Technology management

An analysis of the relationship between embedded ties and supplier innovation in the cooperative sector

Uma análise da relação entre laços imersos e inovação do fornecedor no setor de cooperativismo

Un análisis de la relación entre vínculos enraizados e innovación del proveedor en el sector de cooperativismo

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Abstract

What are the main predictors of the development of embedded ties? What are the impacts of supplier-knowledge, client-knowledge, and embedded-tie variables on the development of supplier innovation in the cooperative sector? What is the moderating role of embedded ties in the development of supplier innovation? This study brings together 126 responses from suppliers of a large agro-industrial cooperative. The results show that embedded ties have a positive impact on the development of innovation and knowledge for innovation. Furthermore, a significant association between supplier knowledge and innovation was found, which is moderated by embedded ties. Data show that embedded ties amplify the ability to develop innovation in industrial relationships.

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Keywords: Embedded ties; Innovation; Suppliers; Knowledge

Resumo

Quais são os principais preditores do desenvolvimento dos laços imersos? Qual é o impacto das variáveis conhecimento do fornecedor, conhecimento do cliente e laços imersos no desenvolvimento de inovações no fornecedor no segmento de cooperativismo? Qual é o papel moderador dos laços imersos no desenvolvimento de inovações no fornecedor? Este estudo reúne 126 respostas dos fornecedores de uma grande cooperativa agrícola. Os resultados evidenciaram que há impacto positivo dos laços imersos no desenvolvimento da inovação e no conhecimento da inovação. Ademais, a pesquisa mostrou que há associação significativa entre o conhecimento dos fornecedores e a inovação, a qual é moderada pelo laço imerso. Isto evidencia que o laço imerso amplifica a capacidade de desenvolver inovação.

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Palavras-chave: Laços; Imersos; Inovação; Fornecedores; Conhecimento

Resumen

¿Cuáles son los principales determinantes del desarrollo de los vínculos enraizados? ¿Cuál es el impacto de las variables conocimiento del proveedor, conocimiento del cliente y vínculos enraizados en el desarrollo de innovaciones del proveedor en el sector de cooperativismo? ¿Cuál es el papel

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moderador de los vínculos enraizados en el desarrollo de innovaciones del proveedor? Este estudio reúne 126 respuestas de proveedores de una gran cooperativa agrícola. Los resultados muestran que existe una influencia positiva de los vínculos enraizados en el desarrollo y el conocimiento de la innovación. Además, se comprueba que hay una relación significativa entre el conocimiento de los proveedores y la innovación, la cual es moderada por los vínculos enraizados. Así, el vínculo enraizado incrementa la capacidad de desarrollar innovaciones.

Introduction

Embedded ties are a type of relationship where social relations are reciprocal between those partners involved (Baldi & Vieira, 2006). Strong embedded ties are more characterized by the influence of an established social structure, the exchange of insider information, and the mutual cooperation to resolve problems than by the proximity and frequency of actors' interaction (Uzzi, 1996). Dyer and Singh (1998) demonstrated that a pair of organizations (dyads) or a network of companies can develop relationships that mutually collaborate with each other, resulting in performance differentials, as well as the integration and development of knowledge, which provides competitive advantages such as innovation.

Authors disagree about the effects of embedded ties on the development of innovation. Specifically, Anderson and Weitz (1989), Day (1994), Rowley, Behrens, and Krackhardt (2000), and Rindfleisch and Moorman (2001) argue that embedded ties favor the development of innovation in relationships between organizations because there is greater trust between partners. In this sense, collaboration between partners creates mutual support (Narayanan, Narasimhan, & Schoenherr, 2015) and innovation is encouraged. Moreover, there is transfer of knowledge and effort in collaboration with a partner that can overcome difficult situations (Figueiredo, Andrade, & Brito, 2010).

