Sun-theme: 7. Place based innovations

Title: A Comparative Analysis of Industry-Academia Collaboration among Three Regions in Japan: Inter-organizational Relation Approach to the Regional Triple Helix

Author Information: Kazuhiro NOZAWA, PhD.
Senior Research Fellow,
Ministry of Education, Culture, Sports Science and Technology (MEXT),
National Institute of Science and Technology Policy (NISTEP),
3rd Policy-Oriented Research Group
E-mail Kazuhiro.Nozawa@gmail.com

Key Words: University-Government-Industry Collaboration, Inter-organizational Relation, Regional Triple Helix, Regional Innovation, Absorptive Capacity

JEL: P510 Comparative Analysis of Economic Systems

Introduction

Regional innovation and triple helix

Many regions have been actively promoting industrial policies that aim to revive local economies by creating knowledge-intensive industries rather than mature, mass-product, low-value-added industries. In other words, knowledge itself has been utilised to revive the regional economy. In fact, various experts (Lundvall 1992, Gibbons et al. 1994, Florida 1995, Nonaka and Takeuchi 1995, Etzkowitz and Leydesdorff 1997, Cooke 2002a) have begun focusing on knowledge as an economic resource. To convert knowledge into economic profit, government bodies have constructed institutional infrastructures for technology transfer. And for a region to effect revitalisation, companies must develop new products or technologies and encourage innovation. Consequently, as a means of revitalising the regional economy, government bodies focus narrowly on technological innovation utilising local assets, for instance, the local university's seeds.

There has been considerable interest in regional innovation not only among scholars, but also local authorities. Many of the regional innovation initiatives have been intended as forms of endogenous development based on utilisation of the local university's knowledge. This is expected to create a knowledge-based, high-technology

cluster. Moreover, several scholars (Lundvall 1992, Maskell and Malmgerg 1999, Morgan 1997) point out that innovation should be fostered by the organisation's interaction with other entities. Therefore, for encouraging innovation in a particular region, it is important to stress interaction with other local entities, such as university, industry and government,

Therefore, building a mechanism of scientific and technological innovation activities in a region is necessary; this requires making use of the characteristics and strengths of regions, an action that can be implemented autonomously by regional government. Consequently, universities are expected to work with local governments and companies as a member of the local community and to contribute to the construction of a regional innovation system.

Government bodies have been strongly promoting collaboration between industry and universities and have made efforts to construct institutional infrastructure for innovation, leading to the formation of a university–industry–government collaboration termed 'triple helix' (Etzkowitz and Leydesdorff 1997). University–industry–government collaboration is expected to function as an indispensable institutional infrastructure for regional development in the knowledge economy era. Hence university–industry–government collaboration in a region—i.e., regional triple helix (or RTH)—seems necessary for regional innovation.

Now, RTH is a coalition of three organisations—university, company and government—whose objectives differ materially. However RTH is not constructed to help maintain the organisations' status quo, but will continue to co-evolve with the three organisations in an upward spiral (Etzkoqwitz and Lydesdorff 2000), with the university positioned as a main component. In other words, RTH is an incubation platform for putting the university's knowledge to practice.

Consequently, the concept of the triple helix has been regarded as key in attracting the broad attention of policy makers and authorities; it has been adopted in many nations and regions. Therefore, the triple helix has already become an institution in many regions. Although these university–industry–government institutions have been introduced in many regions, economic performance in each region varies. As a result, even with a common element—the coalition of three organisations, each RTH may manifest as a different triple-helix system. RTH results emerge from different regional and industrial conditions, e.g., research level, agglomeration density or sector field. When we investigated RTHs by examining the institutions themselves, we could see little difference among them because most regions have already encouraged collaboration and equipped their universities, industries and government agencies.

Thus, the need is now to examine the triple-helix structure in more detail, and importantly, to consider how RTH should operate. The relationship between academia, industry and government might vary greatly because of differences in the positioning of the spatial division of labour and industries of concentration, in absorption capacities of enterprises in the region (Cohen and Levinthal 1990) and so on. In this analysis of the RTH structure, we reveal its characteristics and problems, and we consider factors that cause differences in RTHs.

Structure of regional triple helix and inter-organisational relation

As described above, RTH is a coalition of organisations that have three different actors, specifically academia, industry and government. RTH is regarded as a regional organisation, so the author focused on the organisational structures of RTHs and on inter-organisational relation among its constituent institutions.

