



The changing bases of mutual trust formation in inter-organizational relationships: A dyadic study of university–industry research collaborations



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ABSTRACT

We examine how trust in inter-organizational relationships develops over time. Specifically, we study the moderating effect of relationship maturity with various trust bases in the context of university–industry (UI) research collaborations. Examining trust formation with dyadic data allows us to take into account that partners' perceptions of relationship factors are not independent of each other's actions. We adopt the Actor-Partner Interdependence Model (APIM) for the analysis of data on 98 matched pairs of recent UI research collaborations and find that relationship maturity moderates the associations of reciprocal communication and decision process similarity with trust. The results further indicate that mutual trust formation is also influenced by the other partners' perceptions of relationship factors. The findings suggest UI research partners can develop and maintain a trustful collaboration through reciprocal communication and, in the long term, by converging towards similar decision making processes.

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1. Introduction

Trust is fundamental to successful collaboration in inter-organizational relationships. It can be defined as a psychological state of willingness to be vulnerable based upon positive expectations of the intentions or behavior of another party in uncertain situations (Morgan & Hunt, 1994; Rousseau, Sitkin, Burt, & Camerer, 1998). Research collaborations between independent partners are exposed to a high amount of uncertainty, and efforts to capture possible future events through contractual specifications therefore have their limitations. Consequently, trust is a key factor for explaining variation in the outcomes of inter-organizational relationships.

However, the literature indicates that trust is not static; rather, trust can vary over the length of the relationship (Schilke & Cook, 2013; Vanneste, Puranam, & Kretschmer, 2014). Thus, examining how trust develops over the duration of inter-organizational relationships is of critical concern. The decision to trust each other, research suggests, is made on different bases as a relationship goes through discernible stages (Lewicki & Bunker, 1996; Zaheer, Alvert, & Zaheer, 1999). Early in relationships, trust is often founded on depersonalized bases

(Li, 2008; Schilke & Cook, 2013) while later in relationships, trust is grounded in more personalized associations (Levin, Whitener, & Cross, 2006; Lewicki & Bunker, 1996). Thus, while parties are apt to rely on institutional categorizations of each other at the beginning of a relationship, over time, trust is increasingly based on the experience of repeated and reciprocal interactions and behaviors (Levin et al., 2006; Ring, 1996). These exchanges enhance understanding and knowledge of each other such that the parties may eventually 'think like', 'feel like', and 'respond like the other' (Lewicki & Bunker, 1996, p. 123). This latter basis of trust emerges from the internalization of mutual preferences and working styles and fosters acting in each other's best interest (Poppo, 2013).

However, there is a lack of empirical research that has examined the bases of trust as an inter-organizational relationship progresses. While the studies of Dwyer, Schurr, and Oh (1987), Ring and Van de Ven (1994), and Das and Teng (2002) have advanced our conceptual understanding of developmental phases of inter-organizational relationships, we know much less about the changing bases of trust in this process (Poppo, 2013). This study seeks to fill this void by examining whether the foundations of trust are contingent upon the maturity of the relationship between the partners. Essentially, we explore the possibility that partner X bases its trust of partner Y with whom it is familiar on different factors than those it would rely on when first-hand experience with the other party is lacking. In particular, we examine whether trust is more strongly associated with a depersonalized base

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(i.e., demographic similarity) in the very early stages of inter-organizational relationships and with personalized bases (reciprocal communication and decision process similarity) in the intermediate and mature stages of the relationship. By doing so, this study adds to our understanding of the varying bases of trust formation in inter-organizational collaborations.

Studying trust formation in a dyadic setting should also take into account that parties vary in their perceptions of relationship factors (e.g., reciprocal behavior) and that these perceptions are not independent of each other's actions (Ferrin, Bligh, & Kohles, 2008). To illustrate, opportunism or caring behavior in the past might affect perceptions of both partners. Partner X who was taken advantage of might expect it to happen again and is careful with trusting the other partner. Partner Y who behaved opportunistically knows that partner X is cautious of trusting and might avoid trusting partner X himself. Alternatively, as partner X begins to care about Y, partner X becomes more trustworthy from Y's perspective and vice versa (Vanneste et al., 2014). This 'mutuality' where the perceptions and actions of one party could influence the perceptions and outcomes of the other party suggests that trust perceptions are interdependent and should be studied as such. While mutual trust perceptions have been recognized as important, few studies have examined trust formation taking within-dyad dependencies into account by disaggregating overall dyad-level effects into separate actor and partner effects, and thus allowing to separately estimate the influence of a focal actor's perception of a behavior or outcome as well as the influence of the partner's perception of a behavior or outcome (Ferrin et al., 2008; Gooty & Yammarino, 2011).

