Institutional Policy and Network Evolution in Industry University Collaborations: Longitudinal Analysis of Joint Patent Networks in a Japanese Biotechnology Cluster during 2000's

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Abstract--**There are growing research interests how institutional policy affects growth of university-industry collaboration for regional economic development of biotechnology clusters. Yet, many of previous research have mainly focused on the best individual practices influenced by policy. However, when we examine effects of policy, we have to pay much more attention to its impacts on dynamics of whole network of university-industry collaboration, using longitudinal social network analysis of it. This paper aims to investigate how new institutional policies develop whole interorganizational networks of university-industry collaborations in a Japanese bioregion during 2000's, and that major research universities located in central positions there, analyzing a regional case of changes of joint patenting networks in, Kansai Biocluster, a major biotechnology cluster in Japan. We retain following main results. First, institutional policy for university-industry collaborations by Japanese Government certainly enhances new R & D linkages between industry and university. Second, indeed, with increase of R & D linkages with large corporations and research institutes, major research universities take more central positions in a cluster. Third, new linkages of major national universities with other organizations are not highly performing in licensing because these universities may be much embedded in networks with large companies and research institutes.**

I. INTRODUCTION

For growth of scientific industries, many national and local governments create institutional policies organizationally encouraging universities to interface with industry more than the previous, since they may transfer novel and advanced knowledge, technology and talents to such industries and have impacts for development of scientific industries. Institutional policies for university-industry collaboration may mainly aim at rapid expansion and high performance of collaborative networks between firms, ventures and universities. However, as Reference [24] criticized, many researchers have mainly focused on how main individual researchers or managers "interact" effectively and what they did excellent actions. We have to pay much more attention to public policy impacts and dynamics of whole networks of university-industry collaboration. Several researchers in this approach reveal development of whole network structure of technology transfer in advanced biotechnology clusters [8, 15,21,22] based on social network analysis. This perspective may let us to recognize how institutional policies can really create new linkages of collaborations among universities, research institutes and firms. In Japan, we have little knowledge about how public policies for university industry collaborations shape R & D alliance networks in a biocluster and what they result in. We attempt to describe what network change and what outcome they make, using regional longitude case study of joint patenting networks between university and industry collaboration.

But, evolution of university-industry collaboration through policies depends on national institutional contexts, based on the variety of capitalism perspective [9]. During early half of 2000's in Japan, Reference [26] argues that new institutional policies for university-industry collaboration aimed at partial privatization of national universities, establishment of intellectual property management divisions in major universities, and introducing new evaluation standards for public research funding. In particular, new emphasis on patent submission as an important performance gave to universities and researchers new incentives for dramatically enhance number of joint research projects and joint patent submission. They may lead to expansion of interorganizational collaborative ties among universities, institutes and firms in Japan. However, instead of weak entrepreneurship, traditional research linkages between major research universities and large corporations within the similar technological areas are still dominant in Japan [17]. New institutional policies for industry and university collaboration seem to mainly strengthen these linkages. This paper aims to investigate how new institutional policies develop whole interorganizational networks of university-industry collaborations in a Japanese bioregion during 2000's, and that major research universities located in central positions there, analyzing a regional case of changes of joint patenting networks in Kansai Biocluster, a major biotechnology cluster in Japan during 2000 to 2007. To examine it, first of all, we state our framework of longitudinal analysis of policy impacts and network dynamics of university-industry collaboration based on social capital approach. Second, we briefly describe impacts of the new research promotion policy on university-industry collaboration during 2000's in Japan. Third, we empirically examine changes in networks of university-industry collaboration, conducing longitudinal network analysis of joint patenting alliances in the Kansai Biocluster, a major biotechnology cluster in Japan, and how well these emerging university-industry collaboration perform. Finally, we confirm certain effects of new policies but relative low economic performance of commercialization.

II. INSTITUTIONAL POLICY AND EVOLUTION OF UNIVERSITY-INDUSTRY COLLABORATION NETWORK

There are growing research and policy interests about evolution process, influencing factors and driving agencies of university-industry collaboration in high-tech clusters. Introducing new policies that aim to institutionally reforming universities and research institutes, encouraging to commit to more collaborations than previous, these institutional policies may increase new R & D linkages regionally. From the view point of social capital approach, such interorganizational networks are organizational social capital for knowledge transfer as they provide special cognition and relational resources to organizations embedded in them [1]. Interorganizational networks between universities, research institutes and firms in a cluster may facilitate building trust relationships and channels of transferring knowledge and ideas so that they may accelerate regional innovation [22, 24].