Many management studies have accumulated on inter-organisational relation (IOR). Auken and Hage (1968) unveiled the interdependencies among organisations in joint programmes; an organisation having many joint programmes allows stretch relations with many entities. In addition, because the organisation requires great resources for innovation, building interdependencies with other organisations is necessary. Morgan (2007) denotes this as an open system that should be managed well in order to satisfy the organisation's internal needs and to adapt to the environment. Lauman et al. (1978) stated a perspective of the stakeholders as a network between multiples such as industry and the community. Warren (1967) presents the concept of inter-organisational field, where a region is actually suitable for cooperation between organisations.

Some applications of IOR theory are used to analyse not only business management, but also industrial agglomeration or regional development. Using IOR, Lazerson and Lorenzoni (2009) analysed the relationship between trading partners in industrial districts. Also using IOR, Geddes (2008) analysed partnership relations in regional economic development. Moreover, Bonaccorsi and Piccaluga (1994) categorised university-industry collaboration in terms of motivation and expectation of companies. Thus, although IOR has been positively utilised since the 1960s, it is now beginning to be recognised as a tool for addressing regional organisational relationships. To utilise IOR as an analytical tool for RTH is both novel and appropriate. Therefore, we analysed RTH as the collective relations of university, industry and government by focusing on differences in RTH collaborative structure from an organisational perspective.

More specifically, this research aims to consider the present condition of Japanese

RTH by unveiling the structure and characteristics of university–industry–government collaborations through comparative analysis among three regions. The three regions were local prefectures, selected because we can more clearly see the relationship between academia, industry and government by focusing in the peripheral area. The three prefectures are Yamagata, Gunma and Nagano, where to some extent we can concentrate on the local manufacturing industry. Data from the survey results disclosed some characteristics of and issues about the Japanese RTH.

Regional innovation initiative in Japan

In Japan, as in other countries, to create a knowledge-based, high-technology cluster, the academia–industry collaborations have been encouraged by central and local governments. Policy makers especially have considered academia–industry collaboration as the key element of regional innovation. Thus, both central and local government bodies intend to transfer advanced university technology to local companies, expecting innovation. Most local authorities have aggressively promoted matches between academia and industry; this means granting funds to local university–industry collaborative research and development (R&D), facilitating R&D, purchasing research equipment and so forth.

As for science and technology governance, the prefecture is defined as the primary entity to implement regional science and technology policy. In 2001, the central government determined this second science and technology basic plan. As Kitagawa (2007) observed, Japan's innovation policy was thus regionalised. However, even though the prefecture should be considered autonomous in promoting science and technology policy, the central government has continually intervened and provided financial assistance for these activities. In other words, university–industry–government collaboration will continue to be promoted as a regional development tool by both the central and local governments.

In the local situation, the prefecture has been promoting a regional innovation policy that includes an industry cluster policy. Despite facing a financial deficit, local government has the power to maintain its own local technology centre (LTC), which is designed primarily to help small to medium enterprises in the prefecture. The main LTC duties are to lend research equipment, to consult with companies on technical issues and R&D, and to match academia with industries for collaboration. In Japan, LTC has played an important role in the innovation activities of local companies (Fukugawa 2005). As for academia, the central government established more than one national university in each prefecture for human resource development and for R&D.

Additionally, local governments established public universities, similar to land grant universities, in each prefecture, but not in all regions. Additionally, all prefectures have a number of private universities. As for national universities, Japan has two types: a traditional research university and a new general university. In addition, each prefecture has a national college of technologies (NCT), whose main purpose is to educate skilled engineering workers.

Profile of three regions

In this section, the features of the three research prefectures are introduced. First, Yamagata Prefecture is located approximately 350 km north of Tokyo, in a peripheral area. Local industries include electronics and machinery manufacturing. For example, NEC-Lenovo's rather large personal-computer assembly plant is in Yamagata Prefecture. But industrial agglomeration is relatively thin, compared with the other two prefectures. Academic resources include National Yamagata University, a new general university, and Tsuruoka National College of Technologies. The prefectural authority has also established an Industrial Technology Centre.

Second, Gunma Prefecture is located approximately 100 km north of Tokyo, in relative proximity to Tokyo. The main Subaru (owned by Fuji Heavy Industries) automobile factory is located in the region. Machinery and electronics industries are also concentrated in Gunma Prefecture where to some extent, the manufacturing industry is thriving. Academic resources include National Gunma University, a new general university, and Gunma National College of Technologies. The prefecture also has some industrial technology centres.

