

Developing Organizations towards Enhancing Regional Knowledge Creation:

The role of Japanese universities' joint research centers in promoting interaction towards
the externalization of knowledge

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Abstract

Regional knowledge is held by the many actors that interact in the same geographical area. Regional knowledge creation is a social process that requires the interaction of actors. This article examines into the role of organizations in fostering knowledge creation by analyzing Japanese universities' joint research centers. These centers helped universities raise their level of collaboration with private firms. It also helped small and medium region's firms to advance their collaboration with universities. Universities that established this organization first show a higher level of increase in joint researches than other universities. Proximity facilitates exchanges among regional actors, but it is necessary to have a set of organizations that help the region benefit from geographical closeness and enhance actors' interaction.

KEYWORDS : Knowledge creation, joint research, industry-university collaboration, *Ba*

I . Introduction

Knowledge and innovation have become very important concepts to understand economic growth (Foray 2006) . In endogenous growth models, knowledge spillovers and technological progress are the main engines of economic change (Romer 1986, 1990; Lucas 1988) . Knowledge has positive externalities on other agents because it is a non rival good (Cortright 2001) . Spillovers have geographical boundaries, making regions the unit of analysis (Krugman 1991; Coe and Helpman 1995; Lim 2007) . The flow of spillovers is highly dependent on the local environment: some environments help knowledge to spill over to the local agents, while other environments hinder this process (Baptista and Swann 1998; Feldman and Audretsch 1999; Greunz 2004; Paci and Usai 2009; see Capello and Nijkamp 2009, for a survey on studies on spillovers) . Innovations are not considered only as the individual result of the action of firms, but as being part of a broader environment that helps firms to innovate. There is still debate on what type of environment promotes better this phenomena, although probably there will never be a definite answer, as each region's particularities may have a different impact.

In the “knowledge economy” , traditional factors of production such as capital and unskilled labor lose importance, while adding “knowledge” to production through the research and development carried out by skilled labor plays a central role. Creating knowledge becomes an important source for the competitive

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advantage of firms, regions and nations (Porter 2003) . Nonaka and Takeuchi (1995) inquire into the nature of “knowledge” and propose that its creation is the result of the conversion between its tacit and explicit dimensions. Despite their application to the firm level, we believe that their knowledge creation framework can be applied to the regional level, with a variety of firms and organizations. Regional systems that foster the conversion between tacit and explicit knowledge will be able to create an environment where new knowledge is created through the interaction of the regional actors. This environment involves the presence of organizations, which can enhance the actors' exchanges. Among these interactions, the relation between firms and universities is recognized as important for the synergy that their collaboration generates (Wright et al. 2008) . Many organizations and programs have emerged in Japan in the last decades to enhance industry-university links. Among them are the Joint Research Centers, established by universities to promote joint researches with private institutions. This paper aims at analyzing if the Joint Research Centers in Japanese national universities have played a role in shaping industry-university interactions and in helping spilling universities' knowledge over regional firms.

This paper is structured as follows: first, a brief review on the recent approaches to regional knowledge creation and local institutions is introduced. Second, a model to analyze the impact of joint research centers in universities and local firms' collaboration is presented. Third, an analysis on the impact that Japan's universities joint research centers had in fostering their universities' and the local companies' joint research numbers is presented. Finally, in the conclusions we discuss the results of our analysis and argue for the importance of building organizations that support regional knowledge creation processes.

II . Theoretical background: Regional knowledge creation

The social rate of return to knowledge is much greater than the private one (Leyden and Link 1991; Jones and Williams 1997) , so markets tend to under-invest in knowledge creation and the role of the government is essential to boost it (Jarboe and Atkinson 1998) . In the context of increasing public involvement in fostering innovation, the growing interest since the 1990s on the process of knowledge creation, regional economics and innovation activity brought to light a handful of theories that aimed at explaining why and how the environment (say private firms, institutions and the government) shaped the flow of knowledge and fostered innovation within the region¹ . They explain the importance of local organizations and their relations, the necessity to have learning organizations and adaptive institutions and norms, and the significance of having an environment of trust that promotes cooperation and collaboration among firms. In many cases innovation and “knowledge creation” are considered as synonyms, when in fact they are processes with different characteristics. Knowledge is “a dynamic human process of justifying personal belief toward the “truth” (Nonaka et al. 2001, p. 14) . It is partly tacit and partly explicit (Polanyi 1967) . Codified knowledge is the one that can be articulated, systemized and stored. Tacit knowledge is the knowledge that people carry in their minds and is the result of a process of learning through interaction with the environment. Personal communication, mutual trust, co-operation, common codes and personal contact

¹ These approaches are “*National and regional Innovation systems*” (Lundvall, 1992; Nelson 1993; Cooke et al. 1997; Cooke and Memedovic 2003) , “*Learning regions*” (Florida 1995; Morgan 1997) and “*innovative milieu*” (Camagni 1991; Malmberg and Solvell 1997; Capello 2001; Crevoisier 2004) .

