Journal of Marketing Thought, 2016
Vol. 2, No. 4, 1 - 14, 10.15577/jmt.2016.02.04.1

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The Effects of Uncertainties on Network Embeddedness and the Mediating Effect of Information Sharing

Conceptual model that both technology and volume uncertainty promote exchange partners to rely on the network norm of information sharing which is the necessary ingredient of the network embeddedness. Data was collected from the 143 manufacturers in high-tech market in which triadic relationships among the manufacturers (seller), their first vendors (first buyers), and the second vendors (customers of the first buyers) in high-tech markets were particularly focused. Results from the structural equation model and multiple regression analysis reveal that while the technological uncertainty has a positive effect on the network norm of information sharing, the volume uncertainty is not statistically significant. In addition, we find that there existsthe mediator effect of the network norm of information sharing in the relation between the uncertainties and the network embeddedness.

Keywords: Technological Uncertainty, Volume Uncertainty, Information Sharing, Network Embeddedness

It is the business market that strong and competitive firms continue to flood andforce manufacturersto proactively exploit a variety of superior business practices. Although it is largely time consuming and cost intensive, working together with exchange partners is a firm's the strategic decision with expectation that the calculative commitment would pay off through long-term relationship (Achrol 1997; Beckman, Haunschildand Phillips 2004; Dreyer andGronhaug 2004; Nooteboom, Berger andNoorderhaven 1997). In responding to the needs for achieving management efficiency and sustainable growth, firms strategically exchange the resources and assets with their relational partners. In marketing, this strategic decision depending on a strong relationship with partners has been viewed as a significant social capital in business economics (Levin and Cross 2004).

In the exchange relationship where firm's resources and assets ought to be exchanged among relational partners over time, explicit or implicit safeguarding mechanisms (e.g., contract, monitoring, trust) play an important role in protectingtheir quasi-rented resources and assets, andin determining the quality and performance of inter-firm relationship management. Interestingly, researchers in inter-firm relationship have found that not all firms use same safeguarding mechanisms even though they are in the same industry (Ghosh and John 1999 JM; Heide 1994; Palmatier, Dant, and Grewal 2007).

The current research aims to explain the underlying causes. More specifically, the main purpose of this research is to study the network embeddedness under environmental uncertainty. Although prior studies enhanced our understanding of environmental uncertainty in inter-firm relationship management, researchers have too narrowly viewed the environmental uncertainty and often threated it as one of external variables impacting on the relationship management. For example, during the neoclassical transaction period, the assumption that there exist no quality or value variations of a homogeneous product was toominimalist and consequently ignored the role of environmental uncertainty in business market (Hobbs 1996). However, the volatility of the market is inevitable due to the forces derived from customers. the role of environmental uncertainty in relationship management should be considered within a whole economic system where economic behavior is not autonomous but largely interdependent (Andersson, Holm, and Johanson 2007; Coleman 1988, 1990; McEvily and Zaheer 1999; Rowley, Behrens, and Krackhardt 2000; Uzzi 1996). With this perspective, not surprisingly, the researchers in relationship marketing have studied the environmental uncertainty over the past 30 years (Bensaou and Anderson 1999; Walker and Weber 1984, 1987).

Essentially, the current research focuses on the for-

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mation of the network embeddedness where the environmental uncertainty leads the network embeddedness through the network norm of information sharing. This view contributes to the relationship marketing literature in two ways. First, prior relationship marketing studies have mainly focused on the dyadic relationships where the unit of data analysis and the focal research interest are centered on the exchange relationshipsmainly between two relational partners (Anderson, Håkansson and Johanson 1994; Hagen and Choe 1998; John and Reve 1982; Rowley 1997; Hite and Hesterly 2001). However, the network relationship where the relationships among the main firm, its immediate partners, and their second tier partners are loosely coupled has obtained insufficient attentions in relationship marketing literature (Madhavan, Gnyawali, and He 2004). The current research tackles the research gap by focusing on a triadic network relationship of which consists of a main firm (manufacturing company or seller), first relational partners (immediate buyers, first vendor), and their relational partners (end buyers, second vendor).

Second, although researchers in inter-firm relationship recognized the importance of information sharing in relational exchange (Wu 2008), only little research has questioned how environmental uncertainty that has been caused by technology and volume uncertainty leads the network embeddedness (Ki and Yang 2015). To answer the question, the current research empirically tests that there exists the mediating effect of the network norm of information sharing in the relationship between the technological and the volume uncertainty, and the network embeddedness.

This paper consists of three main parts. The first section discusses the theoretical background of network theory, transaction cost, and information sharing, and then illustrates our proposed theoretical framework and the research hypotheses. In the next section, we empirically testthe proposed model with the data from the manufactures in the high-tech market. Data analysis assessed the degree of which the technology and the volume uncertainty affect the network norm of information sharing and its moderating effect on the network embeddedness. The last part highlights the conclusion and discussions about the importance of information sharing in interfirm relationships, along with the areas of further research.