Third, Nagano Prefecture is located approximately 200 km west of Tokyo in a mountain region. In this prefecture, industrial agglomerations are scattered. Precision machinery industries (e.g., watch manufacturing) has been thriving for a long time. In recent years, automobile parts manufacturing and electronic component and device manufacturing have blossomed. Academic resources include National Shinshu University, a new general university, and Nagano National College of Technologies. The local government has also established some industrial technology centres.

Methodology

Data Collection

As has been emphasised, three components—academia, industry and government—are indispensable to RTH, and this research analysed RTH as a collective

organisation through an IOR perspective. Although the research focuses on the relationship among all three entities, the main innovator is a company that serves as a node extending links to the other organisations. Since the company seemed to be central, we decided to analyse how companies have built relationships with universities and/or LTCs that represent governments. For this reason, our survey targeted company activities. For investigating the characteristics of relationships with local companies and the RTH structure, a certain amount of data was required. Therefore, a survey was conducted using a postal questionnaire that focused on collaboration between manufacturing firms and universities and/or LTCs.

To administer the survey, destination companies were selected by random sample. In October 2012, the questionnaire was sent to 1900 manufacturers. Because each prefecture's agglomeration magnitude of manufacturing firms differed, the number of destination companies also differed: 500 to Yamagata, 700 to Gunma and 700 to Nagano.

Responses to the survey numbered 699, a response rate of 36.8%. The questionnaire consisted of several parts, with items concerning the following: company profile, relationships with universities and technical collages, relationships with prefectural industrial technology centres, development experience with new products/technology and partnering informally to solve technical problems.

Structure of analysis

To classify the characteristics and structure of RTH, we carried out the research in three steps (see Figure1).

First, from the analysis of collected responses, the companies in the region were divided into six categories, and two attributes of each company were analysed: one is activity, i.e., relationship with a university, an LTC and private companies; the other is experience with new product development. University, LCT or private companies are selected as one of the external resources in research and development. The first attribute is the type of entity with which a company forms a relationship. Classification of local companies is defined by the extension of links between industry–academia–government in the region, and the second attribute is the company's attitude toward innovation, judged by whether the company has developed a new product or new technology within the last five years.

Figure 1. Six Categories of Collaboration by Regional Companies

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="3">University-Industry-Government Collaboration</td></tr>
<tr><td>University</td><td>Government</td><td>Private or Self</td></tr>
<tr><td rowspan="3">R&D</td><td rowspan="2">Done</td><td colspan="2">①</td><td rowspan="2">④</td></tr>
<tr><td>②</td><td>③</td></tr>
<tr><td>Not Done</td><td colspan="2">⑤</td><td>⑥</td></tr>
</table>

Figure 1 shows six categories of regional companies. Two attributes were examined to analyse the relationships of the companies. For the first attribute, ①, ②, ③, and ⑤ were in the public sphere, in other words, the companies collaborated with a university or LTC; ④ and ⑥ were in the private sphere, i.e., companies collaborated with other private companies or collaborated internally. For the second attribute, ①, ②, ③, and ④ are R&D-oriented, i.e., experienced development of new products or technology within the last five years; ⑤ and ⑥ were not R&D-oriented, i.e., they did not experience development of new products or technology within the last five years.

The general features extracted from each category follow: ① comprises both university and LTC government utilisation for developing a new product or new technology; ② is solely university utilisation for developing a new product or new technology; ③ is solely LCT government utilisation for developing a new product or new technology; ④ is utilisation of another private company or self-utilisation, i.e., the company does not collaborate with a university or government LTC even though the company has developed a new product or new technology; ⑤ indicated companies that have interacted with a university and/or government LTC but have not developed new products or technology; ⑥ indicates companies that have not utilised university or government LTC and have not developed new products or technology.

After the first step of dividing the respondent companies into six categories, we proceeded to the second step, in which each category's characteristics were revealed through the following five points: 1) technical consult, 2) management issues, 3) sector, 4) company size and 5) future intentions for collaboration. This process deepened our understanding of each category's characteristics. In addition, we could extract the RTH structural features from the composition ratios of the six types of companies and could discover their intentions for university–industry–government collaboration.

In the third step, by adding comparative analysis, we could more clearly see the issues and features of RTH. However, comparative analysis of structural points was not intended to determine the relative RTH merits. Instead, we focused on the relationship between institutions from the perspective of inter-organisational relations. We were able to do so because the regional contexts, for instance industrial characteristics and regional resources, were relatively similar among Yamagata, Gunma and Nagano Prefectures.

