

Article

Geospatial Response for Innovation in the Wine Industry: Knowledge Creation through Institutional Mobility in China

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Abstract: Thus far, knowledge network research has been quantitative research, emphasizing that in limited industries, knowledge creation increasingly strengthens through geographical proximity or institutional connections. Although it has been suggested that knowledge networks should be researched using dynamic rather than static methods, the dynamic process of knowledge networks according to spatiotemporal changes has not been sufficiently researched. This paper uses the Chinese wine industry case to conduct related research. The results show that, first of all, wine-related knowledge creation activities were carried out in the big cities that formed the early market in the mid-2000s, and the geographical conditions in which the spatial scope was expanded were in the places that gradually developed over time. Second, although the spatial scope of knowledge creation activities is expanding with the active participation of private enterprise networks, private enterprises and the overall knowledge creation process are relatively isolated. Finally, in terms of the process of knowledge creation related to wine, in the development of regional linkages organizations relate to the knowledge providers who provide the required information, and have little to do with the geographically close knowledge providers.

Keywords: knowledge creation; patents; spatiotemporal changes; geospatial; wine industry; institutional mobility; China; technology innovation; terroir

1. Introduction

Studies related to knowledge creation have steadily discussed the diffusion of knowledge through cooperation among institutions based on geographical proximity [1–7]. Some traditional analyses have addressed the importance of an organization's location for knowledge creation [8–14]. These studies have mainly focused on the locations of industrial clusters [2,15–18] and claimed that innovation activities are concentrated in specific regions owing to the flow of knowledge through the connections between individuals, corporations, and institutions in these clusters [12,15,19–21]. Thereafter, most studies focused on the location of the knowledge creation network [2,15–18], but such research on the knowledge network has been quantitative research, emphasizing that in limited industries, knowledge creation increasingly strengthens through geographical proximity or institutional connections.

Such research on the knowledge network has led to research on firm-specific characteristics based on geographical proximity, and researchers have argued that the knowledge creation process is gradually transferred in uneven and selective ways [22–30]. The transmission of knowledge indicates that the process is evolving differently from the idea of an 'industrial atmosphere' claimed by Marshall [10,25,31]. In particular, there are studies that have evaluated the effect of academic research

on industrial innovation [32–34]. As an important source of new knowledge, universities are important for promoting technological innovation. Many countries have adapted science policy for incubating innovation, emphasizing the linkage between university and industry [35–37] and rapid economic development. Institutions such as universities and research centers play a role in the transmission of knowledge in the Chinese wine industry to enhance its global competitiveness [38]. Some research focused on several important vineyards of the major countries that analyze the three key stages: grape production, wine making, and the distribution process. This research tries to examine the up-to-date strategies in the wine industry by analyzing regulations, organization theory, industry organizational efficiency, and vertical integration [39].

This empirical research has advanced through the combination of network theory and proximity [40,41]. The advantage of network analysis is that it can prove relationships through data [42]. Such data-based network analyses that prove relationships have expanded to various fields. Knowledge network studies using knowledge-sharing relationships [25,43–46], patents [47–52], and participation in research and development [32,53–56] have begun to emerge [57].

In particular, research using patent data, which gradually developed and resulted from knowledge creation, shows how active knowledge creation or innovation are carried out [58–60] and reveals the meaning of technology changes [59–61]. Knowledge creation has become the core of competitiveness in the knowledge-based economy, and the influence of knowledge creation on regional growth has been analyzed [62–68]. Recently, empirical research in support of theoretical research on knowledge networks has appeared. However, some researchers have argued that innovative creation based on location proximity is still static and should be explained more dynamically [57].

This study analyzed the geographical characteristics of the network formation process through the knowledge creation process and the institutional relationships based on patent data for the Chinese wine industry. Knowledge creation through patents is referred to as a ‘knowledge network’, which has a complex meaning based on the patents’ economic value and intellectual property rights.

In addition to collecting and quantitatively analyzing patent data for the Chinese wine industry, the present study monitored the changes in the industry in all regions over time to examine the temporal changes and the knowledge creation research within the clusters, which have not been sufficiently assessed in previous research.

Regional knowledge networks can improve the mobilization of specific regional knowledge resources and thus become a relevant factor of the regional economic development potential in terms of a socially produced location advantage. Recently, in the theory of regional innovation networks, the potential of the relationship between regional science and research institutions has been emphasized, just as in the theory of regional innovation clustering [69,70]. In the study of knowledge networks, the exchange of knowledge with economic actors is being considered as a basis of regional-specific innovation capacities using patent data [71–74]. The dynamic agglomeration benefits of knowledge generation within regionally networked ensembles are also picked out as a central theme in the theory of regional clustering, which specializes districts with institutions.

