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Entrepreneurship in East Asian Regional Innovation Systems: Role of Social Capital

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Abstract

This paper aims to identify the role of social capital in entrepreneurial RIS (Regional Innovation Systems). We propose the features of mature entrepreneurial RIS with the three dimensions of social capital including structural, relational, and cognitive dimensions. With the features of mature entrepreneurial RIS, we apply them to the cases of still-evolving entrepreneurial RIS from East Asia including Daedeok Innopolis of Korea and Hsinchu Science Park of Taiwan. In order to analyze the cases, the spawning effect of representative companies within focal industries, collaboration among the key organizational actors, and attraction and retention of talent are taken into account. The results of this study provide a new aspect on the features of still-evolving entrepreneurial RIS which complement the existing typology categorizing RIS into institutional RIS and entrepreneurial RIS. Whereas the conventional literature has viewed the East Asian RIS as institutional RIS, the findings of this study allow scholars to view the East Asian RIS as entrepreneurial in their own distinctive manner. Meanwhile, we also find an important implication on making a shift from top-down to bottom-up approach for the still-evolving entrepreneurial RIS to vitalize cognitive social capital. Thus, we suggest the transitions from outward-looking social capital to inward-looking social capital.

Keywords: regional innovation systems, entrepreneurship, social capital

1. Introduction

There are two major ways to create regional innovation system (RIS). Spontaneous creation is prevalent in western countries, such as the Bay Area in the United States, Cambridge in United Kingdom and Marseilles in France. In contrast, most of RIS in East Asia such as Hsinchu Science Park of Taiwan and Daedeok Innopolis of Korea were led by governments. The origin determines the fundamental differences in the focus and outcome of each RIS [1, 2]. In particular, whereas the entrepreneurship has been a driving force for spontaneously-created RIS, entrepreneurship has been considered as a missing ingredient in government-led RIS [1]. As a result, entrepreneurship has been neglected by the literature dealing with East Asian RIS. Recently, however, the government-led East Asian RIS have started to recognize the importance of entrepreneurship and promote start-up activities. Likewise, exploring the issue of evolution and adaptation of East Asian regional innovation system under such changing orientation toward entrepreneurship is of great importance [1]. In addition, when explaining the fundamental difference derived from entrepreneurial activities in each RIS, social capital is of a great relevance [3-5]. Social capital helps securing resources by virtue of membership in social networks and is a key determinant of national and regional success in the global struggle for economic predominance [4, 6, 7]. In this regard, Su and Hung [1] argued that the still emerging entrepreneurship of East Asian RIS is lacking the features embedded in social capital. However, it is important to note that each region has evolved in different manner with its distinctive complex systems, which result in varying innovation performance. Thus, this paper posits that the different level and features of entrepreneurship activities are displayed in East Asian regional innovation systems. For instance, whereas mature entrepreneurial RIS actively cultivates and sustains entrepreneurial activities, still-evolving entrepreneurial RIS lacks social capital to sustain spontaneous entrepreneurial activities.

In order to investigate differentiating entrepreneurship activities in East Asian RIS, we first develop propositions on the features of social capital in mature entrepreneurial RIS as evidenced from U.S. and other Anglo-American countries. Then, we apply the propositions to the cases of still-evolving entrepreneurial RIS including Daedeok Innopolis and Hsinchu Science Park by taking into account their genetics and evolution. Thus, the main goal of this study is to apply the dimensions of social capital to the still-evolving entrepreneurial RIS of East Asia, thereby identifying the different features of the still-evolving entrepreneurial RIS. Based on the findings, we also discuss the different features of the still-evolving entrepreneurial RIS and mature

entrepreneurial RIS. In order to apply the dimensions of social capital to entrepreneurial activities within the regions, we link the social capital consisting of structural, relational, and cognitive dimensions with the sources of entrepreneurship. Since the conventional literature on regional entrepreneurship has focused on the entrepreneurial activities, the source of entrepreneurship has received relatively little systematic attention [8]. In addition, the source of entrepreneurship not only encompasses individual entrepreneurs but also the entities operating within RIS, thus we apply these dimensions at sector, organizational, and individual level. Accordingly, we first take into account the spawning effect of incumbent firms resulting in clustering of start-up firms at sector level. Secondly, we analyze the collaborations among the regional entities including universities, public and private research institutes and corporations at organizational level. Lastly, we look into to the attraction and retention of both foreign and locally-educated entrepreneurs within the region.

Above all, our study contributes to the literature in three important aspects. First, we apply the notion of entrepreneurial RIS [9] to explain the emerging entrepreneurship practices in East Asian RIS. In fact, there is a great interest from latecomer countries in establishing innovation and production hubs to foster regional entrepreneurship. In this sense, our analytical approach is meaningful, as the conventional studies on East Asian RIS have overlooked the importance of entrepreneurship [1]. Secondly, we explain the role of social capital in vitalizing entrepreneurship in RIS. Since only a few studies theorize and examine the relation between social capital and regional entrepreneurship, this study seeks to make a contribution to filling the gap [3]. Lastly, we provide policy implications for latecomer governments by documenting different approaches to make their RIS more entrepreneurial. Accordingly, this paper addresses the difference in institutional rules and societal norms that have an impact on the way RIS evolve [10].

The remainder of this study is organized as follow. Section 2 begins with the theoretical background by reviewing the concept of entrepreneurial RIS and its relation with social capital. Section 3 entails the core features of social capital in mature entrepreneurial RIS, thereby developing relevant propositions. Section 4 explains methodological approach along with brief background information on our cases including Daedeok Innopolis and Hsinchu Science Park. The section also applies the above propositions to the cases of still-evolving entrepreneurial RIS. Section 5 and 6 provide implications as well as detailed future and applied research agenda to approach the role of social capital in entrepreneurship from micro-perspective.

2. Literature review

2.1. Revisiting the concept of entrepreneurial RIS

The concept of entrepreneurial RIS was suggested by Cooke and Leydesdorff [9] to describe innovation systems that concentrate on supporting private sector. In order to present the concept of entrepreneurial RIS in a concrete manner, Cooke and Leydesdorff [9] made a distinction between entrepreneurial RIS and institutional innovation systems, which is considered as traditional innovation systems. Using the cases of the U.S and other Anglo-American economies, they argued that entrepreneurial RIS relies more on individual actors such as entrepreneurs, venture capitalists, researchers, incubators and demanding pioneering customers for developing innovations. This is the reason why small business entrepreneurship and scalable start-up entrepreneurship are vitalized in entrepreneurial RIS [10, 11].