The characteristics and issues of regional triple helix in Japan

Result of postal survey

The postal survey unveiled some results about relationships with academia, relationships with local government, consultations on technical problem and attitudes toward innovation.

1) Relationships with academia

In Yamagata, 35.6% of the responding companies had previously collaborated with a university and/or an NCT. The most frequent answer to items about collaboration with academia was in technical consultation, 24.6%. The second was R&D, 21.3%. In Gunma, the survey showed that 34.7% of the companies had previously collaborated with academia. The most frequent answer to items about collaboration with academia was R&D, 28.4%. The second was technical consultation, 23.7%. In Nagano, the survey showed that 51.4% of companies had previously collaborated with academia. The most frequent answer to items about collaboration with academia was R&D, 36.9%. Overall, for relationships with academia, Nagano was the most active prefecture among the three regions (see Table1).

Table 1. Relationship with Academia among Three Prefectures

	experience of collaboration with academia						no experience	N/A
	Total	R&D	Technical consultation	Use of research equipment	Human resource development	other		
Yamagata	35.6%	21.3%	24.6%	10.4%	9.0%	2.4%	61.6%	2.8%
Gunma	34.7%	28.4%	23.7%	14.7%	8.4%	0.5%	64.2%	1.1%
Nagano	51.4%	36.9%	33.6%	17.8%	13.8%	2.3%	46.3%	2.3%

2) Relationship with government

In this survey, research collaboration with the local public technology centre represented a relationship with the government. In Yamagata, 64.5% of companies responding had previously collaborated with an LTC. The most frequent answer to items about collaboration with LTC was use of research equipment, 45.5%. The second

was technical consultation, 40.3%. In Gunma, the survey shows that 47.9% of companies had previously collaborated with an LTC. The most frequent answer to items about collaboration with an LTC was use of research equipment, 34.2%. The second was technical consultation, 23.7%. In Nagano, the survey showed that 62.1% of companies had previously collaborated with an LTC. The most frequent answer to items about collaboration with LTC was use of research equipment, 46.3%. The second was technical consultation, 41.3%. Overall, Yamagata was the most active in government relationships, but Nagano was nearly as active. Gunma was less active than the others (see Table 2).

Table 2. Relationship with Government among Three Prefectures

	experience of collaboration with local technology centre						no experience	N/A
	Total	R&D	Technical consultation	Use of research equipment	Human resource development	other		
Yamagata	64.5%	15.2%	40.3%	45.5%	20.9%	0.9%	30.3%	5.2%
Gunma	47.9%	15.8%	23.7%	34.2%	8.4%	2.1%	46.8%	5.3%
Nagano	62.1%	15.4%	41.3%	46.3%	12.1%	1.0%	31.5%	6.4%

3) Consults on technical problem

In Yamagata, the most frequent answer to items about consults on technical problems was LTC, 48.3%. The second was sector peer company 28.4%. In Gunma, the most frequent answer to items about consults on technical problems was same industry company, 39.5%. The second was LTC, 28.4%. In Nagano, the most frequent answer to items about consults on technical problems was LTC, 53.0%. The second was university and technology college, 29.2%.

As for consultation on technical problems, LTCs were felt to be reliable in Yamagata and Nagano. But the percentage in Gunma was relative low. In addition, the same industry company was reliable, especially in Gunma (see Table 3).

Table 3. Consults on Technical Problems among Three Prefectures

	1	2	3	4	5
Yamagata	Local Tech Centre	Same Industry	Univ. Tech collage	Industrial Support Agency	Different Industry
	48.3%	28.4%	20.9%	17.1%	16.6%
Gunma	Same Industry	Local Tech Centre	Univ. Tech collage	Industrial Support Agency	Different Industry
	39.5%	28.4%	23.2%	21.6%	17.9%
Nagano	Local Tech Centre	Univ. Tech collage	Same Industry	Different Industry	Industrial Support Agency
	53.0%	29.2%	28.2%	22.5%	14.8%

4) Attitude to innovation

The questionnaire asked companies about their experience of developing a new product or technology within the past five years. In Yamagata, the percentage of

companies that developed new products or technology was 57.4%; the percentage of companies that had not developed new products or technology was 41.2%. In Gunma, the percentage of companies that had and had not developed new products or technology was evenly divided at 50.0%. In Nagano, the percentage of companies that had developed new products or technology was 65.8%; the percentage of companies that had not developed of new products or technology was 32.9%.

