Making university and industry collaboration : sources of seeds, needs and their matching process

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Background and research questions

- University and industry collaborative research is an important mechanism in exploiting science for innovation.

  -A half of the inventions involving university researchers are co-inventions between university and corporate researchers in Japan.

- In order to understand how such collaboration works and what policy might improve the process, it is important to understand the process of making such collaborations.

Matching theory perspective

- University and industry collaborative research is not a random event, rather it aims at creating new synergy through combining new scientific knowledge and its application for a specific use.
- There often exist specific seeds and needs motivating the collaboration projects.
- Thus, matching perspective is very important for studying the performance of university and industry collaborations.

A simple model

- $Output\ from\ Collaboration\ between\ i\ and\ j \quad = \alpha_{i,j} \times Quality\ of\ seeds_i \times Quality\ of\ the\ need_j$ (1)

- $\partial Output_{i,j} / \partial (Quality\ of\ seeds_i) = \alpha_{i,j} \times Quality\ of\ the\ need_j$ (2)
- A researcher with high quality seed gains more from the collaboration with a researcher with high quality need. → positive assortative matching (Becker (1973))
- Fit ($\alpha_{i,j}$) can be also important.

Research questions

- How important are the seeds and needs for initiating the collaborations?
- Does the researcher with better seed and better needs use the “efficiency” enhancing criteria (the research capability of a partner and the good fit between the partner and the research) more in selection?
- Which channels contribute to efficient matching?
- Does matching based on efficiency criteria in fact perform well?

3. Overview of the survey and the seeds and needs for the collaborations

- Survey on university and industry collaboration:

- focusing on co-inventions between university and industry, as disclosed in the Japanese patent applications from 2004 to 2007 (two matched questionnaires to a single co-invented patent)

- population of the survey: 3,483 patents, removing duplications of the patent applications from the same project

- Implemented in 2012

- 25% response rates (743 responses from university researchers and 704 responses from firms)

The definition of seeds and needs

- Seeds = “the technology which served as the base for cooperative research”
- Needs = “specific use envisaged for the output of the joint research”
- Three quarters of cooperative research projects have both specific seeds and needs for suggesting and/or implementing the projects. Neither seeds nor needs existed only for around 5% of the projects.

The definition of seeds and needs

- Seeds = “the technology which served as the base for cooperative research”
- Needs = “specific use envisaged for the output of the joint research”
- We asked the researchers to identify their existence as well as up to three most important seeds and needs.

Major survey findings

- Both seeds and needs are important (Three quarters of cooperative research projects have both specific seeds and needs for suggesting and/or implementing the projects. Neither seeds nor needs existed only for around 5% of the projects.)
- University often provide needs and industry often provide seeds.
- Both seeds and needs are predominantly domestic.

Table3-1. Incidence of the seeds and needs for university and industry joint research projects

	Reponse (%):University scientists		
	Specific needs: Yes	Specific needs: No	
Seeds: Yes	74	13	87
Seeds: No	9	4	13
	83	17	100
N=694			

	Reponse (%):Corporate researchers		
	Specific needs: Yes	Specific needs: No	
Seeds: Yes	74	12	86
Seeds: No	8	6	14
	82	18	100
N=656			

Figure 3-1. Institutions providing seeds and needs for collaborative research between industry and university (consolidated sample)