In contrast, Cooke and Leydesdorff [9] argued that the traditional innovation systems focus on developing and exploiting engineering-based knowledge and building on close collaboration between and among institutions for production of knowledge [10, 11]. In fact, East Asian RIS have been quite successful in supporting manufacturing activities of the national champions that were the main driving force of economic development throughout 80s and 90s. Specifically, Korea's Daedeok Innopolis have secured abundant basic science resources throughout its industrial age and contributed to national economic development by providing core technologies to Korean conglomerates [12]. In this sense, East Asian RIS have been quite entrepreneurial in supporting large company entrepreneurship [10, 11].

However, after the 1997 and 1998 Asian Financial Crisis, East Asian economies have recognized the importance of small business and scalable start-up entrepreneurship for sustainable economic growth [13]. One of the main reasons for this phenomenon is the shift from industrial economy to knowledge-base economy. Despite the importance of heavy industrial sectors in the catching-up of East Asian economy throughout the last few decades, the heavy industrial sectors have witnessed a declining importance during the recent period, as new emerging creative and knowledge-based technological sectors have instead been expanding rapidly. These new sectors are in general located where the entrepreneur already lives and/or works and are often created in the form of small business and scalable start-up entrepreneurship that are mostly spin-offs from other organizations [11, 14].

In light of this economic shift, many East Asian RIS have been trying to become more entrepreneur-

friendly by pursuing institutional transitions to open the floodgates of entrepreneurship [1, 15]. The main actor vitalizing the entrepreneurship in East Asian RIS is government, as East Asian economies have been clinging to foster the formation and growth of state-owned enterprises and large conglomerates. In this sense, it is important to note that the categorization of Cooke and Leydesdorff [9] may have been far too simplified, as institutional rules of the game and different societal norms have an impact on the way individuals and organizations evolve [10, 16-18]. Even though Saxenian [19] mainly used the cases of Silicon Valley and Route 128, she never claimed that they were typical of the U.S. In fact, the space program of the U.S. government decades ago was an example of traditional innovation systems. Also, the understanding that European RIS show different entrepreneurial characteristics has been well established for decades [10]. Above all, we argue that there are stages through which entrepreneurial RIS evolve based on the focus of the roles.

----------Insert Table 1. Categorization of entrepreneurial RIS----------

With the above explanations and argument on the types of RIS derived from institutional difference, we categorize entrepreneurial RIS into mature entrepreneurial RIS and still-evolving entrepreneurial RIS (See Table 1). Whereas mature entrepreneurial RIS is spontaneous driven which aims to generate small business and scalable start-up entrepreneurship with the significant contributions of individuals, still-evolving entrepreneurial RIS is government-led which aims to support large corporate entrepreneurship with the significant contributions of government and state-owned institutions.

2.2. Features of social capital in entrepreneurial RIS

With the growing importance of social capital, the concept has been applied to the streams of literature in regional development and innovation studies [20]. Putnam et al. [21] viewed social capital as “features of social organization, such as trust, norms, and networks, which can improve the efficiency of society by facilitating coordinated actions”. In a similar context, Lesser [22] argued that social capital consists of inter-organizational ties, certain interpersonal dynamics, and a common context, language and code of individual behavior. Among various components, Fukuyama [23] emphasized that trust is the most fundamental element of social capital which must lead to cooperation in groups. In summary, social capital features networking among

entities and relational ties based on trust, and common norm that are represented in faces of social capital [24].

In entrepreneurship literature, a stream of research emphasizes the importance of networks and the social capital inherent in them, for the creation of new ventures in RIS [5, 25, 26]. From individual perspective, entrepreneurs cannot succeed without an atmosphere of trust derived from social capital, which helps entrepreneurs overcome uncertainties and secure tangible commitments from skeptical resource holders. Social capital at individual level can be widely seen in the U.S., where investors, entrepreneurs, and employees have learned to trust each other with eyes wide open [7]. At organizational level, networks among organizations are established and promoted by entrepreneurs based on social capital [1, 2]. This type of social capital can be easily seen in East Asia where networking with government departments and/or institutions is prevalent [27]. In fact, East Asian entrepreneurs heavily depend on the government-run investment institutions to receive financial support on their start-up activities [28]. Overall, East Asian RIS tend to show different kind of entrepreneurial practices derived from social capital [1].

In order to propose the key features of social capital in mature entrepreneurial RIS and apply them to the cases of still-evolving entrepreneurial RIS from East Asia, we adopt three dimensions of social capital consisting of structural, relational, and cognitive dimensions [24]. First, structural social capital is a constitutional network, in which entrepreneurs acquire information, support, and resources. For instance, if an entrepreneur holds a central position within a network, it is much easier for the entrepreneur to gain access the resources [29]. In this sense, for such an entrepreneur, structural social capital provides more opportunities for new business creation. Second, relational capital conceptualizes the degree of trustworthiness in personal relations. Although the dimension has mostly been applied at individual level, Inkpen and Tsang [30] point out that the dimension may be applied at inter-organizational level. This is evident in emerging technology industries such as software development, where entrepreneurial organizations take advantage of economies of time, by sharing information and adapting quickly to changing demands [31]. In fact, information sharing in inter-organizational networks becomes possible with a high level of trust set in place which on one hand, reduces opportunistic behavior, and on the other, promotes long-term shared goals and interaction transparency [30, 32]. In applying the dimension to the context of RIS, Etzkowitz [33,34] asserts that the degree of inter-organizational relations determines the formation of different RIS models: static, laissez-faire and normative model. Lastly, cognitive social capital represents the social norm including shared systems of meanings and

language which facilitate the exchange of information, learning and knowledge creation among the individuals [5, 35, 36]. The cognitive dimension is broadly divided into two main categories: shared goals and shared culture [37].

We use this theoretical background to develop research propositions as follows. Based on the structural social capital perspective, entrepreneurial RIS require entrepreneurs to hold a central position in gaining access to resources and information. For instance, at least 23 out of 67 entrants to the semiconductor industry in Silicon Valley between 1957 and 1976 had at least one founder who worked for Fairchild [38], including Advanced Micro Devices, Intel, and National Semiconductor, almost all of which were based in Silicon Valley. In addition, regional economic growth in Austin, Texas has significantly benefited from the industry consortia “Micro-electronics”, “Computer Technology Corporation”, and Sematech. “Dell”, “Advanced Micro Devices” and “3M” have also formed an industry consortium. These IT industry consortia approach reflects planned efforts of the local chamber of commerce, city government, and the University of Texas at Austin [39]. These firms allowed the would-be entrepreneurs to be exposed to a network of suppliers of labor, goods, and capital, as well as to a network of customers [19]. Likewise, would-be entrepreneurs learn how to found companies by participating in the entrepreneurial process alongside other, more experienced entrepreneurs [8]. Within an industrial cluster, several firms could be facilitators of knowledge and commercialization for successful regional growth. However, Agrawal and Cockburn [40] explain that focal firms within regional clusters play a leading role of diffusion of technology and knowledge. Malipiero et al. [41] also demonstrate the leading firms are gatekeeper role of utilizing external knowledge for other firms; subsequently, they formulate and implement business idea. Scalable start-up firms generated from the network of focal firms in industrial clusters result in the growth of entrepreneur RIS [42]. Hence, the entrepreneur RIS have a focal industry and national champions.

