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The effects of social capital on knowledge heterogeneity

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Abstract

Purpose – The purpose of this paper is to examine the influences of social capital on knowledge heterogeneity in order to advance the understanding of the effects and to reconcile existing inconsistent findings.

Design/methodology/approach – Survey data collected from 105 new product development (NPD) projects were analyzed with regression-based methods.

Findings – The results indicated that trust, centralization and shared vision as the three social capital dimensions generally have negative impacts on the domain and presentation dimensions of knowledge heterogeneity. However, the three dimensions of social capital do not exhibit consistent influences on the tacitness heterogeneity (i.e. an epistemological dimension of knowledge heterogeneity).

Research limitations/implications – More research is needed to explore the role of social capital dimensions in developing a range of knowledge attributes of NPD teams, among which knowledge heterogeneity is one. The various dimensions of knowledge an NPD team possesses should have performance implications and deserve future investigation.

Originality/value – The study is one of the first documented attempts to demonstrate contingencies in the relationship between social capital and knowledge heterogeneity. The effect of social capital on knowledge heterogeneity should be understood at the level of dimensions of the two respective constructs.

Keywords Social capital, Knowledge heterogeneity, New product development project

Paper type Research paper

Introduction

Organizations are knowledge-processing entities that operate in competitive business environments. In such contexts, high-quality knowledge management activities, including the creation, acquisition, sharing and integration (Grant, 1996; Nonaka and Takeuchi, 1995) of knowledge as critical firm-level intellectual capital (Ling, 2013; Su and Carney, 2013), have become crucial for organizational capability building and success (Teece, 1998; Teece *et al.*, 1997).

As business environments are rapidly changing and organizations are compelled to change to cope with environmental changes, knowledge is a cornerstone for enacting organizational changes but also a key barrier to changes if not being well managed. Laszlo and Laszlo (2002) argue that knowledge evolution is key for organizational members to align with societal changes with sustainable leaning so as to create competitiveness of organizations. Under such a premise, a detailed clarification of the relationships between specific enablers and specific types of knowledge (henceforth called knowledge dimensions) useful for the development of organizational competitiveness under rapidly changing environments is vital and crucial for organizations (Chalkiti, 2012; Jones and Mahon, 2012). By contrast, failing to continue the course of knowledge development may lead organizations to face great challenges in high-velocity contexts (Mahon and Jones, 2016; Scalzo, 2006).

Thus, many scholarly works have supported an expansion of the scope of knowledge (i.e. increasing the degree of knowledge heterogeneity; Rodan and Galunic, 2004; Tsai, 2016;

Tsai *et al.*, 2014), arguing that the continuous investment in and broadening of knowledge bases is beneficial for organizations (e.g. Tushman and Anderson, 2004). More recently, De La Torre-Ruiz *et al.* (2011) found that job-related skill (i.e. knowledge) heterogeneity in a team, in joint consideration of average skill levels of individual team members, positively influences action team performance. They found that teams high in knowledge heterogeneity (i.e. knowledge structure) outperform those low in knowledge heterogeneity.

However, knowledge heterogeneity does not emerge from a vacuum, and extant studies have not thoroughly investigated antecedents that might lead to the emergence of knowledge heterogeneity. Understanding the antecedents which influence knowledge heterogeneity can help organizations proactively predict and plan for the development of such heterogeneity as a collective knowledge structure.

The above-mentioned gap can be addressed through an examination of the effect of social capital on knowledge heterogeneity. Social capital has been widely accepted for its role in facilitating the exchange and combination of knowledge assets (Chuang *et al.*, 2016; Nahapiet and Ghoshal, 1998; Tsai, 2016). Subramaniam and Youndt (2005) argue that knowledge embedded in and potentially obtained through social networks and relations can grow in diversity for innovative purposes. Cooper (2005) demonstrated that high-quality networking facilitates access to different knowledge assets located in different units within organizations. Combining these viewpoints, social capital is a critical factor that may determine the development of knowledge heterogeneity.

Furthermore, research must do more than simply examining the effect of social capital on knowledge heterogeneity at the surface and overall level. To truly understand this relationship, research must examine the effects of different and detailed dimensions of social capital on different dimensions of knowledge heterogeneity. Such an examination may provide fine-grained implications for organizations which heavily rely on social capital as a collectively possessed knowledge asset (e.g. Tsai and Ghoshal, 1998; Tsai 2002, 2016). However, few scholars have addressed this issue.

In sum, the purpose of the present study is to empirically analyze the data to better understand the effects of specific social capital elements on the creation of knowledge heterogeneity. In the following section, we start by discussing the dimensionality of social capital and knowledge heterogeneity. We then proceed to develop hypotheses that will guide our empirical analyses, and end by reflecting on the results.