This result revealed that the attitude of innovation among the three prefectures was rather active (see Table 4).

Table 4. Attitude to Innovation among Three Prefectures

	Development of New Product/Technology		
	Done	Not Done	NA
Yamagata	57.4%	41.2%	1.4%
Gunma	50.0%	50.0%	0.0%
Nagano	65.8%	32.9%	1.3%

Characteristics of inter-organisational relation among regional companies

We have distinguished similar characteristics of six categories (see Figure 1) based on differences of inter-organisational relation of local companies.

① Utilisation of universities and government LTCs for development

Many companies that formed relationships with either universities or technical colleges and LTCs utilised both rather evenly. Moreover, these companies also collaborated with local government's industry support organisations at the same time. The scale of enterprises in this category was 50 to 100 employees in many cases.

② Utilisation of universities for development

The percentage of companies that had relationships with peer companies was relatively large, similar to relationships with academia. Companies in the electronic parts and devices industry tended to collaborate only with universities and technical colleges, not with LTCs.

③ Utilisation of government entities for development

Many of these companies collaborated with local governments' industry support organisations, too. Intentions to collaborate with academia were relatively weak, except in the case of Gunma.

④ Utilisation of other private companies or internal resources for development

Many companies formed relationships with other industries and competitors, business partners or parent companies rather than with public authorities. Companies wishing to collaborate did not purposely form collaborations within the same

prefecture.

⑤ Utilisation of university and/or government for other than development

Companies often formed partnerships with universities and/or LTCs not for innovation, but for improvement of products or technologies in order to reduce costs. Companies often related to peer companies and/or LTCs for the same purpose. The metal products manufacturing industry showed a relatively high percentage in this area.

⑥ Utilisation of private companies or internal resources for other than development

The scale of enterprises with less than 50 employees comprised a relatively large percentage of this category, especially metal products and general machinery manufacturing industries. One reason that metal product manufacturing industry tended not to do R&D was that the industry depended heavily on tacit knowledge of skilled workers rather than on scientific, academic knowledge from universities. Even when companies had technical problems, many of them had no consulting partner, and they solved the problems internally. Finally, many companies had no intention of future collaboration with academia.

Characteristics of the regional triple helix in three regions

1) Yamagata

Supremacy of technical consultation in R&D rather than joint R&D with a university was one characteristic of RTH in Yamagata. Relatively large companies with more than 100 employees were generally experienced with academic collaboration.*[1)] In addition, local small-to-medium enterprises (SMEs) were relatively inactive in academic–industry collaboration. In Yamagata, the reasons for less activity in university–industry–government collaboration were the weakness of management capacity, due to scale of the companies themselves and their role as subcontractors to larger companies. Companies in conjunction with LTCs were generally not innovation-oriented, but improvement-oriented in many cases. Even medium and relatively large-scale companies were reluctant to cooperate with academia for development because many were branch plants of capital-intensive apparatus industries. These companies seldom had any intention of cooperating with academia in the future.

2) Gunma

To solve technical problems, in Gunma, local companies tended to contract with companies in the same industry, rather than with academia and/or an LTC. One possible reason was the availability of many highly skilled companies in relatively

dense industry agglomeration, as in the Tokyo Metropolitan area. In such a case, the contribution of LTCs was less than in other prefectures. Nevertheless, a relatively high number of companies that had not contracted with academia, but have experienced R&D, want to collaborate with academia. On the other hand, many companies that have not contracted with academia and have not experienced R&D do not intend to collaborate with academia in the future.

In Gunma, the inactive type of company was most common, but many companies did leverage both universities and LTCs for research and development. Clearly two types existed, so it is reasonable to say that RTH was polarised into active R&D with academia and/or government and inactive R&D without academia or government. The most thriving industry in Gunma was the automobile manufacturing industry: many relatively large-scale, tier-one subcontractors collaborated with universities and/or government. On the other hand, many relatively small-scale, tier-three subcontractors did not collaborate with academia or government and did not practice product development.

3) Nagano

Nagano was the most positive prefecture for university–industry–government collaboration among the three regions. Small and medium enterprises tended to contract with LTCs to solve technical problems; medium and large companies tended to contract with both academia and LTCs. The companies that connected with academia tended to form relationships with other public bodies, such as LTC, RDA and so on. Moreover, they also contracted with the same or other industry firms to solve technical issues. Quite a few companies that had not contracted with academia, but have experienced R&D want to collaborate with academia. And non-local companies hesitated to contribute of local industry–academic collaboration. Thus in terms of RTH, Nagano was the most developed and evolved among the three prefectures (see Table 5).