- **Proposition 1: Entrepreneurial RIS leverage structural social capital with a focal industry and national champions**

From the viewpoint of relational social capital, entrepreneurial RIS needs to form an environment in which idea generating, knowledge sharing, and commercializing activities are vitalized. Companies are no longer sole knowledge creators; universities as well as government research institutes (GRI) have emerged as

key participants in RIS [33]. Participants in RIS often discard hierarchical and bureaucratic structures to form new relations across boundaries; therefore, a single focus only on strengthening the individual competencies of participants will not achieve regional innovation effectively. In other words, a successful entrepreneurial RIS requires the formation of a regional innovation ecosystem in which participants form and maintain a mutual and interdependent relationship as collaborators. In particular, many scholars insist that the trust relationship is important for successful RIS evidenced by high density of network among entities. In fact, trust relations also play a critical role when entrepreneurs gain access to finances by contacting venture capitalists. This is why the start-up founders of Silicon Valley are usually engineers who have education or working experiences in industrial clusters, where local culture and institutions are favorable to new firms from the region [43]. In Austin, Texas, many incumbent firms also have a direct or indirect tie to the University of Texas at Austin. The tie between entrepreneurs and the university initiated when entrepreneurs were involved in research activities at the university that have been expanded into their businesses. This induces entrepreneurs to continue their stay in the area to maintain their relationship with the university and other university-grown companies [44]. Since start-ups suffer from lack of trust when accessing entrepreneurial resources and are known to take on extra-ordinary risk, entrepreneurs' local connections and local institutional support have a positive impact on the formation and growth of a start-up.

- **Proposition 2a: Entrepreneurial RIS leverage inter-dependent relational social capital for promoting and supporting spin-offs**

Among the local actors of RIS, the role of entrepreneurial university has recently gained attentions from scholars. As the global economy is making a shift towards a knowledge-based economy, there exist significant needs to increase indigenous capabilities of universities [45]. In fact, there were 25,600 active companies founded by living MIT alumni, employing 3.3 million people and generating annual world revenues of nearly $2 trillion [46]. Roberts and Eesley [46] estimated that approximately 6,900 MIT alumni companies are headquartered in Massachusetts with their annual sales of $164 billion which represent 26 percent of the sales generated by all Massachusetts companies. This impressive economic impact of MIT is derived from supporting organizations and initiatives that contribute to MIT entrepreneurial ecosystem [12, 46]. In this sense, Stanford also has incubated ideas, educated entrepreneurs and fostered breakthrough technologies that drove the

economic growth of Silicon Valley. Eesley and Miller [47] estimated that 39,900 active companies have their roots to Stanford. Among them, 18,000 firms created by Stanford alumni are headquartered in California generating annual sales of $1.27 trillion. Above all, entrepreneurship education and knowledge commercialization through university-industry collaboration have been highlighted by these entrepreneurial universities [48, 49].

- **Proposition 2b: Entrepreneurial RIS leverage relational social capital generated by entrepreneurial universities**

Cognitive dimension of social capital consists of two main categories including shared culture and goals [26, 37, 50]. Shared culture allows knowledge transfer, which is easily managed by the networks consisting of the actors with similar cultural backgrounds [30]. However, it has been argued that cultural diversity of partner networks could be a driver for knowledge exchange [51]. In this sense, the growth of the entrepreneurial RIS “Silicon Valley” from 1970s through the 1990s coincides with the inflow of immigrants which resulted in cultural diversity of the region. Most of the immigrants were international students for graduate engineering education who eventually accepted jobs in Silicon Valley. By 2000, over half (53%) of Silicon Valley's scientists and engineers were foreign-born. Indian and Chinese immigrants alone accounted for over one-quarter of the region's scientists and engineers, or approximately 20,000 Indian, 5,000 Taiwanese, and 15,000 Mainland Chinese engineers [52]. In addition, highly skilled immigrants contribute to Texas' innovation industries by earning patents, products, and ideas. In fact, over 73.8 percent of patents from the University of Texas system in 2011 had at least one foreign-born inventor which amount to $38.3 million in University of Texas system licensing and royalty revenues [53]. After being exposed to entrepreneurialism cultivated in the multi-cultural environment, some of these foreign-born or educated engineers return to their home countries to start new companies by taking advantage of their experience and professional networks. In fact, their experiences allow them to quickly identify promising new market opportunities, raise capital, and build management teams to run their start-up companies [52].

- **Proposition 3a: Entrepreneurial RIS leverage cognitive social capital to promote brain influx and circulation.**

In addition, shared goals allow mutual comprehension and the exchange of ideas and resources within networks, by brining actor perspectives into line with what they want to achieve [38]. In this sense, Venkataraman [54] argued that "if a region has created very successful institutions and firms, it is these organizations that will attract talent". In fact, successful alumni entrepreneurs from Stanford University and MIT participate in workshops and seminars to stimulate in entrepreneurialism among the students of the Stanford and MIT community. These alumni entrepreneurs of successful start-up firms contribute to create shared goals among the community members which result in finding and retaining of local talent. As a result, the start-up founders from the region rarely move outside the region when they decide to start new firms and are usually engineers who have education or working experiences within the region [43, 55].

- **Proposition 3b: Entrepreneurial RIS leverage cognitive social capital to retain successful start-up firms spun-off from local institutions**

3. Research design

3.1. Methodology

This study mainly uses an in-depth longitudinal and comparative case study methodology. Our methodology is claimed to be the most appropriate approach for studying the evolution of analysis object involving the participation of various stakeholders [56]. The approach captures how each region walked through unique paths to evolve into entrepreneurship-oriented RIS, rather than simply comparing the degree of vitalization in entrepreneurship. As such, we have reviewed a number of articles published in high-impact journals as well as referring to the papers published by the authors. We have conducted interviews with the key representatives of the entities located in Daedeok and Hsinchu. The key representatives were from universities, government research institutes, and firms located in each region. They also helped us validate our propositions and analytical approach to identify the features of entrepreneurial RIS. Secondary data were also collected through library research to cross-check and complement our field data (See Table 2).