Literature review and hypotheses development

Knowledge heterogeneity

Effective knowledge management is implemented by a collective of people with heterogeneous knowledge within an identical governing structure (e.g. a new product development (NPD) team, a strategy group, a small interior design company). As an attribute describing the knowledge structure of a collectivity, knowledge heterogeneity refers to the degree to which members' knowledge is different from that of other members (Rodan and Galunic, 2004; Tsai *et al.*, 2014). As knowledge management takes place at a collective level, knowledge heterogeneity exists in a collective geared toward a certain knowledge activity or process. If a unit or collective has a high level of knowledge heterogeneity, people establish a knowledge base with highly diversified sources and domain areas (Littlepage *et al.*, 1997; Reagans and Zuckerman, 2001). Rodan and Galunic (2004) discuss knowledge heterogeneity and its influences on innovation and suggest that focal actors connect with external actors with diverse knowledge. Exchanging and learning different knowledge in such contexts may motivate members to engage in knowledge activities; in other words, knowledge heterogeneity may constitute a real "motivator" (Quigley *et al.*, 2007) for collective knowledge activities.

From an organizational demography perspective, research has examined various kinds of diversity related to knowledge heterogeneity, including educational and functional diversity

(Ancona and Caldwell, 1992; Smith *et al.*, 2005). More recently, studies have begun to investigate the essence and effects of knowledge heterogeneity in depth. The investigation involves the direct assessment of the heterogeneity in knowledge itself rather than in knowledge-related factors (e.g. Tsai *et al.*, 2014).

Following the aforementioned study trend, knowledge heterogeneity should be examined by its specific dimensions. When organizational knowledge is investigated, important dimensions include the domain areas of the knowledge (Cohen and Levinthal, 1990), the ways that knowledge is presented and articulated (Hedlund, 1994; Hedlund and Zander, 1993) and the epistemological attributes of knowledge, such as tacitness (Grant, 1996; Zander and Kogut, 1995), in particular. Thus, we categorized knowledge heterogeneity into three sub-dimensions: domain, presentation and tacitness heterogeneities. Here, domain heterogeneity refers to the total number of categories and sub-categories of expertise within an identical organizing structure. For example, individuals in an organization's advertising unit are in a knowledge domain different from their colleagues who work on electronic chip design. Since these people may come together for a NPD project someday, that project could have an overall knowledge base composed of two different knowledge domains. Presentation heterogeneity refers to the degree to which members within a unit present their knowledge in different ways. For example, while some people might vocalize their knowledge publicly, others might do so by writing a technical note and uploading it to the company portal. Tacitness heterogeneity indicates the degree to which the knowledge that members possess differs from that of other members in terms of knowledge tacitness.

Social capital
Social capital can either positively or negatively influence organizational outcomes (Adler and Kwon, 2002). The literature has indicated that social capital is an important factor that influences general knowledge management (Inkpen and Tsang, 2005; McFadyen and Cannella, 2004). In the knowledge management context, social capital refers to interpersonal relationships and the resources embedded in and among those relationships that generate impacts on knowledge activities at the collective level (e.g. McFadyen and Cannella, 2004; Nahapiet and Ghoshal, 1998; Tsai and Ghoshal, 1998). Social capital, such as the relationships between and among knowledge workers, can be examined by and from its important constituent elements, including trust, norms, obligations and identification, which collectively guide patterns of interpersonal interaction and communication for processing knowledge.

Social capital is an inherently multidimensional construct represented by structural, relational and cognitive aspects in an integrative framework (Adler and Kwon, 2002; Nahapiet and Ghoshal, 1998; Tsai and Ghoshal, 1998). We selected one important constituent element for each of the three dimensions, as suggested in the literature (Adler and Kwon, 2002; Nahapiet and Ghoshal, 1998; Tsai and Ghoshal, 1998), and then adjusted these elements to the knowledge context as the centralization of knowledge activities (for the structural dimension), the trust in knowledge co-workers (for the relational dimension) and the shared vision of knowledge (for the cognitive dimension).

Centralization. Centralization refers to the degree that important organizational activities (here, collective knowledge activities) are concentrated in and within a particular group of people (Huang and Cummings, 2011; Tsai and Ghoshal, 1998). In a knowledge management context, resource exchange and combination methods are heavily affected by centralization (Tsai and Ghoshal, 1998). The higher the overall centralization, the higher the degree to which knowledge-based interactions are centralized around one or a few actors within a social network, within which actors interact frequently (Kilduff and Tsai, 2003, p. 32).