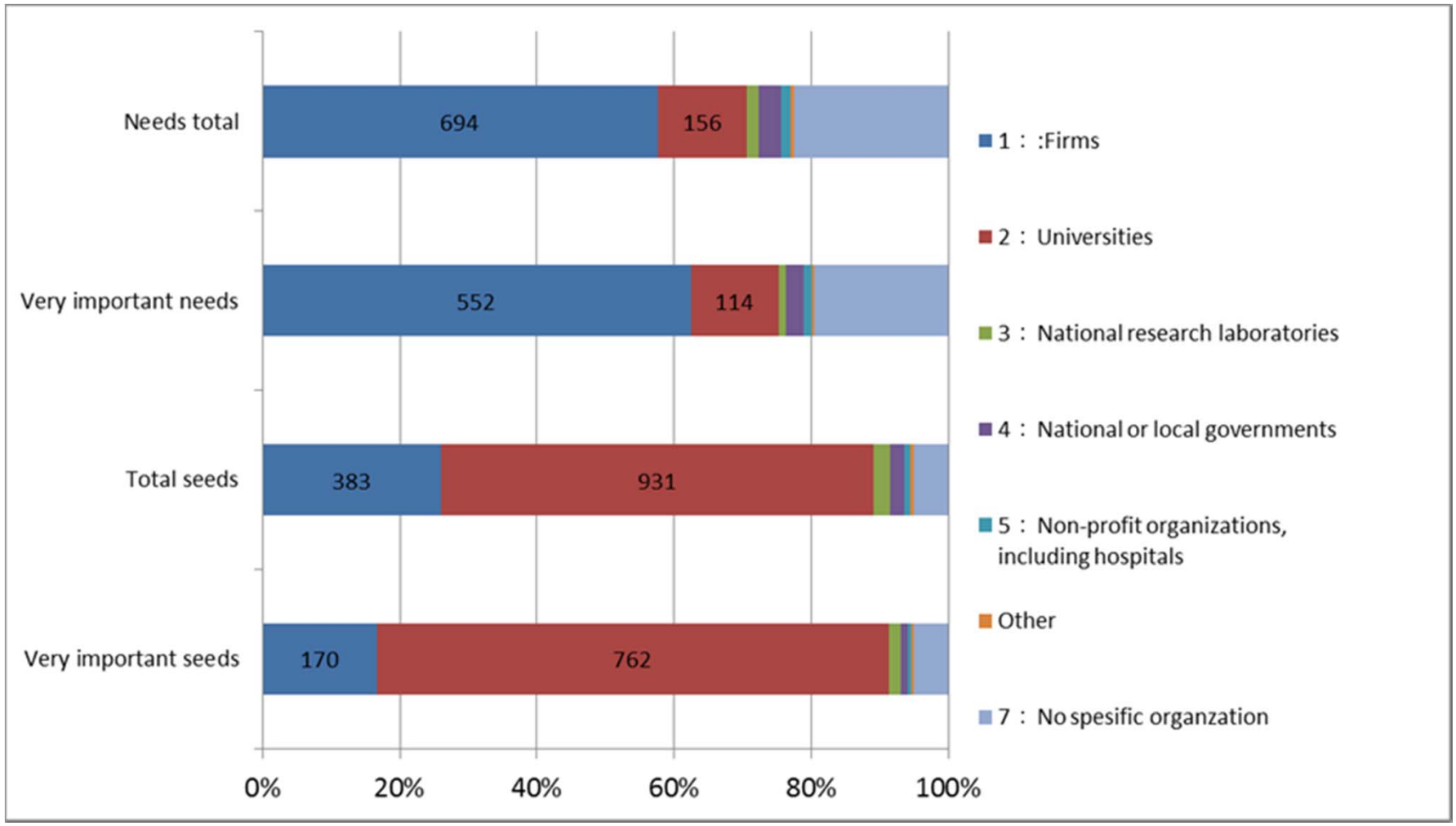
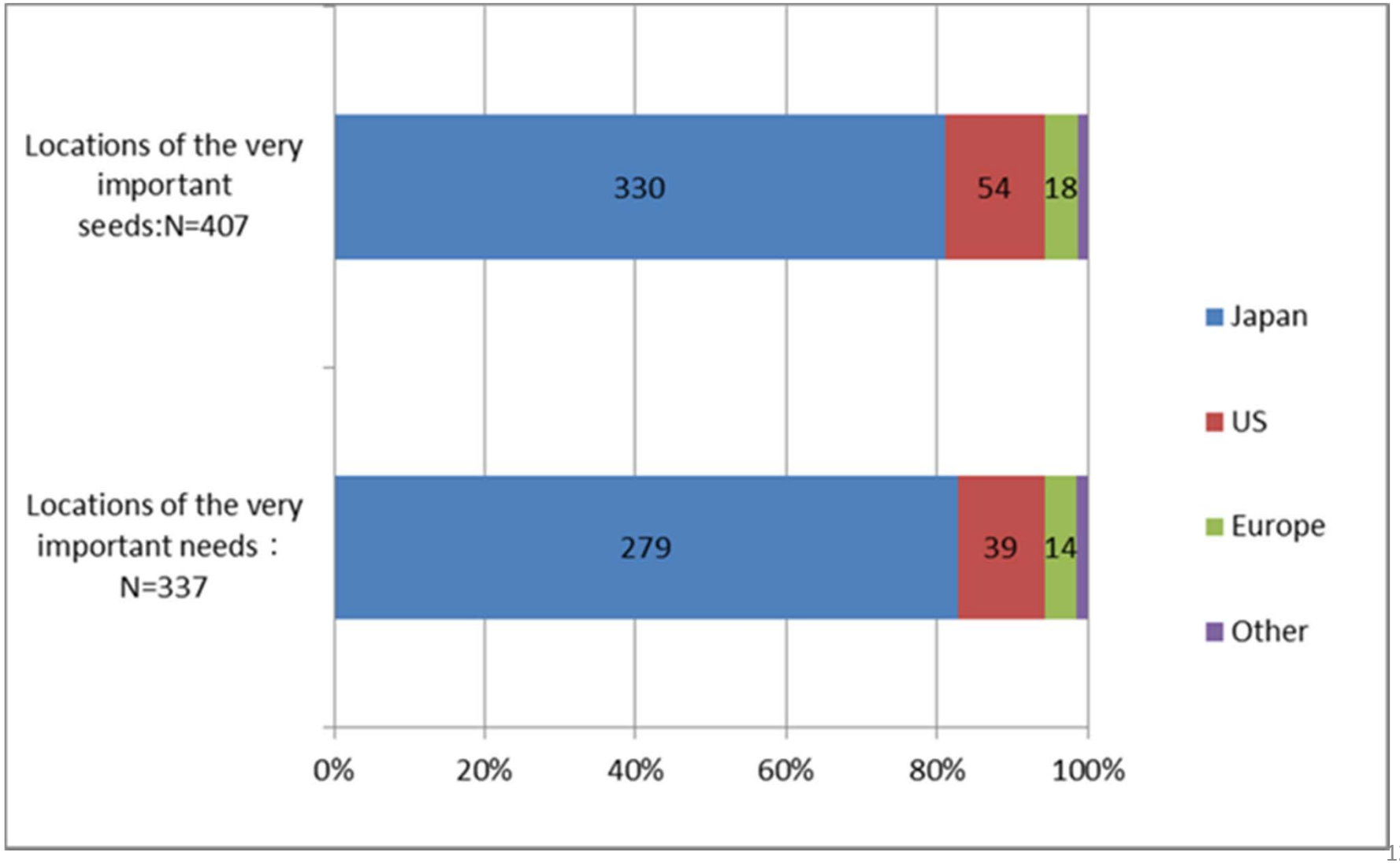