After, in United States, Bayh–Dole Act of 1980 brought about increase of universities to collaborate with industry for technology transfer, other advanced countries followed it, using university and governmental laboratories as transfer milieu organizations [6]. In United States, reference [4] argues that government supports rather than are still important in the joint research program in university because they encourages academic researchers to make professional networks with corporate researchers and help technology transfer to industry. Reference [4] also suggests that, in US, although governmental initiatives are complementary, however, like a government center, formal organizational networking supported by governments rather than informal individual networking may play an important role in knowledge transfer because it legitimates interactions in university-industry linkages for corporate researchers. As suggested in several previous studies, university-industry linkages are regional social capital for development of biotechnology clusters as they facilitate knowledge transfer in research and commercialization from academia to industry. In United States, reference [21, 22] show that, in Boston, connections between biotechnology research institutes and venture firms function as channel of knowledge transfer of advanced bio-technologies and help survival of ventures. Thus, one of main aims of current institutional policy for biotechnology cluster development is to create artificial networks among researchers, managers, business supporting professionals, investors, in order to promote transferring knowledge, technology and talents between industry and university.

Yet, to clarify how policy influence the evolution process of interorganizational networks in biotechnology clusters, their dynamics should be longitudinally examined. Reference [2] suggest importance of longitudinal analysis of new tie formation because they recognize how alliance networks are formed and poorly embedded firms develop their networks. In previous studies of biotechnology clusters, new public policy for university industry collaborations arose several linkage enhancing results as facilitating growth of collaborations among research institutes and firms [22], continuous spin-offs and serial venturing from university [8, 11], and widening alliances between universities and industries [22]. Discussing these results, Reference [24] points out that institutional policy for university-industry collaboration may really influence development of whole networks among university, research institutes and firms. However, Reference [8] stresses that economic institutions and extension of mobility of financial, intellectual and human capital may foster or limit effects policy for university and industry collaboration. In Market Economy System in United States and United Kingdom, its higher mobility financial, intellectual and human capital make such policy arise more easily expand direct and new business linkages between university and industry than lower mobility in Socio Economic System in Germany. In Germany, the government attempts to enhance linkages among large corporations via national research institutes as Max Plank Institutes.

In Japan, government started late initiatives from early 2000's [26] and mainly formed linkages with large corporations. Especially, the Japan Society of Promotion of Science (JSPS), the public research funding agency, which provides large public research funds to scientists and researchers in national universities and research institutes, requires funded researchers to deliver information of numbers of patenting, especially with industry, as new critical evaluation measurement of research outputs of its funded research projects from the early 2000's. This led to dramatic increase of number of joint patententing mainly among national research institutes and industry. When we look over the whole network dynamics of collaborations between academia and industry, new funding and policies for university-industry collaboration may cause increase of number of their linkages.

Hypothesis 1: If institutional policy provides to research institutes organizational incentives for collaboration with industry, they are likely to enhance number of linkages among them.

In global bioclusters like Boston, Bay Area and Cambridge, major research institutes including major research universities play a key role to connect firms, ventures and other institutes. Since major research universities have many researchers in a special research field and appear to have a relatively neutral position for industry, so they may occasionally connect firms and organizations that may compete each other. In recent studies of longitudinal analysis of interorganizational networks, organizations which previously formed alliances tend to continue these alliances or create new other collaborative ties, because they already share mutual interests, knowledge and competencies [2, 12]. Even in research of University-Industry Collaboration, Reference [24] argues that universities with continuous linkages may share similar value, knowledge, perception and behavioral patterns in a cluster so that they are likely to

develop their positive and strong linkages. Previous collaboration between universities and firms may stimulate formation of new ties in different dimensions. If a pharmaceutical firm has supplied anti-cancer drugs for a hospital of a university, it also tends to form new research projects with researchers of a faculty for new anticancer drug, in order to increase reputation of their drugs in this university hospital. Furthermore, Major universities provide their professional alumnus to pharma, bio-ventures and other research organizations over long term and these alumnus make a professional community across organizations. They tend to have common background and share similar knowledge, perception and goals. In social network research, the principal of homophily represents that individuals sharing common characteristics in gender, races, status, educational background or occupational experience tend to create linkages more than those not[1, 18]. In particular, Reference [18] remarks this tendency as "inbreeding homophily" that means linkage creation effect after people share the same background. Alumni from the same university or occupational professionals in the similar area are likely to form their linkages and transfer knowledge with their common interests. Therefore, major research universities in research of biotechnology fields may have potential organizational advantages in making joint research collaboration over the long term and become highly embedded in a regional cluster.

