in Technopolis locations, but connections with nearby university research were weak and support mechanisms for knowledge transfer to local economies, or the creation of venture firms from university research, were insufficient.[39]

Overall, it appeared that many basic factors that supported the strength of manufacturing firms in Japan had all but disappeared by the turn of the new century. Accordingly, there were calls for a new approach in which the emphasis should be to start innovation at an early stage rather than improve existing technologies in an incremental manner. But in order to do this basic research had to be strengthened and the industrial patent system changed in order to encourage the commercialization of radical innovation. Policies were called for that improved university links with industry, strengthened Japan's SME base with a specific focus upon nurturing independent small firm entities, and which aided the horizontal networks of firms in Japan's local regions.[40]

Recent Advances in Japan's Innovation System

In response to mounting economic problems the Japanese government responded by passing laws and plans almost every year from 1998 to 2006 to build new institutional frameworks for national and regional innovation systems (see Table 1). Japan's new approach has four aspects:

- revised governance mechanisms supporting science and technology policies;
- programs to link research and industry;
- support for innovative small- and medium-sized firms; and
- development and support for regional technology clusters.

Perhaps the most significant result was the passage in the Japanese Diet of the Science and Technology Basic Law, 1995, and the adoption of the First Science and Technology Basic Plan, 1996. This set the goal that Japan should become an advanced science- and technology-oriented nation, designated the basic strategy for technology and innovation policies in the period from 1996 to 2000, and worked as a guideline for each ministry in charge of R&D policies. In particular, even in the severe economic circumstances of the late-1990s the government strengthened budgets and infrastructure for publicly supported scientific research. However,

Table 1. Japanese frameworks promoting industry science relationships

1995	The Science and Technology Basic Law
1996	The First Science and Technology Basic Plan (1996–2000)
1998	Law Promoting Technology Transfer from Universities to Industry
1998	Abolition of the Technopolis Law
1999	The Law to Facilitate the Creation of New Business
2000	The Law to Strengthen Industrial Technology
2001	The Second Science and Technology Basic Plan (2001–05)
2001	Council for Science and Technology (CSTP) Policy: CSTP attached to the Cabinet Office
2004	National University Incorporation Law
2006	The Third Science and Technology Basic Plan (2006–10)

Source: Kitagawa, 2005; Council for Science and Technology Policy, 2006.

during the entire five year period it lacked any central organization to coordinate Plan-related activities at the various ministries and agencies. Hence the Second Plan, published in 2001, set up a new Science and Technology Policy Council situated in the Cabinet Office and hence above the influence and rivalries of individual ministries. Its 15 councilors include the Prime Minister and four Cabinet politicians, and seven members drawn from the private sector and university professors and presidents. This Council is intended to be the 'control tower' for Japanese science and technology policy, ensuring 'joined up' policy making and implementation, especially between the Ministry of Economy, Trade and Industry (METI) and the Ministry of Education, Culture, Sports, Science and Technology (MEXT). Priority sectors encouraged by the government were designated as life sciences (including biotechnology), information technology, environmental sciences, nanotechnology and new materials. The Third Plan covers the period from 2006 to 2010 and sets the goal of raising public R&D expenditure to 1% of GDP by the end of this period. It also establishes targets for the hiring of young and female researchers, as well as foreign researchers in Japan.[41]

Improving university relations with industry was identified as a critical feature in encouraging national competitiveness based on science and technology, and so one of the first measures enacted under the 1995 Basic Plan, enacted in 1998, authorized universities and other publicly supported research agencies to establish technology licensing organizations (TLOs). This was designed to assist researchers to obtain patents on their inventions and to license those inventions to private industry. A second step, the Law of Special Measures for Industrial Revitalization, enacted in the year 1999, was a Japanese version of the US Bayh–Dole Act, making it easier to trade intellectual property rights derived from publicly funded research. Other legislation in the year 2000 legitimized external research by national university professors provided that the intent of that research was to assist them in commercializing their own inventions. Following this new law, 45 TLOs were established (as of 2004) both at national and private universities, and the number of filed patent applications, patent grants and licensing and option contracts increased as a result of these government efforts. Nonetheless, many problems have been revealed, including the poor financial sustainability of TLO activities and the lack of professionals skilled in university–industry collaboration.[42] In 2004, Japan's 87 national universities became National University Corporations rather than branches of MEXT and their faculty were no longer civil servants. This resulted in universities being able to claim ownership over all discoveries made by their faculty members, so long as the inventors were given reasonable remuneration.[43]