Figure 3-2. Locations of the very important seeds and needs for domestic collaborations



4.1 Matching criteria used by university and industry researchers

- The criteria for selecting the partner gives a key information on the matching process. 5 major selection criteria:

  -research capability of a partner,

  -good fit between the technology area of the partner and the research,

  -past relationship,

  -geographical proximity and

  -invitation from a partner.

Selection criteria by the quality of the seeds/needs

- The importance of the research capability of a partner, and that of a good fit increases markedly with the quality of the seed or that of the need.
- The regression results shows that

-The importance of these selection increases significantly not only with the importance of such seeds for the research but also whether they are own seeds or needs. → positive assortative matching.

- Domestic geographic proximity does not become more important with the quality of the seeds and (negative coefficient for the importance of the seeds).

Figure 3-5 Criteria for selecting the partner by university scientists: case where very important own seeds existed (N=200) vs. the own seeds existed but not very important(N=358),%

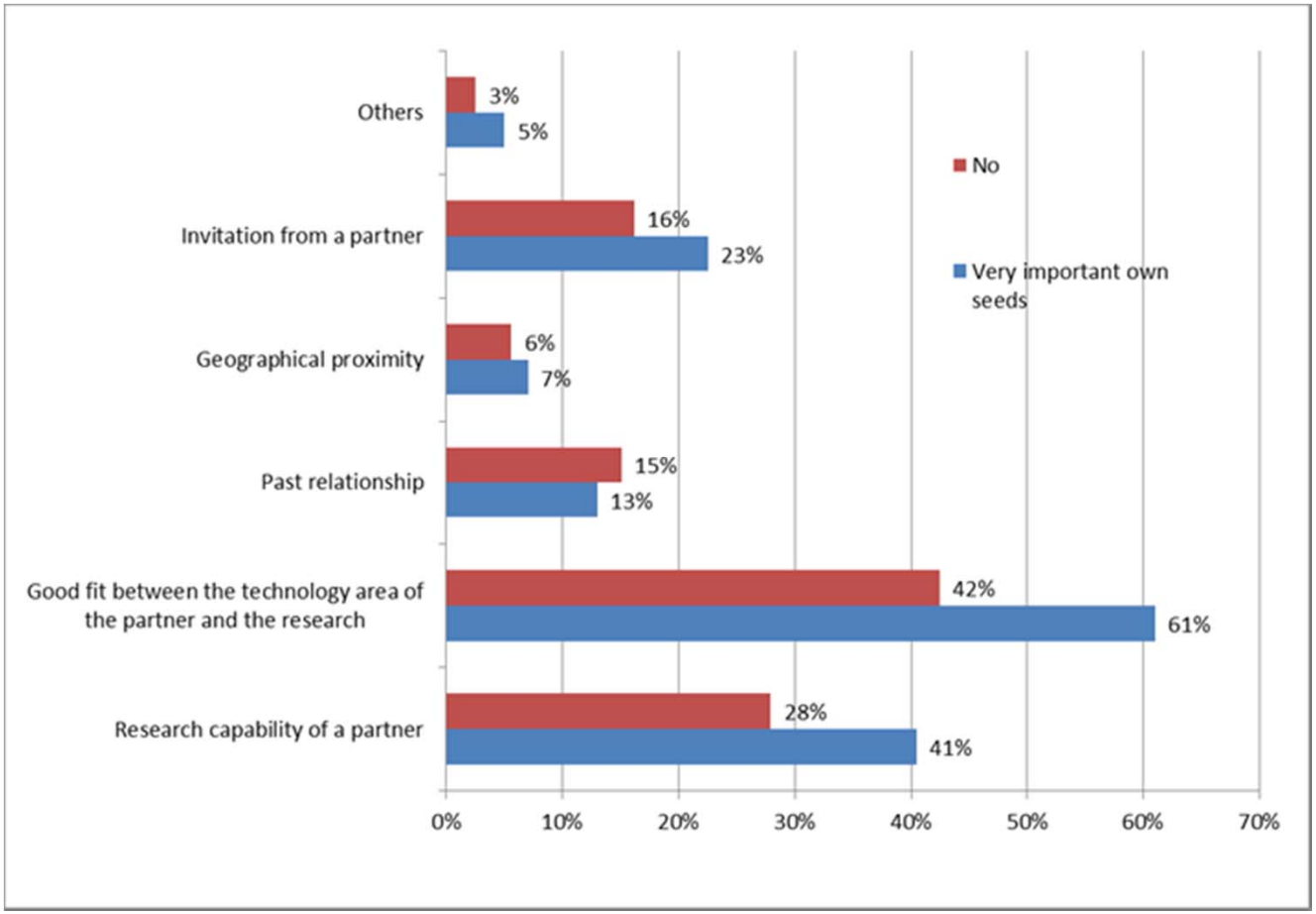
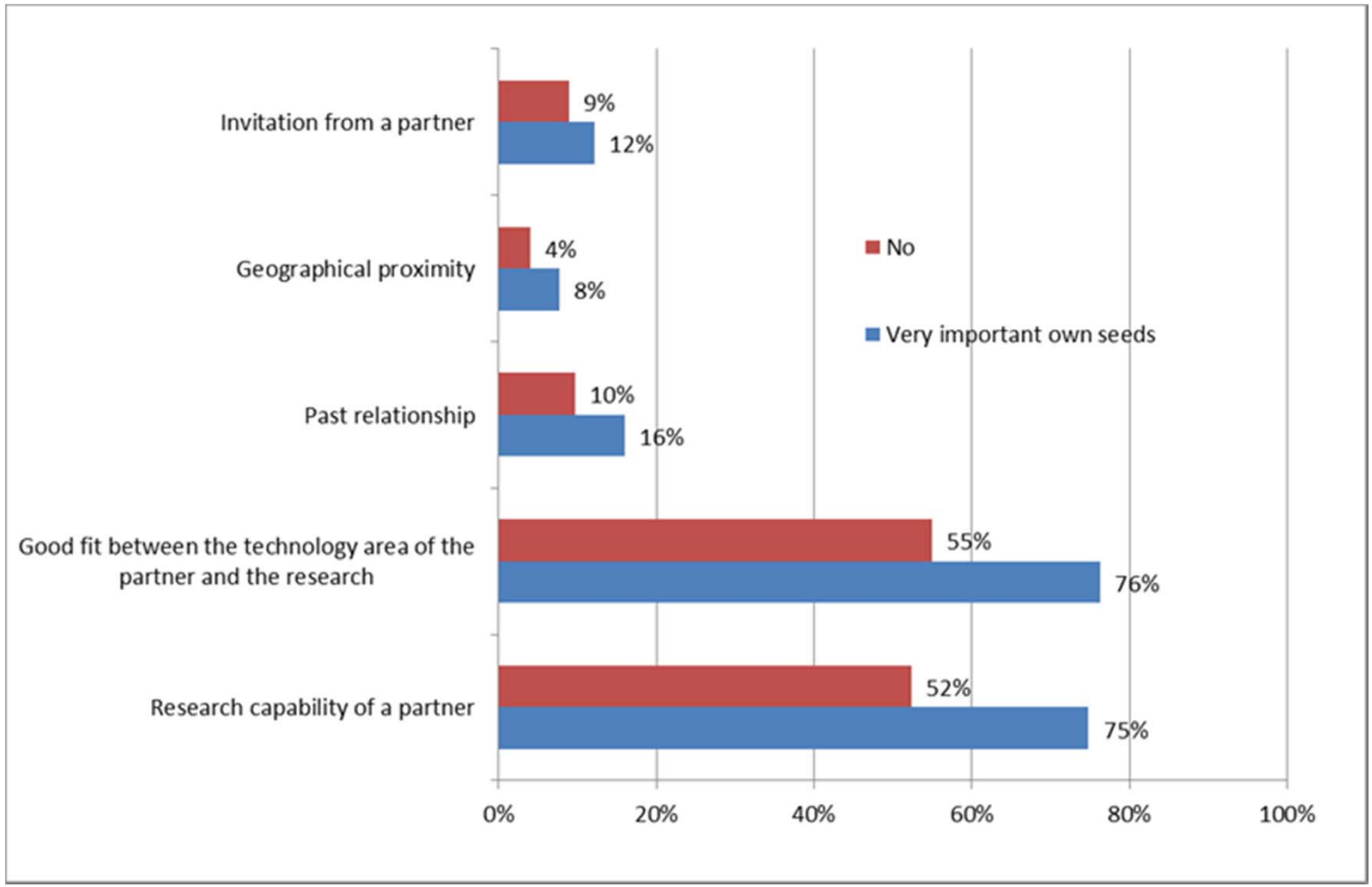