The work of Nelson and Winter [75] reports on the evolutionary theory of firms. The viewpoint shows that firms are heterogeneous and there is an asymmetrical distribution of the knowledge base in the industrial cluster [76]. The process of developing a knowledge network at the intra-firm level is path-dependent due to the heterogeneity of firms [77].

This research on dynamic knowledge networks beyond static conditions has also gradually expanded to research on inter-firm networks [78], proximity-based inter-firm networks [79–81], and the geographical diffusion of networks and interregional networks [82–84]. Although the knowledge network research has evolved from early research by arguing for the need to work with more dynamic rather than static methods, it was still unable to capture the dynamic process of the knowledge network owing to spatiotemporal changes. China is a traditional agricultural country with a long history. The wine industry has also a very long history and there is a rich knowledge of wine-making. However, China’s traditional wine industry mainly involved liquors. In recent decades, with the spread of the

western culture and lifestyle, red wine has become an increasingly important beverage. Based on this, the introduction, innovation, and diffusion of wine knowledge has become relevant for us to study in terms of the role of knowledge networks. Therefore, the present study meaningfully contributes to the literature by examining the knowledge creation process of regional knowledge networks over time based on patent data for the Chinese wine industry and through the temporal changes of interregional and inter-firm networks.

2. Methods and Data

This study collected patent data for the Chinese wine industry for the period 2007–2016 and examined the connections of the knowledge creation network with a focus on actors (see Table 1). The original data were collected by searching for wine-related patents registered at the Chinese Patent Office (also the State Intellectual Property Office (SIPO: <http://www.sipo.gov.cn/>) using the search keyword ‘wine’ (‘putaojiu’). Codes were assigned to the actors of the patent applications identified from the collected data, and the regional unit of data was set to ‘province’. To construct the analysis data for the institutional network, the relationships between the applicants were processed into one-node data based on the original data in order to establish the relationship between actors. The data were processed into geospatial data, and the institutional connections were examined through node data.

Table 1. Network data.

Year	¹ Basic Data	Data Collection	² Network Data
2007–2009	389	Collect wine-related patent data	147
2010–2012	367	Data categorized by region and	2231
2013–2016	4089	institution	7075

¹ Number of participants, ² Network shown through joint studies.

Some research discusses the comparative advantages of wine producing nations and their selective views on their evolution process over time in a qualitative way [85,86]. However, it still lacks an analysis in terms of the perspective of institutional mobility by geospatial linkage [86–89]. The wine-related knowledge network analysis is an empirical form of analysis that measures the institutional relationships in knowledge creation. For the institutional connections, the actor was regarded as a node, and the interaction between the nodes was analyzed using Netminer 3.0, which is a social network analysis tool that establishes the relationships between joint patent applications as a network. Furthermore, a geographic information system (GIS) was used for the geographical analysis, and to diversify the network analysis that attributes associated to each node, the functions and roles of the organizations were analyzed using geographical cluster analysis.

The wine-related data in China were transformed into adjacency matrices, and institutional attributes (university, research center, private organization, industry) were assigned to them in accordance with the research purpose. To facilitate the analysis of the rapidly growing wine industry in China, the changes were divided into three periods: 2007–2009, 2010–2012, and 2013–2016. The temporal classification of patents was based on the end date of the patent application (for example, if the patent was applied on 1 March 1983 and registered on 1 August 1984, it was based on the patent registration time). The flow of this research is as follows:

The Chinese wine industry and the drivers of development were researched through a literature review, and the results show that empirical research is still insufficient despite the growth of the industry.

The wine-related data from all over China were collected and processed. The original data were divided into the three periods of 2007–2009, 2010–2012, and 2013–2016. In addition, codes were assigned to patent applicants with the basic data and they were divided by institutions. The patent data were collected from the SIPO and processed into data suitable for the research purpose. The network status of each region was visualized with the processed data, and an analysis according to type of institution was performed. The knowledge creation characteristics were examined by visualizing the

node networks for each region. The data were processed and analyzed through a GIS to investigate geographical characteristics over time.

As mentioned in introduction, this research attempted to analyze the patent data, one of the indicators of innovation capability, to monitor the technological innovation process of wine in China. The patent data reprocess network data based on joint applicants. These data included attributes of patent applicants, co-applicants, and applicant's institutional relationship information [71–74]. Thus, the data have been reprocessed to visualize the network based on institutional, regional, and inter-regional data. In particular, co-applicants were used to identify inter-geospatial characteristics by geo-coding the address of the institution, with division into the institutional relationship level.

Until now, studies on the Chinese wine industry have mostly been reports on sales volume and status [90–92]. This study analyzed the changes in the institutional knowledge creation activities caused by the expansion of geographical networks beyond location in previous research on the knowledge creation process in the wine industry in China. In this study, the term 'regional' in the regional response for innovation also pertains to the *terroir*, or the natural condition in which grapes can grow.