We study bases of mutual trust formation in university-industry (UI) research collaborations. These collaborations are close inter-organizational relationships between universities and companies aiming at the generation of new products, technologies, or processes. As a result of competitive and institutional pressures, both companies and universities increasingly reach out to each other (Etkowitz et al., 2008; Laursen & Salter, 2004), resulting in unprecedented opportunities for successful collaborations between academe and industry, particularly in science-based industries. However, trust in UI research collaborations can be difficult to develop because universities are driven by cultures that emphasize scientific interest rather than corporate profit and incentivize academic performance unrelated to market or strategy considerations (Bstieler, Hemmert, & Barczak, 2015; Dasgupta & David, 1994). In contrast, companies typically insist on delaying publication of research outcomes so they can comb the results for patentable material necessary for the ultimate goal of financial return (Bruneel, D'Este, & Salter, 2010). How to overcome these deep-rooted differences and facilitate cooperation is of great concern to both managers and academics and the formation of mutual trust is at the core of this concern (Hemmert, Bstieler, & Okamuro, 2014). With these challenges in mind, UI collaborations offer a relevant setting for studying mutual trust formation. Furthermore, as UI research collaborations tend to be longer-term with companies and universities often engaging in an ongoing string of projects, UI research collaborations are highly suitable for studying the development of trust between collaboration partners over various maturity stages of their relationship.

This study contributes to the literature on trust formation in inter-organizational relationships in the following ways. First, it examines the changing trust bases that collaborators rely on in the inter-organizational context. By doing so, the study responds to recent trust literature indicating that consideration of how trust develops over various stages of a relationship is an important issue to examine (Li, 2008; Schoorman, Mayer, & Davis, 2007; Vanneste et al., 2014). In addition, by using process theory, the study incorporates a theoretical foundation not often found in innovation studies (Van de Ven & Poole, 2005). Second, it contributes to the nascent perspective of mutuality in inter-organizational trust development by shedding light on how the interdependence of perceptions between collaborators affects mutual trust formation (Ferrin et al., 2008). Thus, we are able to capture

both dyadic parties' underlying expectations, attitudes, and behaviors in the research collaboration. Third, our study contributes to a better understanding of the effects of relationship maturity on trust in an increasingly important, yet understudied, form of inter-organizational relationship, that of UI research collaborations.

2. Research model and hypotheses

Trust cannot be mandated, but is an outcome of consistent efforts and perceptions over time. It is individuals, as representatives of organizations, and their interpretation of another's behavior that are crucial to the establishment of trust (Blois, 1999). Research indicates that trust may be built on different bases or cues depending on the progression of the relationship (Levin et al., 2006; Lewicki & Bunker, 1996; Poppo, 2013). The length of the relationship is often considered a proxy for relationship maturity indicating the progression of the relationship (Anderson & Weitz, 1989), which may affect the relation between different trust bases and trust. As collaboration partners interact and learn about each other, their relationship evolves and the bases of trust change (Levin et al., 2006; Lewicki & Bunker, 1996; Poppo, 2013).

2.1. Process theory

Process theory conceptualizes relationship development as a sequence of stages, explaining outcomes (e.g., trust) as the result of a temporal order in which change unfolds under contextual conditions (Poole, Van de Ven, & Dooley, 2000). Process theory enables explanations of *how* a process develops over time (Schilke & Cook, 2013). Specifically, we model trust formation as a function of changing trust bases as the relationship progresses between two parties. Relationship progression is structured around three phases of maturity from nascent to intermediate to mature relationships. The process approach explains the order in which varying trust bases are used and the stage in the process at which these bases are used. In this study, the trust bases examined include the depersonalized base of demographic similarity and the personalized bases of reciprocal communication and decision process similarity of collaboration partners. These bases follow a temporal sequence of increasing familiarity from institutional categorization to observed behavior to shared perspectives and decision making styles (Dirks & Ferrin, 2002; Fisher, Maltz, & Jaworski, 1997; Hogg & Terry, 2000; Levin et al., 2006; Schilke & Cook, 2013; Zaheer et al., 1999).

In nascent relationships, the parties often lack information about each other (Li, 2008; MacDuffie, 2011). In such instances, a depersonalized categorization process may be used to assess trust (Schilke & Cook, 2013). Categorization allows the parties to evaluate each other based on a 'prototype of the key characteristics of an organizational member' (MacDuffie, 2011, pp. 38–39). As a result, trust is based on institutional cues such as demographic similarity (Schilke & Cook, 2013), defined as the extent to which a party views itself as sharing relevant characteristics with another party (Riordan & Wayne, 2008). Once the collaborators gain more relationship experience, however, the relevance of demographic similarity decreases. While a party generates an initial judgment about another party's trustworthiness based on available cues, it then recalibrates that judgment in light of subsequent evidence derived from continued interactions (Dietz, Gillespie, & Chao, 2010). Thus, over time, the assessment of trust becomes more experience-based and personal (Lewicki & Bunker, 1996; Schilke & Cook, 2013). This implies that in developing UI collaborations, company and university partners will increasingly build trust based on observations of each other's behaviors (Levin et al., 2006) such as reciprocal communication, defined as the degree to which partners exchange information in a reliable, timely, accurate, adequate and complete manner (Bstieler & Hemmert, 2008). With increasing relationship maturity, the parties subsequently develop an appreciation of each other's preferences (Lewicki & Bunker, 1996), leading to a common understanding consistent with these preferences (Schilke & Cook, 2013). As a

consequence, mutual trust is more and more built on decision process similarity, defined as the extent of compatibility and similarity between partners related to decision making processes and working styles (Bucklin & Sengupta, 1993; Saxton, 1997). This convergence of each other's operating styles contributes to a shared perspective on how to go about the collaboration (Schilke & Cook, 2013). In the following, we elaborate on the changing importance of each trust base over the duration of a relationship. Fig. 1 depicts our research model.