However, Anderson and Jap (2005), Granovetter (1985, 2005), Moorman, Zaltman, and Deshpandé (1992), and Selnes and Sallis (2003) point out that embedded ties can provoke associate accommodation, which maintains the status quo in a relationship between partners, decreasing innovation. In this context, there may be a softening in the exchange of knowledge between agents to the point that there is no significant new information to share, harming the development of new product strategies. Arguments from those who believe that embedded ties favor the ability to develop innovation and those who believe that embedded ties diminish it were the insights to be advanced in this research. Therefore, this investigation studies the embedded ties of suppliers of a large agro-industrial cooperative and the consequent development of innovations in a supplier dyad. This research not only empirically tests the antecedents of embedded ties and innovation with suppliers from this cooperative, but also analyzes the moderating and mediating role of embedded ties, contributing in four different ways.

First, this paper encounters evidence of the positive effect of embedded ties in the development of supplier innovation, consistent with the aspects discussed by Granovetter (1985), Moorman et al. (1992), and Selnes and Sallis (2003). Second, the result shows that relations between supplier knowledge and innovation as well as between client knowledge and innovation are moderated by embedded ties, altering the magnitude of the effects (Rindfleisch & Moorman, 2001; Rowley, Behrens, & Krackhardt, 2000). Specifically, when embedded ties are present and strong, the relationship between knowledge and innovation development becomes amplified, increasing the direct effect. Third, this research shows that client flexibility (based on Moura, Botter, & da Silva, 2010), supplier flexibility, and client investment in the supplier explain variations in the creation and maintenance of embedded ties. Such conditions of flexibility are relevant and meaningful as being the antecedents for the level of an embedded tie. Fourth, this study demonstrates that client and supplier flexibility and investments have indirect effects on innovation via embedded ties, supporting the mediating condition of the embedded tie.

After this introduction, the article presents the hypotheses of the research and the theoretical model. Subsequently, the survey research method with cooperative suppliers is explained and analysis, discussion of the findings, and general considerations are presented.

Research hypotheses

Direct effects

The first hypothesis indicates the relationship of embedded ties between the supplier and client and the development of supplier innovation. This association is based on social networks literature (Granovetter, 1985) and basically has two different lines of argument. The first line states that embedded ties allow for the development of innovations between partners of a relationship (Anderson & Weitz, 1989; Day, 1994; Rindfleisch & Moorman, 2001; Rowley, Behrens, & Krackhardt, 2000), which is called the "bright side" of embedded ties. The second line of argument holds that embedded ties weaken the development potential of innovation between associates (Granovetter, 1973; Moorman, Zaltman, & Deshpande, 1992; Selnes & Sallis, 2003), which is referred to as the "dark side".

We suggest a positive influence to support this relationship in line with the bright side, which we argue from three different perspectives. First, the positive effects of embedded ties between partners can result in innovation and improve supplier knowledge about their own business, facilitating the transfer of complex, tacit knowledge between business associates (Noordhoff, Kyriakopoulos, Moorman, & Dellaert, 2011). Second, Rowley et al. (2000) argue that motivations caused by a supplier's embedded ties with a client positively stimulates the supplier in the development or use of experiences

(Barden & Mitchell, 2007) and market knowledge in order to develop innovations that meet client needs. Third, a characteristic of embedded ties is the presence of trust in a partnership (Buchan, Crosson, & Dawes, 2002), which can positively influence the development of supplier innovation. For Dyer and Nobeoka (2000), trust is necessary for the sharing of confidential and complex business information (e.g., expansion plans, profits, and strategies), which is important for the development of innovation and technology (Noordhoff et al., 2011; Rindfleisch & Moorman, 2001). Since embedded ties tend to increase knowledge, motivation (Barden & Mitchell, 2007), and trust (Uzzi & Lancaster, 2003), it is believed to be a trigger for innovation. Therefore:

H₁. Embedded ties between the supplier and the client positively influence the development of supplier innovation.