are specific to this knowledge. For transmitting tacit knowledge, distance matters (Handy 1995; Saviotti 2007) . Knowledge creation is the result of the interaction between tacit and explicit knowledge (Nonaka and Takeuchi 1995; von Krogh et al. 2000) . Knowledge is created in social interaction. Knowledge is not only the construction of reality, but it also “empowers its possessors with the capacity for intellectual and physical action” (Foray 2006, p. 4) . This capacity to change the world we live in is closer to the concept of innovation, understood as “the embodiment, combination, or synthesis of knowledge in original, relevant, valued new products, processes, or services” (Luecke and Katz 2003; 2) . Knowledge is, then, the base for innovation.

Knowledge is exploited and created in a certain time and place, which receives the name of *Ba*, for its Japanese signification. *Ba* is “a shared space for emerging relationships” (Nonaka and Konno 1998, p. 40) . The most important aspect of *Ba* is that it is created through interaction among individuals and with the environment. Several authors have adapted the *Ba* concept (originally thought for companies) to the regional level (Nonaka et al. 1998; Kostiaainen 2002; Harmaakorpi and Melkas 2005) . Knowledge is partitioned in many regional actors (universities, firms, organizations, government) and new knowledge creation will arise from the interaction of those actors (Zucker and Darby 2001) . Institutions and networks are important to develop trust and cooperation within a region (Martin 2000) . They help bring actors together, re-enforcing the advantages of geographical proximity (Coulson and Ferrario 2007) . A strong institutional presence and high levels of interaction between organizations are two important factors for the development of the region (Amin and Thrift 1994) . In order to promote regional knowledge creation, the development of organizations is important to enhance and manage the interaction of regional actors towards the creation of knowledge through the conversion of the tacit and explicit knowledge possessed by them (Argüero and Ito 2009) . Analyzing the role of organizations to promote actors exchanges, then, becomes relevant in order to understand the processes by which a region creates its own knowledge.

III . Enhancing externalization of knowledge through organizations: the impact of universities’ joint research centers

Universities may have a significant impact on local economies (Bleaney et al. 1992) and can be an important source of transfer of tacit and explicit knowledge (Wright et al. 2008) . University research centers oftentimes generate industry-related outputs and outcomes (Gray et al. 2001; Feller et al. 2002; Dietz and Bozeman 2005) and help local industry through many channels. One of these channels is the performance of joint researches between universities and private firms. These interactions set the base for the externalization of the tacit knowledge possessed by these actors (Argüero 2009)². Enhancing industry-university links may help regional actors to create more knowledge and, through that, enhance their innovative capacity.

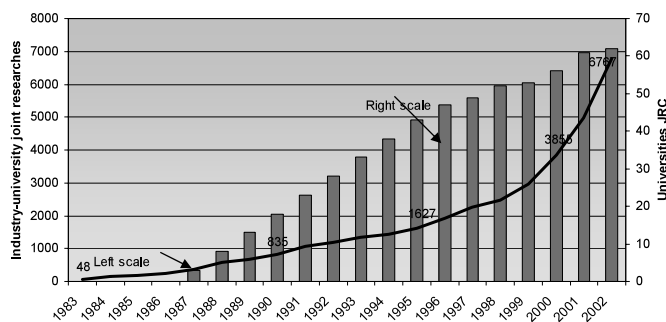
Since 1983 Japan's national universities are legally able to carry out researches with private firms, and

² For Nonaka and Takeuchi (1995) , knowledge is created in the conversion of tacit knowledge into tacit knowledge (called the “socialization” stage) , tacit into explicit (“externalization”) , explicit into explicit (“combination”) and explicit into tacit (“internalization”) . The initials of the stages (SECI) give the name to this model of knowledge creation.

only from 1989 they can openly accept donations from private companies. In Japan, big firms have traditionally taken the initiative to use scientific knowledge into commercial products, while universities focused on higher education and basic research. From the 1990s, however, economic difficulties, loss of competitiveness, as well as a realization of the economic benefits of industry-university collaboration, spurred efforts from the Japanese government to diffuse scientific knowledge from universities to industries. In terms of benefits, firms gain access to new university research and discoveries while universities get funds for lab equipment and get insights into their researches (Lee 2000) . The successful experience of the Bayh Dole Act³ in the USA (Henderson et al. 1998) served as background for the change in the Japanese innovation approach: various institutional reforms have seen the light in the last decades aiming at enhancing industry-university collaboration (for example, the TLO (Technology Licensing Organization) Law in 1998 and the introduction of the Japanese version of the Bayh-Dole Act in 1999) (Kitagawa and Woolgar 2008) .