In order to analyze the structural dimension of the social capital, we find how national champions of a certain industry form an ecosystem network for investment and commercialization of research outcomes [57]. Specifically, we take into account the composition of industries and the spawning effect of national champions. As for the relational dimension of the social capital, we use co-patenting data to analyze and explain the

relations amongst the key actors of RIS. Although our data do not address the depth of such relationships, our analytical approach may still capture the pattern of relational social capital within RIS [58]. Lastly, we use secondary data on the influx and circulation of human capital to capture the pattern of cognitive social capital. We have referred to the survey indices on international students provided by QS World University Ranking and the reports published by representative regional institutions.

----------Insert Table 2. Summary of analytical approach----------

3.2. Case selection

The targets of our case analysis are the representative RIS from East Asia including Daedeok Innopolis of Korea and Hsinchu Science Park of Taiwan. According to the 2013-2014 global competitiveness index report published by the World Economic Forum [61], Taiwan ranked 1st and Korea ranked 28th out of 148 nations for the state of cluster development. Although the establishment of Korean and Taiwan was led by government, they adopted different approaches to regional entrepreneurship. In this sense, a comparative study on the evolution and the current state of the RIS is of high interest and an appropriate approach [58].

Daedeok Innopolis of Korea was formed as a result in 1974 with a focus on research and development in advanced science and technology. After laying foundation of Daedeok with the involvement public institutions, Daedeok focused on supporting Korean conglomerates in terms of core technology development. In fact, Daedeok Innopolis has been at the forefront of Korea's scientific and technological development, with Korea Advanced Institute of Science and Technology (KAIST) and Electronic and Telecommunications Research Institute (ETRI) as key knowledge-creating entities [62]. In 2009, there were approximately 46,000 people in the R&D workforce, a third of whom had a master's degree or higher [63]. Hsinchu Science Park of Taiwan was established in 1980 by the government with the inspiration of California's Silicon Valley. Hsinchu focused on the private sector to encourage the creation of small and medium sized firms, after the public institutions have laid the foundations and established the basic rules [60]. In fact, TSMC, UMC, AU Optronics are main actors of the innovation network at Hsinchu Science Park that have now become national champions. By 2011, Hsinchu Science Park housed 469 companies and more than 140,000 personnel, with annual sales of $29.5 billion [64].

Throughout the last decade, Daedeok has been generating more start-up firms than Hsinchu (See

Figure 1). In addition, there were over 1000 companies with $10 billion in sales and 23 companies listed on the KOSDAQ stock market. Despite the achievement of Daedeok, sales per firms located in Hsinchu surpass that of Daedeok in two fold (See Figure 2). This may have been due to the nature of each region that whereas the companies act as the core gatekeeper for innovation activities in Hsinchu, universities and research institutes are acting as key entities of Daedeok. In this sense, we may infer from these descriptive statistics that Hsinchu has been more effective than Daedeok in terms of generating economic impact through active commercialization of knowledge resulting in entrepreneurship.

----------Insert Figure 1. Total number of the firms in Hsinchu Science Park and Daedeok Innopolis----------

----------Insert Figure 2. Sales per firms in Hsinchu Science Park and Daedeok Innpolis ----------

4. Case studies

4.1. Daedeok Innopolis

Korean government encouraged the agglomeration of similar convergence technology sectors including information technology convergence, bio-medical convergence, nano convergence, and etc. [57,58]. In this regard, there are a number of government research institutes across these technological fields in Daedeok Innopolis. Except the information technology industry of Daedeok, the role of other technology sectors in entrepreneurial activities has been quite limited. In fact, the firms engaged in information technology industry takes the largest portion of the firms operating in the region. Consistent with the fact, ETRI (Electronics and Telecommunications Research Institute) has been the key government research institute of the region by successfully developing core information technologies including electronic exchanger (TDX) (1982-1991); CDMA system (1989-1996); VHSIC D RAM semiconductor (1986-1997) and others. Despite ETRI's efforts and excellence in technological development, the presence of national champions in the region is missing.

In Daedeok Innopolis, whereas the link between government research institutes and universities is strong, the link amongst these research and educational institutions and the firms tends to show weaker relations (See Figure 3 and compare Figure 5). This is consistent with the observations of Kim and An [64] which asserted that the low commercialization rate of Daedeok Innopolis is derived from the lack of inter-personal and organizational networking activities. In order to cope with the issue, the government has been trying to

encourage inter-organizational knowledge sharing and the use of social networking platforms. In addition to the government initiatives, a local university “KAIST” is also making a transition toward entrepreneurial university by forming a consortium with other would-be entrepreneurial universities abroad.

----------Insert Figure 3. Relational environment of Daedeok Innopolis----------

Likewise, KAIST has been making efforts to become more entrepreneurial by collaborating with foreign universities and attracting international students to the region. According to QS World University Ranking 2014, KAIST ranked 303 in attracting international students. Korea as a whole is developing policies to prevent brain drain, thereby retaining well-educated human resources. Nevertheless, Korea was ranked 40th out of 61 countries in BDI, while the rank of Korea ten years ago was 6th out of 37 countries. Even though some foreign-educated Koreans return to Korea and work for local research institutions and universities, they are far less likely to be involved in entrepreneurial activities. This may have been due to the absence of success stories which would-be entrepreneurs are skeptical about and eventually hinders the discovery and creation of entrepreneurial opportunities within region. In this sense, although there are 180 incumbent firms founded by ETRI alumni, they do not have a strong relation with Daedeok Innopolis. In fact, only 18 firms out of the 180 firms are currently residing in Daedeok Area. In addition, only 4 percent of university start-up firms spun-off from KAIST stays in Daedeok area. This may have been due to the lack of venture capital which has been the most critical issue for potential and incumbent entrepreneurs of Daedeok.

4.2. Hsinchu Science Park

Hsinchu Science Park consists of six strategic industries including integrated circuits, computers and peripherals, telecom, optoelectronics, precision machinery and materials, and bio- technology. Among them, integrated circuits and optoelectronics take the largest portion of the sales generated within the region. In fact, Taiwanese government established ERSO (Electronics Research and Service Organization) within ITRI (Industrial Technology Research Institute) to focus on the development of semi-conductor industry. With these government initiatives along with the R&D efforts of ITRI, such national champions as UMC, TSMC, and TMC were established which spun-off from ITRI. These spin-off firms have further resulted in the creation of

additional spin-off firms which is depicted in the entrepreneurial genealogy map of the firms engaged in Hsinchu's semi-conductor industry (See Figure 4). According to Hu et al. [66], in the initial stage, ITRI spin-offs have benefited from the local infrastructure in Hsinchu Science Park. After that, ITRI R&D incubator center provided technological support and promoted the creation of spin-off companies. These descendent firms from ITRI have provided impetus for Hsinchu to form an environment for the successful competition of Taiwanese companies in global semi-conductor industry.

