

## IDENTIFYING THE STRUCTURE OF RESEARCH FIELDS ON VENTURE

TATSUYA KURODA  
The University of Tokyo  
tmi@kuro.org (Corresponding)

ICHIRO SAKATA  
The University of Tokyo  
isakata@ipr-ctr.t.u-tokyo.ac.jp

### ABSTRACT

"Venture businesses," "start-ups," or and "entrepreneurs" bring many social and economic benefits. They promote innovation, boost the national economy, and create employment. Universities and research institutes are expected to foster human resources such as entrepreneurs to create the seeds of venture businesses. They also play an important role in the venture ecosystem by industry-government-academia cooperation.

However, due to the rapidly increasing numbers of academic research papers on venture businesses, and the lack of a research overview, it is difficult to understand the whole structure of this field.

This research overviews the studies on venture companies, reveals the emerging fields, and indicates the current state of venture research in Japan.

We extracted academic papers including the words "venture," "start-up," or "entrepreneur" in the titles and abstracts from the Web of Science provided by Thomson Reuter's with data from 1900 to 2014. Then we conducted citation analysis for these papers using network analysis.

With these search queries we extracted 67,130 papers. In addition, we specified five main clusters and fifteen sub-clusters (including 17,480 papers). From the result of analysis by country, we figured out that the share of Japanese papers was only about 1% in the data set. Also, through the time-series analysis, we identified young and growing research topics containing the keywords "internationalization," "born global," "institutional entrepreneur," and "political corruption" in particular. In these fields, Japanese papers have a slight 0.2% share.

Japan should invest human resources, goods, money, and information into the topics that are growing in this research field. We believe excellent researches will make policies more effective, increase the benefits through business, and contribute to the development of the Japanese and global economies.

**Keywords:** Citation Network Analysis, Academic Landscape, Venture, Start-up, Entrepreneur

## INTRODUCTION

“Venture businesses,” “start-ups” and “entrepreneurs” bring a variety of benefits to society such as economic growth and the creation of employment (Wennekers and Thurik, 1999).

Accordingly, universities and research institutes are expected to develop human resources to become entrepreneurs, create seeds that will become the core of venture businesses, and play a central role in the venture ecosystem realized by industry, government, and academic collaborations.

Research on venture businesses is an interdisciplinary area that spans a wide range of fields and, as interest in this area grows and research progresses, the topics are becoming further subdivided (Gregoire et al., 2006).

The number of papers related to this field has rapidly increased since the 1990s and, as will be described later, more than 1,500 papers have been published every year over the past few years. As it is becoming more difficult to gain a broad understanding of the research field of these papers, an academic overview and systemization are becoming increasingly necessary (Landstrom et al., 2012).

To meet this need, tools to extract important papers and fields that are rapidly attracting attention out of the increasing amount of information on papers are under development. In particular, a method originally established by Garfield (1955) that focuses on the relationship of citations of papers was developed by those such as Börner et al. (2003) and has become widely used as a method for devising an overview of the entirety of research and for clustering information into different fields.

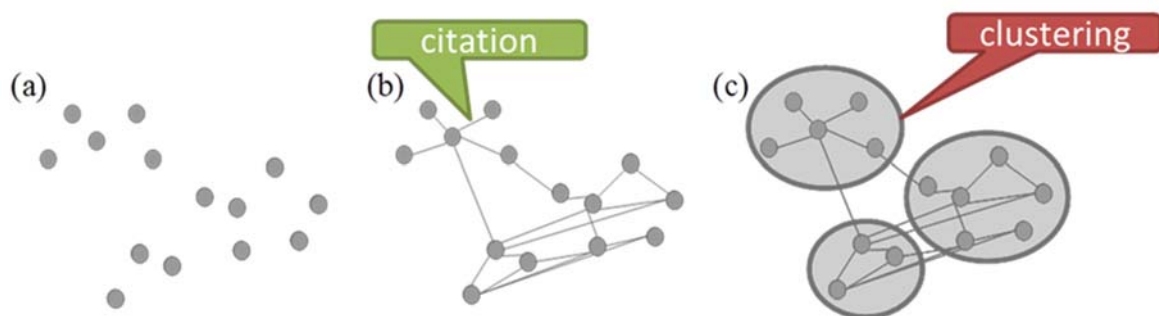
This paper applies the said method to an aggregation of papers widely extracting papers related to venture businesses and discovering appropriate topics for each cluster through the process of clustering. In addition, further attempts are being made to discover rapidly increasing fields of publications in recent years through time series analysis while also discovering the characteristics of each field by performing analysis based on the country of publication. In regard to Japan, which aims to “accelerate ventures and the metabolism of industries” (June 2014 “Japan Revitalization Strategy – Revised Edition of 2014”) as one of the key policies in the “growth strategy” (which is the third arrow of “Abenomics”) and raise the current entry and exit rate of approximately 4.5% to approximately 10%, which is similar to that of Western countries, this paper presents issues of the current state of research in this field and indicates how they relate to the entirety of the said research.