The next hypothesis is about the negative influence of client opportunism on embedded ties (Antiqueira, Saes, & Lazzarini, 2007; Gulati, 1995). For Noordhoff et al. (2011), in relationships with embedded ties, there are greater risks of clients improperly appropriating supplier information and then going on to compete with them. This risk tends to increase as social embeddedness of the relationship intensifies, resulting in possible opportunistic behavior by a client (Wathne & Heide, 2000). Client appropriation of know-how with malice to the supplier is negative to the relationship and also to the development of supplier innovation, because opportunistic behavior tends to stop the supplier from sharing confidential and strategic information that could add to the client experience through the development of innovations (Provan, 1993).

Results from Saxenian (1996) illustrate how preoccupations with opportunism can undermine the implementation of innovations in relationships between organizations, such as the example of Hewlett Packard having in the 1980s and 1990s an increased ability to identify market trends, because of strong integration of embedded ties with suppliers compared with companies like D.E.C. and Apollo Computer. Saxenian (1996) commented that the embedded ties between Hewlett Packard and its suppliers helped the company to develop more innovations and better position itself against competitors, which meant that Hewlett Packard could enjoy supplier expertise and avoid opportunistic behavior. Based on the arguments (Antiqueira, Saes, & Lazzarini, 2007; Gulati, 1995; Noordhoff et al., 2011; Saxenian, 1996) and the possibility of increasing risk and undermining trust (Vieira, Monteiro, & Veiga, 2011), it is reasonable to assume that the presence of opportunism negatively impacts embedded-tie relationships. Following from this:

H₂. The presence of opportunism in the relationship between supplier and client exerts negative influence on embedded ties.

The next hypotheses deal with investments. Investments from a client in a supplier are defined as resources invested in the supplier equipment, human resources, and information systems (Williamson, 1975, 1983). According to Noordhoff et al. (2011), client investments in a supplier reduces the possibility of opportunistic behavior because "these investments serve as hostages and customers are unlikely to threaten those investments by behaving opportunistically. Likewise, these investments signal customer commitment, which should reduce the supplier's worries about customer opportunism" (p. 39). In addition, Noordhoff et al. (2011, p. 39) comment that "investments may also improve the quality of customer insights, thereby reducing knowledge redundancy", creating more helpful insights to the innovation. The literature shows evidence of the association between client investment and supplier innovation from the perspective of joint collaboration (Narayanan, Narasimhan, & Schoenherr, 2015; Saxenian, 1996; Williamson, 1983, 1991), suggesting a positive association. Given these reasons, this research assumes that the investments made by a client in a supplier result in increased knowledge for supplier innovation (due to commitment and improved quality) and result in embedded ties (given mutual collaboration). In light of this:

H₃. Client investment in their supplier positively influences supplier knowledge.

H₄. Client investment in their supplier positively influences embedded ties.

For Sivadas and Dwyer (2000), formalization is the degree to which partners have explicit rules for relationship management, with such rules having an impact on embedded ties. Formalization can reduce concerns about opportunism between partners (Holloway & Parmigiani, 2014), because formalization develops relationships by instilling a level of transparency to information exchanges. For Sivadas and Dwyer (2000), the process of formalizing industrial relationships is an indication of willingness in partnerships that signals a partner's acceptance to fulfill contractual requirements, which reduces the possibility of future opportunism and has a positive impact on embedded ties. Noordhoff et al. (2011) argue that formalization has the advantage of reducing the sense of redundancy of knowledge (see also Cavusgil, Calantone, & Zhao, 2003), because communication becomes more structured, logical, specific, and refined. Therefore, since there is a difference between non-formal and formal relationships – with the latter having a less repeatable and more organized flow of information, we believed that:

H₅. The formalization of relationships positively influences embedded ties.

The next two assumptions deal with client and supplier flexibility. Client and supplier flexibility in a relationship can have positive effects because flexibility improves formal and informal information exchanges between partners, helping in the development of time-to-market and innovation initiatives. Client and supplier flexibility can also develop cooperative interactions, which collaborate in the growth of new knowledge, even though these interactions are not expressly formalized in contracts (Sivadas & Dwyer, 2000). Thus, flexibility in relationships is important for the strengthening of the dyad and the development of innovations – as is formalization – because it helps rapidity, facilitates the exchange of knowledge, improves communication between agents, and increases fluidity of activities between associates, which tend to be beneficial to relationships (Noordhoff et al., 2011). Therefore, it is assumed that flexibility

– if used in the right measure – has a positive impact on the development of embedded ties. Therefore:

H$_{6a}$. Client flexibility in supplier relationships positively influences embedded ties.