As a result of these changes there was a sharp increase in the number of start-up firms based on university basic research and technology breakthroughs. This was bolstered by the year 2000 by the Law to Strengthen Industrial Technology, which legalized compensated consulting and also holding of line management positions in private companies by university faculty, provided permission was obtained in advance in the case of management positions. In 2001, the 'Hiranuma Plan' of METI set a goal of creating 1,000 new firms within three years. In effect, about 1,500 new enterprises were created by year 2005; however there have been questions about the long-term sustainability of many of these start-ups.[44] In addition, the Small and Medium Enterprise Basic Law was radically revised in 1999 with a new focus on promoting business innovation and new business start-ups more generally. Subsequently, the government established a Small Business Innovation Research Program (modeled after a similar scheme in the USA) to allow subsidies and other fiscal incentives for SME research that hitherto had been made principally only to large firms.[45]

Dramatic changes also took place in regional technology policy. Subsequent to the Science and Technology Basic Law one of the government's aims has been to promote science and technology policy in each region. Accordingly, the Technopolis program was abolished and in 1999 it was replaced with a new law for promoting the creation of new enterprises and providing local municipal and prefectural governments with far more autonomy and responsibilities. A new model for support, called the 'local platform', was created in order to implement regional development policies that were more oriented towards entrepreneurship and indigenous models of economic development. With the new Science and Technology Basic Plan the geographical limitations favoring peripheral regions applied to the Technopolis program were no longer defensible. As shown above, every local government was affected by 'hollowing out' of manufacturing and so needed to develop a 'local platform' supporting firms on the basis of local resources and regional opportunities.[46]

An important development in the evolution of policies for small firms has been the emphasis on regional technology clusters derived from similar programs in the USA and Europe. In the past, regional growth pole policy (including Technopolis) was mainly perceived in terms of creating a concentration of firms but not necessarily emphasizing their complementarities or potential to work together to build producer chains or other types of networks. As can be seen from METI's vision of its regional cluster system (Figure 5), the new emphasis is on nurturing horizontal links between key agencies—such as local universities, local companies, technology licensing organizations, specialized services such as patent attorneys, former executives of companies that can act as mentors for new entrepreneurs, and a range of infrastructure (business incubators, industry support organizations) often provided by local governments.

The 17 designated METI Industrial Clusters for Japan's regions are shown in Figure 6, each selected and administered by METI's regional offices. The main participants are around 5,000 SMEs, over 200 universities, the regional METI staff and specified network organizations. Whereas the METI Industrial Cluster Program concentrates on existing industrial complexes to help them develop technological strength, the Knowledge Cluster Initiative of the MEXT focuses on universities and local governments. The aim is to encourage universities to work