Expansion of joint patenting networking of major research universities allow them to take a central role of regional innovation in a cluster, and public funding may boost it. Many researchers show that major research institutes are likely to occupy central positions in interorganizational R & D networks in major bioclusters in Boston, Bay Area and San Diego [8, 21, 22].

Hypothesis 2: Because major research institutes are easier enhance number of joint research collaboration with firms and other research institutes in a biocluster, so that they are likely to occupy central positions in regional R & D networks over the long term.

However, can major research universities much embedded in a regional cluster by development of previous linkages and old alumni networks really provide novel ideas and radical innovation? Rather, they may not always be innovative in long-lasting and closed ties. In terms of "strength of strong ties," Reference [16] surely stresses that strong and closed ties facilitate deeply sharing homogeneous and tacit knowledge so that they may be effective only for continuous improvement and incremental innovation. In contrast to it, Reference [7] argues that bridging ties may connect isolated actors with few linkages and create new opportunities of unencountered and heterogeneous ideas so that they can facilitate novel ideas and radical innovation. In contrasting effects of closed and bridging ties in interorganizational knowledge transfer and learning, Reference [15] argues that former ones may perform well in incremental innovation but later in radical innovation. Therefore, major universities with central positions in continuous and closed networks may easily make new joint research projects with firms having previous relationships but are likely to exchange relatively homogeneous and similar information and knowledge. Therefore, many of these projects seem not to be performing well in radical innovation. In patenting, they are also easier to start joint many research programs and jointly apply patents with these ordinary partners. But, their submitted patents may not always be definitely novel and often have difficulty to get approved by governmental agencies over the average.

Hypothesis 3: Major research universities with highly central positions in strong linkages with large firms and major research institutes are not always likely to perform well in licensing.

In investigation of policy impacts on network changes, we need to do longitudinal analysis of dynamics of interorganizational networks caused by institutional policy. Many linkages in university-industry interfaces surely function as social capital to help knowledge transfer and commercialization collaboration between industry and university. Although modern institutional policy of many governments attempt to create such network linkages, however, we must carefully examine effects of such policy changes, analyzing whole structural changes of university-industry interfaces and their performance after application of institutional policy over the long term.

III. RESEARCH CONTEXTS

However, if it increases new R & D linkages with proper incentives for universities, effects of institutional policy and incentives depend on economics institutional contexts and. Reference [9] proposes "the variety of capitalism perspective," there may be regionally different evolution patterns of networks in biotechnology clusters from county to country because of their economic institutional contexts. For example, they argue that, while new ventures may play a critical role in university-industry linkages in US market economy, major national research institutes connect new linkages between university and industry in German Socio-economic System. In Japanese biotechnology clusters, we may find features of dominance of major research universities and large corporations and strong regulating power of the Japanese government in joint research and commercialization activities. Institutional policy for increase of industry and university interfaces are designed and implemented under the Japanese institutional contexts.

To examine policy effects, we find that following four Japanese features of economic institutional contexts of university-industry collaboration; low mobility and weak entrepreneurship, dominance of major universities and large corporations, strong impacts from governmental policies, and partial privatization policies. Considering these institutional contexts, we have to examine effects of institutional polices for university industry collaborations.

First, in biotechnology industry in Japan, there is low

mobility of capital, labor, intellectual properties and ownership not only between industry and university but also within industry. In particular, Japanese scientific researchers have lower mobility among universities and firms. Weak entrepreneurship is also commonly seen in Japan as we see that researchers tend to have much less experiences of spin-offs and venturing than those in the United States and some European countries like United Kingdom and Sweden. Thus, mobility of researchers, firms and intellectual properties do not strongly promote knowledge transfer among organizations in Japanese clusters.

Second, in life science area in Japan, major national universities and nation-wide large companies have dominance and strong linkages in R & D in some of biotechnology fields. Major universities, especially, major national universities such as University of Tokyo, Kyoto University and so on, still have larger part of researchers, faculties and research activities than private universities so that they still acquire huge grant mainly from the governmental and non-governmental funds. Large companies also have large corporation research laboratories and run many R & D activities with big budget in biotechnology industries, in particular, pharmaceutical industry. Furthermore, major national universities still provide number of alumni to corporation laboratories of large firms, these alumni work over the long term in the long-term employment system. Some of these old alumni often take top initiatives of technology directions in major firms, including decision-making of joint research programs with universities. For example, in the typical case like the Graduate School of Medicine, Kyoto University, one of the top research faculties in Japan, alumni have got research jobs in leading pharmaceutical companies over the long term. In 2010, 36 % of master graduates from this school acquired jobs in corporation research laboratories of top-class pharmaceutical companies in Japan. Thus major national universities and large corporations have strong personal linkages in established R & D areas.