2.2. Demographic similarity

Consider that sometimes people with little or no prior interaction experience grant or develop initial trust to another party. Initial trust is especially important in research collaborations where reliance on existing ties would likely limit the range and novelty of collaboration outcomes (Levin & Cross, 2004) or where there is not enough opportunity for the sort of experience necessary for stronger trust to emerge (Meyerson, Weick, & Kramer, 1996). Such initial trust without much firsthand knowledge is likely based on a party's disposition to trust, on credentials reflecting expertise in a domain, adherence to professional role expectations, or on a similar social background (McAllister, 1995; McKnight, Cummings, & Chervany, 1998). Homophily theory suggests that individuals are more prone to grant initial trust to other parties who are similar on given characteristics, such as gender, race, age or education (Ibarra, 1992; Torres, 2007).

Demographic characteristics are often used as a means of inferring desired similarities in levels of experience, skills, training, intelligence, or wisdom and can have positive initial effects on trust (Tsui, Porter, & Egan, 2002). Demographic similarity works as a presumptive trust base rooted in observable demographic characteristics of another party. Perceived similarity in demographic characteristics serves to put the other party in a more favorable light than others with whom no such similarities exist (Torres, 2007). Thus, we expect partners in nascent relationships to more likely trust each other when they share similar demographic characteristics.

Demographic similarity is based on categorical social characteristics including age, gender, or education. In the UI context, the similarity of the educational background is particularly relevant and easily observable. Similar educational training provides compatible language that leads to easier access to the background and thought-world of the partner, and in general enhances a process of mutual attraction (Tsui et al., 2002). Even without knowing the counterpart, similar demographics can foster positive attitudes and emotional empathy (Hogg & Terry, 2000) and facilitate mutual understanding and collaboration (Lui, Ngo, & Hon, 2006). In the medium- to long term, however, demographic similarity is less likely to play a role for trust formation.

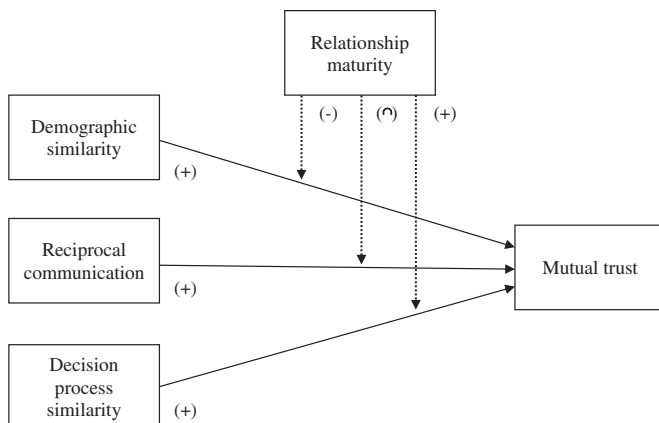


Fig. 1. Research model.

H1. In a UI research collaboration, relationship maturity will moderate the association between demographic similarity and mutual trust such that less mature relationships will exhibit a stronger association than more mature relationships.

2.3. Reciprocal communication

As people experience working with one another, trust grows through mutual behaviors and perceptions, particularly through two-way communication (Bstieler & Hemmert, 2008; Dirks & Ferrin, 2002). The partners cultivate their knowledge of each other, observe one another, and respond to each other's thoughts, feelings, and reactions to different situations (Lewicki & Bunker, 1996). During this process both partners develop conclusions about the other's trustworthiness, and then reciprocate accordingly (Ferrin et al., 2008).

In research collaborations, reciprocal communication is an indicator of a partnership's vitality and a key factor of its success (Mohr & Spekman, 1994). A high level of reciprocal communication creates an atmosphere of mutual support and respect and is critical to building trusting relationships (Anderson & Weitz, 1989). The quality of reciprocal communication can be viewed in terms of a specific combination of trust building facets, including a timely, accurate, adequate, and complete communication between partners. As communication behavior is essential to achieve the goals of the partnership, it contributes to the development of mutual trust (Mohr & Spekman, 1994). This suggests that perceptions of reciprocal communication will gain importance for mutual trust building in UI research collaborations.

Research suggests that mutual trust may develop via the effect of own prior trust perceptions on own cooperative behavior, and the effect of own behavior on trust perceptions of others (Ferrin et al., 2008; Kenny, Kashy, & Cook, 2006). Partner X's trust is affected by X's own communication behavior towards partner Y (the 'actor' effect). X's trust is also affected by its perception of partner Y's communication behavior (the 'partner' effect). Vice-versa, partner X's communication behavior affects Y's trust. Partner Y's trust is also influenced by its own communication behavior towards X. Consequently, perceptions of reciprocal communication should contribute to mutual trust building over time. It is the partner effect that captures the notion of mutual influence and interdependence (Kenny et al., 2006).