Figure 3-6 Criteria for selecting the partners by corporate researchers: cases where very important needs (N=254) vs. cases where own needs exited but not very important (N=159) ,%



The regression model

- Independent variables:

- seeds_r (needs_r) measures the importance of the seed (needs) as knowledge source for suggesting and implementing the collaborative research

- seeds_own (needs_own) measures whether the university researcher has its own research output as a seed (whether the firm has its own important needs for the project)

- seeds_patent and seeds_paper indicates the existence of the patent or the scientific paper embodying the own seed

- *Control variables:*

- the scope of the joint research (basic, applied, development,other)

- 8 technology area dummies

- *Ordered logit model*
- *Sample size around 600 for bot university and corporate researchers*

Table 4-1 Criteria selecting the partners by university researchers

	(1)	(2)	(3)	(4)	(5)	(6)
	res_cap		*good_fit*		*geography*	
seeds_own	0.543***		0.314*		0.171	
	(0.182)		(0.189)		(0.181)	
seeds_r	0.139***	0.119**	0.133***	0.130**	-0.0680	-0.0744
	(0.0465)	(0.0545)	(0.0489)	(0.0571)	(0.0433)	(0.0521)
seeds_patent		0.312*		0.303*		-0.0387
		(0.173)		(0.179)		(0.166)
seeds_paper		0.201		-0.0914		-0.478*
		(0.271)		(0.292)		(0.250)
needs_r	-0.0620	-0.0441	0.0190	-0.00891	-0.0106	-0.00543
	(0.0450)	(0.0503)	(0.0464)	(0.0526)	(0.0411)	(0.0471)
basic	0.207	0.0505	0.0129	-0.103	-0.255	-0.244
	(0.165)	(0.185)	(0.168)	(0.190)	(0.161)	(0.183)
applied	0.0327	-0.0636	0.178	0.341	0.318*	0.304
	(0.199)	(0.250)	(0.211)	(0.249)	(0.181)	(0.214)
development	0.316**	0.185	0.293*	0.281	0.101	0.0621
	(0.161)	(0.183)	(0.168)	(0.191)	(0.150)	(0.172)
other	1.272**	1.434**	-0.214	-0.0102	-1.252*	-0.753
	(0.623)	(0.639)	(0.660)	(0.729)	(0.659)	(0.534)
Observations	664	523	670	529	660	520
pseudo-R-squared	0.0257	0.0180	0.0264	0.0251	0.0134	0.0133
log likelihood	-750.9	-584.4	-607.5	-469.0	-947.6	-745.9
chi-squared	42.20	23.85	29.80	19.51	24.22	21.27
Robust standard errors in parentheses. The coefficient of technology class dummies not s						
*** p<0.01, ** p<0.05, * p<0.1						

Table 4-2 Criteria selecting the partners by corporate researchers

	(1)	(2)	(3)
	res_cap	*good_fit*	*geography*
needs_kown	−0.0298	0.0267	−0.285
	(0.282)	(0.284)	(0.258)
needs_r	0.132*	0.137**	0.0174
	(0.0688)	(0.0693)	(0.0597)
seeds_r	0.0650	0.0615	0.00967
	(0.0474)	(0.0460)	(0.0407)
basic	0.364**	0.231	−0.116
	(0.180)	(0.178)	(0.168)
applied	−0.482**	−0.163	−0.0541
	(0.203)	(0.200)	(0.180)
development	0.0474	−0.103	−0.0175
	(0.182)	(0.182)	(0.168)
other	−0.332	−0.464	−0.815
	(0.550)	(0.666)	(0.551)
Observations	631	637	620
pseudo-R-square	0.0283	0.0317	0.00559
log likelihood	−545.5	−500.3	−917.3
chi-squared	32.62	35.34	11.70
Robust standard errors in parentheses			
*** p<0.01, ** p<0.05, * p<0.1			