Third, the Japanese Government still have relatively strong regulating power for funding, staffing and commercializing, and show strong policy pushing in joint research and licensing between university and industry in biotechnology fields. Because relatively bigger parts of research in this area are still implemented by major national universities, mainly funded by governmental funds, therefore, main policy changes from the ministry of education, economics or healthcare the Japanese government have more direct impacts on R & D activities through these national universities

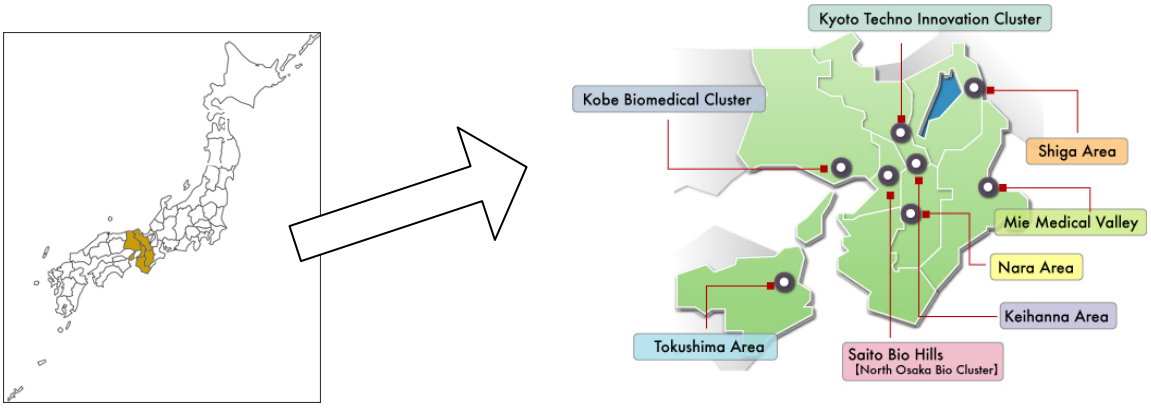
Fourth, in Japan, the Japanese government implemented partial privatization policies of national universities and induced them to have more of joint research collaborations in early 2000's [26]. This new institutional policy dramatically increased number of joint research projects and patenting between industry and university. There are three following major policy changes influencing university-industry collaboration. First, to allow national universities to have collaboration with industries, the Japanese Government did partial privatization of national universities and changed them into state agencies, putting the new National University Corporation Act in force from 2004. Second, in order to encourage universities to attain licenses from research outputs, the new IPO policies and related regulations from 2004 moves the ownership of intellectual property based on research output in university from individual researcher to universities or institutes. Third, in order to encourage researchers to commit to licensing, the Japanese Government set up new research evaluation standards focusing on number of joint research projects and patents with industry rather than number of academic papers or books.

As a result of these institutional policy changes, we find that number of joint research projects between national universities and firms nearly doubly increase in all areas, as shown in Figure 1. Even in the life science area, we recognize rapid increase of number of joint research between university and industry from 2138 projects in 2003 to 3844 in 2008 [19], which absolutely leads to increase of number of joint patent applications.

These big increase of joint research projects and patents leads to rapid expansion and structural change of interorganizational networks of University Industry Collaborations.

We examine big increase of joint patenting and growth of interorganizational networks based on industry and university collaborations by new institutional policy in early 2000's, using a case of "the Kansai Bio cluster" in west Japan. It is one of the biggest biotechnology clusters in Japan. Figure 1 shows geographical areas of the Kansai Bio Cluster. Actually it is complex of 9 sub- clusters across regions, including two major clusters, the Kobe Biomedical Cluster and the Saito Bio Hill near Osaka City. As a whole, the Kansai Bio Cluster has 200 firms, 36 universities, 14 institutions, 12 incubators in 9 prefectures [14]. As main competitive biotechnology industries, this cluster has many firms in pharmaceutical, food, medical equipment and cosmetic industries. The Ministry of Economy, Trade and Industry (METI), Japan, set up the huge national development initiative for regional development of biotechnology clusters from 2000 to 2009.Reference [20] suggests that these governmental cluster initiative programs during 2000's nationally have provided direct and indirect supports for creation of network linkages between university and industry, showing certain effects for network formation. After 2010, the Kinki Bio-industry Development Organization, the local non -profit organization supported by the local branch of the METI, continue the local development initiative of the Kansai Bio Cluster.