## METHODOLOGY

The Web of Science (containing papers from 1900-2014 written in English), a database of papers compiled by Thomson Reuter, was searched for papers that contain any of the three words “venture,” “start-up,” and “entrepreneur” or a derivative form of these in the title, keywords, or abstract.

Next, in relation to the data of these, with each of the individual papers as nodes and the direct citation relationships as links, a network was constructed to acquire the maximum connected component. Furthermore, upon clustering these using the N-clustered n-method (Newman, 2004), several clusters were extracted. From this point on, focus was placed on main clusters that include more than 300 papers and the keywords that frequently appear in the papers included in each of the clusters were checked and further visualized to prepare an overview of the relative positional relationships between the clusters.

The algorithm employed for the visualization was the “large graph layout” (Adai et al., 2004), which is a drawing method based on the spring model. That is, an attraction is assumed between papers (nodes) that have a relationship of mutual citations (links) and a repulsion is assumed otherwise, and then the positions of stable nodes are calculated and drawn on a coordinate plane. In other words, groups of papers with a strong citation relationship are placed close together in terms of distance while groups of papers without a citation relationship are placed further apart for a program that forms clusters based on groups of papers with a strong relationship on the coordinate plane (Fig. 1).



*Fig. 1 Steps of Citation Network Analysis*

Furthermore, by displaying nodes and links belonging to the same cluster using the same colour and separating the colours used between different clusters, the relative positional relationships of cluster groups have been visualized in a manner that is easier to understand.

## RESULTS

As a result, 67,130 papers that contain any of the three words “venture,” “start-up,” and “entrepreneur” or a derivative form of these in the title, keywords, or abstract were extracted from the Web of Science (Table 1).

*Table 1: Number of papers extracted from the database of the Web of Science core collection*

search words (* wild letter)	the number of extracted papers	
<b>ventur*</b>	<b>21,614</b>	⇒
venture	16,892	
<b>entre*</b>	<b>33,799</b>	⇒
entrepreneur	10,444	
entrepreneurship	9,683	
entrepreneurial	7,916	
<b>startup*</b>	<b>4,623</b>	⇒
startup	4,623	
<b>start-up*</b>	<b>11,802</b>	⇒
start-up	10,684	

"ventur\*" or  
"entre\*" or  
"startup\*" or  
"start-up\*"

**67,130**

Next, in relation to the individual papers as nodes and the direct citation relationships as links, a network was constructed to acquire a maximum connected component of 21,778 papers. Furthermore, 165 clusters were extracted from this component by using the N-clustered n-method. From this point on, focus was placed on seven clusters that include more than 300 papers (Table 2) and the keywords that frequently appear in the papers included in each of the clusters were checked and further visualized to prepare an overview of the relative positional relationships between the clusters (Fig. 2).

Table 2: Cluster structure 1

Cluster No.	key words	# of papers	Average Year
C1	entrepreneurship/firm/venture capital	7,129	2006.9
C2	alliance/ Joint Venture	4,724	2006.4
C3	corporate/ performance/ institutional	3,827	2006.9
C4	immigrant/city/ethnic/ urban	1,483	2005.6
<b>C5</b>	apple scab/ venturia inaequalis	1,117	1996.6
<b>C6</b>	startup shear flow	435	2005.2
C7	china/political/corruption	317	2006.0
<b>Maximum Component</b>		<b>21,778</b>	<b>2005.7</b>
<b>Total (C1-7)</b>		<b>19,032</b>	<b>2006.8</b>
<b>Total(C1-4&amp;7)</b>		<b>17,480</b>	<b>2006.6</b>