This research indicates that '*terroir*' is a specific concept that describes components among soils, climates, and practices. It may not be as large as a province and regions. Here, the term wine 'chosen by nature' is intended to explain the characteristics of the wine according to geographical characteristics, because the *terroir* of the region where wine is produced is selectively given by nature. In particular, this research, which deals with wine-related patents, is focused on China's wine technology, in which innovation is encouraged by local investment and funding efforts based on the environment given by nature as an essential condition for wine production.

3. Results

Wine in China is developing with various social, economic, and cultural meanings. Culturally, red wine has become popular owing to the implications of the color red, which is the symbol of happiness in China [93]. Socially, the wine industry is growing rapidly as the power consumption class, born from the 1980s to the 1990s, has begun to drink wine, enjoying foreign cultures. Economically, wine has also been revitalizing the local economy through the development of unique wines in line with local climate characteristics [94]. Amid this growth, the Chinese government implemented a wine industry promotion policy in the late 2000s and is currently developing the industry through qualitative improvement of wine-related technology. In particular, it develops the industry through promoting industry–university–government relationships among local universities, research institutes, and companies. In the early development process, foreign companies participated in joint ventures with companies in China, and such joint ventures led to the development of wine technology in the country and provided an opportunity for foreign companies to enter the Chinese market [95]. The Chinese wine industry has been developing since the mid-19th century. The Shandong region, where the wine industry started, has rapidly grown under the government's support policies since the 2000s. For decades, the Chinese central government did not realize the wine industry's potential for regional innovation and as a growth engine. In the mid-2000s, when it finally recognized the value of the wine industry, it set a national growth strategy [94,95]. China has been fostering the wine industry with regional development strategies through its 12th and the 13th five-year plans. Therefore, it promotes regional innovations in the development of the wine industry and pursues technological development and continuous growth through industry–university–government cooperation [96].

China has traditionally enjoyed distilled rather than fruit liquors. The wine drinking culture is growing rapidly among the increasing number of consumers who have experienced foreign cultures. The main wine consumption class of China is the generation born in the 1980s and 1990s ('*balinghou*' and '*jiulinghou*', respectively), which actively leads the latest trends in terms of consumption and the performance of economic activities in the society [95]. This generation was born during China's high-growth period, when the country began to socially and economically prosper, and members of this generation are politically and ideologically free and have strong personalities. The Chinese wine

industry began to develop as this generation started to enjoy wine [97–105]. During the early days of wine production, Chinese wine technology was considered inferior. Since the year 2000, however, the Chinese wine industry has achieved technological innovations as wine companies from France, Italy, and the United States entered the Chinese market and established joint ventures with Chinese companies. Wine consumption in China has grown rapidly since the 1980s, following economic reforms, making China one of the top 10 wine consumption markets worldwide. Currently, leading wine brands differ by region and include Changyu, Greatwall, Dynasty, and Grand Dragon. Wine demand is high in Beijing and Shanghai, and sales in large cities are growing by 30–40% annually [106,107] (see Figure 1).

China is currently experiencing social problems due to wine overproduction and is implementing structural reforms for the supply side. China's 12th five-year plan tried to upgrade the structure to overcome low growth, but increasing growth was difficult to achieve [108]. A new government policy has been implemented in the wine industry to address the overproduction that has long been considered a problem in the country's 12th and 13th five-year plans. To foster the wine industry, central and local governments in China have funded land acquisition, low-cost renting of farmland, and infrastructure investment in related facilities and roads. They have also supported wineries through government investment, credit for facility investment, and support for visiting famous overseas wineries. In particular, the Chinese government has set wine production goals (22 million hl for 2015 in the 12th five-year plan in 2012) to control overproduction and has encouraged the expansion of grape production in line with the goals [94].

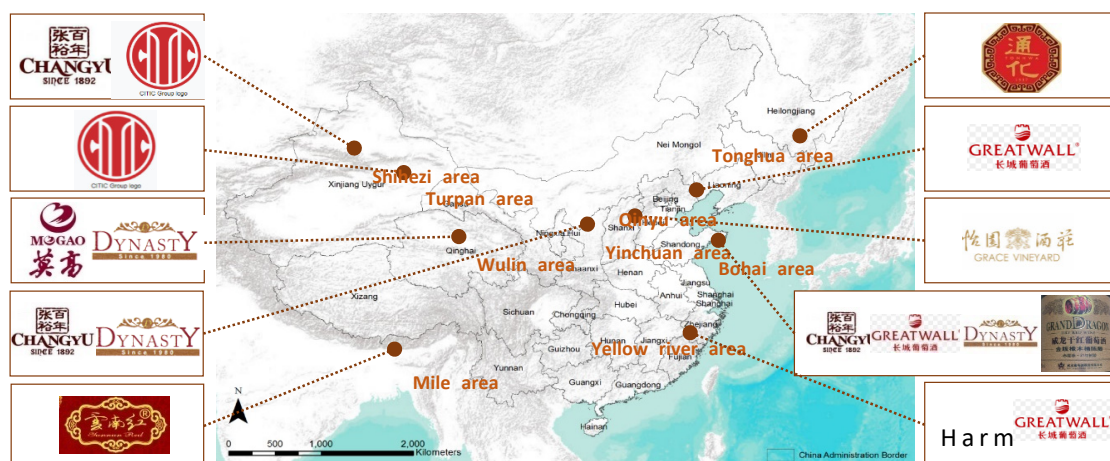


Figure 1. Major locations of wine activities in China [109,110].