Theoretical Background

Network Embeddedness

According to the network theory, the network embeddedness explains why some powerful firms do not take their instant economic gains from their vulnerable partners where there is no contractual relationship, and also the opportunism could have easily taken advantages from the trust and reciprocity relationship (Powell 1990; Smitka 1991; Uzzi 1996). Studies using the network theory have construed the reasonsusing the network embeddedness.

The network embeddedness has the three perspectives: structural embeddedness, relational embeddedness, and cognitive embeddedness (Simsek, Lubarkinand Floyd 2003). *Structural* embeddedness is the status of either the presence or absence of ties among actors. *Relational* embeddedness refers to the degree to which partners consider their mutual needs and goals, and expect their behaviors in favorable to their exchange partners. The relational embeddedness determines the strength or density of the network(Simsek, Lubatkinand Floyd 2003). *Cognitive* embeddedness pertains to the similarity in the representations, interpretations, and systems of meaning among firms (NahapietandGhoshal 1998).

By extending the prior work by Hite (2003), the current research concentrates on the relational embeddedness that specifically focuses on the way of how multiple relational actors could achieve their business goals. According to Uzziin his research (1997), there are two relational embeddedness forms in exchange relationships: *first*, the arm's length ties called "market relationships" and *second*, the embedded ties called "close or special relationships." The typical characteristic of arm's length ties is the lack of reciprocity between exchange partners, the non-repetitive nature of the interaction, and narrow economic matters (Uzzi 1997, p 41). Thus, the market relationship is commonly studied in economic literature where pure competition is greatly assumed. Granovetter (1983) regards the arm's length ties as weak ties and distinguishes the weak times from the embedded ties (i.e., strong ties). He suggests that the strong tiescan be formulated byconstant transactions among partners. In addition, Hansen (1999) mentions that strong ties naturally increase the frequency of interactions and communications among partners, eventually decrease monitoring costs, and significantly shorten the decision-making process even in handling a complex problem. Thus, the strong ties help firms overcome challenges in safeguarding their shared resourceswith exchange partners, and further realize the existence of available resources and business opportunities that could strategically lead the pieexpansion output (Hite andHesterly 2001; Jap 1999).

Environmental Uncertainty and Transaction Cost Analysis

Transaction cost analysis (TCA) consists of various ex-ant and ex-post costs resulted from the frictions occurred during the relationship development process by exchange partners, including the costs of screening the qualified partner, negotiating after contract, monitoring opportunism, enforcing a contingent claims contract, and of evaluating partner's performance (Heide 1994; Hill 1990; Williamson 1973). The current research focuses on the environmental uncertainty in which transaction costs are created due to the adaptation of environmental uncertainty, and the opportunity coststhat could have avoided by choosing alternatives.

According to Hobbs (1996), he argues that "the standard neoclassical transaction implies the exchange of a homogeneous product that there is no quality variations between products and consequently no costs involved in measuring the value of a product. Where products do exhibit quality differences, they are regarded as distinct products serving separate markets. Economic agents are assumed to

possess perfect information, hence, there is no uncertainty regarding pricing, product characteristics, or the behavior of competitors and trading partners."

Although the neoclassical approach enhanced our understanding of relationship management, there has been little focused on social relationships, an important form of capital and asset useful in the market (Adler and Kwon 2002; Burt 1997; Coleman 1988; Inkpenand Tsang 2005; Kokaand Prescott 2002; NahapietandGhoshal 1998).The promise of the social relationships approach is that firms cannot exist in isolation in the market. Besides, the close relationships are the firm'scritical asset that its competitors are difficult to copy, and thus not all firms can obtain easily. Nevertheless, firms are very difficult to ignore their own advantages that could easily extract from the existing relationship with their partners. According to Aldrich (1979), it is the uncertainty that is fundamentally caused by human's bounded rationality. The uncertainty that leads the adaptation costs and information processing problems results in the partner's opportunism. Rindfleisch and Heide (1997) also explain that decision makers have constraints in their cognitive capabilities that are often explained as the bounded rationality. Any changing circumstances under the bounded rationality make decision makers more difficult to handle the environmental uncertainty. Opportunistic behavior becomes an effective short-term solution to pay off the adaptation costs induced from the environmental uncertainty.

Williamson (1985, p. 47) defines opportunism as "self-interest seeking with guile" and suggests that it includes such behaviors as lying and cheating, as well as more subtle forms of deceit, such as violating agreements. In economics and other social science disciplines, opportunism is a common motivation, and a strong form of the self-interest (Ghoshaland Moran 1996). Evidently, even a firm under the long-term relationship with its partners may unscrupulously seek to serve their self-interests. Jap and Anderson (2003, p.1696) concerned, "*the counterpart's performance is better, more competitive advantages are achieved by the pairing, joint profits are higher, and the relationship is expected to last longer. These effects apparently diminish, even evaporate, as ex post opportunism mounts.*" In addition, Barney (1999) emphasizes that it is difficult to know a priori who is trustworthy and who is not.