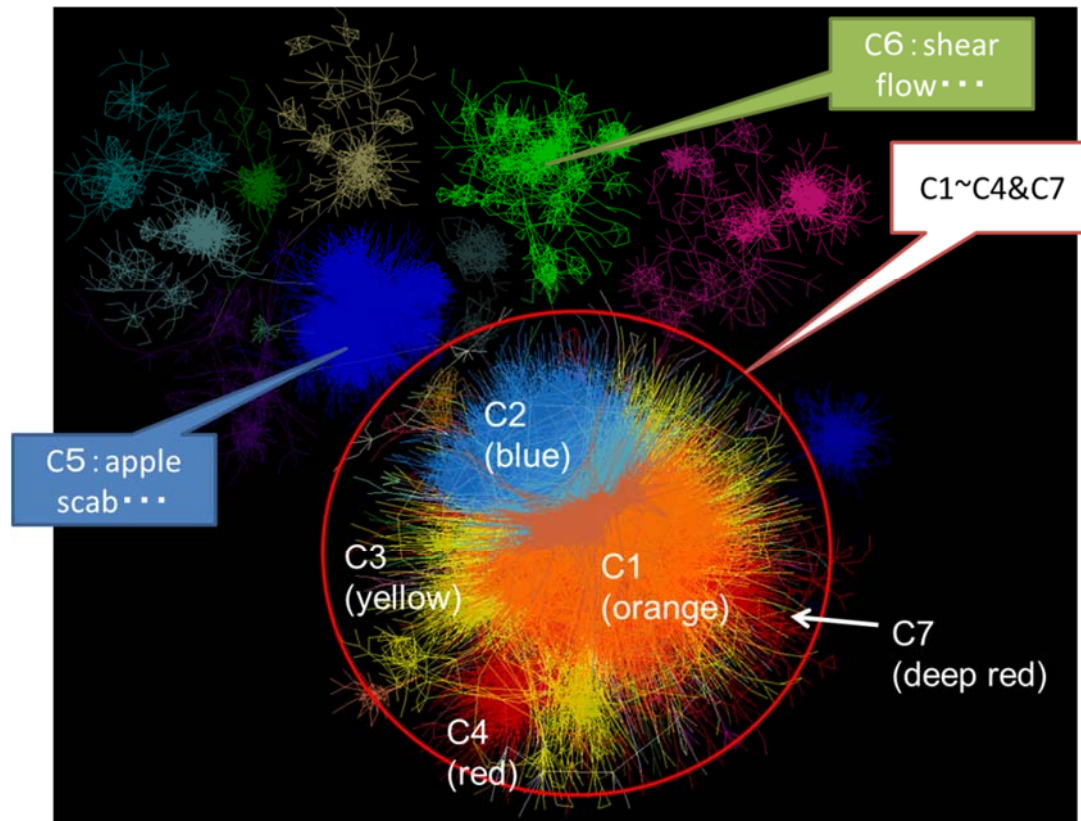


Fig.2 the largest connected component (21,778papers); ex. "C1" means "Cluster 1"

## FINDINGS

First, in relation to the 67,130 papers extracted from the Web of Science, the manner of classification based on pre-established academic fields was studied (Table 3). While the table shows 33 fields with a share of 1% or more, and although it can be understood that venture-business-related research is interdisciplinary across many academic fields, it is difficult to see the relationships for every field and interdisciplinary research from these results.

Meanwhile, Table 2 was prepared upon extracting the maximum connected components of 21,778 papers based on citation relationships and further narrowing these down to seven cluster lists of 19,032 papers, which account for 87.4% of the maximum connected components of 21,778 papers.

In addition, the fifth cluster when listed in order of those with a greater number of nodes (C5: number of nodes = 1117) has been excluded due to being further away from the cluster groups C1 through C4 and having the keywords "apple scab" and "venturia inaequalis" (a type of disease caused by pests resulting in scratches on apples) and the sixth cluster (C5: number of nodes = 435) was also excluded due to having the keywords "startup shear flow" ("initial shear flow" being a term related to hydrodynamics). Consequently, clusters C1 through C4 and C7 were further examined as "basic subject clusters" (17,481 papers, Table 2). It should be noted that as the papers belonging to these "basic subject clusters" (17,480 papers) account for 80.3% of the entirety of the maximum connected components (21,778 papers), this can be considered sufficient for preparing an overview of the academic fields of research in regard to so-called venture businesses.

Table 3: Academic fields of "Web of Science"

rank	field	# of papers	share
1	BUSINESS ECONOMICS	19227	28.56%
2	ENGINEERING	10786	16.02%
3	ENVIRONMENTAL SCIENCES ECOLOGY	3608	5.36%
4	CHEMISTRY	2766	4.11%
5	PUBLIC ADMINISTRATION	2747	4.08%
6	SCIENCE TECHNOLOGY OTHER TOPICS	2661	3.95%
7	SOCIAL SCIENCES OTHER TOPICS	2298	3.41%
8	GOVERNMENT LAW	2257	3.35%
9	ENERGY FUELS	2133	3.17%
10	HISTORY	2043	3.03%
11	PHYSICS	1709	2.54%
12	AGRICULTURE	1640	2.44%
13	PSYCHOLOGY	1635	2.43%
14	COMPUTER SCIENCE	1515	2.25%
15	GEOGRAPHY	1480	2.20%
16	BIOTECHNOLOGY APPLIED MICROBIOLOGY	1436	2.13%
17	SOCIOLOGY	1432	2.13%
18	MATERIALS SCIENCE	1317	1.96%
19	NUCLEAR SCIENCE TECHNOLOGY	1271	1.89%
20	BIOCHEMISTRY MOLECULAR BIOLOGY	1241	1.84%
21	OPERATIONS RESEARCH MANAGEMENT SCIENCE	1158	1.72%
22	EDUCATION EDUCATIONAL RESEARCH	1019	1.51%
23	WATER RESOURCES	1002	1.49%
24	PLANT SCIENCES	974	1.45%
25	GENERAL INTERNAL MEDICINE	957	1.42%
26	LITERATURE	919	1.37%
27	AREA STUDIES	916	1.36%
28	MECHANICS	872	1.30%
29	URBAN STUDIES	822	1.22%
30	INFORMATION SCIENCE LIBRARY SCIENCE	790	1.17%
31	GEOLOGY	764	1.14%
32	PUBLIC ENVIRONMENTAL OCCUPATIONAL HEALTH	727	1.08%
33	INTERNATIONAL RELATIONS	721	1.07%

