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*Article*

# Local Management of National Cluster Policies: Comparative Case Studies of Japanese, German, and French Biotechnology Clusters

**Hiroyuki Okamuro [1,*] and Junichi Nishimura [2]**

[1] Graduate School of Economics, Hitotsubashi University, Naka 2-1, Kunitachi Tokyo 186-8601, Japan

[2] Faculty of Economics, Gakushuin University, Mejiro 1-5-1, Toshima Tokyo 171-8588, Japan; E-Mail: junichi.nishimura@gakushuin.ac.jp

* Author to whom correspondence should be addressed; E-Mail: okamuro@econ.hit-u.ac.jp; Tel.: +81-42-5808792; Fax: +81-42-5808882.

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**Abstract:** Cluster policies have attracted increasing attention worldwide, but only a few studies have focused on their management by local cluster organizations. We investigate the relationship between national cluster policies and their management by local cluster organizations from a comparative perspective. For this purpose, we provide a detailed comparison of national cluster policies in Japan, Germany, and France as well as six prominent biotechnology clusters in these countries. Information on the focal clusters and on the management of cluster policies was obtained using semi-structured interviews with cluster managers. We find that national cluster policies considerably differ among these countries according to basic conditions of clusters and that the patterns of national cluster policy are closely related to those of local cluster management, despite some differences between clusters in the same country caused by various regional characteristics.

**Keywords:** cluster policy; cluster organization; biotechnology; case study; international comparison; Japan; Germany; France

## 1. Introduction

High-tech clusters are expected to contribute to regional innovation and development, especially by promoting collaboration and knowledge spillover among research organizations and local firms, and thus have been attracting much attention from practitioners, policymakers, and researchers in several countries including Japan, Germany, and France.

To date, most studies on clusters comprise detailed case studies on specific cluster areas such as Silicon Valley [1,2], while others describe cluster policies in various countries (several European countries [3,4]; Germany [5–8]; or France [9–12]). Moreover, some recent studies empirically evaluate the effects of cluster policies on participant firms using micro data, such as [13–15] for Germany, [16,17] for France, and [18,19] for Japan. There is a vast amount of literature on the economies of agglomeration (e.g., [16] and on the clustering process or mechanism in an established cluster (e.g., [1]). However, no empirical studies examine effective organization of cluster policies [16]. The management or implementation of national cluster policies by local cluster management organizations is also an important issue, and should affect the performance of each cluster [20–22]. However, to the best of our knowledge, there are no in-depth studies on the local management of national cluster policies by comparing clusters in various national contexts.

Clusters vary in their origins and evolution. Some studies distinguish between top-down and bottom-up clusters [23], spontaneous and policy-driven clusters [24], or research-driven and industry-driven clusters [25]. Jungwirth and Müller [26] argue that governance regimes, which differ between top-down and bottom-up clusters, should conform to cluster managers' tasks. However, these studies do not explicitly investigate the relationship between national cluster policies and cluster management. Therefore, we propose to investigate how national cluster policies and local cluster management are related, and how and why they differ across countries or regions.

For this purpose, this study provides a detailed comparison of national cluster policies in Japan, Germany, and France, focusing on six biotechnology clusters in these countries: (1) Kobe Biomedical Innovation Cluster (KBIC) in Kobe (Japan); (2) Fuji Pharma Valley Cluster in Shizuoka Prefecture (Japan); (3) BioM Biotech Cluster in Munich (Germany); (4) BioRegion Rhein-Neckar (BioRN) Cluster in Heidelberg (Germany); (5) Alsace BioValley Cluster in Strasbourg (France); and (6) Lyonbiopôle Cluster in Lyon (France).

Our research targets these countries for three reasons. First, excluding the United States, they are among the leading nations in science and technology (including life science and biotechnology). Second, they have all recently promoted clusters using national policies by investing significant public funds to catch up to or compete with the United States. Third, as we later show, there are distinct differences among their national cluster policies that deserve further investigation, although these countries are all classified into the same group of coordinated market economies in the concept of the varieties of capitalism [27].

Furthermore, we select these cluster regions for three reasons. First, these are outstanding biotechnology and life science clusters in their respective countries. Second, they all receive major public subsidies from their national (federal) governments. Third, they all have distinct core organizations to manage their cluster policies.

We focus this research on biotechnology clusters for a number of reasons. First, biotechnology is regarded as one of the most important high-tech industries in Japan, Germany, and France. In addition, biotechnology is a science-based industry in which networks between industry and academia are especially important for innovation [28] Asheim *et al.* [29] also assigns an analytical (science-based) knowledge base to the biotechnology industry. A recent study [21] using an online survey of cluster managers shows that high-tech cluster development often relies on intentional cooperation between public and private institutes. These countries thus emphasize national cluster policies targeting biotechnology. Moreover, focusing on a specific technological field removes differences in cluster management policies due to technological differences as a factor.

We obtained information about the focal clusters and cluster policy management by interviewing cluster managers and presidents of cluster firms in Kobe in December 2010 and June 2011, in Munich, Heidelberg, and Strasbourg in February 2011, in Shizuoka in July 2011, and in Lyon in November 2012. We also gathered information from the websites of related ministries and focal cluster management organizations.

The remainder of this paper is organized as follows. Section 2 explains the conceptual framework and research methodology. Section 3 investigates the basic conditions of cluster policies and local management, including a review of each cluster, and discusses how they may affect the patterns of cluster policies and local management. Section 4 reviews the Japanese, German, and French national cluster policies. Section 5 compares the local management of national cluster policies by the core management organizations in each cluster region. Section 6 summarizes the findings and concludes the paper with policy implications and a discussion of this study's limitations.

## 2. Conceptual Framework

### *2.1. Basic Concepts*

Since Porter's seminal works, clustering has become a key concept of regional competitiveness and innovativeness. Porter [30] provides a rather rough definition of a cluster as a geographical concentration of interconnected companies and institutes in a particular field. More recently, Hospers *et al.* [31] indicate that there are diverse concepts and definitions of clusters, and it is thus a fuzzy concept without a fixed geographical scope or border.

We do not go into detail about the concept of clusters in this paper, and instead rely on the political or administrative definitions of clusters and conceptualize these as the targets of existing cluster policies. In this respect, providing the European Commission's definition is useful: "…clusters can be defined as a group of firms, related economic actors, and institutions that are located near each other and have reached a sufficient scale to develop specialized expertise, services, resources, suppliers and skills. A common element of most cluster definitions is the aspect of a concentration of one or more sectors within a given region as well as the emphasis on networking and cooperation between companies and institutions" [32] (p. 9).

In this paper, we discuss the differences in cluster policies across countries and consider why they have these differences. Moreover, we explore how national cluster policy patterns and local cluster management may be related. Cluster policies are generally specific governmental efforts to support the

emergence and development of clusters [32]. Local cluster organizations should manage and implement central governments' cluster policies. Cluster organizations are the legal entities engineering, steering, and managing the cluster, including the participation and access to the cluster's premises, facilities, and activities [32]. Cluster management includes implementing cluster policies, coordinating activities, and providing various support measures to the participants.

We can expect that cluster organizations' management of cluster policies may affect the performance of each cluster and its participants [20–22]. However, to the best of our knowledge, there are no in-depth studies into cluster organizations' management of cluster policies using international and inter-regional comparisons. Therefore, the local management of national cluster policies deserves further investigation.