The researchers in TCA literature have greatly studied the safeguarding problemsand the governance mechanisms as strategic solutions. For example, theexchange partner's opportunistic behavior can be suppressed by planning the process of which future contingencies and consequential duties and responsibilities are to occur in the on-going exchanges (Macaulay 1963), monitoring the extent to which contractual compliance has taken place (Heide 1994), and enforcing the fiat and contact (Ghoshaland Moran 1996). According to the TCA theory, if these costs are enormous and may lead to a crisis with the standing and management of the company, a deterministic solution is to internalize the transactions. When transactions are internalized, it is unnecessary to anticipate all contingencies leading to complex negotiations(Granovetter 1985), which offer the theoretical foundation of the vertically integrated structure among channel members.According to the research by John and Weitz (1988), "vertically integrated structures permit sequential, adaptive decision making to proceed more smoothly because of administrative mechanisms. Authority structures permit quicker resolution of conflicts arising from differing interpretations of the evolving circumstances. These structures enhance the information flow between the parties, thus enabling them to react better to the uncertainties." However, what if the vertical integration is not feasible? How could the relationship partners minimize the transactions costs? The current research aims to answer the question by understanding the characteristics of network form of information sharing.

Network Norm of Information Sharing

Relational norms such as solidarity, flexibility, information exchange, role integrity, and long-term orientation govern the complexity of relationships among firms of which a contractenforcement is largely ineffective because of the great degree of uncertainty embedded in channel relationship (Antinaand Frazier 2001; Ganesan 1994; Kaufmann and Stern 1988). By extending the prior studies in relational norms, the norm of information sharing is defined as an expectation that relationship partners proactively sharestrategic information each other (Antinaand Frazier 2001; Heide and John 1992; Flazier, Maltz, Antia, and Rindfleisch 2009). Drawing on the channel relationship literature, inter-firm relationship studies, and network theory, the current research views the norm of information sharing as a network norm that is a necessary ingredient of trilateral relationship. In addition, the current research empirically investigates the norm of information sharing among relationship partners where their spontaneous alliance quickly responding to the needs for fast moving consumer market, and to suppress suppliers' opportunistic behavior caused by the failure of technology adaptation in the high-tech market (Antina and Frazier 2001; Devlin and Bleackley 1988; Dyer 1997; Heide and Weiss 1995).

Considering the triadic relationships between a manufacturer (seller), firstvendors (first buyers), and second vendors (their customers or second buyers),the manufacturer often confronts to the "make" or "buy" decision problem in technology (Heide 1994; Heide and Weiss 1995; Walker and Weber 1987). For example, if a manufacture that developed ("make") a new technology, the first vendors (first buyers) will be asked to negotiate how to share the increased costs by the manufacture's investment. This negotiation process results in the ex-post costs. Even if the manufacturer purchased ("buy") the new technology so that the cost sharing problem may be trivial, the unanticipated and various needs from the second vendors (the first vendors' customers) will still result in the ex-post costs from the maladaptation. Imagine that what if the second vendors are not ready tocustomize their production routine and system in favorable to the new technology.

They would behavior opportunistically to avoid the

adaptation costs. Therefore, the manufacture is difficult to decide if the "make" or "buy" decision in technology would be profitable or not (Auster 1992; Teece 1986, Atuahene-Gimaand Li 2004; Bensaouand Anderson 1999; Walker and Weber 1987). To overcome the difficulty in choosing the"make" or "buy" decision in technology, we argue that a manufacturer should keep in touch with its first vendors (first buyers)toobtainthe useful informationthat wouldhelp the manufacture prepare how to minimize potential conflicts with the first vendors (first buyers), and how to strategically influencetheir customers (second buyers)' technology adaptation(Frazier and Rody 1991). With this backdrop, we argue that the norm of information sharing is a useful channel governance strategy particularly when the volatility of technology is likely to hamper the relationship among partnersand thus to decrease the relationship performance. Prior studies in the norm of information sharing literature have demonstrated its effect on firm's performance by reducing costs of operation process and market information acquisition (Humphreys, Li and Chan 2004), promoting collaborative communication under uncertainty (Daft andLengel 1986; Galbraith 1973), enhancing the product quality (Takeishi 2001), and dissolving delivery schedule compliance (Brown andEisenhardt 1995). In summary, when the volatility of technology is high and increases technological uncertainty in high-tech markets, the relational partners in triadic relationships will greatly rely on the shared information. Taken together, we posit the hypothesis as following;

H1: The technological uncertainty is positively associated with the network norm of information sharing.