Given that sources of interaction may affect the type of knowledge which people are gaining access to (Rodan and Galunic, 2004), centralized interactions may limit the development of knowledge heterogeneity. If centralization is high, members in the unit may not be able to develop a range of alternatives to the issues or problems at hand because of

limited access to a variety of information. Therefore, centralization of knowledge activities may limit the breadth of information channels (Damanpour, 1991). Additionally, the working knowledge domain is restricted to the range of the few central actors with whom people interact (Huang and Cummings, 2011), resulting in low domain heterogeneity.

Moreover, centralization may limit fully interactive knowledge activities among all members. Tsai (2002) reported that centralization, one of the fundamental dimensions of organizational design, negatively influences knowledge sharing. Without knowledge sharing, it is difficult for an organization, as a whole, to create new knowledge that departs from its original portfolio of collective knowledge. Additionally, Pertusa-Ortega *et al.* (2010) noted that centralization, as a characteristic of organizational structure, negatively affects new knowledge generation in organizations.

Centralization may also have a negative impact on the presentation/style dimension of knowledge heterogeneity. People tend to imitate or be molded by the leader in a centralized situation. People may reasonably attribute the central person's popularity to his/her behavioral and verbal styles when publicly expressing or managing information and knowledge (Howell and Avolio, 1993), which may also easily legitimize the knowledge presentation styles of such a leader.

However, centralization should positively influence tacitness heterogeneity. The tacitness heterogeneity addresses the overall configuration of epistemological attributes of knowledge, not quantitative categories (e.g. "type" or "sort"). Indeed, tacitness heterogeneity refers to a proportional continuum, since the tacit and explicit dimensions of collective knowledge may co-exist. As previously mentioned, in a centralized context, the overall communication and interactions regarding knowledge may be limited to/around a few persons. However, Nonaka (1991, 1994) and Nonaka *et al.* (1995, 2000, 2006) argued that through face-to-face interaction, tacit knowledge is more likely to be transferred and transformed (into codified knowledge and then be further internalized as tacit, and so on) via close interactions, conversations and justifications. Thus, knowledge of members in the unit not engaged in knowledge-related communication has fewer opportunities to be expressed than those engaged in such communication, thus, making what was tacit remains tacit. As a result, the degree of collective tacit heterogeneity in a situation of centralization may be high:

> *H1.* Centralization in knowledge activities negatively influences the domain and presentation dimensions, but positively affects the tacitness dimension of knowledge heterogeneity.

Trust among co-workers. We argue that trust among members is negatively associated with knowledge domain heterogeneity. Trust between actors could be defined as one's belief that one's co-workers are reliable and will seek to maintain a good relationship among co-workers and to be responsive if there is any call for help (Zaltman and Moorman, 1988). On this basis, trust also constitutes an important foundation for collective knowledge activities (Davenport and Prusak, 1998). Because human beings are generally risk averse, the heterogeneous development of knowledge is not welcome given the potential costs of exploring new knowledge areas. Also, members' trust is likely to be strengthened by the influences of overall team climate, especially in diverse team settings (Wei *et al.*, 2018). Diversity and trust may also interact in influencing team performance (Khan *et al.*, 2014). Thus, in a work unit, the fact that one member trusts another may lead to the member seeking knowledge substitution from the trusted co-worker if the co-worker's knowledge is deemed superior (cf. Conner and Prahalad, 1996). Put differently, a high level of trust as a form of relational embeddedness between knowledge givers and receivers can be less helpful for handling heterogeneous knowledge (Bonner and Walker, 2004). Furthermore, Hoegl and Parboteeah (2006) found that if members use social skills to enhance social relationships, they will better empathize with one another's thoughts.

The empathy may extend to those who hold differing views or even those who oppose the views of the focal members. Members in general will be more apt to accept criticism and recognize one another's needs. For this reason, people may tend to rely on colleagues' existing knowledge for problem solving, thus, keeping the domain heterogeneity low.

Trust may be negatively associated with knowledge presentation heterogeneity. To be effective, knowledge should be transferred from one member to another in multiple ways if necessary (Grant and Gregory, 1997). However, trust stimulates more frequent, recurring patterns of interactions, facilitating familiarity and better understanding between and among members in a work unit (Nahapiet and Ghoshal, 1998). Trust also lower possibilities of misunderstandings and interpersonal distance (Napier and Ferris, 1993). Therefore, in a work unit where trust is highly developed, members do not need multiple methods for knowledge sharing, reducing the degree of knowledge presentation heterogeneity. Moreover, Dedahanov and Rhee (2015) also found that trust can lead to employee silence especially in the existence of organizational commitment.