### *2.2. Research Question and Analytical Framework*

Most previous studies focusing on clusters are case studies of a specific cluster (or a few clusters), or comparisons of numerous clusters using a survey of cluster organizations [25,33–36]. While the latter explores the role of cluster organizations with international comparisons, only a few investigate local cluster management in detail [25,26,37]. Moreover, as far as we know, no studies explicitly address the relationship between national cluster policies and local cluster management with international comparisons. However, as we later demonstrate, this relationship is essential for cluster policy and cluster management efficiency.

Thus, this study addresses (1) how national cluster policies differ from each other; (2) why they have these differences; and (3) how national cluster policies are related to cluster management by cluster organizations (*i.e.*, verifying whether their types are consistent). Figure 1 presents a simple framework to address these research questions.

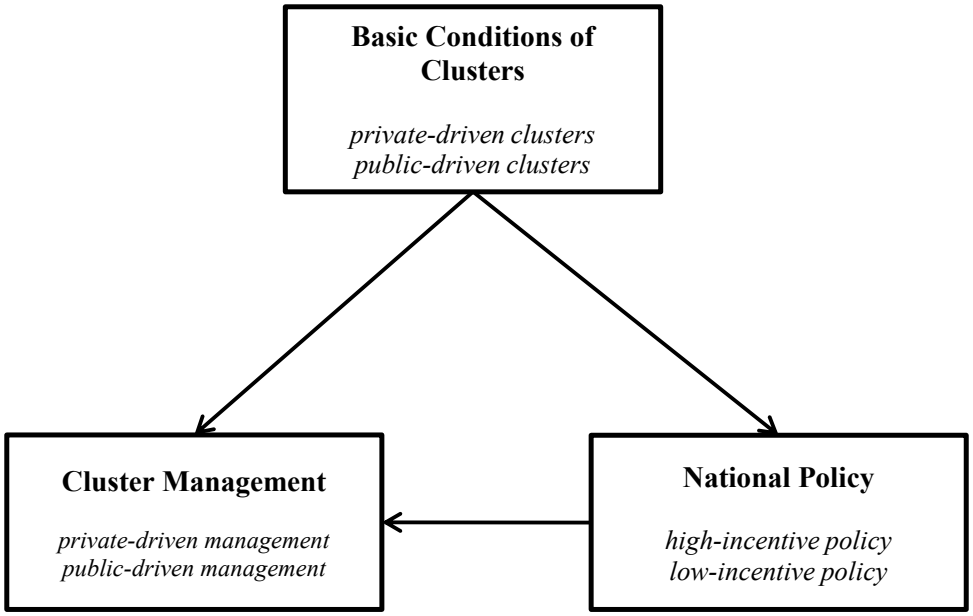


**Figure 1.** Conceptual Framework.

First, we assume that both national cluster policies and local cluster management depend on the basic conditions of clusters comprising various regional characteristics such as the size of industry agglomeration, industrial specialization, firm size distribution, local firms' research potential, the

number and quality of research institutes including universities, and the initial level of inter-firm and university-industry research collaboration. Moreover, scientific or industrial focus may vary by cluster in life sciences or biotechnology. Although these conditions may significantly differ across regions in a country, central government policymakers should recognize the overall conditions in designing national policies, as their policies will be unfeasible otherwise. Therefore, we expect that various national policies be designed according to the overall basic conditions of clusters in each country. In contrast, local cluster managers cannot ignore their local cluster situations in decision-making. Rather, their strategy depends on the research capabilities and other resources of the cluster participants, which include local firms, universities, and public research institutes. They should consider participants' and local authorities' various interests, and coordinate these with their own strategies.

Second, in preparing for and managing public subsidy programs, we expect that national policies will also affect cluster management because local cluster managers must implement national cluster policies, coordinating them in accordance with the interests of local authorities and cluster participants. Therefore, we expect that national policies will have varying effects on local cluster management.

This simple framework indicates that both local cluster management and national policy depend on the clusters' initial conditions and that national policy affects local cluster management. In this sense, local cluster management should be consistent with national cluster policy. However, this is not necessarily the case, because national policy is formulated considering the overall or average situation of clusters across the country and in various technological fields. By contrast, local cluster management is tailored to the basic conditions of each cluster and a specific technological field, such as biotechnology, and is also affected by regional cluster policy or controlled by local authorities Furthermore, national policymakers are not necessarily better informed than local organization managers about the economic potential of the regions [31]. Therefore, this information asymmetry may cause inconsistency between local cluster management and national cluster policy.

We next distinguish between the types of clusters, national cluster policies, and cluster management, and discuss consistent combinations of these types.

First, we consider the types of clusters. We briefly discussed the basic conditions of clusters in each region and nationwide. Here, we assume that clusters can be classified into two types according to their basic conditions. Some studies distinguish between top-down and bottom-up clusters [23,36] or spontaneous and policy-driven clusters [24]. Bottom-up or spontaneous clusters are initiated, driven, and financed mainly by local firms seeking to benefit from positive externalities, whereas top-down or policy-driven clusters are publicly initiated and funded, driven mostly by policymakers [26].

According to the previous definition of clusters, universities and public research institutes play an important role as the local cores of scientific research and advanced knowledge. Therefore, the local cores' level of commitment to cluster development is also a key factor in the basic conditions. Another essential factor is the number and research capability of cluster participants, especially of small local biotechnology ventures. Thus, we distinguish between *private-driven clusters*, in which numerous small biotechnology ventures with high research capabilities spontaneously agglomerate, and *public-driven clusters* initiated and supported by public research institutes and local authorities (these are similar to industry-driven and research-driven clusters [25]). We assume that our concepts of private-driven and public-driven clusters cover those of bottom-up and top-down clusters, respectively [26]. In Section 3.1,

we discuss how the basic conditions differ across clusters and countries in more detail, and then classify each cluster and country into one of these types.

Second, national cluster policies can be classified according to the selection process of target clusters (*i.e.*, administrative or competitive) and financial support rules (*i.e.*, full or matched funding). The government may select some clusters as policy targets using an administrative process (top-down) considering regional characteristics or a competitive process (bottom-up) based on regional initiatives. Moreover, the government provides full or matched funding for research consortia in targeted clusters. Matched funding, wherein the government finances only half of the research budget, may enhance member firms' incentives to succeed and partially prevent moral hazard and crowding out because participating firms must raise the other half of the research funds elsewhere, presumably from venture capitalists and business angels.

Traditional national policy combines administrative (top-down) selection with full funding, whereas recent patterns [5,6] have competitive (bottom-up) selection and matched funding. We term the latter *high-incentive policy* and distinguish it from the former, termed *low-incentive policy*. A great advantage of the bottom-up approach is that applicants (local cluster management organizations) have a considerable degree of freedom in arranging the organizational form for innovation activities that correspond to their specific regional needs, which in turn enhance applicants' motivation compared to a top-down approach [7].

The financial support rules depend on the main targets of public financial support, *i.e.,* whether they are private firms or public research institutes, including universities. It is difficult for public research institutes to find matched funding because they can hardly raise funds from venture capitalists. Hence, matched funding is applicable only to cases where private firms are major players in the clusters, and are thus policy targets.

Third, we consider different types of cluster management. In the private-driven clusters supported by a rich agglomeration of biotechnology ventures, cluster management aims to maximize benefits for participating firms, whereas public-driven cluster management may be controlled by local authorities and public research institutes. Accordingly, we can distinguish between *private-driven* and *public-driven cluster management*.

Moreover, cluster organizations may take a top-down or bottom-up approach to manage national cluster policies. Specifically, in selecting research projects to be supported financially by national policy, a cluster management organization may determine which projects to include in the application using a top-down process or select them competitively through open calls for projects (*i.e.*, using a bottom-up process). We assume that a private-driven cluster management organization is more likely to take a bottom-up approach than a public-driven one because private-driven cluster management is based on the larger research potential of local firms.