Over time, relationship partners come to realize that it is important to strengthen their relationship through consistently exchanging their resources involving their assets, sensitive and unique information, and specific relationship investment (Bensaouand Anderson 1999; Rokkan, Heide, and Wathne 2003). The benefits of relational exchange areimportantparticularly when the market and product life cycle are short, needs of product diversity of product is high, and firms are very difficult to predict the demand (volume) of products (Dreyer andGronhaug 2004; Krishnan, Martin andNoorderhaven 2006; Zhou, Yim,andTse 2005).

In the case of triadic relationships, for example, a manufacturer under the volume uncertainty is difficult toaccurately predict how many products should be produced. It is also too risk for the firm to determine the specific quantity and delivery schedulethat the first vendors used to use under uncertainty. Besides, the uncertainty involume (demand) uncertainty become even serious and result in governance problems particularly when the first vendors (first buyers)make rush orders at the same time, inquire unreasonable delivery schedule, or either cancel or delay their prior orders on behalf of their second vendors (second buyers). The failure of handling the volume (demand) uncertainty results in negative perception of the manufacturer likenon-cooperative partner.For example, the consequence induces the sequential damages. For example, the manufacture's first vendors (first buyers) are likely to threaten the contractual obligation with the manufacture's cost (e.g., honoring the additional costs due to the delivery delay). The damaged relationship between the first vendors and their customers, the second vendors even make the first vendors to consider switching the manufacture with alternatives. Prior studies in inter-firm relationship have continued to offer the empirical evidences that the failure of safeguarding the environmental uncertainty and the opportunistic behavior could seriously hamper the long-term relationship orientation (Bensaouand Anderson 1999; Ganesan 1994; Heide and John 1992; Rokkan, Heide, and Wathne 2003).

In summary, it is indeed a strategic choice that the manufacturer should make efforts to keep in touch with its relational partners where strategic and useful information plays an important role managing the triadic relationships. We posit the hypothesis as following;

H2: The volume uncertainty is positively associated with the network norm of information sharing.

Mediator Effect of the Network Norm of Information Sharing

The information sharing can be easily observedat the individual level when workers engage in prosocial transformations such as wishing for a good outcome for themselves and others (Constant, KieslerandSporull 1994). Similarly, the information sharing is common at the organizational levelif the information sharing was "usual, correct, and socially expected workplace behavior," so that workers rationalize that it is useful not only for their own interests, but also for their organizations. Evidently, the marketing literatures continue to suggest that firms can increase their profits by information sharing in the inter-firm relationships. For example, to reduce operation costs, the information sharing among relational partners is useful to determine the inventory level, the right time to purchase raw materials, and the amounts of order (Lee, So and Tang 2000; Sahinand Robinson Jr. 2005). In addition, organizations invest in collaborative information and communication systems to facilitate sharing of information to prevent potential damage so that it helps firms foresee changing in future conditions (Antinaand Frazier 2001; Constant et al. 1994; Jarvenpaaand Staples 2000). Therefore, the information sharing leads to a close relationship in business economics because it is a sign of the trustworthiness of the relational partners (Dyer 1997). We argue that the information sharing is more critical in the context of triadic relationships. Stated differently, under a technologicaluncertainty environment, the relationships between the existing triadic firms can be strengthened when the network norm of information sharing is working well.For example, in case of triadic relationships where a manufacturer and their network partners share useful information, the manufacturer could effectively respond to the market needs through the information that their first and second vendors (buyers) offer (e.g., new consumer market trends, first vendor's sales event planning,

second vendor's competitors). In addition, even if the predicament circumstance due to the defective product problem occurred, the manufacturer could solve the problem fast and properly based on the shared information that helps the manufacturer comprehensively understand how the first and second vendors (buyers) confront to the problem initially.

By dubbing the results by Sahin and Robinson Jr. (2005), we also argue that information sharing makes a firm possible to flexibly secure the complement in handlingunpredictable situation. In terms of a trilateral relationship, for example, it is often that a manufacturer that is currently difficulty topredictthe future product volumes is still need to makegoods for the first vendors. The danger in preparing goods for the first vendors is that the manufacturer is largely uncertain what their second vendorswant, when these vendors order, and how many orders will be made. Given this uncertainty in the triadic relationships, the needs for the shared information are likely to increase for the purpose of handling the manufacturer's unpredictability, avoidinginventory crisis, and promoting strong relationships among relational partners. It is rational that if firms exchange knowledge with partners, more coordinating interaction will appear among them in order to convey the demands as accurately as possible. Reversely speaking, when one of the actors fails to share information about issues involving the partners, the others feel anxious until the order is filled. As a result, under volume uncertainty, the network norm of information sharing is poor, and the triadic relationship is weakened.

Accordingly, sharing helps firms to reduce the cost of inventory management and to perform at peak efficiency. Therefore, manufacturer and vendors endeavor to achieve maximum performance. This action creates a well-disposed organization and creates strong ties in the interfirm network. Taken together, we posit the following hypothesis;

H3: The greater the network norm of information sharing is the more the network embeddedness increases.