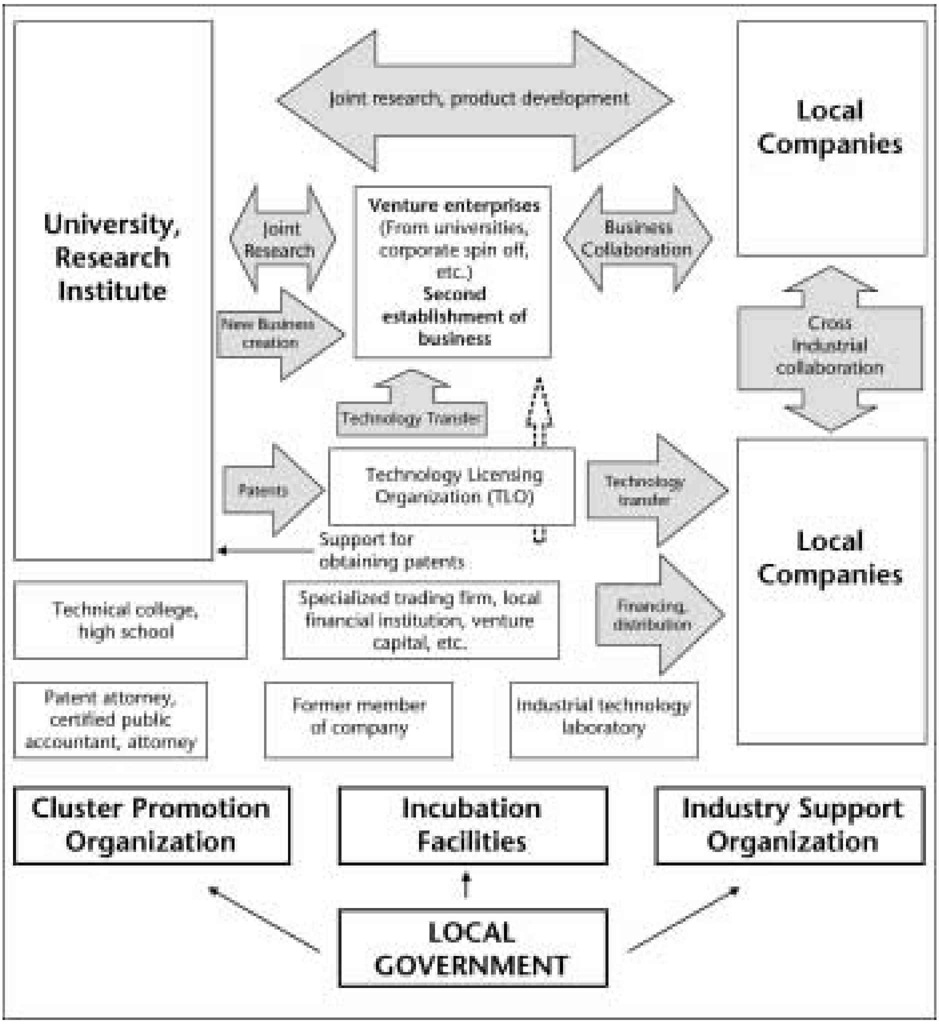

Figure 5. Model of triple-helix arrangements in Japanese regions.
Source: adapted from METI, *The Industrial Cluster Program 2006*.

with firms in local areas, as well as with financiers, in order to commercialize new technologies. MEXT will invest about $500 million over the five years in 18 designated cluster areas (shown in Figure 7). 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 and industry, and by networking other principal stakeholders providing seed funding for joint activities. The emphasis on both initiatives is on encouraging stronger face-to-face interaction between the various actors who are likely inadequately connected at present. Nonetheless, the cluster program has not been without its critics. For instance, Ibata-Arens contends that national government programs are still administered in a 'top-down' manner that is often insensitive to regional history; a case in point is