---------Insert Figure 4. Genealogy of ITRI spin-offs in semi-conductor industry of Hsinchu Science Park---------

In Hsinchu Science Park, there is a strong relation between the companies and government research institutes (See Figure 5). Since Hsinchu has a pro-circulatory supply and demand structure through the cooperative network, sufficient economic returns have been generated with the establishment and growth of TSMC, UMC, and AU Optronics. In this sense, Hinchu has encouraged the key entities to establish knowledge sharing space and use social networking platforms to foster the exchange of technological resources [58]. In fact, TSMC has set up an 'Open Innovation Platform' to share its intellectual properties and library sources for chip design with its domestic and overseas partners [67]. As a result, TSMC has become a gatekeeper network for companies, thereby generating the revenue of $13 billion in 2010 [68]. Also, the universities located in Hsinchu actively collaborate with other regional innovation entities for business incubation activities. In fact, National Chiao Tung University was ranked in Top 10 Global University Business Incubators of 2013 [69].

----------Insert Figure 5. Relational environment of Hsinchu Science Park----------

As for the inflow of international students at National Chiao Tung University, the university ranks 281 in attracting international students. Taiwan has celebrated the inflow of many skilled emigrants return home to boost the economic development [70]. In 2000, 113 of the Hsinchu's 289 companies were started by U.S.-educated Taiwanese who maintain their overseas connections by operating offices in Silicon Valley along with the rotations of personnel [71]. Likewise, foreign-educated Taiwanese engineers have bridged the link between technology development expertise of Silicon Valley and manufacturing expertise of the Hsinchu region [70].

The inflow of foreign-educated Taiwanese engineers dates back to the founding year of Hsinchu, when incentives and infrastructure such as housing facilities and international schools in the surrounding area have been designed and implemented for the returnees [58]. In addition, the government sponsored international conferences on science and technology to provide workers in the Hsinchu with better access to the international scientific community [71]. In turn, the inflow has promoted the vitalization of entrepreneurial culture within Hsinchu as well as nationwide. The successful entrepreneur, Morris Chang was educated in the U.S. and had worked for Texas instrument before founding TSMC. These success stories of the foreign-educated engineers also resulted in the retention of the local talents. The ratio of ITRI Alumni remaining in Hsinchu from 1973 to 2005 has been 31%. According to the interview with Hsinchu administrators, ITRI has a consensus on their employees to start new businesses based on their research outcomes and they are allowed to return to ITRI anytime. Even though some alumni fail to start new businesses, ITRI is open to accept them. In this sense, entrepreneur-friendly environment of Hsinchu contributes to the retention of local talents.

4.3. Key findings

With the propositions developed in the literature section, we have compared the role of social capital in still-evolving entrepreneurial RIS with the cases of Daedeok Innopolis and Hsinchu Science Park (See Table 3). In Daedok Innopolis, there are multiple convergence industries without any leading or successful firms that are ready to foster the formation of entrepreneurial networks. As a result, we found a limited support for **proposition 1**. In fact, the structural social capital in Daedeok Innopolis is dispersed which makes it difficult for potential and/or incumbent entrepreneurs to gain resources and information relevant to their industry. We also found a limited support for **proposition 2a and 2b**, as government research institutes and universities have weak relations with the local firms which create barriers for entrepreneurs from these institutions to start new business. However, government research institutes and universities such as ETRI and KAIST are putting immense efforts to cope with the problem. In fact, these research and educational institutions have recently established technology holding companies to incubate local business entities. Lastly, **proposition 3a and proposition 3b** are not supported, as successful start-up cases are nonexistent in the region which hinders the attraction and retainment of well-educated human resources with strong entrepreneurial intention. In addition, the involvement of international students in entrepreneurial activities is also a missing element. Overall, despite the lack of social

capital to vitalize entrepreneurship, some existing social capital of Daedeok Innopolis has successfully spearheaded the technological innovation of the nation.

----------Insert Table 3. Models of still-evolving entrepreneurial RIS of East Asia----------

Hsinchu Science Park has a focal industry, which has co-evolved with the entrepreneurs. There is a strong presence of structural social capital in semi-conductor industry of the region. If entrepreneurs start their business in Hsinchu that are relevant to the focal industry, they can easily take advantage of technological and managerial resources. In fact, national champions of Hsinchu provide enough collaboration opportunities and inspire entrepreneurs with new business ideas. Thus, **proposition 1** has been well-supported. In addition, these representative companies have strong relations with other entities of Hsinchu including government research institutes and other firms. In particular, ITRI has been leading this collaborative initiative with various entities of Hsinchu since the 1980s. Also, National Chiao Tung University also became more entrepreneurial by having its business incubation center ranked as one of the best in the world. Despite the strong presence of inter-dependent network among the entities, the central role of the local university is lacking. As a result, whereas there were sufficient evidences to support the **proposition 2a**, we found a limited support for **proposition 2b**. As for the cognitive social capital, the foreign-educated engineers commercialized new technologies from ITRI and successfully launched start-up, thereby contributing to the promotion of entrepreneurialism. However, the presence of international students in entrepreneurial activities is absent. In this sense, whereas the **proposition 3b** was fully supported, we found a limited support for **proposition 3a**. Above all, despite the top-down approach initially shown in Hsinchu Science Park, social capital of Hsinchu has so far successfully driven the regional entrepreneurship.

In order to generalize our claims on the features of social capital in still-evolving entrepreneurial RIS of these latecomer countries, we briefly document the case of a Brazilian aerospace cluster “São José dos Campos”. Throughout the military regimes of Brazil in 1950s and 60s, the government understood the importance of forming an industrial cluster to support the development of aerospace industry. As a result, the education and research institutions including CTA (Aerospace Technical Center) and ITA (aeronautics Technological Institute) were established within the region. Not only the president of Embraer, but most of the

engineers and staff of Embraer had been graduates of ITA or researchers at CTA. In this manner, Embraer, established in 1969, was a natural spin off of the CTA [70]. This group of alumni has displayed a considerable influence on the creation of new start-up firms in aerospace industry of the region. In addition, "triple alliance" amongst multinational corporations, local private entrepreneurs and Embraer has resulted in technological and economic development of the region. However, Goldstein and LeBlanc [73] argued that the local spillovers have been quite modest, as the local small and medium-sized firms have been too dependent on the lead firms, thereby lacking capabilities to seize potential technological opportunities and broaden their customer networks. Overall, São José dos Campos is a still-evolving entrepreneurial RIS and shows its features relevant to proposition 1, 2a, 2b, and 3b.