In university-industry collaboration, we focus on three major players; major research niversities (i.e. Osaka, Kyoto and Kobe University), research institutes (i.e. RIKEN and AIST (the National Institute of Advanced Industrial Science and Technology), and firms (i.e. Takeda, Tanabe- Mitsubishi, Shionogi, Dainihon-Sumitomo in the pharmaceutical industry).



Source: http://www.biobridge-kansai.com/ Available at May 1, 2012.
Figure. 1. Kansai Bio Cluster

IV. EMPIRICAL ANALYSIS OF JOINT PATENTING NETWORKS IN KANSAI BIO CLUSTERS

A. Data and Method

We investigate increase of joint patenting between industry and university interfaces by new institutional policy in early 2000's, conducting longitudinal interorganizational network analysis of joint patenting during 2000's in "the Kansai Biocluster." A main reason to use joint patenting relationship is because they mean the joint research collaborations and their outputs between universities, institutes and firms. In this area, we investigate 1411 joint patents submitted to the Japanese patent agency from the organizations in the Kansai area during 2000 to 2007 in the category of pharmaceutical drug (A61K)[1]. We use joint patents which organizations locating in the Kansai Area[2], submit to, and find 902 collaborating organizations, including universities, research institutes and firms including ventures. Although we focus on joint patents from organizations in the Kansai area, however, partners partially include organizations not only in other areas in Japan but also 43 foreign companies (mainly, United States, Western Europe, Korea and China). First of all, we focus on joint patent submitting although number of approved patents is very small (nearly under 10 %).

We examine three types of network data in order to investigate structural changes of university-industry collaboration, using the UCINET IV, the network analysis software (Borgatti et al., 2002). First, we make one whole social matrix data of joint patenting in interorganizational collaborations during 2000 and 2007, and check the main features of whole structure of collaboration networks. Second, examining the effects of new policies from 2003, we divide this whole network dataset in two periods: the first period from 2000 to 2003 and the second period from 2004 to 2007. Third, focusing on the structural changes of interorganizational collaboration networks of major organizations, we pick up frequently patenting organizations ranked in top 10% and having more than six patents in eight years[3] and make up two periodical network datasets from 2000 to 2003 and from 2004 to 2007. To do longitudinal network analysis of joint patenting, we mainly get following four findings about whole structure of network over all eight years, whole comparison of structural changes before and after policy impacts, focused comparison of structural changes of major organizations before and after policy impacts, and achievement of central organizations in approving patents.

B. Change of Whole Network Structure

Average number of interorganizational linkages, in other word, partners of each organization increases from 1.04 in the period 1 (Year 2000 – 2003) to 1.72 in the period 2 (Year 2004-2007), because institutional policy changes totally enhanced number of these after 2004. In looking into details of increasing pattern by organizational types, we find that university dramatically increases average number of their joint patenting linkages twentyfold from the first to the second period as shown in Figure 2. Research institutes also roughly double averaged number of ties from the first to second period. Thus, new institutional policy shows effects to increase linkages from universities and research institutes[4]. Especially, in 44 cases of research institutes, total amount of national science funding (Kaken in pharmaceutical area) increase number of joint patent application, indicated in high correlation score .609. As universities have strong incentives to promote and manage joint patenting with industry, due to new evaluation standards for public funding, hypothesis 1 is accepted.

[1] The data source is the PATOLIS database, which is provided by the Patolis company, Japan. This company is making the arranged database, based on the data from the Paten Agency, the Japanese governmental agency of patenting.

[2] We choose organizations located in prefectures of Osaka, Kyoto, Hyogo, Nara and Shiga, except Wakayama.

[3] Exactly, the proportion of organizations having more than six patents is 12.42%.

[4] However, before new policies, individual university researchers submitted joint patents with companies but universities did not control or have information about it. After new policies, university control joint patenting of all researchers.