Japanese national universities saw, from the latter half of the 1980s, the establishment of Joint Research Centers (JRC) in their compounds due to recommendations from the Ministry of Education, Culture, Sports, Science and Technology (*Monbukagakusho*) . They were established to foster the cooperative research by providing infrastructure, technological and legal consultation and guidance to private institutes as well as providing scientific information to the private sector on universities' researches. From the establishment in 1987 of the first JRC, their number increased steadily and by 2002, 62 national universities had built one. Meanwhile, the number of joint researches has grown steadily since they were allowed in 1983, increasing from a mere 48 in that year to 6767 in 2002 and 17638 in 2008 (Figure 1) . Despite the relevance given by the *Monbukagakusho* to this type of institution and the growing importance on industry-university collaboration (Okamuro 2009) , the impact of JRC in universities and local companies' capabilities is generally inferred from the general growth in joint research cases. In this paper we aim at elaborating a model to analyze their impact and examining how much did they help to the increase of joint researches. We intend to answer these questions: Have the JRC helped increase the number of joint researches performed by the universities? Have the JRC helped increase the number of joint researches performed by local firms in the period 1983-2002?

Figure 1: Number of industry-university joint researches in Japan and JRC establishment, 1983-2002



Source: Monbukagakusho (2003)

³ University and Small Business Patent Procedures Act of 1980, usually referred to as the “Bayh Dole Act” due to the names of its authors, gave USA universities intellectual property rights over their inventions

Method

In order to measure the role of JRCs, the year of establishment of each JRC and the number of joint researches performed by the universities in which they are located are cross-analyzed. The number of joint researches has increased steadily since 1983 (figure 1) , so it would be incorrect to compare the amount of researches performed before and after the establishment of the JRC. Therefore, we choose to use the proportion of the joint researches carried out by those universities in the total amount of industry-university joint researches in Japan. We picked the most important national university with engineering and science faculties in each of the prefectures of Japan. The university chosen is the one that performs more joint researches in the prefecture where it is located. We compare the proportion of joint researches by that university in the national total cases in the three and five years previous to the establishment of the JRC with the three and five years subsequent to it.

Formula(1) shows the calculation of the proportion of the university's joint researches in the national total number in the five years previous to the establishment of the JRC. X is the number of joint researches performed by the analyzed university (a) ; t is the time variable, with t=0 being the year in which the JRC in university a was established (if, for example, the JRC was established in 1988, t-1 is 1987; t-2 is 1986, and so on) . Y is the number of joint researches between universities and firms for all Japan. The total number of universities analyzed is 44.

$$\frac{XU_a^{t-5} + XU_a^{t-4} + XU_a^{t-3} + XU_a^{t-2} + XU_a^{t-1}}{Y^{t-5} + Y^{t-4} + Y^{t-3} + Y^{t-2} + Y^{t-1}} = P_1 \quad (1)$$

Formula(2) presents the proportion for the five years subsequent to the establishment of the JRC, following the same logic as formula(1) .

$$\frac{XU_a^{t+1} + XU_a^{t+2} + XU_a^{t+3} + XU_a^{t+4} + XU_a^{t+5}}{Y^{t+1} + Y^{t+2} + Y^{t+3} + Y^{t+4} + Y^{t+5}} = P_2 \quad (2)$$

Finally, the change in the proportion is calculated by dividing P₂ by P₁ (multiplied by 100 to get the percentage)

$$(P_2 * 100) / P_1 \quad (3)$$

We use the same methodology to calculate the three year period before and after the establishment of the JRC.

The second objective of the research is to analyze if the establishment of the JRC had any impact on local firms. To do that, we aim at comparing the joint researches performed by firms located in the same prefecture as the university before and after the establishment of the JRC, for universities with JRCs

established between 1987 and 1997 (so it includes the period up to 2002) . The proportion of joint research cases performed by the prefecture's firms on national total in the three and five years previous to the establishment of the JRC and the three and five years subsequent to its establishment are calculated, following a similar line to the model presented previously.

$$\frac{XF_{p_i(a)}^{t-5} + XF_{p_i(a)}^{t-4} + XF_{p_i(a)}^{t-3} + XF_{p_i(a)}^{t-2} + XF_{p_i(a)}^{t-1}}{Y^{t-5} + Y^{t-4} + Y^{t-3} + Y^{t-2} + Y^{t-1}} = S_1 \quad (4)$$

$$\frac{XF_{p_i(a)}^{t+1} + XF_{p_i(a)}^{t+2} + XF_{p_i(a)}^{t+3} + XF_{p_i(a)}^{t+4} + XF_{p_i(a)}^{t+5}}{Y^{t+1} + Y^{t+2} + Y^{t+3} + Y^{t+4} + Y^{t+5}} = S_2 \quad (5)$$

$$(S_1 * 100) / S_2 \quad (6)$$

In formulas (4) and (5) X is the number of joint researches performed by firms (F) located in the prefecture $i(p_i)$ where the university (a) with the JRC is established; t is the time variable, with t=0 being the year in which the university's JRC was established. Y, as in formulas (1) and (2) is the total number of joint researches between firms and universities for all Japan. The total number of prefectures (p_i) analyzed is 39. Formula (6) shows the change in percentage in the five years following the establishment of the JRC, comparing to the five years previous to it. We use the same methodology to calculate the three year period before and after the establishment of the JRC.