Recently, the Chinese wine industry has utilized technological innovation to qualitatively develop production, that is, to develop wines comparable to imported wines. For this purpose, the Chinese government promotes the development of wine technology through local industry–university–research cooperation. To continuously develop wine technology in China, the need for knowledge creation through connections among institutions has been highlighted. Individuals and small-scale businesses pursue technical cooperation through the expansion of opportunities for such connections and the linkage with external information. This technological cooperation process develops into inter-regional links. China now produces a variety of regional wines according to terroir, involving various factors such as climate and soil.

3.1. Before 2010

Wine-related knowledge creation in China started in the early 1990s, when major wine companies from countries with developed wine technology, such as the United States, France, and Germany, established joint ventures with companies in China to enter the market. Famous international wine brands currently sell wine products to China while trying to establish production bases in the country.

For example, Domaines Baron de Rothchild established a wine company in Yunnan province, which is famous for its pu'er tea, and Moët Hennessy established a company in North Ningxia. Further, the Italian Wine Association and Italian Wine Maker Association launched the 'Italian Wine in China' business and entered China in 2012. The foreign companies' wine production, which is based on local natural conditions, creates knowledge through joint ventures with local enterprises [111]. This development energized the Chinese wine industry in 1995, in particular by promoting the dry red wine trend [112]. In the mid-1990s, the patents of foreign companies from the United States, Germany, France, and Canada started to appear in China, showing the efforts of wine technology development. The geographical characteristics of early wine-related knowledge creation tended to expand from the areas around the large cities to the regions with the natural conditions for growing grapes. Since the year 2000, wine-related patents have emerged throughout China rather than only in the east region, and the participation of inland areas has been increasing, which indicates that the network is expanding.

3.2. 2010–2012

China implemented its 12th five-year plan as a promotion policy for the wine industry. The government pre-emptively invested in the regions in which internationally influential wine companies had also invested to promote the wine industry, and supported the development of symbolic regional brands using grapes as a local resource. In particular, the government actively encouraged viticulture and wine production in the central, western, and northeastern regions, where the development was relatively slow [113]. The regional network was activated, and a patented knowledge network was formed in areas such as Shandong, Yunnan (6), Tianjin, and Guangdong (15). The participation of foreign organizations also increased significantly, and the United States (13), Australia (7), Japan (6), and The Netherlands (5) have participated in the development of Chinese wine patents. Patent production, which occurred around metropolitan areas, gradually expanded inland, and the market-oriented trend changed into a nature-oriented trend. These changes indicate that the creation of wine-related knowledge expanded to the areas of Xinjiang and Nei Mongol, which have favorable natural conditions for grape growing.

3.3. 2013–2016

In the mid-2010s, the regional network became increasingly activated, connecting with Shandong, Nei Mongol, Hebei, Beijing, Yunnan, and Jinan. In the late 2000s, the government implemented a wine-industry nurturing policy, and the number of wine-related patents increased rapidly. After 2010, the regional and institutional networks became activated and have been developing in Heilongjiang, Nanning, Beijing, Hebei, and Xinjiang, which is an inland area in the northeastern region affected by the oceanic climate. Chinese wine technology has developed in accordance with the regions' vast geographical and natural conditions, which have provided a unique opportunity to produce wine based on the regions' specific environmental conditions. In the mid- and late 2010s, China began fostering the wine industry with regional specialization strategies through its 13th five-year plan. It is developing the wine industry in terms of regional innovation and is pursuing technological cooperation and continuous growth through industry–university–research cooperation. Further, the Chinese wine industry is developing in conjunction with tourism. Thus, the government is constructing a new unique regional tourism system by combining vast natural resources (places), abundant manpower (people), and promotion [95,114]. The Shandong region, which has made great advances in patents, has developed rapidly with the government's support policy since the 2000s. For decades, the Chinese central government had overlooked the wine-related industry's potential for regional innovation and as a growth engine. In the mid-2000s, however, it finally recognized the value of the wine and set the goal of fostering the industry under the country's leadership [94].

An examination of institutional networks reveals that the network is expanding with the active participation of private businesses, which can be isolated from the knowledge creation process owing to funding power or company capability. This situation suggests that the government policy for the

wine industry should include supportive measures to prevent the isolation of organizations in the knowledge creation process (see Figure 2, Table A1).