H$_{6b}$. Supplier flexibility in client relationships positively influences embedded ties.

The moderating effect of embedded ties

Next, we assume that embedded ties moderate the effect of client and supplier innovation knowledge because it helps to effectively develop knowledge-sharing capabilities. Effective knowledge-sharing capabilities are critical to a number of organizational processes, including the use of best management practices and the development of new products (Reagans & McEvily, 2003). The congruence of management practices in a relationship can facilitate the transfer of knowledge (Reagans & McEvily, 2003) and increase supplier innovation knowledge. According to Day (1994), embedded ties with clients collaborate with the ability of the supplier to employ knowledge in the development and implementation of innovations, generating a complementary effect in innovation. So, embedded ties should amplify the effect of supplier innovation knowledge. Rowley et al. (2000) argue that embedded ties with clients amplify a supplier's motivation to use experience and market knowledge to develop innovations that meet client needs. Based on research by Day (1994), Reagans and McEvily (2003), and Rowley et al. (2000), it is assumed that embedded ties amplify the capability of the supplier to develop innovations from their own knowledge. Therefore:

H$_{7a}$. Embedded ties moderate the association between supplier innovation knowledge and supplier innovation.

This hypothesis also deals with embedded ties having a moderating effect on knowledge from the client. The quality and diversity of knowledge shared with partners can determine how impactful the resulting innovation from this knowledge will be. According to Granovetter (1973) and Reagans and McEvily (2003), the more homogeneous associates' knowledge is the less impactful it will be in producing innovation (e.g., incremental innovation), and the more heterogeneous associates' knowledge is the more effective the development of innovation will be (e.g., radical innovation).

Specifically, the risk of the partner appropriating information with malicious intentions (Noordhoff et al., 2011) inhibits the exchange of confidential and strategic information, which is useful for the development of innovation. This risk is greater as the embeddedness of ties increases (Granovetter, 1985). Knowledge is associated with innovation – based on the argument that tacit and explicit knowledge are predictors of performance – with innovation being a type of result (Dhanaraj, Lyles, Steensma, & Tihanyi, 2004). Embedded ties favor the development of supplier innovation, which increases the impact of knowledge. Here, the effect is amplified by the sharing of information with the client, creating more capability to implement innovations. With this in mind:

H$_{7b}$. Embedded ties moderate the association between client innovation knowledge and supplier innovation

Fig. 1 features the conceptual model proposed by this work, which shows the direct effects. The model was examined by analyzing these routes with multiple regressions (similar to that employed by Ahearne, Rapp, Hughes, & Jindal, 2010) and using a sample of suppliers from a large agro-industrial cooperative. The dotted arrows represent the moderating effects. Covariates sought to control the levels of variation of the embedded ties.

Research methods

Procedures

The chosen research method was a cross-sectional survey, investigating several suppliers of an agro-industrial cooperative. Suppliers had previously been warned about the research through emails sent by the cooperative. The agro-industrial cooperative closed 2014 with a turnover of more than R$ 2800 billion, has more than 1000 employees, and approximately 9800 registered suppliers. Data collection with suppliers employed structured questions with a Likert-type scale, and had obligatory answers for all questions. The option for having mandatory responses eliminated the possibility of missing values in the surveys. The sample of respondents of this study consists of a group considered as having embedded-tie relationship characteristics, that is, the suppliers with the most frequent relationships in the last semester.