Findings

①JRCs and joint researches performed by universities

Of the total 47 prefectures of Japan, 44 are included in this research with its main national university in terms of joint research activity. Figure 2 shows the results obtained. When measuring in a period of five years, universities increased from a sum of 60.35 % to a 78.44% of all Japan's industry-university joint research cases. They show an overall 29.98% average increase in the national proportion after the establishment of the JRC compared to the period previous to its establishment. It can be noted that a few universities concentrate a large proportion of the total joint researches. We separated the group “Imperial universities”⁴, which were the ones established by the Japanese empire between 1877 and 1939 and are traditionally the most important Japanese national universities, and the rest of the universities. “Imperial universities” show a decline of 4.48% in their proportion of total joint researches, dragged by the steep decline in Nagoya University. Other universities (a total of 37) , saw an average increase of 59.67% in their proportion after establishing the JRC.

For the three years period, the proportion after the establishment of the JRC is slightly higher than in the five years proportion. But the proportion in the three years before the establishment of the JRC varies 11%

⁴ “Imperial universities” includes Hokkaido, Tohoku, Tokyo, Kyoto, Osaka, Nagoya and Kyushu Universities

with the five years proportion. In the two groups analyzed, no major change is seen in the “Imperial universities” , but a higher variation can be seen in the “others” (more than 20%) . This difference suggests that universities may have decided to install the JRC as they were seeing an increase in the joint researches. It may also be the result of certain networks established by the universities (like employees and offices in charge of developing joint researches with private firms) before the formal establishment of the JRC.

Figure 2. Change in proportion of universities’ joint researches in national total before and after the establishment of the JRC

Prefecture	Main national university	Year of establ. of JRC	Proportion of university Joint researches on total national					
			Five years before	Five years after	% Change	Three years before	Three years after	% Change
Hokkaido	Hokkaido Univ.	1996	2.24	2.88	28.57	2.29	3.18	38.86
Aomori	Hirosaki Univ.	1997	0.47	0.70	48.94	0.67	0.55	-17.91
Iwate	Iwate Univ.	1993	1.41	2.28	61.70	1.78	2.21	24.16
Miyagi	Tohoku Univ.	1998	3.31	3.37	1.81	3.52	3.62	2.84
Akita	Akita Univ.	1993	1.25	1.21	-3.20	1.75	1.31	-25.14
Yamagata	Yamagata Univ.	1992	1.38	1.26	-8.70	1.73	1.48	-14.45
Ibaraki	Tsukuba Univ.	2002	1.34	1.87	39.55	1.31	1.73	32.06
Tochigi	Utsunomiya Univ.	1989	1.17	1.66	41.88	1.52	1.91	25.66
Gunma	Gunma Univ.	1988	0.45	2.02	348.89	0.57	2.36	314.04
Saitama	Saitama Univ.	1994	0.65	1.01	55.38	0.93	1.09	17.20
Chiba	Chiba Univ.	1994	1.16	1.46	25.86	1.17	1.38	17.95
Tokyo	Tokyo Univ.	1996	4.64	5.43	17.03	4.77	5.12	7.34
Kanagawa	Yokohama National Univ.	1991	0.46	1.89	310.87	0.60	1.65	175.00
Niigata	Niigata Univ.	1991	1.27	1.95	53.54	1.67	1.87	11.98
Toyama*	Toyama Univ.	1987	0.99	2.42	144.44	1.08	2.41	123.15
Ishikawa	Kanazawa Univ.	1995	0.60	1.45	141.67	0.82	1.27	54.88
Fukui	Fukui Univ.	1992	0.76	1.40	84.21	0.99	1.48	49.49
Yamanashi	Yamanashi Univ.	1990	1.79	1.38	-22.91	1.96	1.46	-25.51
Nagano	Shinshu Univ.	1993	1.30	1.43	10.00	1.47	1.44	-2.04
Gifu	Gifu Univ.	1988	0.64	1.53	139.06	0.57	1.66	191.23
Shizuoka	Shizuoka Univ.	1991	1.06	1.56	47.17	1.34	1.53	14.18
Aichi	Nagoya Univ.	1988	7.90	3.87	-51.01	8.25	4.79	-41.94
Mie	Mie Univ.	1990	1.01	1.95	93.07	1.31	1.67	27.48
Shiga	Shiga Univ.	2001	0.04	0.03	-25.00	0.05	0.03	-40.00
Kyoto	Kyoto Univ.	2001	3.20	3.76	17.50	3.37	3.39	0.59
Osaka	Osaka Univ.	1995	3.57	4.00	12.04	2.86	3.38	18.18
Hyogo*	Kobe Univ.	1987	0.43	1.70	295.35	0.46	2.36	413.04
Wakayama	Wakayama Univ.	1999	0.29	0.48	65.52	0.42	0.61	45.24
Tottori	Tottori Univ.	1993	0.99	1.21	22.22	1.20	1.33	10.83
Shimane	Shimane Univ.	1996	0.31	0.57	83.87	0.43	0.39	-9.30
Okayama	Okayama Univ.	1990	1.66	1.41	-15.06	1.60	1.19	-25.63
Hiroshima	Hiroshima Univ.	1995	0.91	1.31	43.96	1.11	1.14	2.70
Yamaguchi	Yamaguchi Univ.	1991	1.13	2.18	92.92	1.44	2.06	43.06
Tokushima	Tokushima Univ.	1991	0.53	1.42	167.92	0.70	1.48	111.43
Ehime	Ehime Univ.	1994	1.74	1.21	-30.46	2.09	1.12	-46.41