Furthermore, of these five clusters, in regard to the three higher-ranking sub-clusters, each of these was visualized with an overview diagram and topics common to the papers included were presumed from highly frequently appearing keywords (Table 4). These will be examined in order from C1, which is the largest cluster.

Table 4: Cluster structure 2 (underline: average year later than 2008)

Cluster	Sub-Cluster	Topic of the cluster	key words	# of papers	average Year
C1		ENTREPRENEURSHIP IN FIRM	entrepreneurship/firm/venture capital	7,129	2006.9
	C1-1	ENTREPRENEURSHIP AND PERFORMANCE	entrepreneurship/firm/performance	3,002	2006.5
	C1-2	ENTREPRENEURSHIP AND EMPLOYMENT	employment/entrepreneurship / self/growth	1,907	2007.7
	C1-3	VENTURE CAPITAL	venture capital/ ipo	1,415	2006.3
C2		JOINT VENTURE	alliance/ Joint Venture	4,724	2006.4
	C2-1	ALLIANCE ON JOINT VENTURE	alliance/ Joint Venture/partner	2,012	2006.2
	C2-2	SUBSIDIARY OF JOINT VENTURE	subsidiary/Joint Venture /foreign/entry	1,337	2005.8
	C2-3	<u>INTERNATIONALIZATION</u>	internationalization/export/ born global	934	<u>2008.1</u>
C3		CORPORATE PERFORMANCE	corporate/performance/ institutional	3,827	2006.9
	C3-1	ENTREPRENEURSHIP ORIENTATION	entrepreneurship orientation/family/corporate	1,014	2006.7
	C3-2	SOCIAL ENTREPRENEURSHIP	social entrepreneurship/ social/ policy	965	2007.5
	C3-2	<u>INSTITUTIONAL ENTREPRENEURSHIP</u>	Institutional entrepreneurship /institutional work	571	<u>2008.9</u>
C4		IMMIGRANT VENTURE BUSINESS	immigrant/city/ethnic/ urban	1,483	2005.6
	C4-1	VENTURE BUSINESS IN CITY	city/urban/governance	384	2007.2
	C4-2	ETHNIC VENTURE BUSINESS	immigrant/ethnic/minority	348	2004.6
	C4-3	BIOTECHNOLOGY	biotechnology/cluster/innovation	176	2006.5
C7		POLITICAL CORRUPTION	china/political/corruption	317	2006.0
	C7-1	PROPERTY RIGHT IN CHINA	china/political/property right	53	2007.8
	C7-2	<u>POLITICAL CORRUPTION</u>	enforcement/corruption/tax	38	<u>2009.4</u>
	C7-3	PRIVATE ENTREPRENEUR IN CHINA	china/capitalism/private entrepreneur	26	2007.1
C1-C4&7				17,480	2006.6

### **C1: Entrepreneurship and Organizations/People**

The papers belonging to this cluster cover, for example, the influence that entrepreneurship has on performance in a corporate organization (C1-1), the relationship between entrepreneurship and employment (C1-2), and venture capital in general (C1-3). As an approximation, there are a greater number of papers related to the relation between entrepreneurship and a firm's performance, how to make use of entrepreneur human resources and risk money in the involvement with companies and organizations.

### **C2: Joint Venture**

Unlike C1, this cluster includes a greater number of papers in regard to joint ventures and alliances with external environments. Some of the topics covered are horizontal alliances (C2-1), joint ventures through vertical subsidization (C2-2), and, furthermore, strengthening of exports and overseas expansion utilizing such schemes (C2-3). In particular, it is worth noting that, in the papers in (C2-3) inclusive of BORN GLOBAL, there is a greater number of comparatively recent papers as can be seen from the average year of publication being January 2008.

### **C3: Corporate Performance and Entrepreneurship**

Unlike C1, there are many papers that interpret entrepreneurship from the perspectives of corporations and societies. Some of the topics covered are how to develop entrepreneurship in an organization (C3-1), social entrepreneurs (C2-2), and institutional approaches in regard to entrepreneurs (C3-3). Again, with (C3-3), there are more comparatively recent papers as can be seen from the average year of publication being September 2008.