We present three hypotheses related to the relationship between the basic conditions of clusters, cluster policies, and cluster management. First, we expect that national cluster policies depend on the overall situation of the country's clusters: high-incentive policies with competitive target cluster selection and matched funding for research projects are positively related to a high concentration of private-driven clusters in the country (Hypothesis 1). This is because private firms are typically far more prepared to compete than public institutes are, and matched funding schemes do not work well for public institutes that lack external investors. Second, the types of local cluster management depend strongly on

the local cluster's status quo (Hypothesis 2). Organizations managing private-driven clusters tend to employ private-driven and bottom-up management, especially in terms of the competitive selection of research projects.

Finally, we expect that national policy and cluster management types are consistent: A high-incentive cluster policy is consistent with private-driven and bottom-up cluster management (Hypothesis 3). This is not only because cluster management is designed to effectively implement cluster policies but also because both are based on the basic cluster conditions in the same country. However, such consistency is not obvious because national cluster policy is formulated considering the overall situation of clusters across the country, whereas each cluster's management depends on the basic conditions of that particular cluster. Cluster organization's management may even differ under the same national cluster policy because of the variations across clusters.

### *2.3. Research Methodology*

To investigate the relationship between the types of national cluster policies and cluster management, we require detailed information about both. Therefore, we conducted in-depth interviews with cluster managers (*i.e.*, managers of cluster management organizations) and top managers of cluster firms. Information on national cluster policies was obtained from the program websites of the related ministries [38–42] and, regarding the French policy, also from previous literature [16,17] supplemented by interviews with cluster managers.

Our research is based on comparative case studies of six prominent biotechnology clusters in three countries—Japan, Germany, and France. These countries, which are all regarded as coordinated market economies [27], conduct national cluster policies with large subsidies (including biotechnology in their target technology fields), and specify that each cluster should have a local management organization implementing the cluster policy. As we later describe, the Japanese government initiated cluster policies in 2001 that were strongly influenced by European policies [18].

Most previous studies of clusters focus on a unique case (such as Silicon Valley) or cases in the same country, compare two countries with one prominent cluster from each [43], or compare numerous clusters in various sectors from several countries [33,36]. Moreover, previous studies are concentrated on the US and EU countries. As compared to these previous studies, our method has several advantages. First, we can demonstrate distinct differences in national cluster policies and implementation, even among countries with similar characteristics (coordinated market economies). Specifically, to our knowledge, there has been no international comparison of cluster policies and management that includes Japan. Second, by targeting two comparable clusters in each country, we can offer some degree of generalization compared to a "one cluster in each country" study, while we can still take advantage of in-depth interviews by concentrating on a small number of cases. Third, by limiting our target to biotechnology clusters, we may exclude noise from differences in sectors and technology.

We selected Japanese biotechnology clusters in Kobe City and Shizuoka Prefecture from several clusters supported by the cluster policy programs of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) [38,39]. These clusters were highly evaluated by the government, and, thus, repeatedly obtained public subsidies for cluster projects. Biotechnology clusters in Germany (Munich and Heidelberg) and France (Strasbourg and Lyon) were selected from the European Cluster

Observatory [44]. The German clusters are considered to be the most innovative biotechnology clusters in Germany, having won both the first (*BioRegio*) and second (*Spitzencluster-Wettbewerb*) public subsidy programs through competitive selection. The clusters in Strasbourg and Lyon are highly ranked by the government among those in France. Section 3.2 provides further details about these clusters.

We obtained cluster managers' contact details using each cluster's website [45–50]. Although some information about the focal clusters was directly available from these websites, the detailed information was obtained mostly from our interviews with cluster managers and participants. In Munich, we interviewed two cluster managers and two cluster participants for 1 h each on 18 February 2011. In Heidelberg, we conversed with the managing director of the cluster organization for 1 h and with two cluster participants for 2 h on 21 February 2011. In Strasbourg, we interviewed the managing director and two cluster managers for approximately 4 h, and two cluster participants for 2 h on 24 February 2011. In Kobe, we interviewed a cluster manager (a department head of the City of Kobe) for 1 h on 13 December 2010 and two cluster managers from FBRI, a public foundation for cluster support, for 1.5 h on 17 June 2011. In Shizuoka, we talked with a cluster manager for 1.5 h and with the president of a participating firm for 2.5 h on 4 July 2011.

We based the semi-structured interviews on a common questionnaire to obtain a wide range of information while securing comparativeness across interviews. We sent interview partners a list of questions in advance to allow them to prepare for the interviews. These questions include (1) the history and research potential of the cluster region; (2) the history, organization and management of the cluster management organization; (3) characteristics of the national cluster policy; (4) roles of the cluster organization and cluster managers in the cluster policy; (5) various support measures for cluster firms; (6) project outcomes; (7) application for cluster competition; and (8) selection of cluster members for public subsidy. These questions were adjusted to national and regional contexts. After the interviews, we sent the case study reports to the interview partners to have the contents checked.

## 3. Basic Conditions of Clusters for Cluster Policy and Cluster Management

This section explains the clusters' basic conditions for national cluster policies and local cluster management. Among the various factors that may affect them, we pay special attention to the innovation system and local cluster development. First, based on macro data from the OECD Science, Technology and Industry Scoreboard 2005 [51] and 2007 [52] and OECD Biotechnology Statistics 2009 [53], we discuss how innovation systems differ across Japan, Germany, and France and compare these with the US as a baseline reference. We refer to the data mainly from the first half of the 2000s to compare situations before the start of the focal cluster policies in Germany and France (in Japan at the beginning of the cluster policy). In this comparison, we use the government's role in R&D; SMEs' (small and medium enterprises') collaboration in innovation; venture capital investment, especially for biotechnology; start-up ratio of new firms; the number of biotechnology firms; and geographical concentration of innovation activity as indicators of innovation systems (Table 1). Then, we describe the development and characteristics of the six clusters based on in-depth interviews. We expect that innovation systems affect national cluster policy, while local cluster management depends on the development and characteristics of local clusters.

**Table 1.** International Comparison of Basic Conditions for Regional Innovation.

| | Japan | Germany | France | USA |
|---|---|---|---|---|
| Government R&D expenditure to total R&D exp. | 16.8% | 30.5% | 37.6% | 29.3% |
| Government-financed R&D in business | 1.2% | 5.9% | 9.3% | 9.3% |
| SMEs collaborating in innovation in general | 6.0% | 8.6% | 11.5% | N.A. |
| SMEs collaborating in innovation with universities | 1.0% | 4.4% | 2.6% | N.A. |
| Venture capital investment to GDP | 0.032% | 0.057% | 0.083% | 0.183% |
| Biotechnology in VC investment | 1.9% | 12.4% | 8.0% | 28.4% |
| Firms' birth rate (start-up rate) | 4.5% | 17.4% | 7.9% | 8.7% |
| Number of biotechnology firms + | 1007 | 587 | 824 | 3301 |
| Patents concentrated in top 10 patent regions * | 83% | 46% | 52% | 65% |
| Geographic concentration index of patents * | 0.79 | 0.43 | 0.57 | 0.63 |

Sources: [50,51] (*), and [52] (+).