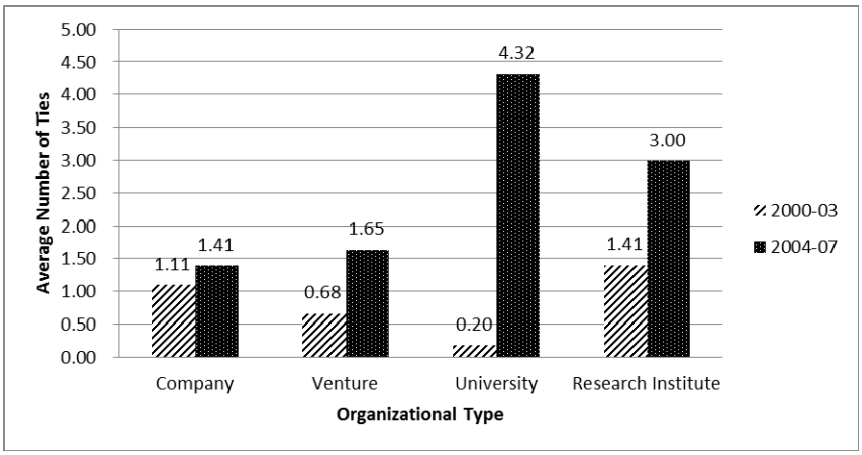


Figure. 2. Average Number of Ties by Organization

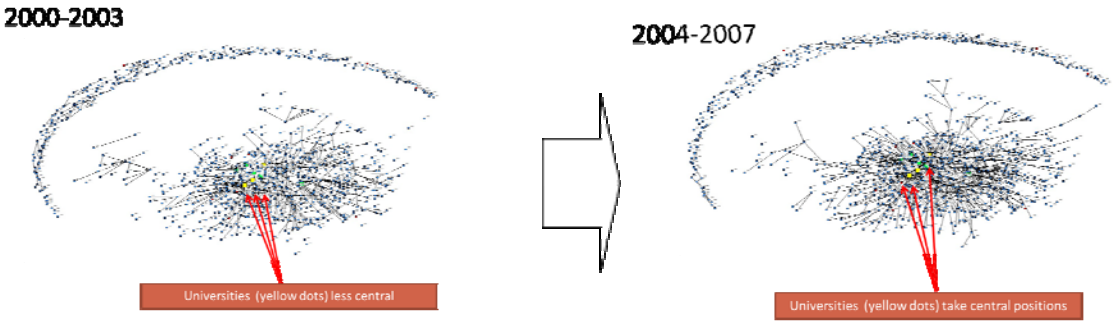


Figure. 3. Change of Joint Patenting Networks before and after 2004

C. Policy Impacts on Network Dynamics

In Figure 3, whole networks of joint patenting in the period 1 (Year 2000-2003) and period 2 (Year 2004-2007) are divided into big two groups of organizations, showing features of Japanese economic contexts. In both networks, the first group shapes big and dense network, consist of 663 organizations such as major national universities, research institutes, companies, especially nation-wide large ones, and foreign companies mainly in pharmaceutical and chemical industry. The second group forms sparse network including 239 organizations such as many local companies in food and cosmetic industry, ventures but little foreign companies. However, total number of ties in not only whole network but also of research universities including two major nationals; Kyoto and Osaka University, in this area dramatically increased, comparing companies and ventures.

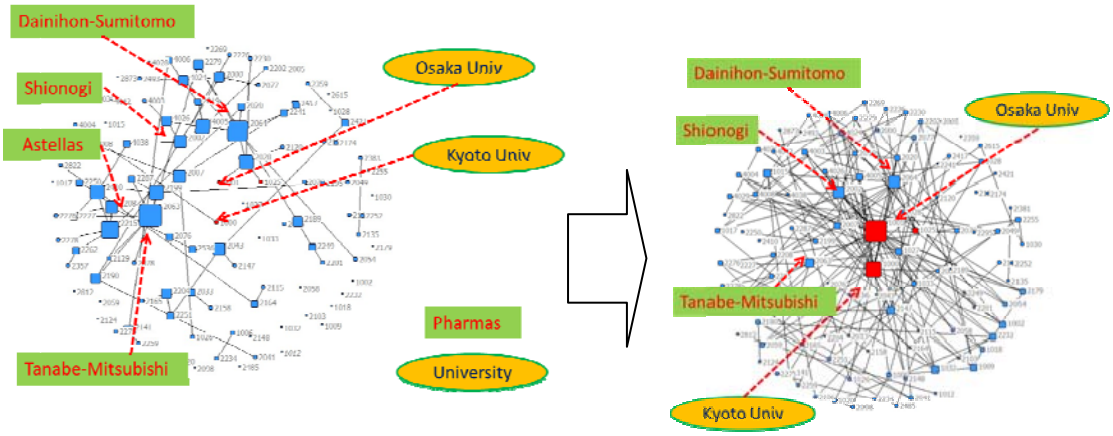
D. Centralization of Research Institutes and their Performance