### **C4: Venture Creation and Starting of Businesses by Minorities in Regions**

With some of the topics covered being environmental conditions in which venture businesses grow mainly in urban regions and policies, etc. of the city government (C4-1), immigrant and minorities creating new businesses from different cultural backgrounds (C4-2), and venture accumulation of biotechnology (C4-3), this cluster includes a greater number of papers in regard to the concept that the way in which local regions and cultures exist has a strong relationship to the starting of businesses (embeddedness approaches, Granovetter, 1985).

### **C7: Political Corruption (China, Russia, etc.)**

Some of the topics covered are problems involving private property rights in China (C7-1), corruption and tightening of regulations (C7-2), and entrepreneurs in China (C7-3). In particular, with (C7-2), there are more extremely new papers as can be seen from the average year of publication being April 2009.



Now, as a whole, papers on venture business began to increase around 1980. Over 1,500 papers have been published every year in the 21st century (Fig. 3).

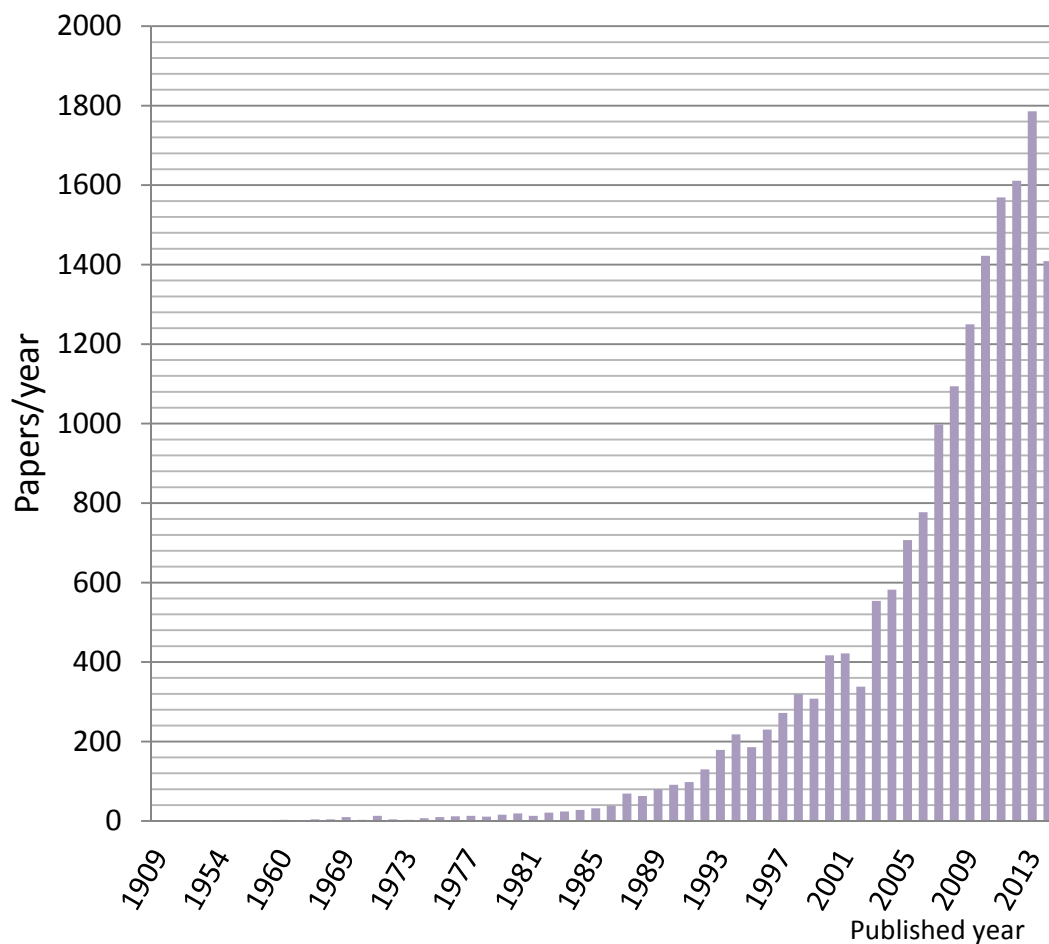


Fig. 3 Papers on venture business have increased steeply. :Total number of papers (n=17,480)

As described in the above, when looking at the average year of publication of the papers included in each of the clusters, three of the clusters have an average of 2008 or later, and from this it can be understood that these clusters are formed of comparatively new papers. These were then graphed in a chronological manner, and upon calculating the shares within the clusters in the last five years (2010-2014), with each in recent years, the increase in the number of corresponding papers was significant. And while it was understood that the shares of papers in these past five years was 5-15% higher in comparison to the entirety of the “basic subject clusters,” it was also understood that research in the area of this topic was particularly active (Fig. 4).