Kochi	Kochi Univ.	1995	0.59	0.64	8.47	0.80	0.72	-10.00
Fukuoka	Kyushu Univ.	1994	3.08	3.38	9.74	3.07	3.56	15.96
Saga	Saga Univ.	1989	0.61	1.37	124.59	0.80	1.51	88.75
Nagasaki	Nagasaki Univ.	1990	0.51	1.18	131.37	0.59	1.22	106.78
Kumamoto*	Kumamoto Univ.	1987	0.43	2.65	516.28	0.46	3.11	576.09
Oita	Oita Univ.	1993	0.86	0.89	3.49	1.11	1.04	-6.31
Miyazaki	Miyazaki Univ.	1994	0.65	1.39	113.85	0.79	1.37	73.42
Kagoshima	Kagoshima Univ.	1992	1.03	1.00	-2.91	1.14	1.20	5.26
Okinawa	Ryukyu Univ.	1995	0.54	0.68	25.93	0.68	0.61	-10.29
Total(% points)			60.35	78.44	29.98	67.24	79.99	18.96
“Imperial Universities”			27.94	26.69	-4.48	28.13	28.48	1.24
Others			32.41	51.75	59.67	39.11	51.51	31.70

Notes: Fukushima, Nara and Kagawa are not included in this research. * The four years previous to the establishment of the JRC are analyzed (not five).

Source: Author, from Monbukagakusho (2003) and JRCs webpages.

Figure 3 shows that 36 out of the 44 universities analyzed show an increase in their proportion on total joint researches, with 19 universities showing more than a 50% increase. The number of universities with an increase goes down to 31 when analyzing the three years period. The number of universities with more than 50% increase was 11, while universities with a modest increase between 0.1 and 25% totaled 13.

Figure 3. Universities joint researches' proportional change after the establishment of JRC

	0.1-25%		25%-50%		More than 50%		Total	
	5years		3years		5years		3years	
Universities with increase	9	13	8	7	19	11	36	31
	-0.1/-25%		-25%/-50%		Less than 50%		Total	
Universities with decrease	5	7	2	6	1	0	8	13

Source: Author

The results on figures 2 and 3 show that the establishment of the JRC had, in general, a positive effect on universities' joint researches. Not only did they increase in the actual number, which could be attributed to the continuing increase in industry-university joint researches, but also increased in their proportion on the total national numbers.

When analyzing the changes in the universities an unexpected result arose: universities that established the JRC earlier show an average larger increase in the proportion of joint researches than universities that established it afterwards. We separated into three time categories according to the year of establishment of the JRC: from 1987 to 1990, from 1991 to 1993, and from 1994 to 2002.

Figure 4 shows the breakdown into the three time categories. Non “Imperial universities” that established the JRC in the first period show a much higher increase in their proportion on total joint researches in the five years after the establishment of the center (101.11% increase). Universities that established the JRC in the second period show a shorter increase (46.53%) than universities in the first

group, but higher than the increase shown by universities that established the JRC afterwards (32.58%) . The findings can also be seen in the three year period analysis, with a much larger difference among the periods (76.86% for those that established the JRC in the first period, 18.68% for those in the second and 6.57% for those in the third) .

Figure 4. Average change of joint researches proportion by period of establishment of JRC in non-Imperial universities

	Previous to est. of JRC*		After the est. of JRC*		Change(%)	
	Five years	Three years	Five years	Three years	Five years	Three years
1987-1990(n=11)	10.81	10.46	21.74	18.50	101.11	76.86
1991-1993(n=13)	13.43	16.92	19.68	20.08	46.53	18.68
1994-2002(n=13)	12.49	11.27	16.56	12.01	32.58	6.57

Note: *These are calculated by adding the proportion of each university in the period previous to and subsequent to the establishment of its JRC.