Table 5. Percentage of Companies Categorised on University–Industry–Government Collaboration among Three Prefectures.

	①UG	②U	③G	④PS	⑤NDC	⑥NDNC
Yamagata	22.7%	4.7%	16.6%	10.9%	24.2%	16.6%
Gunma	27.4%	3.2%	9.5%	9.5%	13.2%	36.3%
Nagano	41.3%	4.7%	10.4%	6.0%	13.4%	18.1%

(Note)
U: University
G: Government
PS: Priovate Self
NDC: No Development with Collaboration
NDND: No Development No Collaboration

Differences of structure of regional triple helix

The survey results showed that the triple helix was completed in each region; this means that infrastructures were instituted by academia, industry and government, all working together. Even though the three regions were located in similar contexts, differences were revealed in their collaborations due to the structure of the regional industries and the technological capacity of the universities or local government entities.

First, Yamagata Prefecture was a typical case of a peripheral innovation system that indicated a weak local absorptive capacity of local firms because of the thinness of industry agglomeration. Even though institutional infrastructure has been completed in this prefecture, RTH seems not to have matured enough. The case of Yamagata RTH could be called insufficient. Second, in Gunma Prefecture, two types of firms were revealed by the study: one type expertly utilised academia and/or government; the other depended less on the local triple helix, and in fact, they positively connected with the private sector rather than with public entities. Therefore, Gunma's RTH tended to be polarised. Third, firms in Nagano Prefecture aggressively conducted university–industry–government collaboration, especially compared with the other prefectures, because many independent firms were not subordinate to a large company. In fact, the atmosphere in Nagano encouraged local firms to utilise external resources. Therefore, Nagano's RTH may be considered evolved.

Despite the fact that the three regions had similar circumstances in terms of a local university, infrastructure and local institutions, the implementation of each RTH varied. Four possible reasons were differences in 1) local resources, 2) local institutions, 3) industry characteristics and 4) company characteristics. At first glance, the three regions had similar local resources: a number of national universities, national technology colleges and local technology centres. For example, the LTC in Gunma was equipped high specification machines and apparatuses, but small local companies seemed to have difficulties using them. As a result, the percentage of Gunma companies using LTC was less than in other regions. In terms of local institutions, Nagano had a very positive atmosphere for university–industry–government collaboration. Indeed, local collaboration has been locked in positively because local government and the university aggressively encouraged match making. Concerning industry characteristics, even though processing and assembly industries were thriving in the three regions, the density of industry agglomeration was different. In Gunma, there are many manufacturers of automobiles and machinery. In contrast, Yamagata's agglomeration was relatively thin and therefore, its industry–academia collaboration

was weak.

As for company characteristics, certain conditions affected motivation for university–industry–government collaboration. First, the scale of capital or employees is a primary factor determining corporate behaviour. A company's capacity is a factor in collaborating with academia. Second, the type of factory or office influences attitudes about university–industry–government collaboration, and in turn the attitude depends on whether the company is independent or a subcontractor and whether it is the factory headquarters or a branch. Independent companies tend to be pressed to develop new products or technologies, and many factory headquarters have their own development divisions.

Issues of evolved regional triple helix

Etskovitz and Lydesdorf (2000) stated that the triple helix is an institutional framework, in which university, industry and government unite, cooperate, affect and co-evolve as a trinity. Generally speaking, from a regional development point of view, companies are expected to evolve from SMEs to large ones, through RTH activities.

By comparing three RTHs, we observed different stages of the evolution process. As mentioned, Yamagata's RTH has not yet evolved and so remains insufficient. On the other hand, Nagano's RTH has evolved. Many companies have connected with academia and/or government, and they were very positive about collaboration. Even so, some RTH issues were discovered.

The more companies accumulate their experiences of university–industry–government collaboration; the more masterful are their ability to exploit external knowledge. This means local companies tended to collaborate with a proximate university at first, because of coordination with the local government. However, given improved exploitive ability, local companies were not necessarily interested in relationships with local universities. National local universities may have difficulty providing the precise knowledge that expert companies want because they are relatively new and have limited resources compared to large, traditional, national research universities. Therefore, companies tend to expand corporate activities outside the region when searching out expertise. Furthermore, local companies do not always intend to become large enterprises; some local SMEs intend to remain in specialised niches in accordance with their corporate strategies.