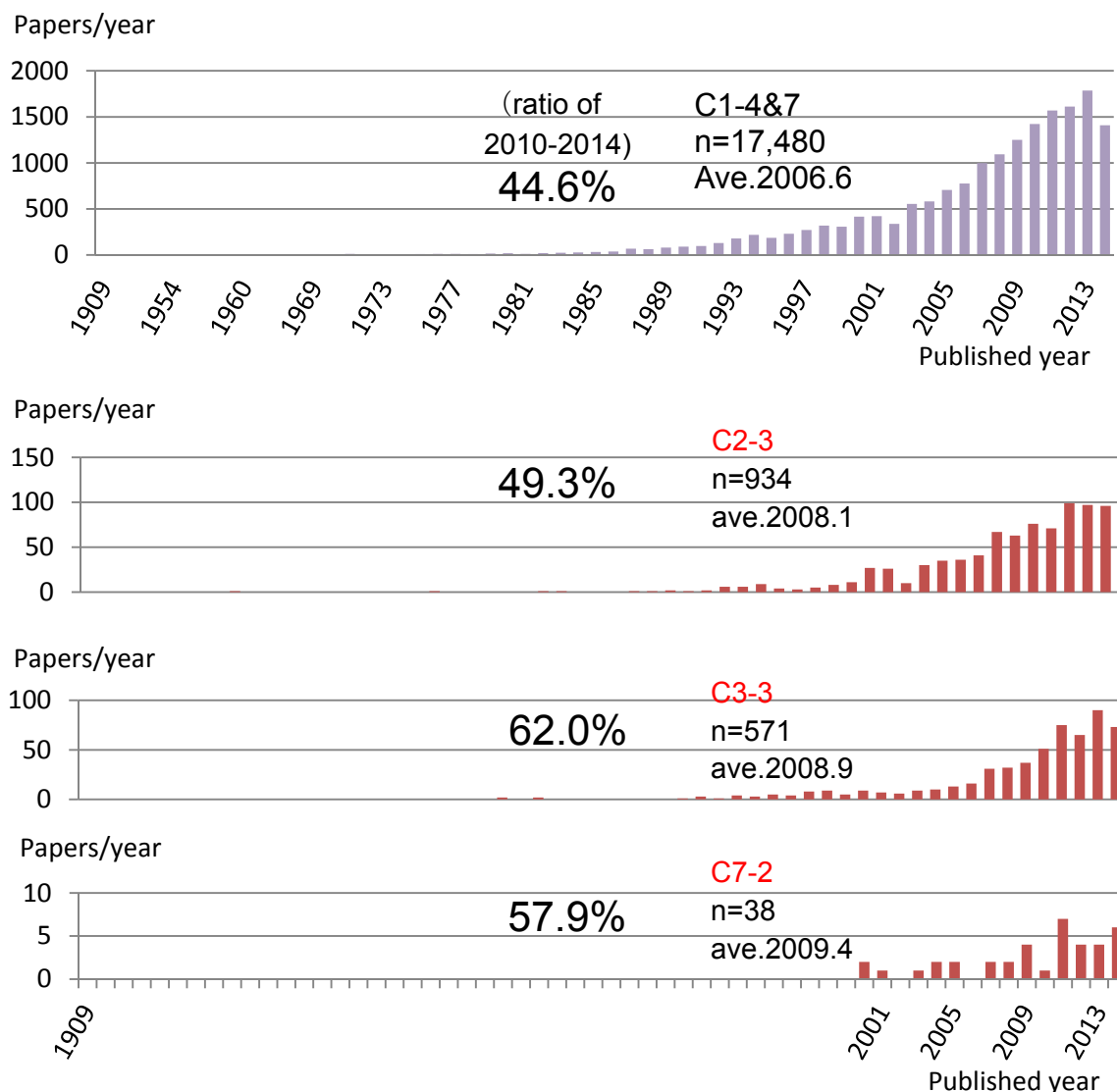


Fig. 4 Papers in the 3 clusters have increased more steeply

Furthermore, each cluster was analyzed based on the country of publication in order to calculate items such as the top five highest-ranking countries, the ranking of Japan within clusters and the shares of papers published in Japan, and the Herfindahl-Hirschman Index (HHI) as an index of diversity (Table 5). As a result, it was discovered that the United States has an outstanding TOP share in all clusters; that Asian countries such as China, Taiwan, Singapore, and Korea have a strong showing in research of, for example, international ventures and joint ventures of affiliated subsidiaries and alliances of C2; and that in research regarding family businesses (of C3-1), China has published a comparatively greater number of papers in regard to the trademark rights of Taiwan, China, and Chinese ventures. In addition, in regard to research related to biotechnological ventures, the Netherlands has a strong presence.

Meanwhile, papers published in Japan do not even account for 1% as a whole (0.77%, 23<sup>rd</sup>-largest share in the world), and in the three clusters emerging in particular, shares in each are less than 0.2%. On the other hand, the shares of papers published in the United States are outstanding in all clusters and there are even clusters that display an HHI index of more than 1,800, which indicates a high degree of oligopoly.