Trust presents members with an informal code of interaction built on mutual interests (rather than self-interest) and a norm of reciprocity, which is especially true in knowledge activities (Davenport and Prusak, 1998). In this type of collective climate, people understand the importance of providing feedback to colleagues during knowledge activities. Thus, in contrast with the effect of centralization on tacitness heterogeneity, trust enables members to externalize their own knowledge to build constructive conversations with their colleagues. Members also express their knowledge confidently and freely when they feel that they are trusted. Such confident expression of knowledge may increase the likelihood of their knowledge being transformed into a different tacitness state (e.g. from tacit to explicit), given members' efforts to externalize and internalize their knowledge:

H2. Trust in co-workers negatively influences the domain and presentation dimensions of knowledge heterogeneity, while it positively influences the tacitness heterogeneity.

Shared vision of knowledge
Organizational members may have a shared vision of their collective goals and aspirations (Tsai and Ghoshal, 1998). Without a shared vision, members with different social, cultural, historical or professional backgrounds may perceive their goals and methods of goal achievement very differently. A shared vision enhances social relationships and provides cognitive benefits for complex collective knowledge activities, especially those which are geared toward learning (Akgün *et al.*, 2005; Akgün and Lynn, 2002).

A shared vision helps people to efficiently undertake collective knowledge building. A congruent set of beliefs offers guidance, helping to manage the tension between diverse knowledge assets and leading collective knowledge development in a similar direction. With a shared knowledge vision, members maintain a better understanding of knowledge priorities, which helps to prevent possible conflicts resulting from personal preferences in knowledge area domains. Nonetheless, any knowledge that is considered to deviate from the shared vision or to threaten the harmony and coherence within the work unit will be excluded or discarded (Tsai *et al.*, 2014).

Moreover, a cognitive premise or planning may serve as an integrative device that guides members' actions and decisions (Simon, 1976). At the organizational level, a shared knowledge vision may guide members' perceptions of preferences, priorities and participation directions of knowledge development in less divergent directions, achieving what Nonaka *et al.* (2000) referred to as coherence through organic interactions. Therefore, a predictable convergence of the knowledge domain, presentation and tacitness should emerge:

H3. A shared knowledge vision negatively influences the domain, presentation and tacitness dimensions of knowledge heterogeneity.

Methodology

Sample and procedures

Following the predecessors (e.g. Saxenian and Li, 2003), our sample included NPD teams of Taiwanese high-tech companies in the semi-conductor, electronics and information technology industries, which were located using the Common Wealth 1000 Database. Mainly, these firms were judged to be knowledge intensive, and emphasize the build-up of social capital within the firms for knowledge exchange, diffusion, application and innovation. In Taiwan, social capital and knowledge management are both considered important for the workplace. Taiwan also witnesses knowledge heterogeneity to be increasingly important for innovation-oriented work organizations/units (e.g. NPD teams) (Tsai *et al.*, 2014). Typically, NPD teams are composed of members from diverse functional backgrounds so as to coordinate and incorporate managerial, marketing and technological requirements.

Thus, NPD teams in high-tech companies in Taiwan are often equipped with heterogeneous knowledge. For instance, while marketing team members might emphasize the importance of customer-friendliness and efficient use of the intended product, other members from R&D department may be reluctant to sacrifice functionality, which increases the product's complexity. Moreover, a team is one fundamental unit for organizations to process knowledge and social relations (Sapsed *et al.*, 2002). Therefore, NPD teams, which serve as the sampling and analysis units for this study, in high-tech companies in Taiwan are suitable for investigating the issue of social capital and knowledge heterogeneity.

Data were collected through the survey method. Survey packets were mailed to heads of R&D departments of the target companies. The introductory letter of the survey stated the purpose and potential contribution of the survey, explained how to complete the questionnaire and promised confidentiality of responses. Follow-ups were conducted via telephone and e-mail to increase the return rate. The head of the R&D department was requested to identify one NPD project team within his/her department and answered the questionnaire on knowledge heterogeneity for the selected project team. At the same time, she/he was requested to provide the questionnaire on social capital within the project team to the project manager who was in charge of the project team. The project manager then answered the questionnaire on social capital.

We sent questionnaires to a total of 400 NPD project teams from 400 companies. The survey resulted in 105 effective questionnaires from 105 NPD teams, reflecting a return rate of 26.25 percent. For all of the raters, 37 percent are female and 63 percent male; with an average tenure of 14.6 years (SD = 5.1); all are in top management teams or in top management advice council; and the raters, on average, are 42.1 years in age (SD = 7.8). The questionnaire was developed from existing measures, as reported below. As the questionnaire was administered in a Chinese language setting, the survey was in Chinese. Translation and back-translation procedures were conducted to ensure that the Chinese instrument was conceptually equivalent. A series of pretests was conducted with a sample of NPD-related professionals and managers (ten persons for each group). The pretest was used to evaluate the content validity of the measures, ensure the clarity of instructions and items and make minor refinements (Tanriverdi and Venkatraman, 2005).