Source: Author

②JRCs and joint researches performed by local companies

The second objective of this research is to analyze if the establishment of the JRC had any impact on the joint researches performed by companies located in the same prefecture as the university for the period 1983-2002. In the overall numbers shown in Figure 5, no important increase can be seen in the local firms' participation in joint researches, as there is a small 0.28% increase for the five years analysis and 1.70% increase for the three year analysis. Nevertheless, when we analyze the results for big prefectures with results for small and medium prefectures, results change considerably. We compare two groups: "Metropolitan" , which comprises the big prefectures of Japan (Hokkaido, Saitama, Chiba, Tokyo, Kanagawa, Aichi, Osaka, Hyogo and Fukuoka) and the rest of the prefectures (in the group named "Local") . Big metropolitan areas show a decrease in their proportion of joint researches after the establishment of the JRC in their main university both for the three and five years analysis. On the contrary, small and medium prefectures' firms see a 39.96% increase in the five years after the establishment of the local JRC (22.3% for the three years comparison) .

Figure 5. Proportion of joint researches performed by prefectures' companies*, 1983-2002

Prefecture	University	Year of establish. of JRC	Proportion of local companies' joint researches according to establishment of JRC					
			5years before	5years after	% Change	3years before	3years after	% Change
Hokkaido	Hokkaido Univ.	1996	4.32	3.55	-17.82	4.20	3.42	-18.57
Aomori	Hirosaki Univ.	1997	0.43	0.60	40.09	0.57	0.48	-15.79
Iwate	Iwate Univ.	1993	0.57	1.07	87.72	0.81	0.95	17.28
Akita	Akita Univ.	1993	0.48	0.37	-23.32	0.64	0.43	-32.81
Yamagata	Yamagata Univ.	1992	0.54	0.39	-27.78	0.70	0.43	-38.57
Tochigi	Utsunomiya Univ.	1989	0.13	0.65	390.24	0.17	0.81	376.47
Gunma	Gunma Univ.	1988	0.60	0.65	8.33	0.62	0.85	37.10

Saitama	Saitama Univ.	1994	0.98	1.71	74.49	1.14	1.61	41.23
Chiba	Chiba Univ.	1994	0.47	0.54	14.89	0.42	0.59	40.48
Tokyo	Tokyo Univ.	1996	41.3	39.21	-5.06	40.49	41.47	2.42
Kanagawa	Yokohama Nat. Univ	1991	1.86	2.60	39.78	2.11	2.50	18.48
Niigata	Niigata Univ.	1991	0.74	0.99	33.78	0.86	0.93	8.14
Toyama	Toyama Univ.	1987	0.80	1.63	103.93	0.87	1.91	119.54
Ishikawa	Kanazawa Univ.	1995	0.43	0.83	93.02	0.56	0.83	48.21
Fukui	Fukui Univ.	1992	0.45	0.92	104.44	0.54	0.98	81.48
Yamanashi	Yamanashi Univ.	1990	0.87	0.70	-19.54	0.93	0.75	-19.35
Nagano	Shinshu Univ.	1993	0.94	1.07	13.83	1.00	1.09	9.00
Gifu	Gifu Univ.	1988	0.71	0.51	-28.17	0.62	0.43	-30.65
Shizuoka	Shizuoka Univ.	1991	1.40	1.75	24.66	1.58	1.52	-3.80
Aichi	Nagoya Univ.	1988	7.56	5.75	-23.94	7.85	6.5	-17.20
Mie	Mie Univ.	1990	0.29	0.78	168.97	0.31	0.69	122.58
Osaka	Osaka Univ.	1995	8.70	7.91	-9.08	8.94	8.03	-10.18
Hyogo	Kobe Univ.	1987	3.52	2.39	-32.10	3.81	2.82	-25.98
Tottori	Tottori Univ.	1993	0.50	0.52	4.00	0.58	0.63	8.62
Shimane	Shimane Univ.	1996	0.08	0.32	300.00	0.09	0.26	188.89
Okayama	Okayama Univ.	1990	0.24	0.58	141.67	0.31	0.42	35.48
Hiroshima	Hiroshima Univ.	1995	1.35	0.92	-31.76	1.54	0.94	-38.96
Yamaguchi	Yamaguchi Univ.	1991	0.00	0.40	N	0	0.17	N
Tokushima	Tokushima Univ.	1991	0.37	0.61	64.86	0.48	0.66	37.50
Ehime	Ehime Univ.	1994	0.55	0.43	-21.82	0.61	0.36	-40.98
Kochi	Kochi Univ.	1995	0.17	0.29	70.59	0.25	0.31	24.00
Fukuoka	Kyushu Univ.	1994	4.47	3.63	-18.79	4.36	4	-8.26
Saga	Saga Univ.	1989	0	0.48	N	0	0.58	N
Nagasaki	Nagasaki Univ.	1990	0.29	0.66	127.11	0.37	0.67	81.08
Kumamoto	Kumamoto Univ.	1987	0.37	0.88	138.02	0.35	0.72	105.71
Oita	Oita Univ.	1993	0.32	0.39	20.42	0.39	0.32	-17.95
Miyazaki	Miyazaki Univ.	1994	0.32	0.63	98.10	0.44	0.93	111.36
Kagoshima	Kagoshima Univ.	1992	0.40	0.48	20.01	0.46	0.55	19.57
Okinawa	Ryukyu Univ.	1995	0.43	0.44	2.33	0.42	0.42	0.00
Total(%points)			88.52	88.76	0.28	90.94	92.49	1.70
"Metropolitan"			73.18	67.29	-8.05	73.32	70.94	-3.5
"Local"			15.34	21.47	39.96	17.62	21.55	22.30