### *3.1. National Systems of Innovation and Research Potential*

First, we consider national systems of innovation as basic conditions of clusters and cluster policy. Freeman [54] first defined the national system of innovation as "the network of institutions in the public and private sectors whose activities and transactions initiate, import, modify and diffuse new technologies" [54] (p. 1). Further, he focused on four elements in discussing the Japanese system of innovation: the role of the government (MITI: Ministry of International Trade and Industry, today METI), the role of business R&D, the role of education and training, and industry agglomeration [54] (p. 4). Lundvall [55] more broadly defined a national system of innovation as "all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring—the production system, the marketing system and the system of finance present themselves as subsystems in which learning takes place" [55] (p. 12).

From among these elements, we focus on (1) the role of government in R&D; (2) the role of private (especially small) business in R&D (SME collaboration in innovation, start-up ratio of new firms, and the number of biotechnology firms); (3) the system of finance (venture capital investment, especially for biotechnology); and (4) industry agglomeration (geographical concentration of innovation activity).

Common across Japan, Germany, and France, the government has traditionally played an important role in industrial and technological development. Governments actively intervene in these countries through industrial and regional policies in the form of regulation and subsidies, especially in Japan, though deregulation and liberalization have gradually taken place since the 1980s [56]. However, OECD statistics show that government plays a smaller role in Japan than in Germany and France in terms of its share in total R&D expenditures and the share of public subsidies for business R&D: in Japan, the government's share in R&D expenditures is 17%, while it exceeds 30% in Germany and France. Moreover, the share of public subsidies in business R&D is only 1% in Japan, but 6% in Germany and 9% in France. Thus, we confirm that in Japan, compared to Germany and France, government did not play a major role in R&D. Japanese investment in R&D is mostly private. Traditionally, public research institutes play an important role in Germany, with numerous Max-Planck Institutes and Fraunhofer Institutes [57], but also in France [58].

The EU Commission's [32] definition of clusters stresses the interaction and networks of local firms and institutions. According to the OECD data in Table 1, the ratio of SMEs collaborating in innovation to all SMEs is 6%, and that of SMEs collaborating with universities in innovation is 1% in Japan; these ratios are clearly lower than those in Germany and France. Considering the possibility of overestimation in Japan, where the upper limit of SMEs is higher (300 employees) than in Germany and France (250 employees), the real difference would be larger. One reason for such a low ratio of SMEs with R&D collaboration is the common practice of subcontracting among SMEs in all industries in Japanese manufacturing: subcontracting firms are less likely to conduct R&D [59].

In innovation, especially in biotechnology, start-ups play an important role. This ratio, presented in the OECD Statistics as firm birth ratio, is lower in Japan (4.5%) than in Germany (17.4%) and France (7.9%). Indeed, among the OECD countries, this ratio has been the lowest in Japan since at least the late 1990s. This suggests that innovative activity by new firms might also be lower in Japan than in other countries.

Japan had a higher number of biotechnology firms in the mid-2000s compared to the other countries. However, controlling for the population size, Japan's advantage over Germany and France disappears. Moreover, we cannot take these data at par because the original data source (Japanese official statistics) employs a broader definition than the OECD does. According to the OECD [53], a biotechnology firm is defined "as a firm engaged in biotechnology using at least one biotechnology technique (as defined in the OECD list-based definition of biotechnology techniques) to produce goods or services and/or to perform biotechnology R&D" [53] (p. 14), In France, in contrast, only the biotechnology firms with R&D expenditures are counted.

It is also common to these countries that capital market has been relatively underdeveloped as compared to the Anglo-Saxon countries, so that start-ups, especially high-tech ventures, have difficulty raising funds for their R&D [60]. This is also supported by the data in Table 1. However, the share of venture capital investment in GDP is the lowest in Japan (0.032%) among these countries, and the share of investment in high-tech sectors, especially in biotechnology, is much lower in Japan (1.9%) than in Germany (12.4%) and France (8.0%). The relative advance of venture capital investment in biotechnology in Germany may be attributed to the BioRegio program in the latter half of the 1990s, which focused on biotechnology clusters [5,6].

Finally, innovation activities, measured by the number of patents, are geographically more concentrated in Japan than in other countries. Specifically, the share of patents in top 10 regions is highest in Japan (83%) than in Germany (46%) and France (52%). This indicates that innovation activities are more decentralized and conducted in several local clusters in Germany than in Japan, implying that innovation in local clusters is more developed in Germany than in Japan. Such differences may reflect the tradition of political and economic decentralization in Germany as a Federal Republic (in this regard, it is noteworthy that federal states' cluster policies also play an important role in Germany [8,43]) compared to Japan, with its high level of political and economic concentration in Tokyo. The Japanese government has promoted manufacturing plant relocation to various regions since the 1970s, which was unable to effectively inhibit the concentration of innovation activities [61]. Scientific research activities by universities and public research institutes are also concentrated in some large cities in Japan, while universities and public research institutes are dispersed in all regions in Germany.

From these comparisons, we may conclude that innovation systems differ considerably across these countries. Although the government plays a smaller role in R&D in Japan than in Germany and France, all other indicators suggest that at the beginning of this century, Germany and France had generally better conditions of spontaneous cluster development than Japan, at least for biotechnology clusters. In the following subsection, we describe the development of each focal cluster in each country.

### *3.2. Cluster Development and Local Research Potential*

This section presents a brief history of each cluster region, and discusses the regional potential in terms of the number of related firms and the variety of public research institutes. The description in this section is based on our interviews with cluster managers and information from the cluster websites. Hence, the information reflects the status quo at the interview. In summary, both Japanese clusters, which were recently created by local authorities and public agencies because there were only few local biotechnology firms, are more public-driven than private-driven. The German and French clusters have a longer history, with numerous small spin-off firms. In this sense, German and French clusters may be regarded as more private-driven than public-driven, in contrast to their Japanese counterparts. It is noteworthy that private and public initiatives often interact in cluster development, so that each cluster may have some public-driven and private-driven characteristics.

#### 3.2.1. Japanese Clusters

##### Kobe Biomedical Innovation Cluster (KBIC)

KBIC is located on a small artificial island close to the Kobe city center and airport. New subsidiaries of established firms located elsewhere (including some foreign companies) have been invited to this area since the late 1990s. As of 2010, there were approximately 200 cluster firms in biotechnology and related fields in KBIC. Furthermore, 13 public research institutes for biomedical research and medical device development are located there.

The concept of the KBIC was developed in the mid-1990s to induce a shift toward a high-tech cluster of medical and pharmaceutical industries. In 1998, the City of Kobe set up a committee to create the KBIC, in which Prof. Hiroo Imura, the director of the Kobe City Medical Center General Hospital, played an influential role. He also became the president of the Foundation for Biomedical Research and Innovation (FBRI), one of the cluster management organizations established in 1998. In 2002, KBIC was selected as a target of a national cluster policy (Knowledge Cluster Initiative: KCI) in its first round. In total, this cluster program funded 16 research consortia in KBIC. In the second round starting in 2007, KBIC was again selected as a policy target.

KBIC is one of the most popular biotechnology clusters in Japan. The cluster management organizations in KBIC are the City of Kobe and the FBRI, a public foundation comprising a hospital and research institute. Thus, the cluster organization is fully integrated into and controlled by both local authorities and a public agency. Hence, KBIC can be characterized as a more public-driven cluster. The distinct features of this cluster are that it is directly managed by local authorities (including the City of Kobe) and most cluster members were invited to the cluster from elsewhere within a decade.

Fuji Pharma Valley Cluster

The Fuji Pharma Valley Cluster (PVC) is located in the eastern part of Shizuoka Prefecture. There are no universities in the cluster area, rather the main research institutes are the research section of the Shizuoka Cancer Center and the National Institute of Genetics (NIG), which cooperate with some universities located outside the cluster. Except for a few biotechnology ventures, approximately 200 small firms in the cluster area are traditional manufacturers of metalwork. The cluster organization has made significant efforts to help local firms change or diversify their business fields to those related to biotechnology (e.g., medical devices and engineering), but few cases have succeeded thus far.