We made several efforts to address the possible threat of common method variances prior to the administration of questionnaires. First, we randomized the order of the item groups (representing constructs) appearing in the survey to prevent the rater from imagining the inter-construct relationships. Second, two respondents separately rated different parts of a single questionnaire. Furthermore, some of the control variables (e.g. team size) were obtained from secondary data such as HR records. We mailed out the survey with instructions asking a senior executive to rate the first section (i.e. knowledge heterogeneity) and asking another knowledgeable person (e.g. project manager or senior project leader) to finish the remainder of the survey (i.e. social capital and standardization).

Measurement

Scales of the focal constructs were adopted from scales with established validity and reliability. This has been seen as a step to ensure the validity and reliability of the measures. Below we report the scales used for this study.

Dependent variables

Knowledge heterogeneity. A three-item, seven-point Likert scale (Cronbach's $\alpha = 0.88$) was drawn from extant studies (Rodan and Galunic, 2004; Tsai *et al.*, 2014). Tsai *et al.* (2014) argued that the true effect of knowledge heterogeneity should be considered distinct from that of educational and functional diversities. They developed and extended an inventory based on the research of Rodan and Galunic (2004) to include the scenario technique which explains the meaning of knowledge heterogeneity in three dimensions. For example, the knowledge between an airline pilot and a computer scientist is heterogeneous because they should have nearly no work-related knowledge in common. The first item (for the knowledge domain of heterogeneity) is "Please indicate the extent to which pairs of working colleagues on your team have similar knowledge in the technological domain (reverse-coded)." The second item (for the presentation dimension of heterogeneity) is "Please indicate the degree to which pairs of working colleagues on your team have similar ways of or approaches to expressing their knowledge." The final item is a semantic difference item, which measures the proportion of collective knowledge composed of tacit or explicit knowledge, the most commonly used proxy for knowledge of an epistemological dimension of knowledge heterogeneity.

Independent variables

Seven-point Likert-scale items ranging from "1" (strongly disagree) to "7" (strongly agree) were used to measure each of the following constructs: trust, centralization, and shared knowledge vision. Trust ($\alpha = 0.85$) was measured by adopting an established inventory (Ng and Chua, 2006). The two items are "All members trust what their colleagues say and do" and "Colleagues on our team believe that no one would do anything to harm or take advantage of us." Centralization ($\alpha = 0.74$) was measured using Atuahene-Gima's (2003) decentralization measure in the centrifugal force inventory. Because Atuahene-Gima originally reverse-coded all items in this scale, we incorporated them as they were. This inventory is especially designed for and validated in the NPD context. Therefore, it is suitable for investigating the structural dimension of social dynamics among many team members. The five items included "We had to ask a senior manager or specific colleagues before we could do almost anything" and "Little action taken on the project until a senior manager approved it." We developed the five-item shared knowledge vision ($\alpha = 0.89$) measure based on a notion in existing research (Nahapiet and Ghoshal, 1998; Tsai and Ghoshal, 1998) about a shared vision revising the superordinate goal inventory of Atuahene-Gima (2003). Items included "All team members were committed to the same learning process and goals for the project's success" and "The project goals and objectives linked all of us together."

Although team-level constructs (e.g. social capital) were rated by individual raters, we were confident of the credibility of the answers because the selected raters were very knowledgeable on the NPD team's dynamics. It is possible to have an individual person to provide information for higher level constructs (Kozlowski and Klein, 2000). In the questionnaire, the wording of all related items carefully referred to their collective subjectivity (e.g. using "our team/project" instead of "my team project" in the item descriptions) (Chan, 1998).

Control variables

Potential variables may affect knowledge heterogeneity, but they fall outside the scope of our conceptual interests. First, team size was controlled because a unit's size might

pre-determine the incorporated scale and scope of team members' knowledge. Second, R&D investment was another control variable based on the suggestions that we received from experts during the pilot study. R&D investment might also affect the likelihood that an NPD project will draw from various knowledge areas to achieve its goals. Third, we assessed the degree of standardization ($\alpha = 0.64$) (Gilson *et al.*, 2005), which reportedly has an impact on teams' innovative use of knowledge. The three-item standardization scale included the following items (rated on a seven-point Likert scale): "There are standard problem-solving procedures"; "Our team works according to the standard operations manual or the employees" guidebook'; and "We seldom adopt new procedures, mostly doing our work according to the original processes." Fourth, we further control educational and functional diversities because they affect knowledge heterogeneity. These two variables were measured using statistics regarding members' educational and functional backgrounds. We then calculated this measure using the Blau's (1977) heterogeneity index.