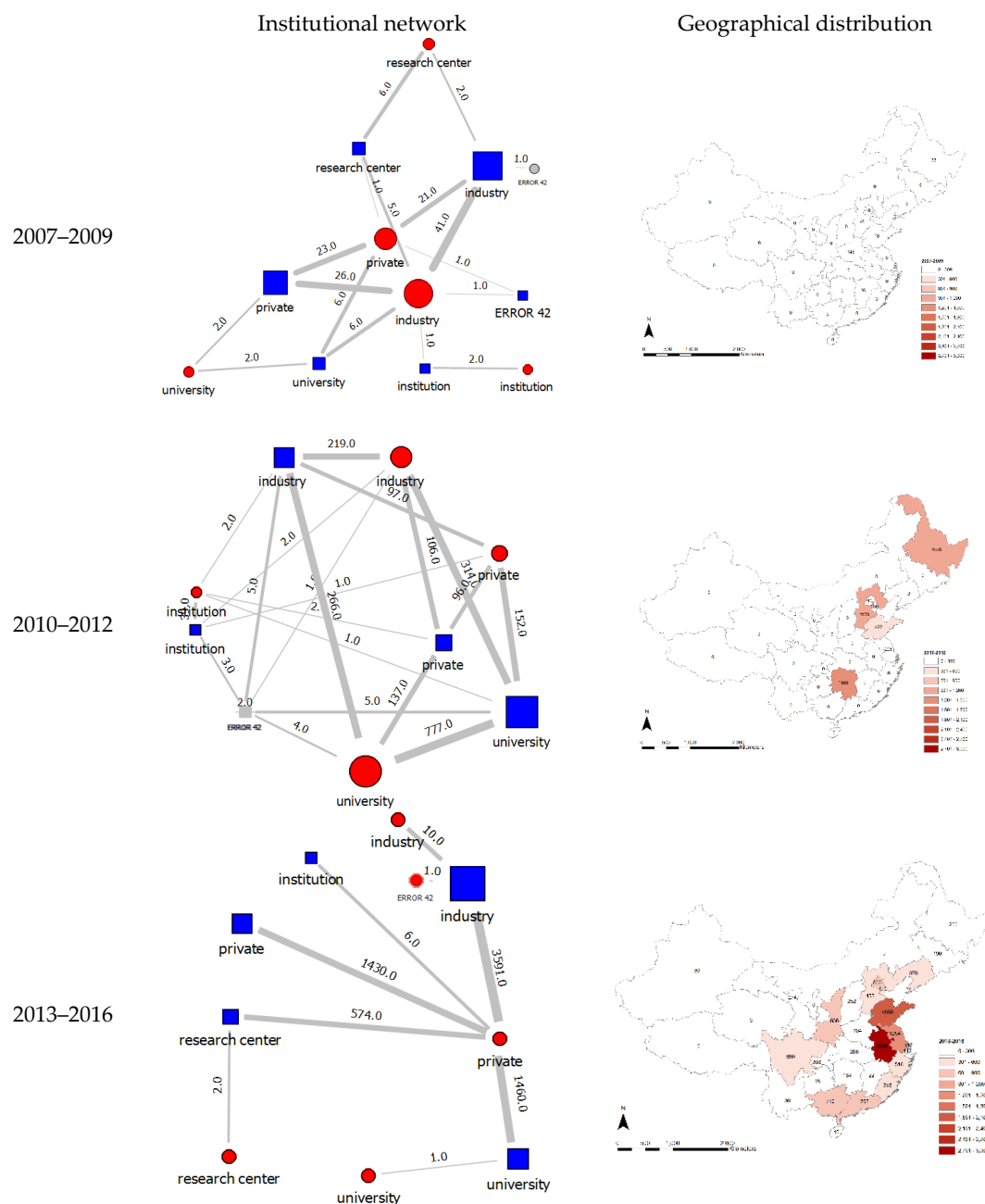


Figure 2. Inter-firm distribution of wine-related knowledge creation. Reference: inter-firm network Figure 2007. Revised from Choi [95]. The colors and shape of nodes(left) refer to the institutional relationship among institutions. The size of node means the power of links.

The analysis of regional network changes over time revealed that the knowledge creation activities related to Chinese wine developed around the metropolitan areas where the early market was formed, and spatial diffusion gradually occurred where geographical conditions were developed. The analysis confirmed that knowledge creation activities occur actively in various regions. In addition, while the knowledge network is not being strengthened, regional diffusion is taking place in the process of knowledge creation, and connections between regions are continuously increasing. This situation shows that regions are pursuing continuous connections with knowledge providers (universities

and research institutes) that are not geographically close but that provide the required knowledge for the innovative growth of wine-related technology. They are building knowledge networks that extend beyond the regions, but eventually, they adapt to the local environment and soil, enabling the production of different wines in different regions (see Figure 3).