Research Methods

Research Context

Recall that the current research aimed to investigate the effectiveness of network embeddedness on environment uncertainty in the context of the strong tie of triadic network relationship. Our proposed model focuses on testing how the information sharing under unpredictable situations increases or decreases the network embeddedness. The research context of this study is the relationships among manufacturers (seller), the first vendors (first buyers), and the second vendors (customers of the first buyers) in high-tech markets. The manufacturers supply their products to a big Korean electronics company. The first vendors supply electronic goods to their customers (second vendors), and also are the buyers of complete products from the manufacturers. The manufacturers were contacted and asked to provide their perceptions of technological uncertainty and that of volume uncertainty.

The data collection was performed using a mail survey distributing to the manufacturers. Sample frame (contact information) was obtained from the managers who currently work for the manufactures. Before finalizing the questionnaire, a few selected managers were invited to participate in the pilot test to further validate the questionnaire. The final questionnaire went through several revisions. Questionnaires were mailed out together with a cover letter explaining the purpose of the survey. Four hundred questionnaires were sent to the manufactures. A total of 154 (38.5%) completed surveys were returned. Among them, eleven questionnaires were removed from the final data analysis because of the excessive missing answers. Therefore, a total of 143 firm-level data were used for the data analysis.

FIGURE 1
The Framework of Uncertainty-Network Embeddedness

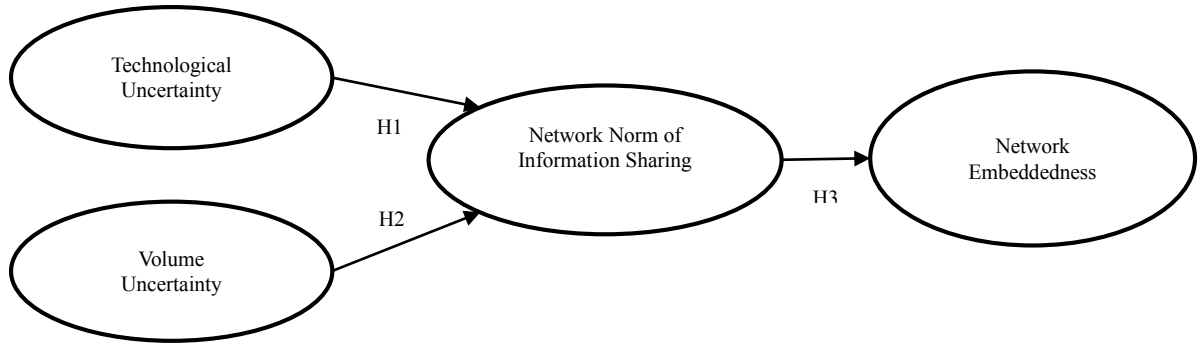

TABLE1
Results of the CFA for the Measurement Model

Construct	Lowest Standardized Factor Loading	Highest Standardized Factor Loading	CFA	Tucker-Lewis Index	RMSEA	X^2 (d.f.)	p-value
Network Norm of Information Sharing	.70	.83	.95	.94	$.09^a$	183.688 (83)	$p < .001$
Technological Uncertainty	.63	.89					
Volume Uncertainty	.60	.74					
Network Embeddedness	.76	.85					

[a] A more stringent RMSEA cutoff of .05 tends to reject properly specified models when sample sizes are close to 100 (Yu 2002).

TABLE2
Measures of Sampling Adequacy (MSA) and Items Used in the Study

	x_{11}	x_{12}	x_{13}	x_{21}	x_{22}	x_{23}	x_{31}	x_{32}	x_{33}	x_{10}	x_{34}	y_{11}
(x_{11}) TechUn1	.901[a]											
(x_{12}) TechUn2	-.078	.733[a]										
(x_{13}) TechUn3	-.244	-.806	.719[a]									
(x_{21}) VolUn1	-.079	-.024	-.080	.832[a]								
(x_{22}) VolUn2	-.038	.000	.060	-.519	.772[a]							
(x_{23}) VolUn3	-.050	.031	-.109	-.079	-.102	.701[a]						
(x_{24}) VolUn4	.146	-.060	.019	-.032	-.117	-.723	.667[a]					
(x_{31}) NetEm1	-.045	.189	-.163	-.005	.124	.001	.014	.833[a]				
(x_{32}) NetEm2	-.012	-.139	.159	-.016	-.089	-.118	.156	-.754	.843[a]			
(x_{33}) NetEm3	.065	-.107	.052	.086	-.052	.001	-.035	-.239	.008	.862[a]		
(x_{34}) NetEm4	-.098	.000	-.003	-.079	.041	.083	-.065	.145	-.151	-.735	.838[a]	
(y_{11})NIS1	-.087	.020	.020	.026	-.057	.086	-.039	-.043	-.233	-.030	.149	.935[a]
(y_{12})NIS2	-.087	-.024	.099	-.090	-.044	-.092	.076	.006	-.008	-.158	.078	-.138
(y_{13})NIS3	-.006	.078	-.046	.072	-.011	-.003	.043	-.198	.169	.217	-.492	-.112
(y_{14})NIS4	.169	-.027	-.094	-.056	.035	-.003	-.055	.114	-.080	.073	-.185	-.385