Fuji Pharma Valley has been supported since its beginning by a national cluster policy: it is one of the nine cluster areas supported by the City Area Program of MEXT from 2004 to 2006 and one of the 10 areas supported since 2007. However, the members of the publicly supported research consortia are all located outside of this cluster, mainly in Tokyo, except for the Cancer Center, NIG, and a few local firms.

The Fuji PVC concept was developed in 2001 in preparation for a new public hospital, the Shizuoka Cancer Center. Shizuoka Prefecture intended to establish a high-tech cluster of medical and pharmaceutical industries around this top-level hospital, possibly involving small local businesses. In 2002, the Fuji Pharma Valley Initiative headed by Ken Yamaguchi, the president of the Shizuoka Cancer Center, was launched along with the center's opening. A unique feature of this cluster is that it is centered at a public hospital and based on its clinical needs. In 2003, the PVC was established as the local cluster management organization. PVC belongs to a public foundation of Shizuoka Prefecture that supports start-up activities as well as business innovation and R&D by small firms in this prefecture. Moreover, the PVC office is located in the Cancer Center. Thus, the PVC is fully integrated into and controlled by the prefecture government and the Cancer Center. Therefore, this case is also a public-driven rather than private-driven cluster.

3.2.2. German Clusters

BioM Biotech Cluster

The BioM Biotech Cluster is located near Munich in Martinsried, where several life science research institutes have been concentrated since the 1970s. Since the late 1980s, spin-offs from research by a public gene study organization have formed a biotechnology cluster. In the mid-1990s, an incubator (IZB) started with 30 firms. In 1996, this cluster was selected by the BioRegio project for a five-year term. In 2006, BioM Biotech Cluster Development GmbH (BioM) was established as the cluster management organization to promote marketing, networking, and coordination. In 2010, this cluster was the only biotechnology cluster to have won the *Spitzencluster-Wettbewerb* cluster policy funding of the federal government in the second round, and has received public support for five years for its new project M4. In total, 32 research consortia with approximately 100 firms (including large multinational companies) obtained public subsidies from this program. Confer Cooke [62] for details about the biotechnology clusters in Munich and Heidelberg.

Since 1997, the number of biotechnology start-ups in this cluster has increased from 31 to 120. In addition, there are over 400 university-industry alliances. As of 2010, approximately 350 cluster firms

(including 120 biotechnology start-ups) were located in this cluster. Several large firms, such as Roche Diagnostics, participate in the M4 Project as consortium members. Global research universities (*i.e.*, the Ludwig-Maximilian University and the Technical University of Munich) and two university hospitals are located in the area. Moreover, three Max Planck Institutes and another national research institutes (Helmholtz Center) play an important role in activating the cluster.

The Federal State of Bavaria provides BioM, a limited liability company, with annual financial support totaling 10 million euro. Moreover, it has been entrusted with managing the Bavarian Biotechnology Cluster to support and network all other biotechnology clusters in Bavaria. These facts suggest that the Bavarian ministry may strongly influence the cluster organization. Confer Sternberg *et al.* [43] for cluster policy in Bavaria.

This cluster can be classified as a more private-driven compared to the Japanese counterparts, although it also seems to have significant influence from and control by the local authorities (*i.e.*, the Federal State of Bavaria).

BioRegion Rhein-Neckar Cluster (BioRN)

The BioRegion Rhein-Neckar Cluster (BioRN) spans the three federal states of Baden-Württemberg, Rheinland-Pfalz, and Hessen. Despite having such a cross-state range, the cluster organization defines itself as a biotechnology cluster with specialized companies located within a radius of 30 km. Traditionally, this cluster area was a core for the chemical industry and life science research in Germany, centered at the University of Heidelberg.

Approximately 200 firms (including 77 biotechnology start-ups) and three multinational pharmaceutical companies (Roche in Mannheim, Merck in Darmstadt, and Abbott in Ludwigshafen) are located in the BioRN Cluster. Excellent universities and six top-level public research institutes are also located there, including the University of Heidelberg (with the university hospital), the German Cancer Research Center (DKFZ), the European Molecular Biology Laboratory (EMBL), and the Max- Planck Institute of Medical Research. Several cluster firms are spin-offs from these research institutes, especially the DKFZ.

The BioRegion Rhein-Neckar Cluster was supported by a BioRegio subsidy from 1996 to 2000. To execute this project, the BioRegion Rhein-Neckar-Dreieck e.V. (BioRN Association) was founded in 1996. In 2008, the BioRN Association set up BioRN Cluster Management GmbH (BioRN) to prepare to apply for the national *Spitzencluster-Wettbewerb* in the first round, and, among the five winners of the competition, it was the only biotechnology cluster. In summary, this cluster policy financially supported 36 research consortia with 24 cluster firms.

BioRN is a semi-public limited liability company (similar to BioM) supervised by various regional associations (including the BioRN Association) with more than 80 members, the Chamber of Industry and Commerce Rhein-Neckar, and Technology Park Heidelberg. Moreover. BioRN's activities are funded mainly by the Federal State of Baden-Württemberg.

This cluster can also be regarded as a more private-driven than public-driven, with numerous start-up and spin-off firms, despite the fact that BioRN's activities are funded mainly by the Federal State of Baden-Württemberg.

### 3.2.3. French Clusters

#### Alsace BioValley Cluster

The Alsace BioValley Cluster is a member of the Trinational BioValley, which also includes the southern part of Baden in Germany around Freiburg and the northwestern part of Switzerland around Basel. The BioValley cluster concept was developed in 1996 with the support of the European Commission's INTERREG II project, which started in 1991 and aimed to promote its network beyond the boundaries of individual EU countries. By receiving public support from the INTERREG, the Alsace BioValley was founded in 1998 as the cluster management organization and as a central office of the Trinational BioValley.

In 2005, the Alsace BioValley was selected as one of the 67 competitiveness clusters in France (and one of eight biotechnology clusters among them) and a "potentially worldwide" cluster. Since then, 56 research consortia have been accredited by the cluster organization for public subsidies by the French ministry by 2010. Moreover, the Alsace BioVally has a close alliance with the biotechnology cluster organizations in Toulouse (Cancer-Bio-Santé) and Lyon (Lyonbiopôle).

There were approximately 390 firms in life sciences (130 pharmaceutical and 260 in medical devices) at the beginning of 2011, including large pharmaceutical companies, in the Alsace BioValley Cluster concentrated in and around Strasbourg. Among them, several firms, especially those involved in medical engineering, are spin-offs from the universities or public research institutes in the cluster region. In 2011, 34 firms were registered as corporate members of the cluster. The University of Strasbourg, two Grandes Ecoles, and several public research institutes are located in this cluster.

The Alsace BioValley board members are selected among cluster members (firms and individual researchers) and public institutes. Executive committees include experts in life science and representatives from the TLO (of the University of Strasbourg), the business incubators, the Chamber of Commerce and Industry in Alsace, and the Regional Development Agency. Hence, this can be regarded as a semi-private cluster, and more private-driven rather than public-driven.