Shown in Table 1, we find that research institutes, including major national universities, dramatically enhance number of patenting applications and it leads to increase of their network expansion. Taking 44 research institutes, from period 1 to 2, we compare development of patenting performance and network variables: centrality, clustering coefficient, and structural holes. The eigenvector centrality is often used in interorganizational networks, showing what organizations have prestige in a network [26]. Clustering coefficient indicates the extent of cohesiveness of networks. Structural holes shows the extent of bridging separated actors [7]. In table 1, research institutes enhance patent applications and led to expansion of their submission network. Research institutes take more central positions in local hubs, as centrality index shows. They form their cohesive subgroups with firms and other institutes, while they extend bridging ties with firms and organizations.

Focusing on network of major organizations ranked in top 10% and submitting more than six patents, we clearly recognize that these major national research universities dramatically increased ties of joint patenting with others and became central hubs of joint patenting alliance networks after 2004 as shown in Figure.4. The new policies for university-industry collaboration show clear effects for tie formation of major national universities. However, these major national universities mainly forms strong linkages with big pharmaceutical firms for which they provide many fresh corporate researchers, senior researchers and research directors from their alumni. Thus, as shown in hypothesis 2, major national universities occupy central positions in regional patenting networks in expanding their linkages.

TABLE 1. COMPARISON OF PATENTING AND NETWORK VARIABLES OF RESEARCH INSTITUTES BETWEEN PERIOD 2000-03 AND 2004-07

	Patent Submission	Patent Registration	Eigenvector Centrality	Clustering Coefficient	Structural Constraint
Period1: 2000-03	0.744	0.026	0.001	0.011	0.201
Period2: 2004-07	6.795	0.308	0.045	0.177	0.547
growth rate (%)	913.8%	1200.0%	3355.0%	1613.2%	271.8%
t-test	**	*	**	**	**
(note) n=38. *: <.05, **:<.01.					



(a) 2000-03 (b) 2004-07

Fig. 4. Change of Network of Major Organizations before and after 2004

E. Low Performance of Central Research Institutes

However, this will lead us to the following important question. Are major universities newly positioning in center really successful in licensing? In table 1, research institutes averagely indicate increase of rate of registration from period 1 to 2, but most of their patents are still not registered in the period 2. Compared to national average of registration rate 21.6 % in year 2005, their joint patents show 6.2%.

Especially, in carefully checking registration rate of patents of these universities, we find its big gap between major universities and top firms in table 2. Obviously, universities are keen to submit patents but reluctant to acquire approval and make efforts to retain commercial value for the joint submitted patents. In the top organizational ranking of submitted patenting in the second period, universities and public research institutes occupy higher ranking but they tend to indicate lower registration rate in terms of registration rate of submitted patents. The Osaka University submitted the most patents in the after 2004, but registration rate of them remain only half of the top private pharmaceutical companies. Leading pharmaceutical firms such as Dainihon Sumitomo Pharma or Shionogi Pharma not only occupy high rank in number of patent submission but also show higher achievement in patent registration in both periods. As argued in hypothesis 3, major central universities and research institutes may not show higher economic performance in terms of increase of registered patents.

To investigate these critical differences between joint submitted and approved patenting ranking in more detail, we conducted several interviews with several managers of research alliances in pharmaceutical firms. Our interview shows that Japanese national universities are generally reluctant to commercialize patents because they only want to raise research funds from public funds, adapting their evaluation standards focusing on number of joint research projects and patents with industry. Our interview with corporate managers also shows following three other reasons why pharmaceutical firms commit to joint patenting with universities. First, pharmaceutical firms only want to acquire new knowledge, technologies and talents from universities but not to share commercial success with them. Second, they tend to have joint patenting alliances with special major universities because they want to build trust relationships with them and make themselves easy access to the other faculty members in these universities for marketing of their own new drugs and equipment. Third, some of pharmaceutical firms attempt to restructure their research divisions and outsource some activities of research to

universities.

Major national universities take central positions and have strong linkages in the joint patenting networks, but have few brokerages with ventures and companies outside pharmaceutical industry. They tend to form linkages with traditional and large companies within pharmaceutical industry. Some private universities are also isolated from large pharmaceutical companies. As shown in figure 6, research institutions are heavily linked with research institutes and large corporations and of pharmaceutical industry but few linkages with ventures. They do not develop linkages outside pharmaceutical and chemical industries in our data. Although reference [7] argues that bridging ties over direct networks may convey novel and heterogeneous knowledge, research institutions highly embedded in networks with special large corporations and similar research institutes are unlikely to encounter such knowledge and implement radical innovation.