[a] Measures of Sampling Adequacy (MSA)

TABLE3
Descriptive Statistics, AVE, Composite Reliability, and Correlation Matrix of Variables Included in the Study (n=143)

	Mean	Std.	AVE[a]	X1	X2	X3	Y1
(X1) Technological Uncertainty	5.48	1.09	.69	.84[b]			
(X2) Volume Uncertainty	4.27	1.23	.56	.38**	.77[b]		
(X3) Network Norm of Information Sharing	3.85	1.12	.69	.32*	.17*	.88[b]	
(Y1) Network Embeddedness	5.80	0.98	.67	.32**	.09	0.85**	.86[b]

* p <0.05 ** p < 0.01
a. Denotes Average Variance Extracted
b. Composite Reliability

Measures

The four constructs in this proposed modelinclude the technological uncertainty, the volume uncertainty, the norm of network information sharing, and the network embeddedness. Whenever possible, the existing multi-item measures were used. If not, the existing scale items were modified and reworded in order to increase respondent understanding of research context. *First*, the technological uncertainty was adapted from Jaworski and Kohli (1993) and Stock and Tatikonda (2008). The managers in the manufacturers were asked to estimate the degree of their perceptions on technological uncertainty. The items composed of three scale items focused on the extent of perceived unpredictable technological changes. *Second*, the volume uncertainty was adapted from Germain, Dröge, and Christensen (2001) and Zhou, Yim, and Tse (2005). Four items were selectedto measure the extent of the inability to accurately forecast the demand for the goods in the external environment. *Third*, the network embeddedness scales composed of four items were adapted from Antina and Frazier (2001) and Wu (2008) to assess the extent to which managers in manufacturers perceive strong and embedded ties with their exchange partners. *Last*, for the norm of network information sharing, we relied on the four existing scale items developed by Antina and Frazier (2001. These items assess the degree to which the manufacturers and their partners keep sharing important information each other. All scale items were scored with the seven-point Likert scale (1 = strongly disagree; 7 = strongly agree). The measurement items and the results of validity analyses are reported in the Appendix.

Construct Validity

Before testing hypotheses, it is important to validate and purify the measures. The results from the exploratory factor analysis (EFA) stringently asserted that the scales items used in the measurement model well reflected their constructs, and thus concluded the measurement model with all items for the four latent constructs (technological uncertainty, volume uncertainty, network norm of information sharing, and network embeddedness). In details, factor loading of the technological uncertainty were 0.63, 0.861 and 0.885. The volume uncertainty showed 0.597, 0.616, 0.736 and 0.732. The network embeddedness obtained the factor loadings of 0.761, 0.79, 0.798 and 0.848 for each scale item. Items of the network norm of information sharing obtained 0.765, 0.704, 0.812 and 0.832 of factor loadings.

To evaluate the internal consistency of four constructs, Cronbach's alpha was used to test the extent to how well the selected scale items consistently reflected their construct. The results showed that Cronbach's alpha for all constructs was higher than 0.8 (lowest =0.82; highest =0.94), which exceeded the cut-off level (0.7) of the norm of acceptable reliability (Bagozzi and Yi 2012). In addition, the composite reliability of all constructors showed higher than 0.7 (i.e., the technological uncertainty factor=0.84, the volume uncertainty factor=0.77, the network embeddedness factor=0.88, the network norm of information sharing=0.86), which exceeded the cut-off level (0.7) of the norm of acceptable reliability (Bagozzi and Yi 2012).

To test both convergent and discriminant validity, the confirmatory factor analysis (CFA) model was used (e.g., Anderson and Gerbing 1988; Bagozzi and Yi 2012; Grewal, Chakravarty and Saini 2010). In testing the convergent validity, the CFA results showed that all factor loadings of scale items were statistically significant (p<0.001) and the goodness of fit indexes of the measurement model close to or above the recommended levels based on Bagozzi and Yi (2012, Table 1).

For the discriminant validity, the measures of sampling adequacy (MSA) for the model and calculated indicators were evaluated (Table 2). Additionally, average variance extracted (AVE) values were calculated on the basis of factor loadings. AVE values of factors were 0.69 of technological uncertainty, 0.55 of volume uncertainty, 0.69 of network embeddedness and 0.67 of network norm of information sharing. These indices were satisfactory because the AVE values of each construct were greater than the cut-off benchmark value (0.5) (Poppo, Zhou and Ryu 2008). In

TABLE4
The Results of Regression Analysis

		Dependent Variables			
		Network Norm of Information Sharing		Network Embeddedness	
Independent variables	Hypothesized Effect	Model 1	Model 2	Model 3	Model 4
Technological Uncertainty	Positive	0.36*** (0.114)			0.07 (0.046)
Volume Uncertainty	No direct		-0.07 (0.074)		-0.04 (0.031)
Network Norm of Information Sharing	Positive			0.91*** (0.076)	