#### Lyonbiopôle Cluster

Lyonbiopôle is a biotechnology and medical cluster centered in Lyon and Grenoble in the Rhône-Alpes Region in France. The cluster organization was founded in 2005 by four multinational medical firms (Sanofi Pasteur, bioMérieux, Merial, and Becton Dickinson France) and two public research institutes, and rapidly grew to become one of the leading biotechnology clusters in France and in Europe. In 2005, Lyonbiopôle was selected as one of the 67 competitiveness clusters (as one of eight biotechnology clusters among these) and into the seven top "worldwide" clusters in France. By 2011, 110 research consortia were accredited for the inter-ministry public support program. Moreover, Lyonbiopôle has a close alliance with the biotechnology cluster organizations in Toulouse (Cancer-Bio-Santé) and Strasbourg (Alsace BioValley).

In 2011, there were approximately 600 biotechnology firms, including more than 100 pharmaceutical firms, in the Lyonbiopôle Cluster, which is concentrated in and around Lyon and Grenoble. In 2011, 110 firms were registered as corporate members of the cluster, of which 80 are SMEs with less than 250 employees. Among these member firms, 83 are located in Lyon and 27 in Grenoble. This cluster hosts

15 public research institutes, including the European Molecular Biology Laboratory and two WHO (World Health Organization) laboratories.

The 14 Lyonbiopôle board members represent six biomedical firms, including four founding members and two biotechnology ventures; four research and training centers, including the Civil Hospital of Lyon; and four local or regional public agencies (such as Rhône-Alpes Region and Greater Lyon) as permanent guests. They are supported by and cooperate with the Technical Group consisting of six firms (including four founding members) and six research institutes (such as the Grand Ecole ENS Lyon and the Pasteur Institute). The Economic Group, which also supports and cooperates with the board, consists of representatives from biotechnology ventures and venture capitalists. Thus, the representatives of the founding firms have a significant presence in the cluster management, but local bio-ventures as well as public institutes and agencies also play an important role. This cluster organization is financially supported by various local, regional, national, and EU-level organizations. Thus, this cluster can also be regarded as a private-driven rather than public-driven cluster.

## 4. National Cluster Policies

This section presents an overview of the national cluster policies in Japan, Germany, and France. Specifically, we compare the subsidy target selection procedures and funding rules. Table 2 summarizes the descriptions of national cluster policies in this section. We will classify the cluster policies in these countries within the framework of *high-incentive* and *low-incentive policies* and consider the hypothesis presented in Section 2.2.

**Table 2.** Comparison of National Cluster Policies.

| **Cluster Policy** | **Knowledge Cluster Initiative (KCI)** | **City Area Program (CAP)** | **Spitzencluster-Wettbewerb (Leading-Edge Cluster Competition)** | **Pôles de Compétitivité (Competitiveness Clusters)** |
|---|---|---|---|---|
| **Country** | **Japan** | **Japan** | **Germany** | **France** |
| Period | 2002–2006 (first)<br>2007–2009 (second) | the same as KCI;<br>three year projects<br>starting in 2002 | 2008–2012 (first)<br>2010–2014 (second)<br>2012–2016 (third) | 2006–2008 (first)<br>2009–2011 (second) |
| Budget | 63 billion yen<br>(EUR 470 million)<br>(2002–2009) | Around 20 billion yen<br>(EUR 150 million)<br>(2002–2006) | EUR 600 million<br>(2008–2016) | EUR 3 billion<br>(2006–2011) |
| Funding scheme | Full funding;<br>“matched” funding<br>since 2007, local<br>authorities cover 50% | Full funding;<br>“matched” funding<br>since 2006, local<br>authorities cover 50% | Matched funding:<br>Government’s share<br>50%, the other half<br>from the<br>project members | Matched funding:<br>Government’s share<br>(max. 50%)<br>depends on the<br>composition of each<br>R&D project |
| Program Initiator | Ministry of Education, Culture, Sports, Science and Technology (MEXT) | Ministry of Education, Culture, Sports, Science and Technology (MEXT) | Federal Ministry of Education and Research (BMBF) | Ministry of Economy, Finance and Industry |

**Table 2.** *Cont.*

| Cluster Policy | Knowledge Cluster Initiative (KCI) | City Area Program (CAP) | Spitzencluster-Wettbewerb (Leading-Edge Cluster Competition) | Pôles de Compétitivité (Competitiveness Clusters) |
|---|---|---|---|---|
| **Country** | **Japan** | **Japan** | **Germany** | **France** |
| Source of Fund | MEXT | MEXT | BMBF | Inter-ministry Funds (FUI) and others |
| Number of Selected Clusters | 12 (first period) | 59 (first period) 30 (second period) | 15 (sum of 3 periods) | 67 (first period) |
| Number of Submitted Applications | 30 (first period) | ? | 85 (sum of all periods) | 105 (first period) |

Note: For Japan, we show the amount euro (EUR) in parentheses for a better comparison with Germany and France. We used the exchange rate as of September 2015 (134 yen for 1 euro). Sources: [38–42], and our own interviews with cluster managers.

### *4.1. Cluster Policies in Japan*

In Japan, MEXT implemented the Knowledge Cluster Initiative (KCI) and the City Area Program (CAP) in 2002, which were reorganized and integrated into the Regional Innovation Cluster Program in 2010, while METI (Ministry of Economy, Trade and Industry) carried out another cluster policy, Industrial Cluster Project ([18,19]). In the MEXT programs, universities and public research institutes play a central role in the clusters as the cores of research collaboration with private firms. Moreover, cluster management is entrusted to the cluster organizations of the selected clusters, which are public foundations designated by local authorities. See Kitagawa [63] for the development of science and technology policy in Japan, including cluster policies.

The KCI selection procedure is a top-down process with limited competition. MEXT selected 30 potential regions in which core research institutes and industrial infrastructure for specific technological fields exist, and invited local organizations to submit business plan proposals for the intellectual cluster that include university-industry research consortia. Based on the proposals, MEXT selected 12 regions to support in the first round of KCI for five the years from 2002 to 2006. Another six regions were accepted in 2003 and 2004 for the following five years, and thus, 18 of 30 regions were eventually selected in the first round. In the second round, beginning during 2007–2009, support was limited to nine areas. However, most clusters supported in the first period could survive in the second period, for example, by integrating with another regional cluster.

The total KCI budget for 2002–2009 was approximately 63 billion yen (JPY) (EUR 470 million): the annual public subsidy per cluster was 500 million yen (EUR 3.7 million) in the first period and 830 million yen (EUR 6.2 million) in the second period (the JPY to EUR conversion is based on the exchange rate in September 2015 (134 JPY for 1 EUR)).

CAP is a minor version of KCI, with a smaller cluster area and budget. Unlike KCI, this program used a competitive selection procedure, at least in the first round. Each area selected obtained financial

support from MEXT for three years. In total, 59 areas were supported in the first round (2002–2006), of which 22 obtained support twice: relatively well-performing areas could expect to be selected later into the higher development stage category with a doubled budget. The total budget of the CAP for 2002–2006 is estimated at 20 billion yen (EUR 150 million): the annual public subsidy per cluster was 100–200 million yen (EUR 0.7–1.5 million).

Both MEXT cluster programs experienced frequent changes in their basic schemes within a decade. Until 2005, for instance, the MEXT programs fully subsidized each research consortia. MEXT changed their rules in 2006 for the CAP and in 2007 for the KCI (at the beginning of the second round) to limit the subsidy to each cluster to 50 percent of the total budget, with the remainder being financed by local authorities or from other sources. This is entirely different from the matched funding scheme prevalent in Germany and France that requires each subsidized project (not the local authority or cluster organization) to finance the remaining half of the budget from other sources (recipients' own financing or funding from venture capitalists). This is probably because the major targets of the MEXT programs are universities and public research institutes that cannot be funded by venture capitalists. Thus, in fact, the full public funding of the research budget did not change in the MEXT programs.