Note: *The proportion of joint researches performed by firms before and after the establishment of the local university' s JRC are compared.

Fukushima, Nara and Kagawa prefectures are not included in this research. In this table Miyagi, Ibaraki, Shiga, Kyoto and Wakayama are not included as their main universities established the JRC in or after 1998. "Metropolitan" comprises Hokkaido, Saitama, Chiba, Tokyo, Kanagawa, Aichi, Osaka, Hyogo and Fukuoka. "Local" are the rest of the prefectures.

Source: Author, based in Monbukagakusho (2003)

Figure 6 shows that, in the five year period analysis, 27 prefectures of the 39 (70%) analyzed show an increase in the participation of their firms in the total joint researches carried out in Japan. Sixteen prefectures show an increase of more than 50% in their firms' participation. Meanwhile, in the three year period analysis, 24 prefectures show an increase (62%) , 13 prefectures show a decrease and one presents no change. When analyzing "Metropolitan" prefectures, it can be seen in Figure 6 that just three present an increase in the five years period, and six present a decline (in the three years comparison, four prefectures increased and five decreased) . 24 out of the 30 (80%) "Local" areas analyzed show an increase in their

firms proportion of the total national joint research cases (in the three years period, 67% show an increase) .

Figure 6. Local firms joint researches' proportional change after the establishment of the local university JRC

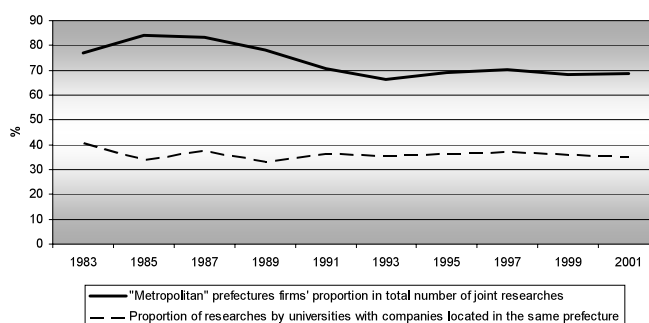
	5years		3years		5years		3years		5years		3years		5years		3years	
	0.1-25%				25%-50%				More than 50%				Total			
	M	L	M	L	M	L	M	L	M	L	M	L	M	L	M	L
Prefectures with increase	1	7	2	6	1	2	2	4	1	15	-	10	3	24	4	20
Prefectures with decrease	-0.1/-25%				-25%/-50%				More than -50%				Total			
	5	3	4	5	1	3	1	4	-	-	-	-	6	6	5	9

Note: 'M' stands for the "Metropolitan" group of prefectures. 'L' stands for the "Local" group of prefectures, as in figure 5.

Source: Author

We believe the difference in the impact of the JRC between "Metropolitan" and "Local" prefectures is the result of two factors: First, the lower impact of one particular university in big prefectures with many universities and a big industrial base. Second, there is a tendency in the period of these prefectures to lose participation in the total number of joint researches. Figure 7 shows that after peaking between 1985-1987 at around an 84% of the total joint researches, these prefectures have seen a decline in their proportion since then, a process that coincides with the beginning of the establishment of JRCs in smaller prefectures' universities.

Figure 7. Participation of Hokkaido, Tokyo, Aichi, Osaka and Fukuoka prefectures' firms in the total number of joint researches in Japan, 1983-2001



Source: Adapted from Monbukagakusho (2003)

Having seen how the results changed according to the year of establishment of the JRC for universities, we checked if a similar relation can be seen in local firms. We established three groups of "Local" prefectures according to the year of establishment of the JRC in their main university: 1987 to 1990, 1991 to 1993 and 1994 to 1997. We added the proportion of each prefecture's firms in the three and five years previous and the five years subsequent to the establishment of the JRC. Figure 8 shows that, in the five year

comparison, joint researches in prefectures with universities that established the JRC in the first period analyzed show a much larger increase (74.8%) than the other prefectures. Firms in prefectures that enter in the second period show a much smaller increase (18.8%) , smaller than the prefectures that established the JRC last (24.2% increase) . For the three years analysis, the first group sees a similar level of increase (72.1%) , but the others see a much steeper decline in their growth levels (just a 7.71% and 1.12% increase) .