5. Discussion

Although the dimensions of social capital are present in still-evolving entrepreneurial RIS in both different degree and manner, top-down approach of still-evolving entrepreneurial RIS focuses more on structural and relational capitals that are outward-looking-oriented social capital serving larger public purpose of society. In contrast, mature entrepreneurial RIS tend to give an equal weight on all three structural, relational, and cognitive social capitals. In particular, relatively weaker presence of cognitive capital in still-evolving entrepreneurial RIS may be strengthened by vitalizing inward-looking social capital that exists only from private relationships. Likewise, still-evolving entrepreneurial RIS requires making a transition from top-down to bottom-up approach in order to make the best use of social capital for regional entrepreneurship. In this regard, there should be more emphasis on reducing government interventions, increasing the role of universities, promoting the collaborations between the venture capitalists and local entrepreneurs, and creating other possible networks with diverse entity types [74]. In addition, the vitalization of social capital across the dimensions should be maximized by promoting the approach of multiple entity-based networks (See Figure 6). In fact, the modern society requires an innovation system based on quadruple helix model, which goes beyond the current triple helix model with the involvement of media and cultural heritages [75]. In this sense, the current triple helix model of still-evolving entrepreneurial RIS does not easily allow the emergence of the requirements for mature entrepreneurial RIS. In order to stimulate spin-off, technology commercialization, and start-up activities for regional entrepreneurship, social capital-based knowledge and information sharing must start flowing

amongst various actors within RIS that articulate entrepreneurial opportunities thereby fostering entrepreneurship. This transition from triple helix to multiple helix approach in turn may help still-evolving entrepreneurial RIS to be transformed into mature entrepreneurial RIS.

----------Insert Figure 6. Conceptualization of entrepreneurial RIS----------

Our paper is not without some limitation derived from the shortage of empirical data. Thus, we have summarized below along with some suggestions for future and applied research agenda. Interest in studying entrepreneurship, social capital, and networking in recent years are gradually filling a knowledge gap in the phenomenon of collective entrepreneurship [10]. Still, however, the source of new entrepreneurial firms has received relatively little systematic attention [8]. As a result, there is a need to approach social capital theory from micro-perspective using entrepreneurial genealogy created by past employment and movement history of incumbent entrepreneurs. This may be done by analyzing the network which incentivizes potential entrepreneurs within region. In this sense, it is also meaningful to investigate the role of social media vitalizing entrepreneurship. In addition, emphasis on the level of social capital varies depending on the nationality of RIS and entrepreneurs. In fact, the social capital in East Asian RIS tends to be vitalized at entity-level with a focus on outward-looking social capital. Ironically, the cultures in Asian firms have emphasized inward-looking social capital much more strongly than those of Western firms. In fact, such inward-looking social capital as guanxi (China), kankei (Japan) and inmak (Korea) provides the framework for business dealings in many Asian countries [76]. However, although China's cultural heritage emphasizes the role of guanxi, China has been considered as a country with low trust. In this sense, future studies could be replicated to address the trust issues amongst the entrepreneurs and the actors within RIS.

6. Conclusion

This study used the dimensions of social capital to analyze the entrepreneurial features of still-evolving entrepreneurial RIS. Despite the lack of cognitive social capital in these still-evolving entrepreneurial RIS, this study found a strong presence of structural and relational social capital in these still-evolving entrepreneurial RIS of East Asia.

Likewise, the public institutions have played a significant role in funding new technologies within the East Asian RIS. Although many of the key technologies have been spillovers of government subsidized R&D programs, the government has not actively participated in the commercialization of such successful technologies. Lack of state-intervention in commercialization of technologies leaves these East Asian RIS with limited opportunities to commercialize technologies, as the presence of private investors such as venture capital is weak in the region. In this sense, the governments of these still-evolving East Asian RIS may consider establishing a number of professionally managed public venture funds to support the commercialization of new technologies by raising funds by issuing bonds in the financial market [77].

Above all, this paper has suggested policy implications and future prospectus for RIS of East Asia and other latecomer countries that are aiming to promote regional entrepreneurship. From theoretical point of view, this research has raised a number of important research questions to carry out future entrepreneurship research using social capital theory.

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Table 1

Categorization of entrepreneurial RIS

Category	Mature entrepreneurial RIS	Still-evolving entrepreneurial RIS
Geographic region	U.S. and other Anglo-American economies	East Asia
Origin	Spontaneous-driven	Government-led
Key role	Generation of small business entrepreneurship and scalable start-up entrepreneurship	Support of large corporate entrepreneurship (ex: Development of core technologies for conglomerates and state-owned companies)
Key actor	Individual actors (ex: entrepreneurs, venture capitalists, researchers, incubators)	Government (ex: government research institutes)

Table 2

Summary of analytical approach

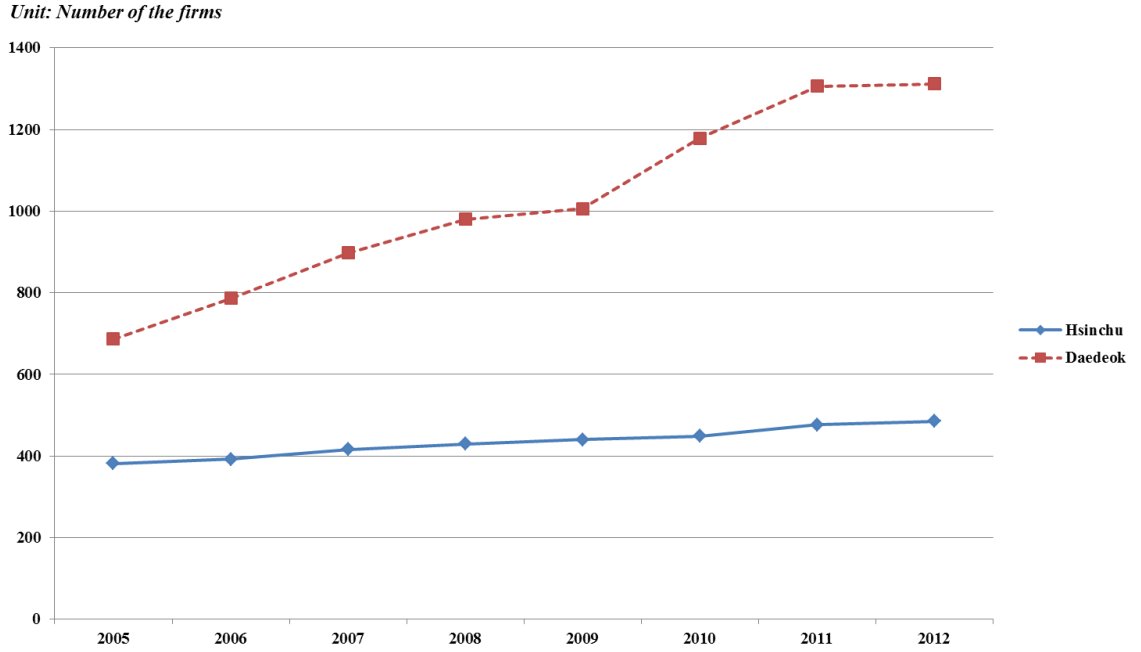
Dimensions of social capital	Unit of analysis	Major content	Source
Structural social capital	Industry network formed by government and spawned by national champions	- Historical review on the development of focal industries and key players of Daedeok using narrative content	- Press articles and published books - Interview by e-mail and direct contact
		- Historical review on the development of focal industries and key players of Hsinchu using genealogy map of Taiwanese semi-conductor firms located in Hsinchu	- Wang [58] - Matthews and Cho [59]
Relational social capital	Organizational network formed by government research institutes (GRIs) and universities	- Comparative demonstration of the collaborative relations among three entities (universities, firms, and government research institutes) of Daedeok and Hsinchu by analyzing co-patenting application network	Yun and Lee [57]
Cognitive social capital	Individual network derived from brain influx and circulation	- Retention rate of ETRI alumni in Daedeok - Secondary data on the inflow of international students to local universities	- ETRI annual report - Interview by e-mail and direct contact
		- Retention rate of ITRI alumni in Hsinchu - Secondary data on the inflow of international students to local universities	- ITRI website report - Interview by e-mail and direct contact