Results

Table I presents the means, standard deviations and correlation coefficients of the variables. Multiple regression analysis was adopted to test the hypotheses. As suggested by earlier research (e.g. Chuang *et al.*, 2016; Jung and Lee, 2016; Makri *et al.*, 2010), regression types of analysis are useful for hypotheses testing because a range of controls can be included so that the explanatory power of the independent variables can be examined. In Table II, the statistics present the results of multiple regressions. All variance inflation factor coefficients are less than 2, thus, indicating that all variables passed the multicollinearity test (Hair *et al.*, 1995). *H1* stated that centralization in knowledge activities negatively influences the domain and presentation dimensions of knowledge heterogeneity, but positively affects the tacit dimension of knowledge heterogeneity. The analysis showed that centralization was negatively and significantly related to the domain and presentation dimensions of knowledge heterogeneity ($\beta = -0.26$, $p < 0.1$ and $\beta = -0.40$, $p < 0.05$, respectively). Furthermore, the analysis showed that it did not significantly influence tacitness heterogeneity, suggesting that *H1* was only partially supported. The hypothesized relationship between centralization and the tacitness dimension of knowledge heterogeneity did not gain significant statistical support. Nevertheless, the β coefficient showed that the influence is in the hypothesized positive direction. The literature on centralization and leadership in knowledge management has shown that knowledge activities need higher-order guidance to be implemented efficiently. However, studies have gradually provided inconsistent findings, challenging the accepted wisdom. For example, centralization has been found to be negatively associated with knowledge sharing (Tsai, 2002), the use of knowledge for competitive advantage (Pertusa-Ortega *et al.*, 2010) and the use of critical knowledge for team performance (Huang and Cummings, 2011). Our study echoes these studies by providing evidence for the negative relationships between centralization and the domain and presentation dimensions of knowledge heterogeneity.

H2 stated that trust in co-workers negatively influences the domain and presentation dimensions of knowledge heterogeneity, while it positively influences the tacitness dimension of knowledge heterogeneity. According to the result, trust was negatively and significantly associated with domain and presentation heterogeneity ($\beta = -0.40$, $p < 0.05$ and $\beta = -0.31$, $p < 0.05$, respectively), and it showed a positive relationship with tacitness heterogeneity ($\beta = 0.52$, $p < 0.1$), thus, supporting *H2*. The result indicated that trusting colleague workers could lead to a narrowed scope of knowledge domain and decreased numbers of ways of knowledge presentation, while the tacitness composition of knowledge objects can be more diverse. This means that members develop knowledge in a narrowed domain and present it in similar way. However, some keep knowledge as the thing they know but they cannot (or do not) say, while others make knowledge explicitly accessible.

The effects of
social capital

Variables	Mean	SD	1	2	3	4	5	6	7	8	9	10
1. Trust	5.92	0.69	–									
2. Centralization	5.55	0.19	0.31*									
3. Shared knowledge vision	4.77	1.01	0.38**	0.49**								
4. Size	5.26	0.79	0.33*	0.28	0.37**							
5. Standardization	4.33	1.57	0.50**	0.38	0.32	0.39**						
6. R&D investment	6.97	0.36	0.22	−0.36*	0.53*	0.33*	0.22					
7. Educational diversity	0.39	0.24	0.63**	0.50	0.67	0.51*	0.12	0.55				
8. Functional diversity	0.51	0.27	0.68*	0.55	0.21	0.46**	0.43*	0.59	0.30			
9. Domain knowledge heterogeneity	4.59	1.32	−0.77*	−0.56**	0.56**	0.06	−0.35**	0.69***	0.28*	0.50*		
10. Presentation knowledge heterogeneity	5.97	0.68	−0.55*	−0.34**	0.27*	0.44**	−0.45**	0.28	0.63**	0.01	0.25	
11. Knowledge heterogeneity	3.01	1.21	0.52*	0.35*	0.05	0.34	0.25	0.17	0.56*	0.22	0.13	0.60*