However, the accumulation of observations of behaviors, such as reciprocal communication, will at some point begin to be abstracted into a representation of the counterpart and lead partners to base their trust less on specific behaviors and more on inferences of personal commonalities (Levin & Cross, 2004). Anderson and Weitz (1989) found older, more mature relationships to exhibit less two-way communication, suggesting the parties have developed a good understanding of each other, resulting in lower communication needs. In the longer run, there may be less emphasis on reciprocal behaviors as expectations arise that outcomes will be balanced over time (Dwyer et al., 1987). Taken together, we expect an inverted U-shaped relationship between reciprocal communication and trust contingent on relationship maturity.

H2. In a UI research collaboration, the association between reciprocal communication and mutual trust will be stronger for relationships with intermediate maturity than for relationships with low or high maturity.

2.4. Decision process similarity

With growing relationship maturity, the partners may uncover commonalities that cause them to accommodate each other's views and develop similar outlooks towards the collaboration. As a result of this mutual accommodation, the partners may converge towards similar working and decision making styles, as they think, feel, and act more and more like each other (Lewicki & Bunker, 1996). As a consequence, the collaborators may increasingly base trust formation on a shared perspective of how to work together than on specific behaviors (Levin

et al., 2006). Decision process similarity enables partners to think, feel, or respond like the other, often resulting in strong empathy and sharing of each other's needs, preferences, or priorities, thereby laying the foundation for broad trust (Lewicki & Bunker, 1996). In essence, once partners develop personal commonalities on how to manage a collaboration, the base of trust will increasingly shift to these commonalities.

We use the construct of decision process similarity that embodies the degree of common understanding in the context of decision making when working together. Decision process similarity can be viewed in terms of a combination of facets of compatibility and psychological closeness between partners on how to conduct a collaboration. These facets include the degree to which collaboration partners share similar management and decision making styles, have similar tolerances for risks or ambiguities, and have a similar time frame in making decisions (Bucklin & Sengupta, 1993; Fisher et al., 1997; Saxton, 1997). People exhibit greater trust in those they perceive as having similar walks of life, outlooks, or goals (Levin & Cross, 2004). When the partners have discovered commonalities in how to organize and coordinate the collaboration, it will be easier to create a compelling vision and stimulate or maintain enthusiasm for the joint endeavor. As trusting relationships are rooted in the compatibility of processes and values, this form of cognitive compatibility facilitates a common understanding of collective goals and ways of acting in the collaboration and provides a strong foundation for trust in the longer term.

Partner X's trust is affected by its own decision process behavior towards partner Y (the 'actor' effect). X's trust is also affected by its perception of Y's decision process similarity (the 'partner' effect). Vice-versa, partner X's decision process similarity affects Y's trust. Partner Y's trust is also influenced by its own decision process behavior towards X. Over time, both partners are likely to slowly calibrate and converge their decision processes. As a result of these interdependent perceptions and the convergence of each other's processes, a shared perspective of the partners may evolve contributing to trust (Lewicki & Bunker, 1996).

H3. In a UI research collaboration, relationship maturity will moderate the association between decision process similarity and mutual trust such that more mature relationships exhibit a stronger association than less mature relationships.

3. The empirical study

3.1. Data collection and sample

We test our hypotheses with survey data from South Korean (hereafter: Korean) UI research collaborations in the fields of microelectronics, software, and biotechnology where such collaborations are particularly prevalent (Meyer-Krahmer & Schmoch, 1998). Korea is an interesting case for studying this topic, as it is a technologically advanced country with a relatively short history of UI research collaborations. Most Korean companies and universities have limited prior collaboration experience and face a strong 'cultural divide', resulting in a need for persistent efforts to create mutual trust (Hemmer et al., 2014).

Initially, we identified 5536 firms with ten or more employees from the 'Directory of Microelectronic and Information Companies', the 'Directory of Bioventure Companies', and a list of companies participating in UI research collaborations obtained from the Korea Association of Industry, Academy and Research Institute. For these firms, a preliminary informant – usually the director of R&D, marketing, new product development, or new business development – was contacted to inquire about the most recently completed UI research collaboration within the last three years. Through this process, 1784 firms with recent UI research collaborations were identified. In the next step, a key informant, the person considered most qualified to respond to our survey within each firm was identified with the assistance of the preliminary informant. Key informants (mostly project managers) were contacted by phone and carefully instructed

about the survey. Thereafter, we sent out and collected the responses via email attachment. The survey instrument was first translated into Korean and then back translated into English by separate native language speakers to secure semantic identity of the survey contents with the original questions adapted from other studies. We collected 315 responses, resulting in a response rate of 17.7%.

Next, we collected data from the corresponding universities regarding the same projects. Among the 315 collaborations, contact information regarding university partners could be obtained for 207 collaborations. We contacted the universities by phone and solicited participation from the collaborating researchers responsible for conducting the projects. We obtained 106 responses from universities for a response rate of 51.2%. Eight responses were incomplete, resulting in a final sample of 98 UI dyads.