Note: Goodness-of-Model fit (Model 1 to 3), $\chi^2(83)$=183.688, p<0.001, GFI=0.85, CFI=0.95; RMSEA=0.09; The entries in the table are regression coefficients with standard errors in parentheses; *** refers to p < 0.001.

addition, the estimated measurement correlation scores of each indicator of each latent variable were significantly different from 1.0 (Anderson and Gerbing 1988; Table 3). The measurement model fit indices was shown as following: χ2(83) =183.688 (p<0.001); Incremental fix index [IFI] =.95; Goodness fix index [GFI] =.85; Comparative Fix Index [CFI] =.95, Root Mean square Residual [RMR] =.14; Root Mean Square Error of approximation [RMSEA] =.09. All values except RMR were statistically significant. The goodness-of-fit index, composite reliability, average variance extracted indices, and model fit, were reported in the appendix in detail. We concluded that our measurement model was shown to possess satisfactory reliability and construct validity for the further data analysis.

Data Analyses and Results

Both structural equation modeling (SEM) using AMOS, and multiple regression analysis using IBM-SPSS were used to test the hypotheses. The basic idea of the SEM is similar to the regression analysis. However, the parameter estimates using the SEM have been known to lead to accurate results by simultaneously estimating structural relations and less restrictive assumptions in selecting the variables (Bollen 2014). In the SEM test, the procedures of Luo (2003) and Grewal et al. (2010) was adopted to estimate three models: as shown in Table 4, Model 1 with technological uncertainty as an exogenous variable to network norm of information sharing as an endogenous variable; and Model 2 with volume uncertainty as an exogenous variable to network norm of information sharing as an endogenous variable; Model 3 with network norm of information sharing as mediator and independent variable in one to network embeddedness as an endogenous variable. To obtain rigorous results, relations between technological and volume uncertainties on network embeddedness was also conducted (Model 4). Results from both SEM and multiple regression analysis provided strong results for the hypotheses test as following;

The multiple regression analysis tested the relationship among constructs shown in the proposed conceptual model as illustrated in Figure 1. First, we testedifthe uncertainty variable was associated with the network embeddedness. Theadjusted R square of technological uncertainty on network embeddedness was .097, with the R square of .104. To examine potential multi-collinearity problem among the predictors, variance inflation factor (VIF) associated with each of the predictors in the model was computed. Results showed that the VIF was 1.00, which was below the cut-off value of 10, suggesting the existence of no multi-collinearity problem. Moreover, the Durbin-Watson value was 1.756, which shoed the acceptable range nearly 2. From the ANOVA results, the F value was 16.295 (p<0.001) where p value of coefficient of both a constant and the technological uncertainty were less than 0.001 (p<0.001).To test the mediator effect of the network norm of information sharing, we ran the multiple regression analysis again to see the adjusted R square valueof the model regressing two independent variables including technological uncertainty and network norm of information sharing independent variable on the network embeddedness as a dependent variable. It was0.721, which was originally 0.725 R square.Durbin-Watson value was 1.874 and F statistic was 184.281 (p<0.001). Results showed thatthe network norm of information sharing was significant (p<0.001) but technological uncertainty was not significant (p =0.25). Therefore, the mediator effect of the network norm of information sharingwas supported.Second, we tested ifthe volume uncertainty was associated with the network embeddedness and then if the mediator effect of the network norm of information sharing was hold.Results showed that the adjusted R square of volume uncertainty on network embeddedness was .000, with the R square of .007. It means that independent variable can explain dependent variable only 7 percent, but this R square's demerit was supplemented to 0 percent. Furthermore, the F value was 1.054 (p=0.306) From the ANOVA results. Thus, the fur-

ther analysis testing the mediation effect of the network norm of information sharing was not performed (see results from Model 1 and 2 in table 4)

Hypotheses Testing

H_1assesses the network logic that a high level of technological uncertainty induces a high level of network norm of information sharing. As shown in Table 4, Model 1 showed the relationship between technological uncertainty and network norm of information sharing was statistically significant (H_1=0.36, p<0.001). However, H_2 regarding the relation between volume uncertainty and network norm of information sharing was not supported (Model 2; p>.40). Although the network norm of information sharing and volume uncertainty marginally showed correlation positively (Table 3), the results did not support for H_2.Regarding H_3positing that the network norm of information sharing increases network embeddedness found in Model 3, it showed significant support (p<0.001). Additionally, we tested a rival model where all were as same as our proposed model but there was no mediation effect. More specifically, we analyzed the direct pathmodel (Model 4) that technological uncertainty causedthe network embeddedness and volume uncertainty caused the network embeddedness. The results were not significant. The path of technological uncertainty on network embeddedness was over p-value 0.1 and the path of volume uncertainty on network embeddedness was over p-value 0.4.As shown by the overall analysis, we concluded that the network norm of information sharing was a critical source of network embeddedness as a mediator betweenthe uncertainty and the network embeddedness.