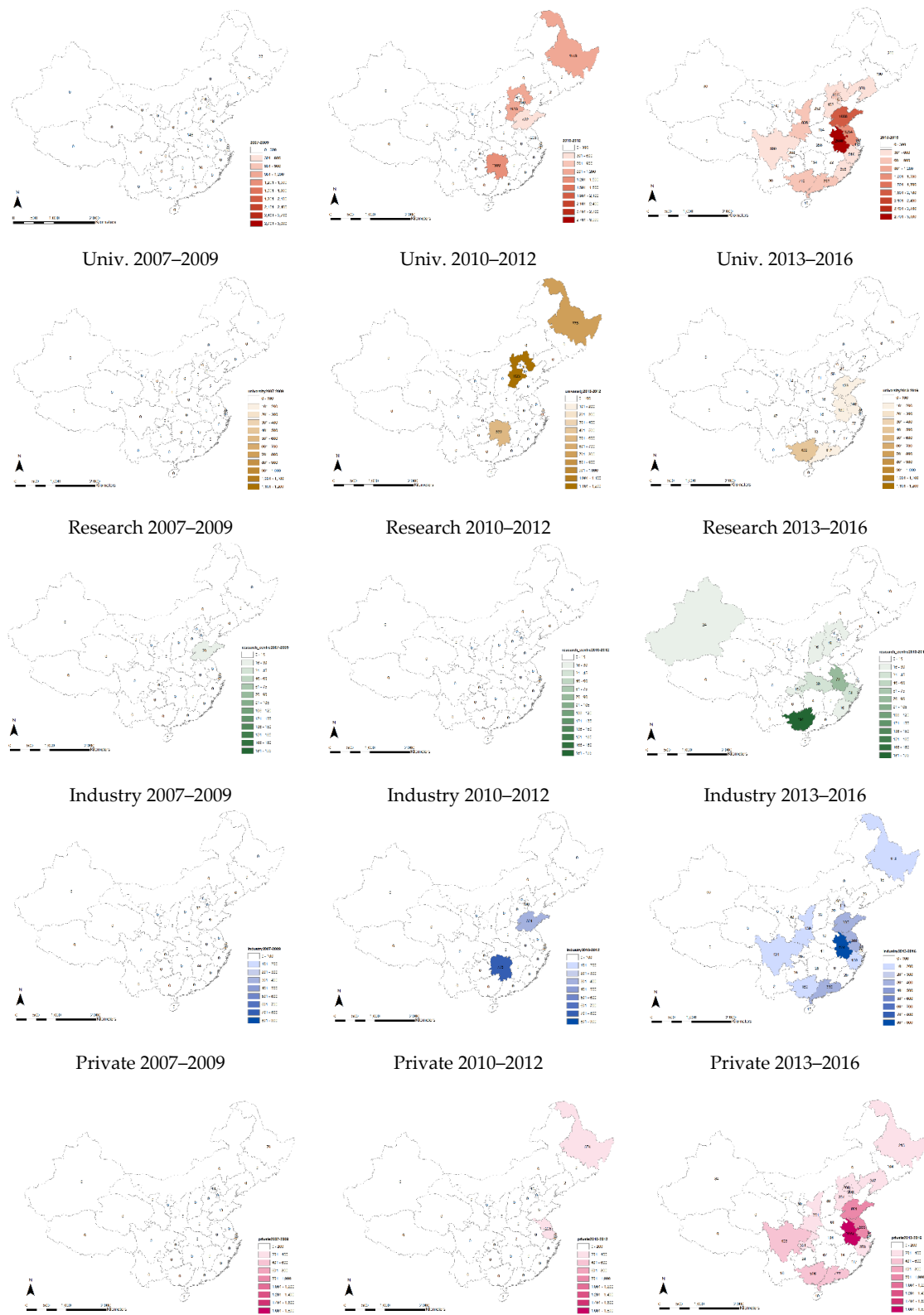


Figure 3. Geospatial distribution of wine-related knowledge creation.

The actual grape cultivation area as of 2014 is as follows: Henan (186 hL/ha), Shandong (135 hL/ha), Hebei (61 hL/ha), Xinjiang (25 hL/ha), and Ningxia [96]. The frequency of wine-related knowledge creation networks is high in Shandong, Hebei, Anhui, and Beijing, which shows that wine-related knowledge creation is influenced by various environmental factors, such as basic grape cultivation area, cooperation with other organizations, and the market [92,93,96]. Therefore, wine-related knowledge creation is not active in wine cultivation areas, but in areas where the geographical conditions are ideal in a broad sense.

The temporal changes of inter-organizational relationships and regional knowledge creation activities in the wine-related knowledge creation process can be analyzed as follows.