It is noteworthy that in Japan, regional governments or local authorities (prefectures and cities) did not play any formal role in the innovation or science policy, except implementing and supplementing the national policy [63].

Overall, the national cluster policy in Japan can be regarded as a typical low-incentive policy with top-down selection or limited competition with a full funding scheme (including partial funding by local authorities) despite some variations across cluster programs.

### *4.2. Cluster Policies in Germany*

In Germany, the BioRegio enacted in 1996 was the first national program with a proposal competition for developing innovation networks (see [5,6] for more details of the BioRegio project). The biotechnology clusters in both Munich and Heidelberg were selected as regional cluster projects and supported by BioRegio for five years. Following BioRegio, there were a series of national cluster programs, initiated mainly by the German Federal Ministry of Education and Research (BMBF), such as BioProfile, BioFuture, EXIST, and InnoRegio (See [7] for more details).

This paper focuses on the most recent national cluster policy, the "Spitzencluster-Wettbewerb" ("Leading-edge cluster competition") by the BMBF, which has been operational since 2008. In this program, there are national-level cluster competitions every two years in three rounds (2007, 2009, and 2011). In each round, five clusters in various technological fields are selected as targets of federal subsidies for five years.

This national cluster competition's selection procedure is a bottom-up process with strong competition. Only 15 clusters were selected for public subsidies from 85 applicants: 38 in the first, 23 in the second, and 24 in the third round (some cluster regions may have applied for this program two or three times after failing in the previous competition). The total budget of the Leading-edge cluster competition for the three rounds in the 2008–2016 period is 600 million euro (8 million euro per cluster annually).

The funding rule is that the federal government provides a matched funding scheme on the subsidy ratio of R&D projects, in other words, fixed at 50% for each research project. The other half of the budget must come from other sources, such as venture capitalists. This funding scheme suggests that the German cluster policy mainly targets private firms, despite the fact that the policy is initiated and funded by the BMBF. In summary, the national cluster policy in Germany is a high-incentive policy based on hard competition among clusters and a complete matched funding scheme.

### *4.3. Cluster Policies in France*

In France, the Local Productive Systems (LPS) issued in 1998 is the first national cluster policy (see [11,16,17] for more details of the LPS projects). In 2005, the national cluster program "Pôles de Compétitivité" ("competitiveness clusters") came into operation. This is a more ambitious and costly cluster policy than the LPS, and a quarter of LPS projects have been transformed into "competitiveness clusters." This cluster policy provided various technology fields with public support for six years from 2006 to 2011 (see [12] for the details of the competitiveness cluster program; see [9,10] for the development of science and technology policy in France, including the competitiveness clusters policy).

This program's selection procedure is a relatively bottom-up process with limited competition. In the 2005 cluster competition, the Ministry of Economy, Finances and Industry selected 67 (of 105) regional clusters as "competitiveness clusters" for subsidies (the number of target clusters eventually increased to 71 during the first period), of which six clusters were ranked among the "worldwide" clusters, and nine as "potentially worldwide" clusters. In the second period, of 71 clusters, seven were ranked as "worldwide" and 11 as "potentially worldwide." Together with the competitive selection of research consortia, the budget distribution concentrates on the highest ranking "worldwide" clusters. In the second period (2009–2011), 50% of the total budget concentrated on seven "worldwide" clusters among a total of 71. Lyonbiopôle and Alsace BioValley Clusters were among the eight regional biotechnology clusters selected as "competitiveness clusters" (after the evaluation at the end of the first period, they were reduced to seven clusters in the second period), and they were ranked among the "worldwide" and "potentially worldwide" clusters, respectively.

This cluster program uses a two-step procedure. After the government selects the target clusters, firms select the clusters and become members (self-selection). To be eligible for public support, each R&D consortium should include at least two firms and a research organization, and its leader should be a firm that conducts R&D in France, though it may also include a foreign firm. Then, after several rounds, the government selects hundreds of research consortia that are accredited and recommended by at least one cluster organization using a direct call for projects (two calls per year). Starting from the first call for projects in 2005 that selected 55 research consortia in 47 clusters, approximately 1000 consortia obtained financial support from this program by 2011. Some members in a cluster collaborate with members of other clusters, and such research consortia were often cooperatively recommended by two (or more) cluster organizations. In this sense, competition among clusters in France has significantly different characteristics than that in Germany.

The total program budget for 2006–2011, provided by an Inter-Ministry Fund (FUI), was approximately three billion euro (1.5 billion euro in each period, 7.5 million euro on average per cluster annually). This program also employs a partial funding scheme for private firms in the R&D project,

where the share of public funding in the project budget differs according to the composition of members and the size and location of participating firms: the government subsidizes 45% of the R&D expenses of small firms (less than 250 employees) if they are located in the R&D zone of a cluster, but only 30% otherwise. The share of public subsidies is limited to 25% for major corporations with more than 2000 employees, and 30% for medium-sized firms with 250–2000 employees. University and public research institute's research expenditures can be fully funded. In summary, the national cluster policy in France may be positioned somewhere between the German high-incentive policy and the Japanese low-incentive policy, with limited cluster competition and a partial funding scheme.

### *4.4. Cluster Policies in Comparison*

In Section 2.2, we argued that national cluster policies depend on the overall situation of the clusters in the country, and presented the hypothesis that high-incentive policies with competitive selection of target clusters and matched funding for research projects are positively linked to the rich presence of private-driven clusters in the country. In Section 3.1, we compared basic conditions for clusters in Japan, Germany and France and suggested that, especially regarding biotechnology, clusters may be more public-driven in Japan as compared to Germany and France, where clusters may be more private-driven.

Based on the comparison of national cluster policies in these countries, we may conclude that cluster policy in Japan, at least that by MEXT, can be regarded as a typical low-incentive policy with top-down selection or a limited competition with a full funding scheme, while that in Germany is characterized as a high-incentive policy based on hard competition among clusters and a complete matched funding scheme. Cluster policy in France may be positioned somewhere between the German high-incentive policy and the Japanese low-incentive policy, with limited cluster competition and a partial funding scheme. These observations are consistent with our first hypothesis about the relationship between basic conditions of clusters and the types of national cluster policies.

The discussion in this paper and in this section focuses on national cluster policies, but we should also be aware of the roles of regional cluster policy, especially for Germany [8,43,64] and France [10].

## 5. Local Management of Cluster Policies

In this section, we compare the local implementation of national cluster policies by cluster management organizations in six biotechnology clusters in three countries, focusing on the selection of research projects in the application process for the national cluster competition. In Section 2.2, we argued that the types of local cluster management depend on the status quo of the local cluster (Hypothesis 2) and that they are consistent with the types of national policies (Hypothesis 3). This means that local cluster organizations of private-driven clusters tend to employ private-driven and bottom-up management, while a high-incentive cluster policy is consistent with private-driven and bottom-up cluster management. In this section, we will test these hypotheses using the cases of six biotechnology clusters.

### *5.1. Cluster Management in Japanese Clusters*

We showed that our focal biotechnology clusters in Japan are public-driven, and the government (MEXT) carries out a low-incentive cluster policy. Then, we expect that local cluster organizations in

Japan tend to employ public-driven and top-down management so that R&D projects as the targets of policy support are determined in closed selection (not through open call for proposals).

In the KBIC, the cluster organizations, the City of Kobe and FBRI, jointly selected research consortia for the cluster project without requesting proposals from cluster firms and universities, except regarding regenerative medicine projects. For each research subject, some research projects were selected from among several candidates by the core organizers of KBIC, including the representatives of the City of Kobe and the general manager and research director of FBRI. Finally, they determined 16 R&D projects that should be supported by the cluster policy.