Notes: $n = 105$. $*p < 0.05$; $**p < 0.01$; $***p < 0.1$

Table I.
Descriptive statistics
and correlations

Variables (X)	Domain	Knowledge heterogeneity (Y) Presentation	Tacitness
Educational diversity	0.47**	0.35**	0.10*
Functional diversity	0.31*	0.52*	0.08
Size	0.40***	−0.36*	−0.15***
Standardization	−0.27***	−0.35**	−0.05
R&D investment	0.47**	0.21*	0.07
Centralization	−0.26***	−0.40*	0.07
Trust	−0.40*	−0.31*	0.52***
Shared knowledge vision	−0.35*	−0.41*	−0.08***
R^2	0.61	0.47	0.16
F	32.40**	34.61**	16.73*

Notes: $n = 105$. *$p < 0.05$; **$p < 0.01$; ***$p < 0.1$

Table II.
The effect of social capital on knowledge heterogeneity

The test results reported here may mean that real creative works are limited and communication for (potentially) new knowledge may be impeded. Good relationship may enable the development of jointly created and shared knowledge (McFadyen and Cannella, 2004). But if good relationship leads to homogeneous domains and methods for knowledge presentation, as well as mixed tacitness dimensions among differing members, cost of knowledge management can be high.

H3 suggested that a shared knowledge vision negatively influences the domain, presentation and tacitness dimensions of knowledge heterogeneity. This hypothesis was supported ($\beta = -0.35$, $p < 0.05$, $\beta = -0.41$, $p < 0.05$ and $\beta = -0.08$, $p < 0.1$, respectively). Our results have demonstrated how an influential and consistent shared knowledge vision, among other social capital dimensions, can guide the development of knowledge heterogeneity. Past studies consistently and strongly promote the benefit of shared vision for knowledge management activities (Chow and Chan, 2008; Li, 2005; Zheng et al., 2010). The result here, however, showed that such benefit may only work from the process view of knowledge management. Ironically, shared knowledge vision may also limit the domain scope and presentation methods of knowledge. Moreover, shared knowledge vision may result in collective knowledge being consistently tacit or explicit.

Ideally, with a shared knowledge vision, members are prone to maintain a shared understanding of knowledge development priorities, which potentially screen out possible conflicts resulting from incommensurability in expertise or tasks. Hoegl and Parboteeah (2006) found that once social skills are developed and used well under a shared vision, team members can better empathize with each other's thoughts, even the thoughts of one are different or opposite. They also found that criticisms from and needs of others are more easily accepted. However, our result seemed to reflect that shared knowledge vision should be a latter developed factor, on the premise that knowledge heterogeneity has already been existed (e.g. Tsai, 2016). We boldly infer that if shared knowledge vision has been already developed prior to the development of collective knowledge (e.g. imaginably by policy or few leaders), then the knowledge structure might be overly affected to be homogeneous. While we do not intend to make value judgment about such a case, concerns could be raised here on the potential increase in homogeneity that shared knowledge vision can cause. Overall, our results showed that social capital might both be a stimulus and catalyst for knowledge heterogeneity. While some studies noted that social capital can intervene the relationship between knowledge diversity and organizational outcomes (Tsai, 2002, 2005, 2016), the present study demonstrated that social capital can also be the determinant of knowledge heterogeneity. With a lens of time for studying heterogeneity (Harrison et al., 1998), social capital plays an important role in the continuous development of knowledge heterogeneity.

More importantly, existing literature mostly suggests the effect in general of social capital on knowledge management (Manning, 2010; Lefebvre *et al.*, 2016), or at best on the sharing and management of two types of knowledge, tacit vs explicit (Hau *et al.*, 2013). This study offers useful insight and information which advances our understanding of the general relationship. As the results showed, social capital may have positive influences on one dimension of collective knowledge structure, while negative on another dimension. This may partially explain inconsistent results of the relationship between social capital and collective knowledge in past studies, and may bring more imaginative implications that go beyond the aforementioned simple, global relationship.

Discussion

Implications for theory

A systematic study of knowledge heterogeneity supports the argument that knowledge attribute and structure can have its good strategic implications (Victer, 2014). Although studies have shown that social capital is a potential facilitator of knowledge management, few studies have explicitly considered the effect of social capital on knowledge heterogeneity. Knowledge with differing degrees of heterogeneity alongside the three dimensions needs to be well coordinated in R&D project groups to be geared toward task completion and goal achievement (Tenkasi and Boland, 1996). While the literature has primarily focused on the effect of social capital on the implementation of knowledge management, the present study advances the current understanding by addressing the effects of social capital dimensions on collective knowledge structures couched in terms of knowledge heterogeneity useful for innovation outcomes.