First, the local expansion of networks is notable in the process of knowledge creation of private businesses in such areas as Anhui (1682), Shandong (981), Jiangsu (886), and Guangxi (516). It can be seen that the private businesses that are relatively isolated from the network undertake technological innovations by continuously networking with knowledge providers (universities and research institutes). Second, regional networks appeared in small numbers in 2007–2009, and regional knowledge creation processes have been increasing over time. In the late 2000s, knowledge creation occurred in the Hebei–Hebei region and then moved to the Hunan–Hunan (2010–2012) and Anhui–Anhui regions (2013–2016). In Anhui, the number of patents of private businesses has increased rapidly in recent years (2013–2016). As shown in Table 2 1083 (2013–2016) knowledge creation networks were formed in Anhui in the same period, whereas 203 knowledge creation networks were formed in Guangxi and Anhui. In the case of Anhui, which has many private company knowledge networks, most of the networks are formed in the same area, which suggests that Anhui should strengthen external networks to prevent isolation from regional networks.

In terms of the temporal changes of regional networks, the knowledge networks within the region initially had a much higher frequency, but the networks are spreading geographically beyond geographical proximity and through institutional proximity (see Table 2).

In the case of Shandong, businesses' participation in knowledge creation networks in the region strengthen such networks. In 2013–2016, the participation of universities and private businesses has increased rapidly. As shown in (see Appendix A) the networks in the region (Shandong–Shandong: 591) are developing, to support the future development of such networks, the participation of knowledge providers (universities and research institutes) in the region and beyond should be continuously promoted. Thus, a virtuous circle of knowledge creation networks should be formed to support private businesses' continuous growth, by playing the role of a knowledge provider that creates new wine-related knowledge. An examination of the temporal changes in the regional connections of Chinese wine-related knowledge networks shows that they are connected to knowledge providers that provide the required knowledge, not to those that are geographically close. This situation confirms that inter-firm connections are made based on institutional rather than geographical proximity. The technological innovation process of the Chinese wine industry has demonstrated that knowledge networks develop through connections with the knowledge providers who have the required knowledge beyond the geographical proximity rather than through the formation of a knowledge network that uses the existing infrastructure such as the local universities and the research institutes.

Table 2. Knowledge creation participants by region across time.

	Industry			Private Organization			Research Center			University		
	2007–2009	2010–2012	2013–2016	2007–2009	2010–2012	2013–2016	2007–2009	2010–2012	2013–2016	2007–2009	2010–2012	2013–2016
Anhui	-	-	852	-	-	1682	-	-	79	-	-	160
Shandong	11	331	335	13	91	981	20	-	15	2	-	128
Jiangsu	-	-	366	-	208	886	-	-	7	-	-	146
Guangxi	-	-	162	-	-	516	-	-	191	-	-	429
Guangdong	-	-	330	-	-	477	-	-	-	-	-	112
Sichuan	-	-	121	-	-	406	-	-	6	-	-	47
Zhejiang	-	-	109	-	-	378	-	-	34	-	-	57
Shanxi	-	-	139	-	-	351	-	-	-	1	3	15
Chongqing	-	-	29	-	-	321	-	-	16	-	-	4
Beijing	8	-	92	14	1	288	-	-	8	-	-	6
Liaoning	-	-	79	-	2	247	-	-	12	-	-	57
Hebei	82	-	20	-	-	234	-	-	19	-	1123	56
Heilongjiang	-	-	114	76	374	213	-	-	10	-	775	31
Tianjin	-	1	115	-	-	208	-	-	6	-	-	21
Hubei	-	-	41	-	2	134	-	-	36	-	-	18
Fujian	-	-	20	-	-	117	-	-	16	-	-	17
Jilin	-	-	16	-	-	104	-	-	4	-	-	8
Shanghai	-	-	25	-	-	97	-	-	1	-	-	-
Ningxia	-	-	49	-	-	90	-	-	-	-	-	12
Xinjiang	-	-	65	-	-	84	-	-	24	-	-	-
Shanxi	-	-	32	-	-	80	-	-	16	-	-	11
Hunan	-	778	26	-	-	67	-	-	4	-	532	13
Henan	-	-	19	-	-	61	-	-	9	-	-	18
Guizhou	-	-	14	-	-	24	-	-	-	-	-	-
Yunnan	-	-	2	-	-	16	-	-	-	-	-	-
Jiangxi	44	-	-	-	-	14	-	-	-	15	-	3
Hainan	-	-	15	-	-	10	-	-	-	-	-	-

4. Conclusions and Discussion

4.1. Conclusions

This study examined the regional–institutional knowledge creation process over time to overcome the limitations of previous research (which emphasizes only knowledge creation in knowledge networks) and to promote the use of the dynamic rather than static method. This study derived several conclusions based on the temporal changes in the geographical–institutional knowledge creation activities in the wine-related knowledge creation process in China based on data for the last 10 years.

First, the analysis results show that knowledge creation activities related to Chinese wine developed around metropolitan areas where the early market was formed in the mid-2000s. Then, such activities spatially spread over time to places with developed geographical conditions. Such expansion confirms that knowledge creation activities related to wine are carried out in various regions.