Regarding the Fuji Pharma Valley Cluster, at the beginning of the MEXT cluster program, the prefecture government of Shizuoka determined research subjects and research consortia without calling for proposals from cluster participants (calling for proposals of research subjects and projects was originally intended but not realized). In the later stage of this program, Ken Yamaguchi, the head of the Fuji Pharma Valley Initiatives and the president of the Shizuoka Cancer Center, played an important role in selecting 10 consortia to be supported. Selection of consortium members was left to the project leaders who were top researchers of the Cancer Center, the National Institute of Genetics, and the Tokyo University of Agriculture and Technology. Eventually, the research consortia supported by MEXT programs included only a few local firms; in this sense, most cluster firms are not directly integrated into the MEXT programs.

Thus, in both Japanese clusters, research projects for public support were determined in closed selection by local authority experts, without using open calling for proposals. This is because cluster managers had to develop clusters from the beginning with the support of some experts and because MEXT's policy aims at developing R&D collaboration of local public research institutes with innovative firms which are not necessarily located in the cluster region. These findings are consistent with Hypotheses 2 and 3.

### *5.2. Cluster Management in German Clusters*

We showed that, contrary to Japan, focal biotechnology clusters in Germany are private-driven, and the federal government (BMBF) carries out a high-incentive cluster policy. Then, we expect that local cluster organizations in Germany tend to employ private-driven management so that R&D projects as the targets of policy support are selected through open calls for proposals.

In fact, in preparing for the cluster competition, both BioM and BioRN called for proposals from research consortia. BioM selected 32 R&D projects that fit well with each other from among numerous proposals and drew up the cluster project plan on the basis of research and budget plans of each consortium. The scientific advisory board of BioRN selected the 36 best R&D projects from among 78 proposals and integrated these project plans into the cluster project plan. Only private firms can be subsidized in BioRN, whereas universities, as their research partners, obtain research budgets through commissioned R&D from subsidized firms.

Moreover, BioRN strictly monitors the progress of R&D projects with an original software, by which cluster firms have to input information on implementation of research budgets. The scientific advisory board of BioRN conducts a strict evaluation of each R&D project. If a project seems unpromising,

BioRN recommends that the federal government ceases to support the project and that it reallocates its budget to other projects. The government usually follows the suggestion of BioRN.

Thus, in both German clusters, R&D projects that are publicly supported are selected by an expert team through open calls for proposals. Supported projects can be replaced later according to regular internal evaluations in case of BioRN. This is because the selection of clusters in the national (federal) policy is highly competitive and numerous biotechnology ventures are available in the region that have relationship with university researchers. These findings are consistent with Hypotheses 2 and 3.

### *5.3. Cluster Management in French Clusters*

We showed that, focal biotechnology clusters in France are also private-driven despite of the centralistic tradition of French policy and economy, and that with the competitive clusters program the government turned to a high-incentive cluster policy. Still, cluster policy in France may be positioned somewhere between the German high-incentive policy and the Japanese low-incentive policy, with limited cluster competition and a partial funding scheme. Then, we expect that local cluster organizations in France tend to employ a management which can be positioned between public-driven and private-driven management, but which is closer to the latter than the former.

In the competitiveness clusters program in France, in fact, firms select a cluster where they get accredited for public R&D subsidy, and then the government selects their consortia proposals [12,17]. Thus, a specific feature of the cluster management in France is that the cluster organization does not select research projects, but consortia member firms self-select clusters. However, the cluster management of Alsace BioValley and Lyonbiopôle still plays an important role in the selection of research projects by supporting the development of project plans in collaboration of member firms and by accrediting project plans. Therefore, we may confirm that our findings are consistent with Hypotheses 2 and 3 also regarding local cluster management in France.

## 6. Conclusions

This paper investigated the relationship between the types of national cluster policies and cluster management from a comparative perspective and considered why cluster policies and cluster management are so different across countries. For this purpose, we provided a detailed comparison of innovation systems and national cluster policies in Japan, Germany, and France, as well as six outstanding biotechnology clusters in these countries. Through in-depth interviews, we confirmed contrasting but consistent combinations of the types of national policies and local cluster management across three countries, especially between Japanese and German cases.

We presented three hypotheses with regard to the relationship between basic conditions, the type of national cluster policy, and the type of local cluster management: (1) high-incentive policies with competitive selection of target clusters and matched funding for research projects are positively linked to the rich presence of private-driven clusters in the country; (2) cluster organizations of private-driven clusters tend to employ private-driven and bottom-up management; and (3) a high-incentive cluster policy is consistent with private-driven and bottom-up cluster management.

In Japan, we observe a low-incentive national policy with a weak cluster competition, combined with a relatively public-driven cluster management in public-driven clusters. In Germany, in contrast, we

observe a high-incentive national policy with a hard cluster competition, combined with a relatively private-driven cluster management in private-driven clusters. These observations seem to support all of our hypotheses. The French cases seem to be positioned between German and Japanese ones, but closer to German than to Japanese ones. Moreover, we argued that these differences might be attributed to those in innovation systems as basic conditions of clusters. In Germany and France, there were relatively more scientific seeds at universities and public research institutes, relatively more R&D collaboration with small and young firms, and relatively more venture capital investments for biotechnology than in Japan. Therefore, biotechnology clusters were more developed in these countries than in Japan before the focal national cluster policy. We may conclude that this enabled the German (Japanese) government to employ a high-incentive (low-incentive) policy and cluster managers to employ private-driven (public-driven) management.

Policymakers and practitioners may learn from other countries' experiences. Specifically, Japanese policymakers and cluster managers can learn from the national cluster policy in Germany how to select and foster competitive clusters and projects. It seems to be especially beneficial because Japan and Germany have some similarities in economic systems in contrast to the US. However, our findings show that cluster policy and its local management are deeply related to basic conditions of clusters and clustering of research activities. Therefore, it is not desirable to directly introduce other countries' policies as a success model to a country with different conditions and context. In this sense, we recommend to modestly start from a place-specific approach of "Regional Realism" [31].

Our research has yet some limitations. First, we focused on national cluster policy and its implementation by local cluster organizations and ignored regional policies by regional government or local authorities. As mentioned before, regional cluster policy plays an important role especially in Germany [8,43], but also in France [10]. From the multilevel governance perspective, we should consider national cluster policy with supranational (like the EU), regional, or local initiatives, although supranational cluster policies do not exist in Japan, where regional and local initiatives play a very limited role in science and technology policy [63].

Second, because our research is based on one-shot or retrospective information, we cannot follow precisely the dynamic changes in clusters and its relationship with cluster policy and cluster management. Specifically, our focal clusters and cluster organizations in Germany and France existed long before the cluster policies we addressed started. In this sense, our study is a static one and can tell little for the development of clusters and its mechanism.

Third, our study employs comparative case studies across six clusters in three countries. Although our study has a clear advantage over case studies on a single country or a single cluster, we cannot generalize our findings because of the heterogeneity of clusters and the variation across countries. Moreover, our findings may be upward biased because we selected "outstanding" biotechnology clusters in each target country.

Finally, our research is limited to a qualitative comparison of six clusters in three countries. As a future agenda, comparative empirical evaluations of national cluster policies and their management in different countries with different characteristics would be necessary using micro data of local participants of different clusters, possibly considering the performance of clusters and participants.

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**Author Contributions**

Both authors conducted all interviews together and contributed equally to the paper.

**Conflicts of Interest**

The authors declare no conflict of interest.

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