Another motivation for innovative companies is the desire to expand their activities beyond a certain locale. As of now, most university–industry–government collaborations are expected to encourage innovation within a region, but if local

companies collaborate many times with the same entities, even though they are external organisations, it is difficult remain innovative. Thus, innovative companies often avoid dealing with the same external organisation all the time.

In other words, companies make progress when they collaborate with university and/or government; RTH results in structural changes because external relationships enable companies to expand. Although RTH is not intended to be restricted to a certain locality, it is possible that an RTH might lose its energy, creativity or dynamics. Unfortunately, it may be possible that the more an RTH evolves, the more vulnerable it becomes.

Conclusions and implication for regional policy

To encourage innovation in each region, university–industry–government collaboration has been actively implemented in Japan. Local governments aggressively coordinate to build relationships between universities and industry for regional innovation. As a result, institutional infrastructure, the so-called triple helix has been constructed in many regions. In fact, triple helix as policy tool is very adaptable, and we can observe many examples all over the world.

In much previous research, institutional analysis was a major approach for researching triple helixes, but it did not clearly reveal differences among them. Because more depth analysis was needed, the author focused on the structure of inter-organisational relationships among academia, industry and government. The research was analysed through IOR, based on an organisational perspective. Furthermore, in order to unveil more clearly the characteristics of RTH, comparative analysis was also conducted.

The results showed clear structural differences in RTHs. Even though the three regions studied had similar institutional infrastructure, the Yamagata Prefecture showed weak activity for RTH collaboration. Conversely, entities in Nagano Prefecture actively contacted one another. In Gunma Prefecture, RTH was found to be polarised: one type was active in collaboration and innovation whereas the other was inactive. The Nagano RTH seemed to be evolved when compared with the others.

However, some problems occurred in relation to evolving RTHs. Experienced companies acquired an ability to exploit external knowledge so that company activity expanded beyond the region. In other words, the more evolved the RTH, the more vulnerable the structure of RTH.

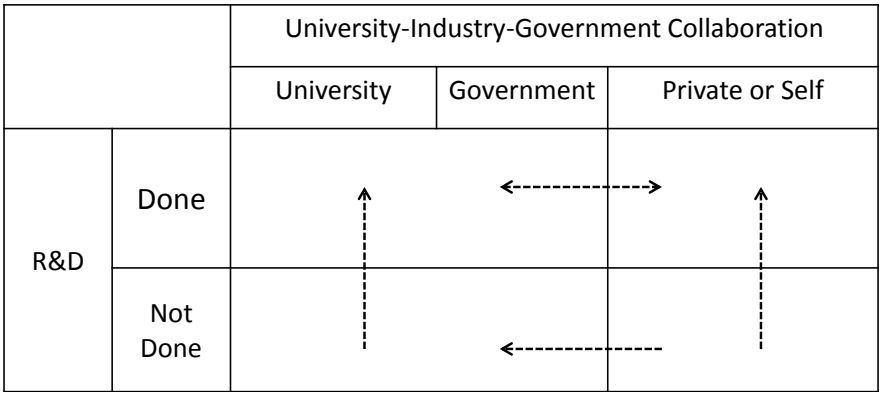
Of course, various regions might not always form the same type of triple helix. In

order to bring innovation to a region, as suggested by Tödtling and Trippl (2005), regional policy must not adapt a single-model policy everywhere. Because of variances in contributions of public and private sectors, the absorptive capacity of local companies or the R&D ability of the local university, regional policy must also vary. In other words, a triple helix should be constructed and operated according to the characteristics that emerge from regional diversity.

As mentioned, the triple helix is a very popular concept among policy makers and hence exists everywhere. But one location could thrive due to regional innovation while others do not, mainly because of the abilities of local companies. Thus, innovation depends on regional absorptive capacity (Cohen and Levinthal 1990) of companies as innovation drivers. Even though the three regions surveyed here were in similar regional contexts and had established triple helixes, the RTH characteristics differed.

In the entirety of Japan, the triple helix has contributed less to regional innovation because the regions have problems with exactly how university–industry–government collaboration can lead to innovation. Therefore, the next action should focus on two policy approaches to the operational, managerial sphere among the three types of organisations: Considering that there are advanced and developing RTHs among regions, the first approach should be stage management. Local companies should not remain subcontractors, but aim to become research and innovation-oriented local companies. Local authorities should not just promote coordination between university and industry, but encourage the development of new products or technology. For innovation-oriented companies, cooperation with universities and/or LTCs is just one option (see Figure 2).