To control for common method bias, we applied various remedies as suggested by Podsakoff, MacKenzie, Lee, and Podsakoff (2003). First, we split the survey into two parts. The first part contained the independent variables and the second part the dependent variable. We sent out the second part after receiving the first part. Second, we used neutral wording in our survey avoiding normative expressions such as 'trust'. Third, we conducted a marker test with the respondents' assessment regarding the 'success of UI collaborations' (in general) as a proxy for social desirability. The correlations between the main variables did not change notably when controlling for this variable. Therefore, we concluded that common method bias may not be a serious problem.

The company sample consists mostly of small to medium-sized firms. More than 92% of the sample firms have less than 100 employees, with an average firm size of 28.6 employees. Most of the university labs in the sample have a modest size, with an average research staff of 5.87 full-time researchers. Ten percent of the sample projects are from biotechnology, 42% from microelectronics and 48% from software. Sample characteristics are shown in Table 1.

3.2. Measures

Most key variables in this study were measured with 7-point multi-item Likert scales or semantic differentials (see Appendix A).

Dependent variable. *Trust* was assessed with four items adapted from Ganesan (1994) related to the extent the company and university representatives regarded their partners as honest, reliable and benevolent, thus capturing both benevolence and credibility-based aspects of trust.

Independent variables. We measured the *relationship maturity* of each UI dyad by the number of years the partner organizations already had a relationship prior to engaging in the focal UI collaboration. We have taken this approach, as we are focusing on the maturity of the partners' relationship since they knew each other, as opposed to the length of the focal UI collaboration. *Demographic similarity* was assessed through the educational background of the key parties of the UI collaboration ranging from 'high school education or less' (= '1') to 'PhD degree in science or engineering' (= '7'). Given the relatively small firm size, R&D directors and CEOs are usually actively involved when collaborating with universities. Demographic similarity was therefore measured with two items on the educational similarity of the firm's R&D director and its CEO with the university professor in each dyad. Then we aggregated the similarity measures of these two firm partner – university professor dyads to form the composite of demographic similarity between the collaborating partners. *Reciprocal communication* was measured by a four item scale adapted from Mohr and Spekman (1994) on

Table 1
Sample characteristics.

Staff size of university labs (mean, S.D.):	5.87 (4.62)
Employee size of companies (mean, S.D.):	28.46 (34.58)
Collaborations by technological field (number, percentage):	
Biotechnology	10 (10.2)
Microelectronics	41 (41.8)
Software	47 (48.0)

the timeliness, reliability, adequateness, and completeness of the information exchanged between the collaboration partners. *Decision process similarity* was measured using four items adapted from Fisher et al. (1997) related to the extent to which UI partners were similar regarding the time needed to make a decision, their decision-making style, their risk tolerance, and their understanding of how things should be done.

Control variables. *UI collaboration experience* was measured by the number of previous UI research collaborations (in general, not with a specific partner). *Tie strength* was assessed through the strength of personal relationships between individuals of the firm and the university partner (from 1 = non-existent–7 = close and established) as a proxy of the tie strength between the two collaborating organizations. *Organization size* was measured by the natural logarithm of the companies' number of employees and of the number of researchers in the university labs. Furthermore, we controlled for *geographic proximity*, measured on an inverse six-point scale regarding the geographical distance between companies and universities in kilometers, as well as for *project length* in months. Finally, we also controlled for the *type of partner* (with universities coded as '1' and companies as '-1').

We subjected all items of the main constructs (demographic similarity, reciprocal communication, decision process similarity, relationship maturity, trust) to a common factor analysis. It settled on a five-factor solution with all loadings >0.80 and no cross loadings >0.24. A confirmatory factor analysis of the multiple item constructs revealed a satisfactory model fit ($\chi^2/df = 1.59$; GFI = 0.924; NFI = 0.951; CFI = 0.981; RMSEA = 0.055). The Cronbach's alphas and composite reliabilities for all constructs are higher than 0.68 and the average variance extracted (AVE) is higher than 0.50 in all cases (see Appendix A), indicating satisfactory convergent and discriminant validity of the scales and suitability of the data for hypothesis testing (Fornell & Larcker, 1981).

3.3. Results

We test our hypotheses by conducting multilevel modeling using a standard dyadic design that focuses on the possible existence of mutual influence within the UI collaboration. We adopt the Actor-Partner Interdependence Model (APIM) for our analyses (Kenny et al., 2006) as it permits us to model and empirically examine interdependent phenomena (Ferrin et al., 2008). The APIM facilitates disaggregating overall dyad-level effects into separate actor and partner effects, and thus allows to separately estimate the influence of a focal actor's perception on an outcome as well as the influence of the partner's perception on the outcome. Following Kenny et al. (2006), we created separate statistical cases for each company and university response. Each observation

for the independent variables was coded twice: as an 'actor effect' and as a 'partner effect'. For example, universities' perceived reciprocal communication is an 'actor effect' for the 98 university responses and a 'partner effect' for the 98 company responses. Additionally, each matched pair was identified as a unique dyad, and within each dyad, observations were coded '1' for university and '-1' for company. The descriptive statistics and correlations are shown in Table 2. The results of the multilevel modeling analysis are displayed in Table 3.