4.2 Search channels and selection criteria

- Four important channels:

-own search (that is, a search by a researcher),

- search by a collaboration partner,

-a specialist organization such as industry and university collaboration unit, and

-academic conferences

- Which channels contributed importantly to efficient matching?

Figure 3-3 Important matching channels as seen from university scientists(Own seeds existed (N=550) vs. No own existed （N=145),%)

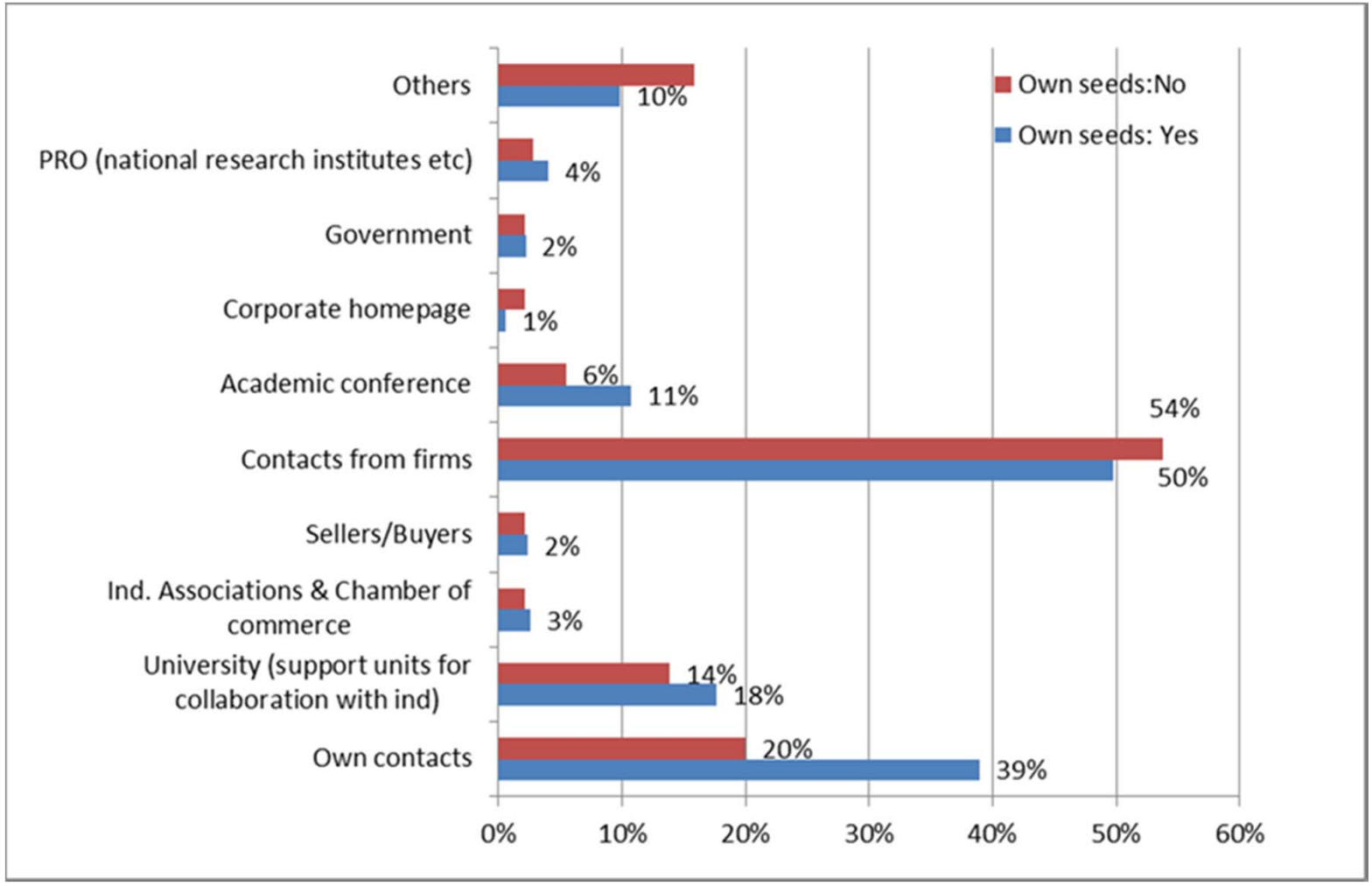
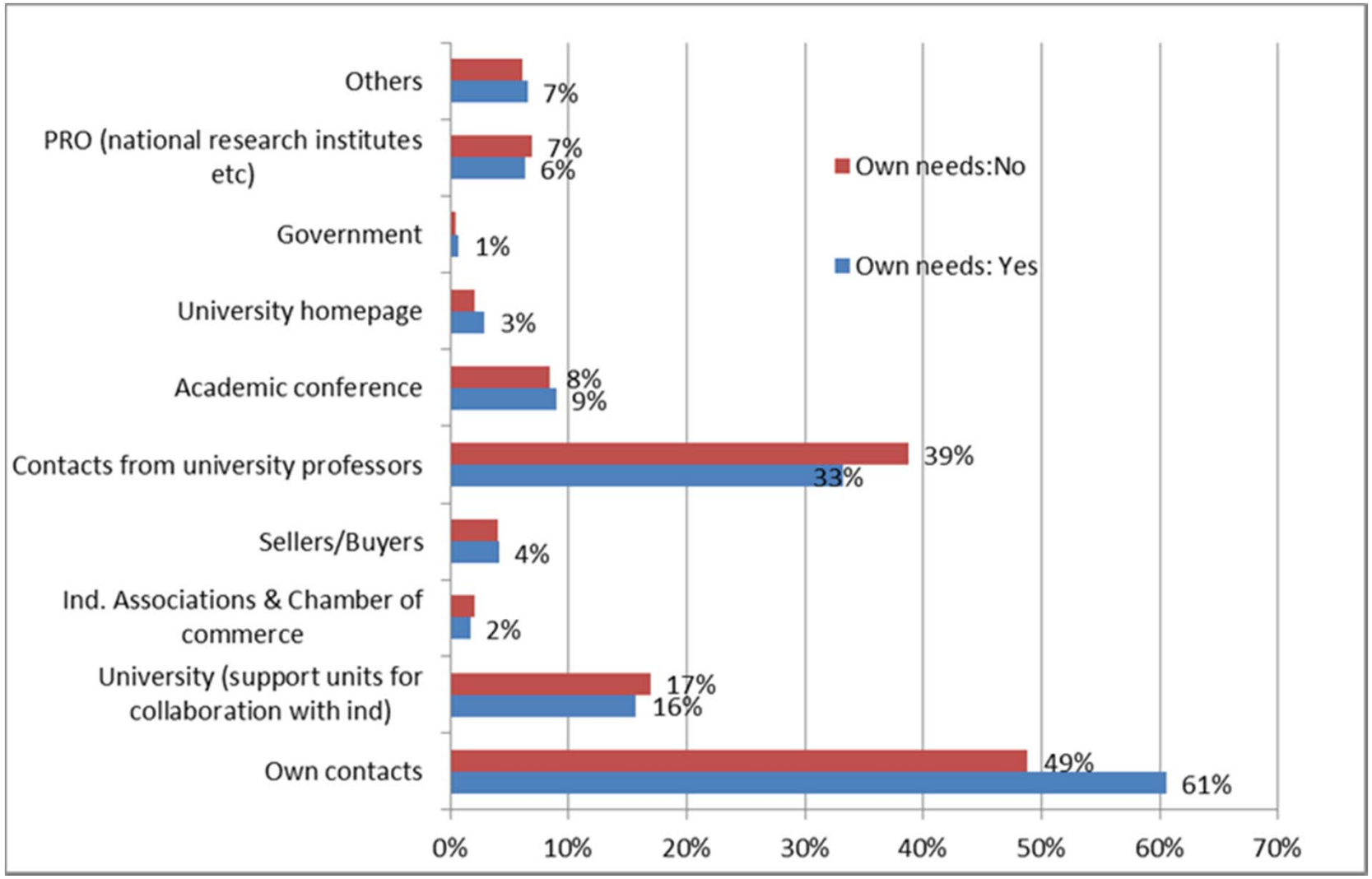


Figure 3-4 Important matching channels as seen from corporate researchers (Own needs existed (N=413) vs. No own existed （N=248),%)



Use of three matching criteria by each search channel

- The contribution of a search channel is revealed in the matching criteria used for the projects from such channel.
- We add the importance of the four channels in selection as independent dummy variables.
- Findings:

-Own contact results in significantly more use of the research capability of a partner and a good fit, followed by academic conference.

-Support units for collaboration with industry in a University emphasize the geographical proximity most

- Contract from a partner is not significant in accounting for the 3 matching criteria.