Figure 2. Conceptual Diagram of Stage Management



The second policy approach is boundary management. Paradoxically, the more enhanced the system, the more vulnerable it becomes. Consequently, to foster regional innovation, local companies should cooperate with an external university and other external entities. Local authorities should not constantly attempt to strengthen relationships among existing stakeholders, but consider balancing partnerships through the introduction of externalities.

In this study, we have clarified the more prominent features and challenges of university–industry–government collaboration in each of three provinces through comparative analysis. The author extracted structural features of relationships among organisations. By comparing a larger number of cases, it might be possible to extract more significant RTH features. That is a challenge for future research.

This study was not able to extract information about the specific content of RTH organisations. Adding a detailed qualitative approach would add to understanding of specific content. In addition, organisational theory is a study built on the basis of organisations, but regional systems and enterprise organisations are different. This study represents a beginning in inter-organisational relation analysis as applied to the regional development context, which can lead to the necessary on-going analysis and scrutiny.

Note

1) In Gunma and Nagano Prefectures, companies with more than 100 employees tend to have experienced collaboration with academia.

Acknowledgement

The views and opinions expressed in this paper are solely those of the author. They should not be considered to represent the views and opinions of the institution at which the author is employed.

Reference

Aiken, M. and Hage, J. (1968) Organizational interdependence and Intra-Organizational Structure, *American Sociological Review*, 33, 912-930.

Bonaccorsi, A. and Piccaluga, A. (1994), A Theoretical framework for the evaluation of University-industry relationships, *R&D Management*, 24, 229-247.

Cohen, W. and D, Levinthal (1990) Absorptive Capacity: a New Perspective on Learning and Innovation. *Administrative Science Quarterly*, 35, 128-152.

Cooke, P. (2002) Knowledge Economies., Routledge: London.

Etzkowitz, H. (2008) The Triple Helix, Rougtledge New York.

Etzkowitz, H. and Leydesdorff, L. (eds) (1997), Universities and the Global Knowledge Economy. Pinter: London.

Etzkowitz, H. and Leydesdorff, L. (2000), The dynamics of innovation: from National Systems and "Mode 2" to a Triple helix of University-industry-government relations. *Research Policy* 29:109-123.

Florida, R. (1995) Toward the learning region, *Futures*, 27, pp. 527-536.

Fukugawa, N. (2005), Characteristics of knowledge interactions between universities and small firms in Japan, *International Small Business Journal*, 23(4). 379-401.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P. and Trow, M. (1994) The New Production of Knowledge. Sage: London.

Geddes, M. (2008), Inter-organizationl Relationships in Local and Regional Development Partnership, in S. Cropper, M. Ebers, C. Huxham, and P. S. Ring, (eds) The Oxford Handbook of Inter-Organizational Relations, Oxford University Press, Oxford.

Lauman, E. O., Galaskiewicz, J. and Marsden, P. (1978) Community Structure as Interorganizational Linkage, *American Review of Sociology*, 4.

Lazerson, M. H. and Loenzoni, G. (2008), Transforming Industrial Districts: How Leading Firms are Escaping the manufacturing Cage, in S. Cropper, M. Ebers, C. Huxham, and P. S. Ring, (eds) The Oxford Handbook of Inter-Organizational Relations, Oxford University Press, Oxford.

Lundvall, B. (Ed.) (1992) National Systems of Innovation. Pinter: London.

Kitagawa, F.(2007). "Regionalisation of Science and Innovation Governance in Japan?" *Regional Studies*, 41, no. 8.

Maskell, P. and Malmberg, A. (1999) Localised learning and industrial competitiveness, *Cambridge Journal of Economic*s, 23, pp. 167-185.

Morgan, K. (1997) The learning region: Institutions, innovation and regional renewal. *Regional Studies*, 31, pp. 491-503.

Morgan, G. (2007) Images of Organization, Thousand Oaks, Sage: London.

Nonaka, I. and Takeuchi, H. (1995) The Knowledge-creating Company. Oxford University Press: Oxford.

Tödtling,F and Trippl,M(2005) One size fits all? Towards a differentiated regional innovation policy approach. *Research Policy,* 34:1203-1219.

Warren, R. (1967) The Interorganizational Field as a Focus for Investigation, *Administractive Science Quarterly*, 12, 396-419.