Table 3
Models of still-evolving entrepreneurial RIS of East Asia

Background and propositions		Daedeok Innopolis	Hsinchu Science Park
Institutional background	Time frame	1974 to present	1980 to present
	Major source of entrepreneurship	Spin-offs from GRI	Spin-offs from GRI and national champions
	Planning	Top-down, government initiated approach using research park model	Top-down, government initiated approach using industrial park model
P1. Structural social capital	Focal industry	Multiple convergence industries (Information technology convergence, Bio-medical convergence, and Nano convergence)	IT (Semi-conductor)
	National champions	Absent	UMC, TSMC, and TMC
P2. Relational social capital	GRI leadership	ETRI	ITRI
	University leadership	KAIST (Limited)	National Chiao Tung University (Limited)
P3. Cognitive social capital	Role of international students	Absent	Absent
	Source of entrepreneurialism	Absent	Foreign-educated engineers
	Major alumni network	Absent	ITRI

Figure 1

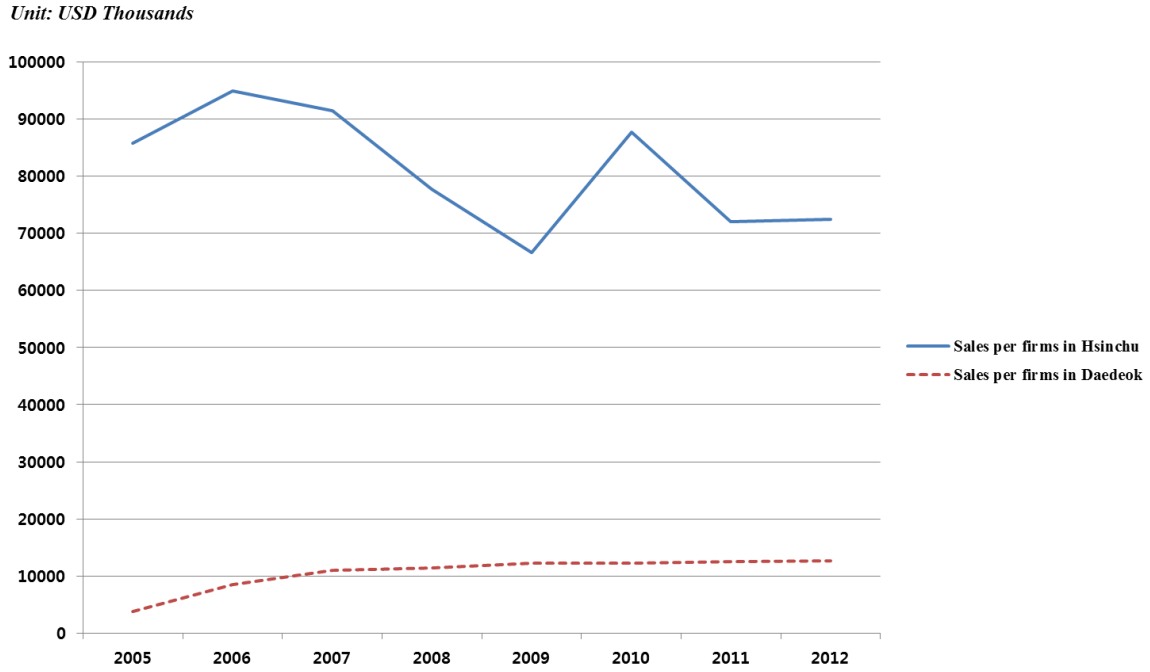
Total number of the firms in Hsinchu Science Park and Daedeok Innopolis



Source: Retrieved from the official websites of Hinchu Science Park and Daedeok Innopolis Foundation

Figure 2

Sales per firms in Hsinchu Science Park and Daedeok Innpolis



Source: Retrieved from the official websites of Hinchu Science Park and Daedeok Innopolis Foundation