Conclusion and Discussion

Recall that the main purpose of this research is to study the network embeddedness under environmental uncertainty. Based on the results from the data analysis, we found that it was fascinating to see actors in business-to-business relationships actually rely on the network embeddedness to proactively respond to the unpredictable market challenges induced by technical and volume uncertainty. Our conventional wisdom is that working together with other firms is often time-consuming and cost-intensive, and even very risky particularly when uncertainty promotes the partner's opportunism. However, our findings provided the opposite evidences that when technical and volume uncertainties were high, direct and indirect exchange partners greatly formulated the network norm of information sharing and strategically used the network embeddedness. We reasoned that even if the uncertainty is seemingly difficult to control so that the partner's opportunistic behavior is greatly expected, the skillful managers who have experienced the benefits of the network embeddedness realizethat the shared important information sharing will determine the degree of business performance.

This researchaims to fillthe gap in the research on network embeddedness and uncertainty in the triadic relationship. Although network performance relationships (JaworskiandKohli 1993; Tsai 2001; Zaheerand Bell 2005) and uncertainty network partner selection (Beckman, Haunschildand Phillips 2004; Shane and Cable 2002) improved our knowledge of relationship management, previous studies mostly have focused on either uncertainty (Carpenter and Fredrickson 2001), network ties (Williamson and Cable 2003), technological uncertainty (Dess and Beard 1984), or volume uncertainty separately. However, this research specifically focused on the relationship between the uncertainty and the network embedded ties. In explain the relationship, we first integrated the transaction cost analysis and the network theory. Our results were promising for the researchers who study the effectiveness of the relational mechanism.

Limitations and Future Research

Nonetheless, this research contributed to theoretical and practical development. There exist limitations that should be considered in further research. First, the research context selected in this research was limited to the high-tech markets where partner's dependence is naturally high due to the complexity of technology implementation. Our proposed model needs to be tested in the conventional relationship between manufactures and their suppliers that deal with commodity products (e.g., raw materials, standardized components). We predict that the network embeddedness will be consistently important, but its antecedents may be different (like organizational memories focusing on interfirm routines). Second, although this research considered the triadic relationship among manufacturers, first vendor, and second vendor, the data that we collected only captured the manufacturers' point of view.A future research should test the relationship between uncertainty and network embeddednessbased on the data collected from the trilateral relationship. The future research should be dealt with not only a manufacturer's response but also partners' responses in triadic relationships. Third, subsequent modifications become necessary due to a variety of possible contingencies (Carson andMadhock 2006). A future research is recommended to include the firm's flexibility as extension of the current model. The flexibility is one of the important relational properties that are useful to handlethe market uncertainty, and encourageexchange partners to behave cooperatively (Cannon, Achrol and Gundlach 2000). Finally, the network embeddedness as safeguarding mechanism against opportunism has never been considered(Carson andMadhock 2006).

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Appendix: Scale Items Used in This Study

Construct[a]	Item[b]	Sources
Technological Uncertainty	Your industry's technology was correctly presented. (R)	Stock and Tatikonda (2008)
	Sufficient information about a technology in your industry is available. (R)	Stock and Tatikonda (2008)
	The technology in your industry is changing rapidly.	Jaworski and Kohli (1993)
Volume Uncertainty	It is difficult to anticipate consumer demand for a brand.	Zhou, Yim and Tse (2005)
	Sales are predictable … unpredictable	Germain, Dröge and Christensen (2001)
	Market trends are easy to monitor … difficult to monitor	Germain, Dröge and Christensen (2001)
	Sales forecast are likely to be accurate … inaccurate	Germain, Dröge and Christensen (2001)
Network Norm of Information Sharing	It is expected that any information that might help our company will be provided by first and second vendors.	Antina and Frazier (2001)
	It is expected that the first vendor will provide proprietary information about a second vendor if it can help our company, and vice versa.	Antina and Frazier (2001)
	Exchange of information in our company with partners (both first and second vendors) takes place frequently and informally.	Antina and Frazier (2001)
	It is expected that our company and partners keep each other informed about events or changes.	Antina and Frazier (2001)
Network Embeddedness	Our company (manufacturing company) has established good working relationships with our business partners.	Wu (2008)
	Our company (manufacturing company) has a group of close business partners.	Wu (2008)
	Our company (manufacturing company) engages in frequent communication with partners.	Antina and Frazier (2001)
	There is a variety of interaction among our partners.	Antina and Frazier (2001)

[a] Goodness-of-fit: $\chi^2(83)=183.688$, p=0.000;
GFI=0.85, CFI=0.95, TLI=0.94, IFI=0.95, RMSEA=0.09

[b] 7-point likert scale with strongly disagree and strongly agree as anchors

R refers to reverse scored item