In Model 1, the control variables are regressed on trust. Not surprisingly, trust is positively associated with tie strength ($t = 5.26, p < 0.001$) between the two parties. Trust is negatively associated with the type of the partner ($t = 1.79, p < 0.10$), indicating that universities develop a slightly lower level of trust when collaborating with companies.

In Model 2, the main effects are estimated. Demographic similarity is not related to trust. Perceptions of reciprocal communication and decision process similarity by the focal organizations are positively related to trust ($t = 6.02, p < 0.001$ and $t = 1.86, p < 0.10$; respectively). Relationship maturity, the moderator, is not associated with trust.

Model 3 shows the moderating effects of relationship maturity on the association between demographic similarity, reciprocal communication, and decision process similarity with trust. The interaction of demographic similarity with relationship maturity is not significant ($t = 0.21, p > 0.10$). Thus, Hypothesis 1 is not supported. The interactions of the actor's reciprocal communication and the partner's reciprocal communication with the squared relationship maturity are negatively associated with trust ($t = 1.73, p < 0.10$ and $t = 2.00, p < 0.05$; respectively), indicating that reciprocal communication is more strongly related to trust in relationships of intermediate maturity, thereby giving support to Hypothesis 2. The interaction of the partners' perceptions of decision process similarity with relationship maturity is positively related to trust ($t = 2.78, p < 0.01$), whereas the interaction of the actors' decision process similarity with relationship maturity is not associated with trust ($t = 1.41, p > 0.10$). Thus, Hypothesis 3 is partially supported.

To examine the robustness of this last result, we further regressed trust on the product term of the squared relationship maturity with decision process similarity. We found this effect to be insignificant ($t = 0.81; p > 0.10$), confirming the partial support for H3.

4. Discussion

The main objective of this study is to examine whether relationship maturity affects the manner in which mutual trust is created in an inter-

Table 2
Descriptive statistics and correlations.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. UI collaboration experience														
2. Tie strength	0.25**													
3. Organization size (actor)	-0.11	-0.08												
4. Organization size (partner)	0.24**	-0.17*	-0.34**											
5. Geographic proximity	-0.10	0.00	-0.06	-0.06										
6. Length of project	0.09	0.15*	0.09	0.09	0.07									
7. Type of partner (university)	0.31**	-0.02	-0.65**	0.65**	0.00	0.00								
8. Demographic similarity	0.14	0.16*	-0.07	-0.07	0.05	0.14*	0.00							
9. Reciprocal communication (actor)	0.23*	0.48**	-0.15*	-0.00	-0.00	-0.02	0.15*	0.11						
10. Reciprocal communication (partner)	0.01	0.08	-0.00	-0.15*	-0.00	-0.02	-0.15*	0.11	0.20**					
11. Decision process similarity (actor)	0.16*	0.26**	-0.17*	0.05	-0.01	-0.03	0.14	0.01	0.47**	0.08				
12. Decision process similarity (partner)	0.02	0.16*	0.05	-0.17*	-0.01	-0.03	-0.14	0.01	0.08	0.47**	0.15*			
13. Relationship maturity	0.23*	0.41**	-0.06	-0.06	0.04	0.25**	0.00	0.23**	0.27**	0.27**	0.30**	0.30**		
14. Trust	0.01	0.36**	-0.09	-0.09	-0.02	-0.06	0.06	0.06	0.56**	0.11	0.36**	0.11	0.17*	
Mean	4.01	5.23	2.19	2.19	4.44	22.0	0.00	4.17	5.40	5.40	4.20	4.20	4.53	5.49
Standard deviation	1.74	1.63	1.11	1.11	1.21	15.2	1.00	1.61	1.22	1.22	1.24	1.24	2.19	1.21

* $p < 0.05$ (two tailed);
 ** $p < 0.01$ (two tailed);
 n = 196.

Table 3
Multilevel regression analysis on trust.

	Model 1	Model 2	Model 3
UI collaboration experience	−0.11 (1.45)	−0.16* (2.33)	−0.13* (1.98)
Tie strength	0.38*** (5.26)	0.16* (2.15)	0.16* (2.09)
Organization size (actor)	0.03 (0.31)	0.04 (0.46)	0.04 (0.53)
Organization size (partner)	−0.11 (1.18)	−0.10 (1.21)	−0.10 (1.22)
Geographic proximity	−0.03 (0.41)	−0.03 (0.45)	0.02 (0.32)
Project length	−0.09 (1.29)	−0.04 (0.56)	−0.08 (1.24)
Type of partner (university)	−0.38† (1.79)	−0.24 (1.23)	0.21 (1.05)
Demographic similarity		0.02 (0.28)	0.00 (0.02)
Reciprocal communication (actor)		0.46*** (6.02)	0.35*** (4.34)
Reciprocal communication (partner)		−0.01 (0.10)	−0.13† (1.70)
Decision process similarity (actor)		0.13† (1.86)	0.17* (2.44)
Decision process similarity (partner)		0.04 (0.55)	0.06 (0.81)
Relationship maturity (RM)		−0.33 (1.60)	−0.68* (2.61)
Relationship maturity squared (RM ²)		0.32 (1.61)	0.94** (2.96)
Demographic similarity * RM			−0.01 (0.21)
Reciprocal communication (actor) * RM			0.17 (0.71)
Reciprocal communication (partner) * RM			0.18 (0.76)
Reciprocal communication (actor) * RM ²			−0.48† (1.73)
Reciprocal communication (partner) * RM ²			−0.55* (2.00)
Decision process similarity (actor) * RM			0.10 (1.41)
Decision process similarity (partner) * RM			0.21** (2.78)
−2 restricted log likelihood	544.95	512.68	511.98