Table 5: Cluster structure 3 (underline: average year later than 2008)

Eng.=England; Ger.=Germany; Ned.=Netherlands; Sin=Singapore; Den.=Denmark; Aus.=Australia

cluster	Topic (key word)	# of papers	1	2	3	4	5	Japan (rank/share)	average publish /HHI
C1-1	ENTREPRENEURS HIP AND PERFORMANCE	3002	USA	Eng.	Canada	Ger.	Spain	32	2006.5
			34.88%	10.42%	5.32%	5.04%	4.80%	0.35%	1,467
C1-2	ENTREPRENEURS HIP AND EMPLOYMENT	1907	USA	Ger.	Eng.	Ned.	Spain	18	2007.7
			28.45%	10.37%	10.16%	7.02%	4.53%	1.02%	1,167
C1-3	VENTURE CAPITAL	1244	USA	Eng.	Canada	Ger.	Ned.	31	2006.3
			35.06%	10.62%	6.74%	5.90%	4.38%	0.67%	1,519
C2-1	ALLIANCE ON JOINT VENTURE	2012	USA	Eng.	Canada	Ned.	China	18	2006.2
			33.52%	7.34%	5.15%	5.11%	4.49%	1.29%	1,348
C2-2	SUBSIDIARY OF JOINT VENTURE	1337	USA	China	Eng.	Canada	Aus.	15	2005.8
			30.14%	14.21%	9.64%	6.01%	4.02%	1.27%	1,311
C2-3	<u>INTERNATIONALIZATION</u>	934	USA	Eng.	China	Aus.	Canada	49	<u>2008.1</u>
			24.90%	10.13%	6.76%	6.05%	5.66%	0.08%	<b>932</b>
C3-1	ENTREPRENEURS HIP ORIENTATION	344	USA	Canada	Eng.	Spain	Taiwan	31	2003.3
			34.38%	7.49%	6.20%	5.72%	4.35%	0.40%	<b>2,003</b>
C3-2	SOCIAL ENTREPRENEURS HIP	965	USA	Eng.	Canada	Aus.	Ned.	-	2007.5
			40.20%	11.74%	6.93%	5.18%	4.16%	0%	<b>1,893</b>
C3-3	<u>INSTITUTIONAL ENTREPRENEURS HIP</u>	571	USA	Eng.	Canada	Ned.	France	30	<u>2008.9</u>
			28.07%	15.80%	11.14%	6.35%	4.80%	0.14%	1,291
C4-1	VENTURE BUSINESS IN CITY	384	USA	Eng.	China	Canada	Wales	24	2007.2
			23.60%	20.92%	6.33%	5.60%	4.62%	0.49%	1,176
C4-2	ETHNIC VENTURE BUSINESS	348	USA	Eng.	Canada	Ned.	Israel	19	2004.6
			39.14%	15.14%	10.29%	8.00%	4.57%	0.57%	<b>1,987</b>
C4-3	BIOTECHNOLOGY	176	USA	Ned.	Eng.	Canada	France	23	2006.5
			21.05%	8.61%	8.61%	5.74%	5.26%	0.96%	<b>756</b>
C7-1	PROPERTY RIGHT IN CHINA	384	USA	China	Eng.	Hungary	Sin.	11	2007.8
			30.26%	22.37%	7.89%	6.58%	5.26%	1.32%	1,610
C7-2	<u>POLITICAL CORRUPTION</u>	38	USA	Canada	Ger.	Spain	Eng.	-	<u>2009.4</u>
			44.23%	9.62%	9.62%	7.69%	5.77%	0%	2,293
C7-3	PRIVATE ENTREPRENEUR IN CHINA	26	USA	Turkey	Eng.	Sin.	Den.	-	2007.1
			52.00%	12.00%	8.00%	4.00%	4.00%	0%	3,024

(continued)

SIMPLE TOTAL <b>13,672</b>							
C1-4&7 <b>17,480</b>	USA	Eng.	Canada	Ger.	Ned.	23	<b>2006.6</b>
	32.29%	10.47%	5.72%	4.55%	4.25%	0.77%	1,304

Lastly, when examining the time series variation of Japan, China, and the world based on the years of publication, in both Japan and the world centered on the United States, the number of papers related to ventures has been increasing since around 1990.

Meanwhile, the number of papers published in China has suddenly increased from around the year 2000 and, in the years after 2005, compared to Japan, a significantly greater number of papers are being published. On the other hand, in Japan, in the years after 2000, the number of related papers has ceased to show an increase (Fig. 5).

(Take note that, as the numbers of papers are as of the end of September 2014, the actual figures of each country are at a pace that will exceed the figures of the previous year.)