Additionally, while most studies have generally investigated the effect of knowledge heterogeneity on particular knowledge consequences, such as innovation in social contexts (e.g. Rodan and Galunic, 2004), the present study has established social capital as a major antecedent of knowledge heterogeneity. Furthermore, the detailed dimensionalization of social capital (e.g. the shared knowledge vision) and knowledge heterogeneity (e.g. the tacitnessattribute) also demonstrates the intricate connections between the two constructs. The present study indicates a need for future research to take the approach reported in this study.

This study also contributes to knowledge management in East Asian contexts as exemplified by Taiwan, the study context. Interpersonal relationships and rapport building are two important cornerstones in the society and business arenas alike. Thus, social capital is emphasized in such cultural spheres and it drives collective knowledge activities such as knowledge sharing and creation (Li *et al.*, 2014; Ling, 2013; Su and Carney, 2013). Given that knowledge structure is one of the fundamental imperatives of knowledge management and that significant differences exist in knowledge management in between western and eastern cultures (Hedlund and Nonaka, 1993), the present study is especially important in enhancing our understanding of the emergence of collective knowledge structures in East Asian contexts. More specifically, while different dimensions of social capital have different influences on different dimensions of knowledge heterogeneity, social capital cannot be treated as a pure panacea; on the contrary, social skills that build up social capital and managerial skills that may utilize social capital are both necessary (e.g. Hoegl and Parboteeah, 2006). Future studies are encouraged to include pertinent factors which facilitate the development and use of social capital.

Future studies are also encouraged to examine the effect of social capital by treating knowledge heterogeneity as moderator or mediator. For example, the literature has suggested that social capital works with knowledge/resources exchanges to create competitive advantages (Nahapiet and Ghoshal, 1998; Tsai and Ghoshal, 1998). However, is such a linkage moderated by knowledge heterogeneity? Or does knowledge heterogeneity serve as an intervening factor that mediates the relationship between dimensions of social capital and outcome variables such as knowledge creation or innovations?

Moreover, considering the potential effects of cultural contexts, future studies are encouraged to investigate the effect of social capital on knowledge heterogeneity across different cultures. Such an endeavor will reveal differing interrelationships between dimensions of social capital and those of knowledge heterogeneity. The investigation may reveal differences in dimensions of social capital in their relative importance for differences in knowledge heterogeneity across societies and cultures.

Implications for practice
Practically, although our findings about the interconnectedness of social capital and knowledge heterogeneity echo previous scholarly work which suggests heavy investment in social capital for knowledge development, we suggest that companies do so with caution. It has been long thought that organizations should develop their capabilities in managing social relations using formal mechanisms and informal practices. However, understanding, predicting and managing the effects that social relations have on collective knowledge heterogeneity is more important. Though maintaining relationships does increase the likelihood of articulations of collective knowledge (McFadyen and Cannella, 2004), our findings have suggested that, in some conditions, highly developed and harnessed social relations may lead a collective knowledge structure to become homogeneous due to excessive socialization. Under such conditions, it will be even more critical for companies to let their employees know that they are evaluated and rewarded based not only on unlimited diversifications and explorations in various knowledge areas (i.e. individual knowledge performance) but also on their efforts to integrate well individually owned knowledge within their work unit, which represents their collective knowledge performance.

Moreover, it is encouraged that innovative organizations/units develop both social and managerial capabilities at collective levels through both formal mechanisms and informal practices. Effective management of innovative teams requires both technical and social knowledge. Balance between extremely autonomous personal creativity and effective applications and development of useful products can be achieved and managed, only when members clearly know that she/he was selected, evaluated and rewarded not only for their professional expertise but also their potential to integrate well with the team.

Finally, this present paper presents evidence which supports the management of intellectual asset portfolios (Jordan *et al.*, 2005). We propose that portfolio management be applied in order to assess and manage collective knowledge structure, including knowledge heterogeneity. Assessing the collective knowledge structure is now just as important as accumulating knowledge stocks.

Limitations and future directions
Because of our focus on a parsimonious model, this study chose only three constituent elements from three respective dimensions of social capital, structural, relational and cognitive. Although these elements are important, social capital encompasses richer phenomena. Future research is encouraged to embrace the full complexity of social capital in the examination of its effect on collective knowledge structure. Such an examination should extend beyond one single society or culture for its results to be generalizable.

As an exploratory study, we investigate only one of the many knowledge attributes, i.e., heterogeneity. To draw a link between social capital and knowledge, future research is encouraged to include knowledge with differing attributes, such as complexity (Zander and Kogut, 1995), ambiguity (Law, 2014) and embeddedness (Hsiao *et al.*, 2006). Likewise, knowledge with differing attributes may have impacts on differing collective outcomes, which have not been thoroughly investigated. Studies which include knowledge of various attributes can facilitate such an investigation.

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