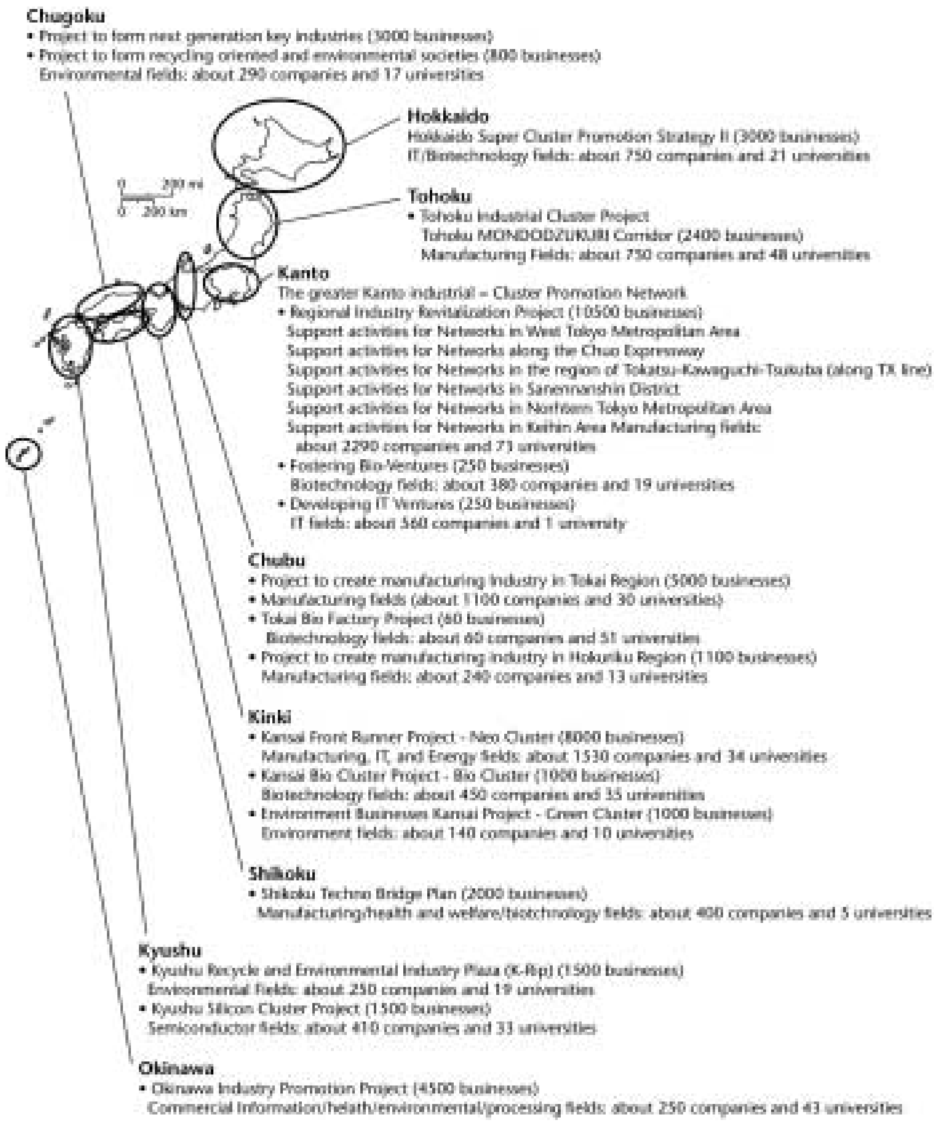

Figure 6. METI, industrial cluster projects in Japan.
Source: METI, *The Industrial Cluster Program 2006.*

that METI's industrial clusters were chosen on the basis of their administrative regional structure rather than the most successful local industrial agglomerations within Japan.[47]

Synopsis of the Papers

Clearly, the new initiatives sketched out above present a number of important theoretical and practical research questions. For example, how have budgets for science and technology in Japan shifted as a result of the new Basic Plans? Have the university reforms of 2004 impacted on faculty research and their interactions with outside business? Has there been a backlash? Are the new arrangements

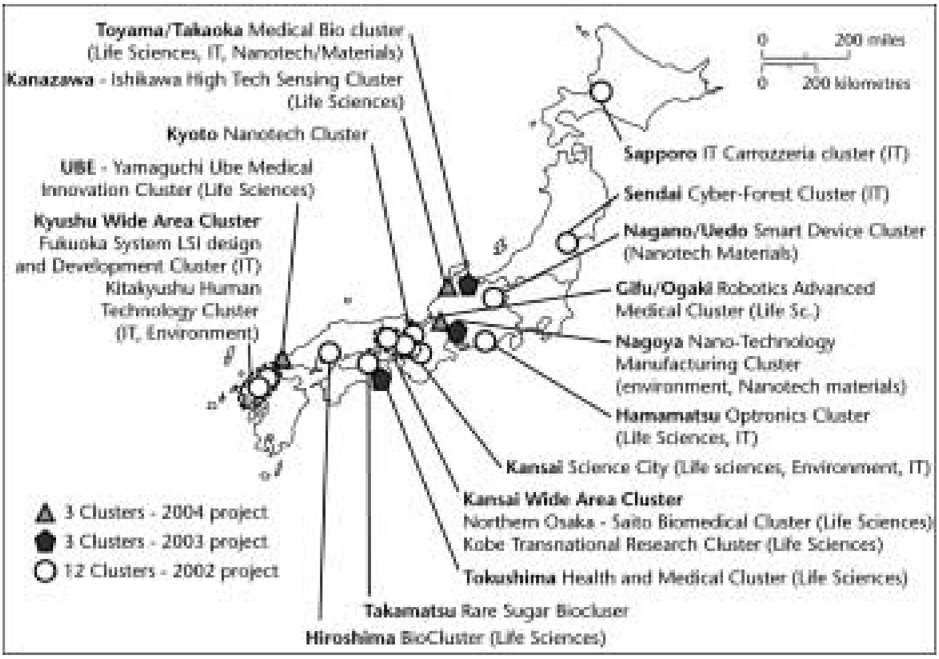

Figure 7. MEXT, knowledge clusters in Japan.
Source: MEXT, *The Knowledge Cluster Initiative 2006*.

likely to assist the rejuvenation of SMEs in Japan? How are the new cluster policy arrangements working in each of Japan's major regions? Will they bring more autonomy to Japan's local governments? Are the new Japanese policies distinct or do they compare broadly with similar programs in other OECD countries? While these issues will require long-term monitoring, the papers in this special edition provide rich descriptions of the advances in Japanese national and regional innovation systems.