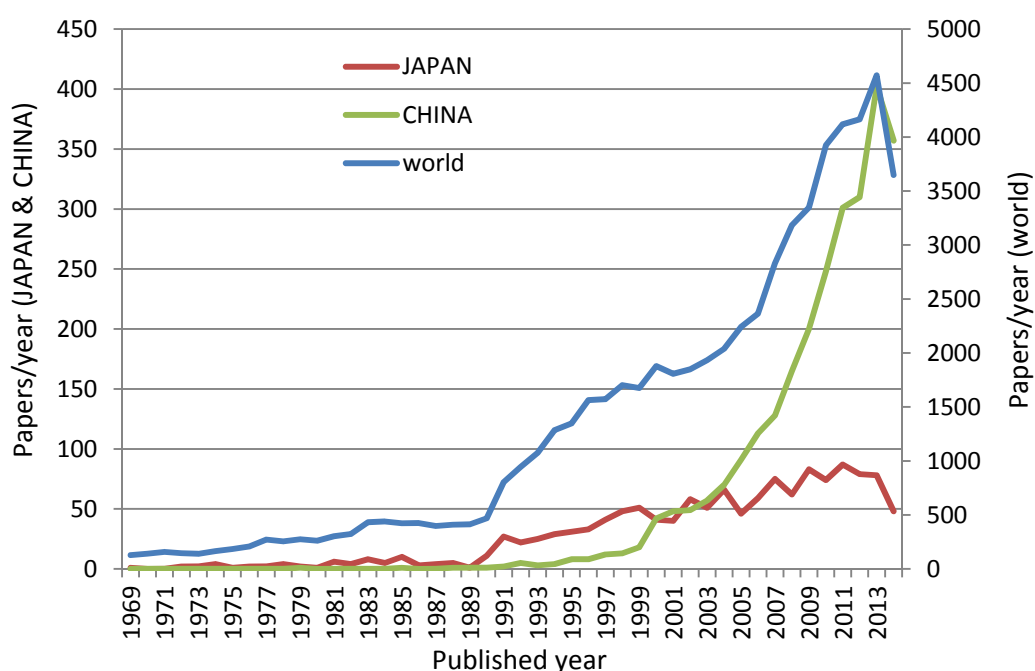


Fig. 5 Papers from Japan are not catching up with China and the world.

## CONCLUSION

Through the research of this paper, it is understood that it is possible to converge papers into topics comparatively clearly classified for each cluster; that overall the number of papers in this field has been rapidly increasing since 1990; and that in particular the United States holds a leading share in each one of the clusters.

In addition, with the three clusters in which the average year of publication is comparatively new, when examined in a time series, the number of papers has been rapidly increasing in recent years, and when examined based on country, it is possible to illustrate how the shares of the United States were the highest and that there was a high degree of oligopoly by a small number of countries. In addition, the countries of Asia starting with China are increasing their presence in those clusters such as international ventures and alliances. Meanwhile, overall, the proportion of the number of papers published in Japan is small and it is clear that the share of Japan in the emerging clusters is particularly small.

Even when examined in a time series, the growth of the number of papers in this field published in China exceeds the growth of the rapidly increasing number of papers published throughout the world, while the figures for Japan have been struggling to increase since 2005.

Challenges for future research include examining individual papers within clusters to express topics even more accurately, systematically grasping venture-related research and considering the positioning of clusters and topics therein, and clustering papers in Japanese corresponding to this category to compare and contrast these against clusters of English papers.

## REFERENCES

- Adai, A., Date, S., Wieland, S., & Marcotte, E. (2004). LGL: Creating a map of protein function with an algorithm for visualizing very large biological networks. *Journal of Molecular Biology*, 340(1), 179-190.
- Borner, K., Chen, C., & Boyack, K. (2003). Visualizing knowledge domains. *Annual Review of Information Science and Technology*, 37, 179-255.
- Garfield, E. (1955). Citation indexes for science; a new dimension in documentation through association of ideas. *Science (New York, N.Y.)*, 122(3159), 108-111.
- GRANOVETTER, M. (1985). Economic-action and social-structure - the problem of embeddedness. *American Journal of Sociology*, 91(3), 481-510.
- Gregoire, D., Noel, M., Dery, R., & Bechard, J. (2006). Is there conceptual convergence in entrepreneurship research? A co-citation analysis of frontiers of entrepreneurship research, 1981-2004. *Entrepreneurship Theory and Practice*, 30(3), 333-373.
- Landstrom, H., Harirchi, G., & Astrom, F. (2012). Entrepreneurship: Exploring the knowledge base. *Research Policy*, 41(7), 1154-1181.
- Newman, M. (2004). Fast algorithm for detecting community structure in networks. *Physical Review E*, 69(6), 066133.
- Wennekers, S., & Thurik, R. (1999). Linking entrepreneurship and economic growth. *Small Business Economics*, 13(1), 27-55.
- Government of Japan(2014). "Japan Revitalization Strategy – Revised Edition of 2014" , [http://japan.kantei.go.jp/97\\_abe/Documents/index.html\(2015/1/5 17:30 GMT\)](http://japan.kantei.go.jp/97_abe/Documents/index.html(2015/1/5 17:30 GMT))