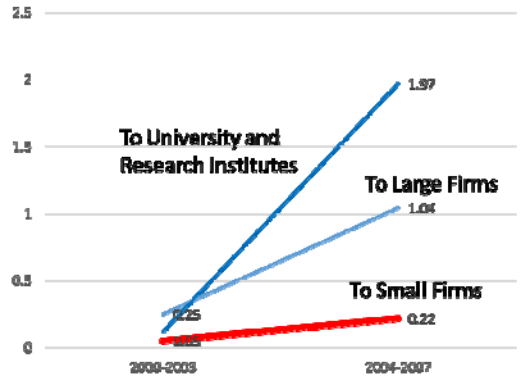


Figure 6. Change of Linkages from Research Institutes before and after 2004

V. DISCUSSION

Institutional policy for university-industry collaboration in Japan in early part of 2000's may make positive impacts on new tie formation between university and industry because they are able to narrowly focus on what tie they create and give appropriate incentives for universities and university researchers to form them. The Japanese Government set up new institutional policy for university-industry collaboration, narrowly focusing on increase of number of joint research projects and submitting joint patents between universities and industries. It also provided new incentives to drive national universities and researchers to commit to joint research with industries in public funding. These new policies dramatically increased number of joint research projects and joint patent submitting between universities and industries even in life science area, therefore, it lead to rapid growth of interorganizational networks in the Kansai Bio Cluster and new central hubs of major national universities within it. Focusing on joint patenting in pharmaceutical area, as a result, in the Kansai Bioregion, major research universities become central hubs of regional joint patenting networks after 2004, taking over those of major pharmaceutical firms in the previous years. Major national universities take more prestigious and central positions in expanding R & D network in the regional cluster than the previous time, as our longitudinal analysis shows.

But, in careful examination of their networking and their performance in joint patent network, we recognize two controversial situations in university-industry linkages. First, major national universities are highly embedded in network with big pharmaceutical and established firms after new institutional policy under dominance of strong linkage between major research universities and large and established companies. Second, although national universities made new ties in joint patent submitting with industry in the Kansai Bioregion, however, they are less likely to succeed to acquire final approval of joint patents with industry than major pharmaceutical firms. We find a huge gap in motivation for collaboration between universities and industry. Universities, especially national universities, only respond to change of new governmental evaluation standards, which values not commercial success of patents but only number of joint patent submission. On the other hand, pharmaceutical firms have different motivation to form ties with universities for acquisition of new knowledge, human resources or marketing or outsourcing opportunities of restructured research activities. It leads to their many failing collaborations.

TAB.2 RANKING OF SUBMISSION AND SUCCESS RATE

No.	Name	Type	Submission:	Rate of Registration
1	Dainippon Sumitomo Pharma	Firm	31	25.81%
2	Mitsubishi Tanabe Pharma	Firm	29	62.07%
3	Sumitomo Chemical	Firm	25	24.00%
4	Kanebo	Firm	18	44.44%
5	Senju Pharmaceutical	Firm	17	17.65%
6	Santen	Firm	16	18.75%
7	Glico	Firm	12	8.33%
8	Shionogi	Firm	11	45.45%
9	Chisso	Firm	11	27.27%
10	Kose	Firm	11	27.27%

No.	Name	Type	Submission:	Rate of Registration
1	Osaka Univ	UNIV	78	8.97%
2	Dainippon Sumitomo Pharma	Firm	41	9.76%
3	Shionogi	Firm	39	20.51%
4	Kyoto Univ	UNIV	37	10.81%
5	Mitsubishi Tanabe Pharma	Firm	33	24.24%
6	Kinki Univ	UNIV	20	15.00%
7	Toyobo	Firm	18	16.67%
8	Kose	Firm	18	5.56%
9	Chisso	Firm	17	5.88%
10	Sumitomo Chemical	Firm	17	5.88%

But, in this research, we still have limitation. First, since we focus on a case of one bioregion in Japan, we might ignore regional differences. Second, for we did not examine what factors lead to successful projects or approval of patents, we are not able to specify the motivation gaps always are obstacles of successful partnerships between industry and universities. Therefore, we should futther examine how public policy affects dynamics of networks, comparing internationally and focusing transformation process.

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