Table 4-3 Contributions of the four channels of finding the partners (university researchers)

	(1)	(2)	(3)
	res_cap	*good_fit*	*geography*
seeds_own	0.348*	0.138	0.0505
	(0.183)	(0.196)	(0.183)
seeds_r	0.160***	0.149***	-0.0545
	(0.0471)	(0.0499)	(0.0443)
needs_r	-0.0660	0.0163	-0.0203
	(0.0459)	(0.0474)	(0.0421)
own_contact	1.013***	0.730***	0.395**
	(0.182)	(0.182)	(0.167)
ind_univ_collbo_unit	0.0586	0.0361	0.759***
	(0.205)	(0.216)	(0.210)
contact_partner	0.154	0.273	-0.0116
	(0.173)	(0.178)	(0.165)
academic_confer	0.526**	0.657**	-0.149
	(0.258)	(0.271)	(0.245)
basic	0.175	-0.00793	-0.287*
	(0.167)	(0.174)	(0.163)
applied	0.0130	0.184	0.329*
	(0.198)	(0.210)	(0.181)
development	0.317*	0.311*	0.0478
	(0.163)	(0.172)	(0.153)
other	1.223**	-0.286	-1.370*
	(0.515)	(0.621)	(0.704)
Observations	661	666	657
pseudo-R-squared	0.0516	0.0435	0.0248
log likelihood	-728.4	-593.8	-930.7
chi-squared	82.33	46.09	42.89
Robust standard errors in parentheses			
*** p<0.01, ** p<0.05, * p<0.1			

4.3 Matching criteria and the performance of the project

- Hypothesis

-If efficient matching for each project is important for project performance, the project matched based on such criteria as the good fit and the capability of the partner performs well.

-On the other hand, under such conditions, the collaboration for which geographical proximity and past collaborations are important does not perform well.

Two performance measures

- Dependent variables:

-*performance_d1 for a university (performance_k1 for a firm*): how significant is the outcome from the project in commercialization of the scientific discovery or technological insights.

- *synergy*: the multiplication of the importance of the seed and that of the need for the suggestion and implementation of the project

Results

- The collaborative research projects matched based on the research capability of a partner and the good fit between the technology scope of the partner and the research performs well
- Those matched based on geographic proximity do not contribute to performance.

Table 4-5 Matching criteria and performance

	University		Firm	
	performance_d1	*synergy*	*performance_k2*	*synergy*
res_cap	0.245*	0.00783	0.519***	0.359***
	(0.134)	(0.1000)	(0.172)	(0.138)
good_fit	0.331**	0.437***	0.221	0.307*
	(0.148)	(0.120)	(0.185)	(0.161)
past_collaborator	0.0578	−0.0401	0.279***	−0.0919
	(0.0925)	(0.0720)	(0.0824)	(0.0734)
geography	0.0996	−0.130*	−0.0802	−0.00741
	(0.0831)	(0.0725)	(0.0752)	(0.0718)
basic	0.243	0.0639	0.0720	0.153
	(0.171)	(0.155)	(0.173)	(0.173)
applied	0.590***	0.457**	0.0844	0.270
	(0.187)	(0.202)	(0.183)	(0.175)
development	0.171	0.279*	0.299*	0.151
	(0.166)	(0.155)	(0.177)	(0.169)
other	0.614	−1.430	−0.420	1.227***
	(0.861)	(1.095)	(0.703)	(0.438)
Observations	613	659	604	612
pseudo-R-squared	0.0357	0.0213	0.0374	0.0194
log likelihood	−717.1	−1020	−715.3	−939.7
chi-squared	48.22	40.02	54.86	30.08
Robust standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

5 Conclusions

- Major findings

(1)A large majority of the collaborative projects have both specific technology seeds and the needs for technical solution, so that efficient matching is important.

(2) A university researcher participates in the collaboration project frequently as a user who needs technical solutions.

(3) The project with good seeds or needs tends to use efficiency enhancing matching criteria (a research capability and a good fit) more, which generates positive assortative matching.

(4)The matching by a university professor himself and at academic meeting uses efficiency enhancing matching criteria, while a university based support unit emphasize local proximity more as a matching criterion.

(5) The collaborative research projects matched based on efficiency enhancing matching criteria performs well. Those matched based on geographic proximity do not contribute to performance.

Policy implications

- First, we need to encourage efficient matching by university and industry researchers.

  - avoid adopting strong regional criteria for university and industry collaborations

- Second, a significant part of university and industry collaboration takes place as university as a lead user, while a government policy tends to focus a “linear model” of transferring university technology to industry.

  - The university procurement policy could be engaged for encouraging technology development based on such collaboration.

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