Figure 3
Relational environment of Daedeok Innopolis

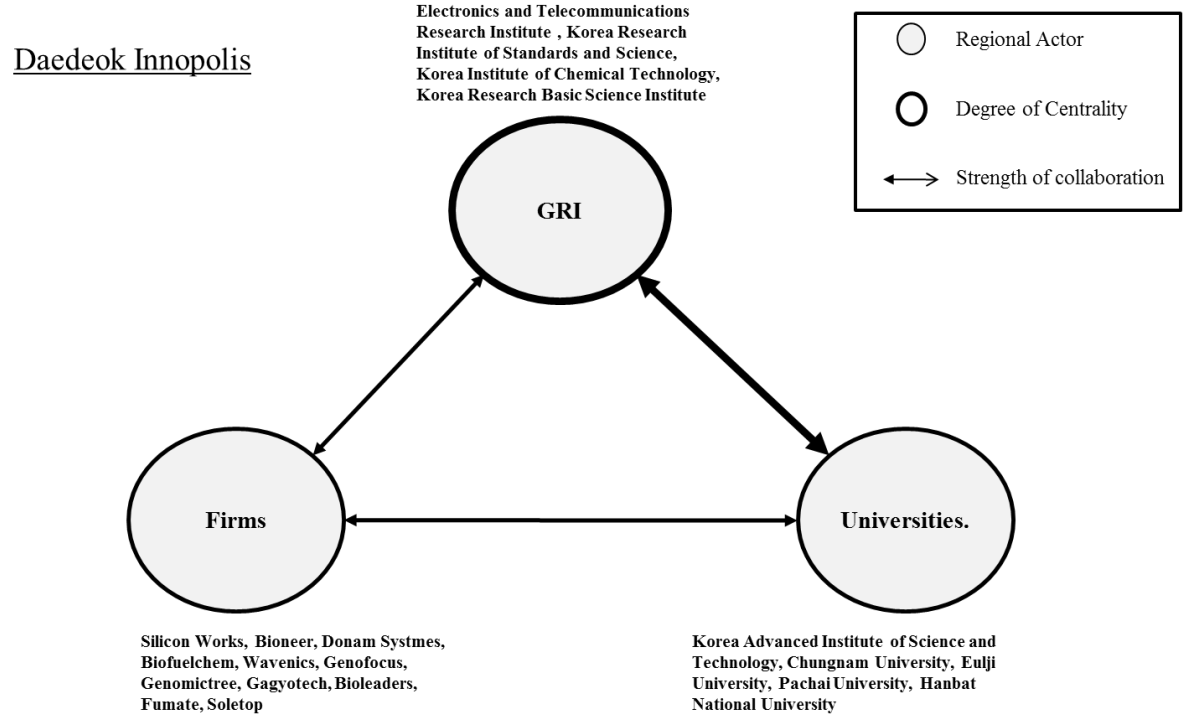
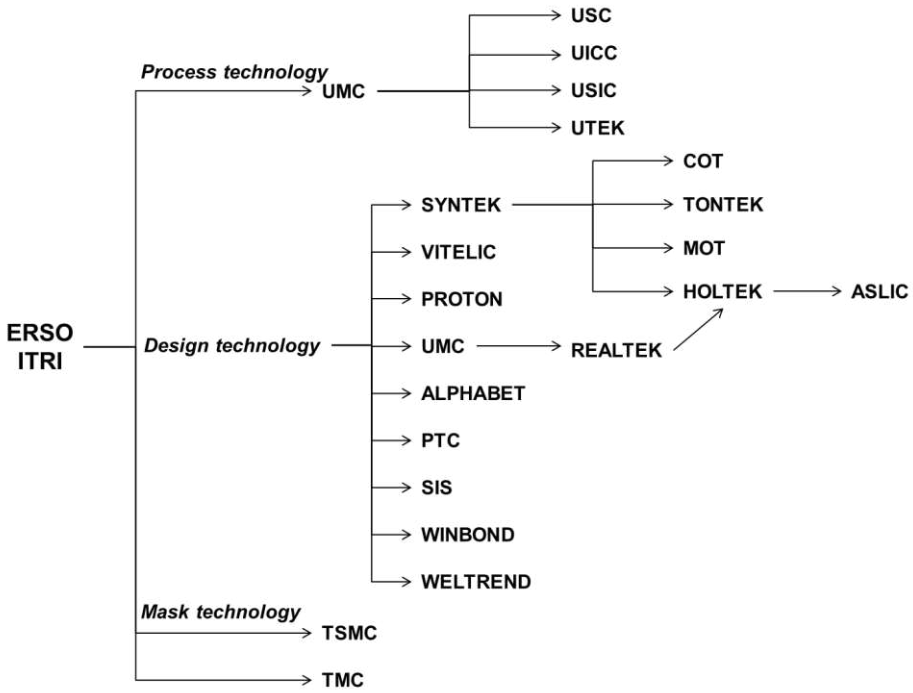


Figure 4
Genealogy of ITRI spin-offs in semi-conductor industry of Hsinchu Science Park



Source: Modified from Wang [58] and Matthews and Cho [59]

Figure 5
Relational environment of Hsinchu Science Park

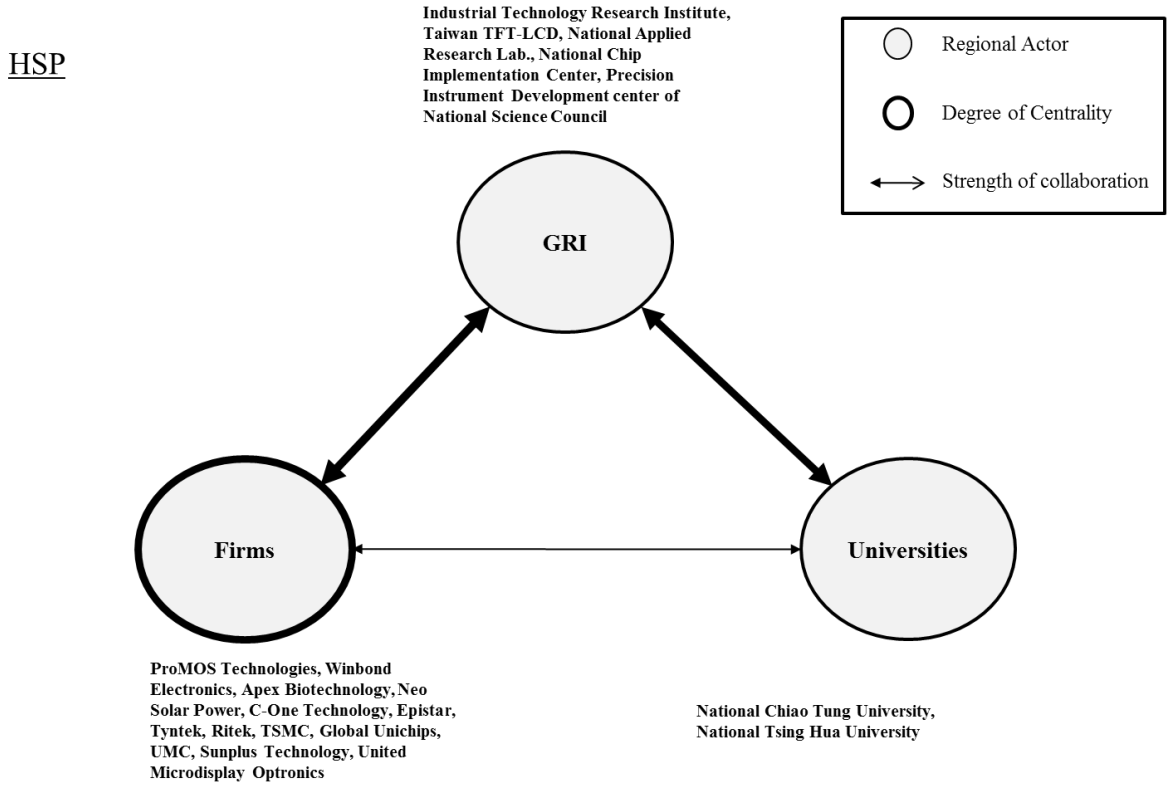


Figure 6
Conceptualization of entrepreneurial RIS