Second, network expansion takes place owing to the active participation of organizations that are relatively isolated from the process of knowledge creation. This situation implies an increase in the organizations' connections with other institutions (universities and research institutes). This result shows that if there is a high external dependency in the knowledge creation process, the knowledge creation network on the network changes in accordance with the characteristics of the institution, and the knowledge creation network is not strengthened. In other words, it suggests that the government should implement supportive measures to prevent the isolation of organization and should combine different kinds of policies related to technological innovation in the wine industry.

Third, regarding the flow of wine-related knowledge creation in China, organizations are connected with knowledge providers that are not geographically close but that provide the required knowledge in the evolution of the regional connections. This phenomenon occurs in the process of innovative growth of wine-related technology, in which knowledge providers (universities and research institutes) are linked through institutional relationships rather than geographical proximity. This confirms that the wine industry develops through organizations' connections with knowledge providers who have the actually required knowledge regardless of geographical proximity, rather than fostering knowledge networks that utilize existing infrastructure such as universities and research institutes in the wine industry.

4.2. Discussion

Overall, this study identifies opportunities to further expand knowledge network research to overcome the challenges of the different natural conditions and geographical environments in studies of countries with large territories, such as China. Thus far, research on the wine industry has focused on the knowledge creation that occurs in wine clusters and the influence of the characteristics of wine-related organizations on quality [100,113,114]. Furthermore, some studies have emphasized location in the wine industry [8–14]. Recent studies have indicated that innovation in wine regions is related to climate change [115–117]. In a broad sense, this study explores the social, cultural, and economic characteristics of a rapidly developing China by monitoring the evolution of wine chosen by nature. Another contribution of this study is that it opened avenues for future research on agriculture where local natural conditions are accounted for with regard to climate change.

This research involves the monitoring of the knowledge creation process in the process of technological innovation in the Chinese wine sector through patent data. While the wine industry is developing rapidly in China, there is still a lack of studies on the technological innovation process in this region. This research is characterized by providing patent data on the Chinese wine-related knowledge creation process, which is still regarded as a black box. In addition, there is still an insufficient understanding of the role of the institution in knowledge creation [118–125]. Therefore, policy implications should be studied by analyzing roles, difficulties, and strategies of the wine industry through interviews and surveys for further research.

This research could be expanded to the characteristics of wine enterprises, in particular, the effect of company size on the production of patents, and links between these characteristics and their innovative characteristics. In the context of wine enterprises, the current research lacks an evaluation of the link between the characteristics of firms and their innovative characteristics. As follow-up research, foreign direct investment (FDI) could take into account the filing of patents with the FDI in the wine sector in China by intra-national mobility.

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Conflicts of Interest: The authors declare no conflict of interest

Appendix A

Table A1. Knowledge creation networks across time.

2007–2009			2010–2012			2013–2016		
a	b	n	a	b	n	a	b	n
Hebei	Hebei	22	Hunan	Hunan	262	Anhui	Anhui	1083
Heilongjiang	Heilongjiang	13	Hebei	Hebei	217	Shandong	Shandong	591
Hebei	Heilongjiang	12	Heilongjiang	Heilongjiang	195	Jiangsu	Jiangsu	552
Shandong	Shandong	10	Heilongjiang	Hunan	17	Guangxi	Guangxi	400
Jiangxi	Jiangxi	9	Hebei	Hunan	157	Guangdong	Guangdong	327
Jiangxi	Heilongjiang	9	Hunan	Heilongjiang	147	Sichuan	Sichuan	247
Heilongjiang	Hebei	9	Heilongjiang	Hebei	13	Zhejiang	Zhejiang	242
Beijing	Jiangxi	8	Hebei	Heilongjiang	12	Gansu	Chongqing	209
Jiangxi	Shandong	7	Hunan	Hebei	115	Guangxi	Anhui	203
Hebei	Jiangxi	7	Hunan	Shandong	64	Shanxi	Shanxi	183
Heilongjiang	Jiangxi	7	Shandong	Hunan	55	Heilongjiang	Heilongjiang	170
Beijing	Heilongjiang	6	Shandong	Heilongjiang	47	Liaoning	Liaoning	168
Hebei	Shandong	5	Hebei	Shandong	47	Beijing	Beijing	160
Heilongjiang	Shandong	4	Shandong	Hebei	44	Tianjin	Tianjin	134
Shandong	Heilongjiang	3	Shandong	Shandong	43	Gansu	Gansu	123
Beijing	Shandong	2	Heilongjiang	Shandong	43	Hebei	Hebei	112
Shandong	Jiangxi	2	Heilongjiang	Jiangsu	36	Hubei	Hubei	96
Shandong	Hebei	2	Hebei	Jiangsu	25	Ningxia	Ningxia	64
Total		141	Total		2164	Total		7008

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