† $p < 0.10$ (two tailed);

* $p < 0.05$ (two tailed);

** $p < 0.01$ (two tailed);

*** $p < 0.001$ (two tailed);

β coefficients (t values); $n = 196$.

organizational context, that is, whether more mature relations draw on different trust bases than less mature relations. We use a dyadic design to account for possible mutual influences within the UI research collaboration. The results of this study advance our understanding of trust development in inter-organizational relationships by showing that the relevance of different trust bases for the collaboration partners changes over time. Furthermore, by disaggregating actor and partner effects we gain a better understanding of how the interdependencies of perceptions of collaboration partners contribute to mutual trust formation.

Our first group of findings relates to the changing trust bases that collaborators may rely on in an inter-organizational context. We identified demographic similarity, reciprocal communication, and decision process similarity as those bases that may affect trust formation. First, we argued that similarity in educational level would facilitate initial trust in ‘young’, less mature collaborations, as this common identity will be treated favorably due to limited relationship experience. Previous studies reported that people who share similar demographic backgrounds regard each other as more trustworthy (e.g., Levin et al., 2006; McAllister, 1995). Contrary to our expectations, we did not find lower relationship maturity to moderate the association between similarity in educational level and trust in the UI research collaborations studied, indicating that at least in this UI collaboration sample demographic similarity is not necessarily more important for trust formation in nascent relationships than in more mature relationships.

A possible explanation could be the important role of relative educational status in Korea. Individuals with strong educational achievements tend to be given a high social status, and relative educational status can work as a mechanism to establish hierarchical social relationships that are common in a Confucian society (Sorensen, 1994). Conversely, when both sides have a similar educational level, the hierarchical order is less clear – a situation that can result in conflicts on who can claim the higher relative status in a relationship, particularly in high power distance societies (Farh, Tsui, Xin, & Cheng, 1998). In the context of UI research collaborations, professors may feel challenged and socially threatened when their company counterpart is highly educated, which is not uncommon in the three industries studied. Such effects may counterveil an otherwise beneficial effect of demographic similarity on trust.

Second, we argued that reciprocal behaviors in the form of communication would show an inverted U-shaped relation with trust contingent on relationship maturity, and our findings support this notion. Reciprocal communication is most strongly related to trust when the maturity of the relationship between the partners is intermediate. This finding concurs with previous research which found that in intermediate length relationships trust is based on reciprocal behaviors (Levin et al., 2006). It also provides support for the contention that as a relationship progresses, the basis of trust moves from a depersonalized mechanism to a personalized mechanism (Lewicki & Bunker, 1996; Schilke & Cook, 2013). By the same token, the results also suggest that the effectiveness of reciprocal communication in trust formation depends on the maturity of the inter-organizational relationship. Reciprocal communication becomes more important when relationships progress from an early to an intermediate stage, and subsequently less important in the transition from an intermediate to a mature stage.

Third, we hypothesized that similar decision processes may increase trust with greater relationship maturity. The empirical findings partially support this hypothesis suggesting that the partner perceptions of decision process similarity are strongly related to trust formation in more mature relationships. Our results indicate that decision process similarity replaces reciprocal behaviors in maintaining trusted relationships in inter-organizational contexts over time, as reciprocal communication is more effective in early to intermediate stages while decision process similarity is more effective in later stages.

A second group of findings contributes to the understanding of the nascent perspective of mutuality in inter-organizational trust development, i.e., whether the interdependence of perceptions of each partner's actions or behaviors affects trust formation. Such interdependence has been found in an intra-organizational context (Ferrin et al., 2008), but to the best of our knowledge has not been studied hitherto in the inter-organizational context. We find that the perceptions of the partner's reciprocal communication behavior and of decision process similarity are related to trust formation. Perusing the terminology of the APIM (Kenny et al., 2006), we find significant partner effects. When taking into account the moderating effect of relationship maturity between a university and its industry partner, the interdependence of perceptions

of each other's actions becomes apparent, as the formation of trust is influenced by the perceptions of the partner's reciprocal communication behavior and its decision process similarity. Our findings show that in collaborations between partners which are typically separated by strong institutional barriers, such as UI collaborations, the partners' perceptions do matter for each party's trust formation. Thus, interdependencies should be taken into account when studying dyadic trust formation.