The first three papers deal directly with the changes in the administrative arrangements outlined earlier. Holroyd revisits the growing challenges Japan has faced and the urgency to revise its innovation systems, and details the changes put in place since the Science and Technology Basic Law, 1995. Her review notes that funding has increased and has supported the research of priority areas as well as improving scientific and technological infrastructure. Her appraisal examines the contents of Japan's Third Science and Technology Plan, 2006, and the new administrative structure of Japan's national innovation strategy. Walsh *et al.* focus on the commercialization of university research since the mid-1990s. Using data from a national survey of university engineering and biomedical faculty the authors in this paper examine changing relations between professors and outside firms and compare outcomes with North American findings. They conclude that informal ties between faculty continue to exist with firms, and they also raise the issue of whether too much emphasis on university patenting can be detrimental to the progress of science and ultimately to industry and society as a whole. Kitagawa and Woolgar scrutinize the new arrangements to discern how regional innovation systems are developing in Japan. They give examples from the peripheral regions of Kyushu and Tohoku. Their research suggests that there has been some movement towards regional diversity in science and technology policies and the emergence of nascent regional innovation networks linking major universities to local industries, as well as the importance of international connections in East Asia and beyond.

Small businesses are an important part of the Japanese scene and upgrading their competence to make them more competitive is a continuing battle. As already noted, SMEs were considered as weak organizations compared to big companies, and how to protect them was the main purpose of government policy-making. But now, SMEs are considered as a source of new business development and policy is more attentive to innovative firms that are capable of creating new products, industries and employment. Shapira compares the Japanese experience with that of the United States to address the needs and opportunities facing mature manufacturing SMEs, and uses three headings—framework actions for improving the general business environment for manufacturing, industrial services aimed at modernizing operations, and regional clustering initiatives. He concludes that policy outcomes differ markedly among the two jurisdictions, but that benchmarking a county against a prominent competitor can be a useful way of reflecting upon policy effectiveness.

The final set of papers deal with two case studies of particular innovative clusters. Ibata-Arens examines Kyoto, the ancient cultural capital of Japan. Her research reveals a distinctive Kyoto model of entrepreneurship and innovation that is based more on 'bottom-up' arrangements and the dynamism of local firms than on national government programs. By contrast, the biomedical industry cluster of Kobe studied by Collins has been engineered by municipal and national governments in the wake of the devastating 1995 earthquake. These research case studies point to important differences in the outcomes of Japanese cluster policies and have ramifications for other jurisdictions considering this approach.

In sum, Japan's new commitment to innovation is ambitious and will ensure that this country remains a global leader in science and technology research and application. At an aggregate level the national indicators revealed in papers by Holroyd and by Walsh *et al.*, suggest that the reforms have relaxed regulations and provided budgetary and other support of university–industry linkages, and these have been successful overall. There has been a significant increase in joint research between universities and firms, a growth of technology licensing organizations, and a big increase in university-based start-ups. Kitagawa and Woolgar's paper shows evidence of local universities playing a stronger role in developing regional economies. Apart from generating new business start-ups Shapira's research notes how the Japanese policy initiatives have continued to support mature SMEs. As noted in the Kyoto and Kobe case studies by Ibata-Arens and by Collins, cluster generation can be the result of both 'bottom-up' as well as new 'top down' initiatives to generate brand new industries.

A general observation is that Japan's innovation system has moved towards the 'US model' with its emphasis on formal licensing and start-ups from universities. Yet beyond these initiatives, described earlier, other challenges associated with core Japanese social values and business behavior persist, such as rigidities in labor recruitment, attitudes towards entrepreneurship, corporate policies on outsourcing R&D, and the lack of mechanisms for financing new enterprises. These traditional characteristics do not lend themselves to change so easily, even though they are also important for optimizing innovation. However, it must be remembered that there are many ways to innovate and no single approach is 'right' for all times and technologies. In biotech and software the USA gained a clear edge from its ability to allow many start-up firms to experiment with new techniques and business models, and to commercialize ideas from university research laboratories as quickly as possible. By comparison, Japanese companies are good at pursuing future technologies in several industries by making things first and making changes for the better later on. Their objective is to improve quality and eliminate costs while rivals in the West waste precious time at the drawing board. While it is true that Japan's traditional style of innovation failed it in software and biotechnology during the 1990s, it can be expected to do well, as it once did in automobiles and electronics, through large corporations making things first and only then pausing to think about how to improve them or put them to new uses. Indeed, it may be even better suited than the US model to a number of burgeoning technologies, such as robotics, aerospace, fuel cells, solar panels, information appliances, animation as well as the electronic game industry.[48]

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