Figure 8. Average change of joint researches proportion in firms by period of establishment of the local university JRC in “Local” prefectures of Fig. 5

	Before the est. of JRC		After the est. of JRC		Change (%)	
	Three years	Five years	Three years	Five years	Three years	Five years
1987-1990(n=10)	4.30	4.55	7.53	7.83	74.81	72.09
1991-1993(n=12)	8.13	8.04	9.66	8.66	18.81	7.71
1994-1997(n=8)	3.80	4.48	4.72	4.53	24.21	1.12

Source: Author

These results point at the importance of JRCs not only for the university but also for the regional firms in small and medium prefectures. JRCs acted directly on linking universities researches with local firms. In general, just one third of the joint researches in the 1983-2002 period were done between universities and firms located in its same prefecture (Figure 7) , but JRCs have helped create links between universities and firms especially in prefectures with very tiny -or non existent- tradition of industry-university collaboration.

Comparing the results on Figures 2 and 5 for “Local” prefectures, it can be seen that out of the thirty areas analyzed, twenty two show an increase for both university and firms after the establishment of the JRC; four see a decrease for both; two see an increase for universities but a decrease for firms and two see a decrease for its university and an increase for firms. Despite this positive relation between local universities' change and local firms' change in joint researches, the assortment of the results indicates that each region had its own industry-university links that helped them take full advantage -or not- of the establishment of the JRC. Other institutions may have played a role in shaping those relations and make the regions gain from their synergy.

IV. Conclusions

This paper began by outlining the literature on local innovation systems and knowledge creation from a regional perspective. In a context where the creation of knowledge is essential for building sustainable economic growth based on continuous innovation, understanding the role played by institutions is important to design policies that can bring local actors together (Boardman 2009) . In a regional system, local knowledge is possessed by the many actors that are within its geographical limits, and new knowledge can be created through the interaction of those actors.

Japanese national innovation policy has evolved in the last decades to induce a more active participation of universities. Japanese universities adopted many policies and initiatives to link their researches with the industrial world (Woolgar 2007) . Among them are the joint research centers. This paper aimed at showing if the establishment of the JRCs had any impact on the universities and local firms joint research conditions.

From the analysis previously presented, we can affirm that JRCs have played an important role in enhancing industry-university collaboration. Links don't emerge solely from the presence of actors: organizations that manage and support those links are necessary. Both actors benefit from their interaction, as they increase their knowledge through their exchanges and in successful cases they can get also economic benefits. The region also wins, as its actors can increase their level of knowledge.

JRCs did not only positively affected universities' joint research conditions, but have helped firms located in the same prefecture increase their collaboration level as well. The vast majority of the prefectures had a very small proportion of joint researches performed by their firms, and a large concentration in a few prefectures can be seen at the beginning of the period analyzed. Nevertheless, this concentration has waned since 1987, year in which local universities started opening their JRCs. These processes point at the importance of the JRCs for creating links with local firms, spilling its benefits beyond the universities' borders and affecting local firms' joint research conditions. The unchanged proportion of joint researches carried out by universities with local companies (fluctuating between 30 and 40 per cent) points at the issue that most of the joint researches are done with firms located outside the prefecture, therefore diluting the benefits that collaboration may bring to the regional productive system. Moreover, the concentration of joint researches performed with companies in big industrial prefectures maintains a center-periphery logic, with rich prefectures' firms absorbing the knowledge of medium and small prefectures' universities.

JRCs establishment was the result of a national policy, and every year since 1987 a number between three and five of this centers were built. By 2002 most of the national universities had a JRC. Universities that established it earlier show a higher increase in joint researches than universities that established it afterwards. Moreover, the same result can be seen for firms located in the same prefecture. This “early bird effect” raises the question on whether the same phenomenon can be seen in the establishment of other organizations. We believe this is an important line of future investigation. As for this research, the “early bird effect” points both at the importance of developing unique organizations at the regional level as well as to the issue that an outcome similar to the one produced in other regions cannot be expected when copying a successful organization.

Despite concentrating in the Japanese system, we believe the implications of this research could go beyond this single country. Universities and local governments elsewhere trying to enhance processes of regional knowledge creation should consider building organizations that specifically support exchanges among them. Regional knowledge arises from the interaction of regional actors, and building a *Ba* that fosters that is essential towards building a knowledge creating region.

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