A third group of findings reveals some interesting observations on the relevance of contextual factors for trust formation in UI research collaborations, an increasingly important yet relatively understudied type of inter-organizational collaboration. Similarly to previous studies on inter-firm collaborations (Poppo, 2013), we found that tie strength between the partners enhances trust. Our finding suggests that this mechanism also supports trust formation between heterogeneous partners, such as firms and universities. Moreover, we also found universities to be somewhat less trusting in their partners than vice versa, as shown by the negative effect of the 'type of partner' variable for universities. This finding could be related to the fact that UI research collaborations are fundamentally asymmetric, as universities have limited leverage over their industry partners and vice versa (Barnes, Pashby, & Gibbons, 2002).

In sum, this study contributes to our understanding of mutual trust formation in inter-organizational collaborations in various ways. First, aligned with process theory, we find that the relevance of certain trust bases (reciprocal communication, decision process similarity) changes with the maturity of a relationship whereas no such effect was observed for demographic similarity. Thus, the bases of trust appear to change with an increasing progression of inter-organizational relationships, suggesting the necessity of incorporating a process dimension into studies on trust. Second, we also find empirical evidence of the interdependence of perceptions pertaining to trust formation. The findings highlight the importance of collecting and analyzing dyadic data when studying inter-organizational collaborations, essentially allowing the researcher to examine interdependent phenomena. Third, our study contributes to the nascent understanding of the changing bases of trust formation in UI research collaborations – an increasingly important type of inter-organizational relationship between fundamentally different partners.

5. Managerial implications

There is significant concern in industry and academe on how to bridge their differences when working together (Hemmert et al., 2014). The results of this study on the formation of trust in UI collaborations indicate a need for strong and persistent mutual efforts in order to create trust between dissimilar and institutionally different partner organizations. Specifically, the findings highlight the importance of reciprocal behaviors and efforts to align decision making styles and perspectives in such collaborations. Managers and academics should give particular attention to engage in reciprocal communication, i.e., communicate regularly, timely, adequately, and accurately with the counterpart to establish positive expectations regarding future reciprocal behavior, particularly when the partners do not have a long collaboration history with each other. In order to maintain and reinforce trust over time, managers and academics should engage in working towards adopting similar operating and decision making styles to diminish the cultural divide.

6. Limitations and conclusion

This study has a number of limitations. It is based on a survey sample of UI research collaborations from three industries in one country, suggesting that caution is warranted when applying its findings to different contexts (e.g., collaborations between firms or collaborations in Western countries). Furthermore, we are relying on cross-sectional data and therefore cannot capture the dynamics of trust formation in UI research collaborations in a longitudinal sense. The cross-sectoral nature of this study does not provide conclusive evidence of the direction of causality. Our inferences concerning reciprocal communication and

trust in the intermediate stage and concerning decision process similarity and trust in the mature stage are based on our research design that emphasized the temporal ordering of the trust bases in our survey and took great care in their formulation and measurement to limit endogeneity. However, this limitation does not invalidate the inherent causal nature of our conceptualization (Whetten, 1989). Finally, whereas we have worked in various ways towards limiting the potential for common method variance, its existence cannot be strictly ruled out.

Given the contributions and limitations of our study, further research on UI research collaborations based on dyadic data analysis can validate our findings and deepen the understanding of trust building processes in such collaborations. In particular, longitudinal studies appear to be promising avenues for future studies in order to capture the nature of trust formation as an inter-organizational relationship progresses. Additionally, contrary to prior research (Levin et al., 2006), our findings show that relationship maturity does not moderate the relationship between demographic similarity and trust. One reason for these differences could be how demographic similarity was measured in the two studies (gender versus education) and the context for the studies (intra-organizational versus inter-organizational; Anglo-Saxon countries versus an East Asian country). Thus, future research should examine specific dimensions of demographic similarity within various contexts to ascertain if demographic similarity is associated with trust and if relationship maturity moderates this relationship.

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Appendix A. Multiple-item measures of key constructs

Construct	Loading
Trust ($\alpha = 0.95$; composite reliability (CR) = 0.95; AVE = 0.83): In this UI research collaboration ... (1 = do not agree–7 = fully agree)	
... the partner's representatives were frank in dealing with us	0.90
... promises made by the partner's representatives were reliable	0.94
... if problems arose, the partner's representatives were honest about the problems	0.91
... we felt the partner's representatives were on our side	0.91
Demographic similarity ($r = 0.51$; CR = 0.68; AVE = 0.52): Education similarity between university partner and company's R&D director (1 = high school education or less – 7 = PhD degree in science or engineering)	0.75
Education similarity between university partner and company's CEO (1 = high school education or less – 7 = PhD degree in science or engineering)	0.69
Reciprocal communication ($\alpha = 0.95$; CR = 0.95; AVE = 0.83): The communication between our and the partner's representatives during this UI research collaboration could be described as ...	
... untimely (1)/timely (7)	0.89
... inaccurate (1)/accurate [you can rely on it] (7)	0.94
... inadequate (1)/adequate (7)	0.90
... incomplete (1)/complete (7)	0.91
Decision process similarity ($\alpha = 0.86$; CR = 0.86; AVE = 0.62): We and our UI research partner were (1 = very dissimilar–7 = very similar) in terms of ...	
... the time it took to make a decision	0.86
... the decision-making style	0.89
... the tolerance of risk	0.66
... the understanding of how things should be done	0.71

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