Data collection

To collect data from the suppliers, a filter was applied that selected the main suppliers registered with the agro-industrial cooperative that had the highest frequency and most recent dealings (Ring & Van de Ven, 1994). In the last six months, the chosen suppliers had an average monthly rate of more than seven deliveries. This process returned 277 answers (3.4%). Later, the cooperative sent an email to suppliers that warned them about the research and invited them to access a link to the questionnaire. After sending the notice, 42 suppliers voluntarily responded to it. Subsequently, remaining suppliers were contacted directly by the researchers. This included a total of 168 calls and generated 84 additional interviews.

There were no significant differences in responses from interviews by phone and voluntary responses carried out directly by suppliers in electronic form. This bias was measured to create two different links with the same form – one for voluntary responses and another for telephone interviews. After data collection, no significant deviations were found, and the responses were gathered in the same database for analysis. The final sample after purification contained 126 suppliers.

Definition of variables

For the supplier-innovation variable, the definition of innovation by Henard and Szymanski (2001) was adopted. Supplier
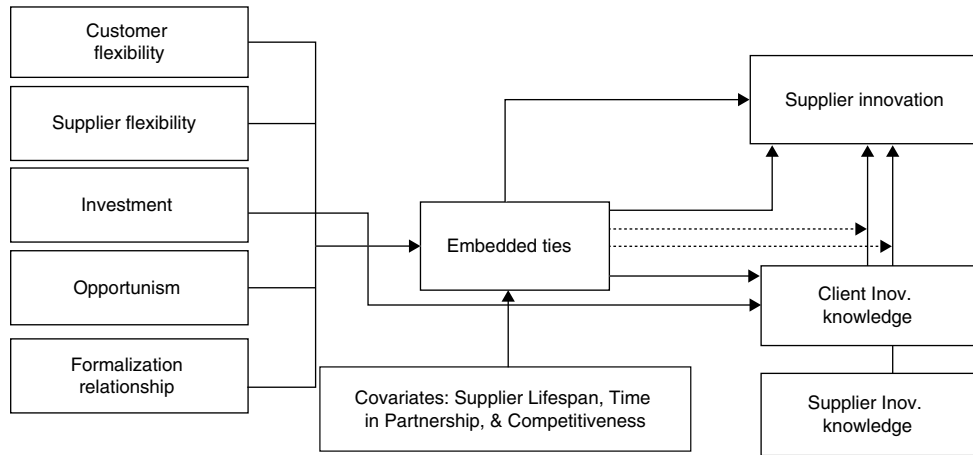
Fig. 1. Proposed conceptual model of the antecedents of embedded ties and supplier innovation.

innovation is associated with understood organizational strategies – planned actions of one or more associated companies for example – which has the potential to create and deliver innovation to the market. The supplier-innovation variable was operationalized through the affirmative: "The company's relationship with the cooperative has helped develop new products/services and/or improvements in its way of working," which was adapted from Kyriakopoulos and Moorman (2004). The scale ranged from "strongly disagree" to "totally agree." All scales had 10 points.

Supplier knowledge for innovation is knowledge, beliefs, behavioral routines, or physical artifacts that range in content, level of dispersion, and accessibility (Noordhoff et al., 2011). The item used to measure this variable was: "The company is engaged in research and development to promote solutions that meet their own needs and the needs of their clients," which was adapted from Von-Hippel (1986). The indicator ranged from "strongly disagree" to "totally agree."

Client knowledge for innovation is a set of beliefs, behavioral routines, or physical artifacts that range in content, level of dispersion, and accessibility (Noordhoff et al., 2011) from the point of view of the customer. Client knowledge was operationalized through the following statement: "The cooperative is an innovative company and conducts research to develop new products and new alternatives." The indicator varies from "strongly disagree" to "totally agree," which was adapted from Von-Hippel and Katz (2002).

Embedded ties are a type of association between businesses characterized by a relationship of reciprocity, closeness, and consistency (Noordhoff et al., 2011). The variable was operationalized through the following statement: "The company considers the relationship with the cooperative as mutually rewarding," which ranged from "not rewarding" to "very rewarding" and was adapted from Rindfleisch and Moorman (2001).

Williamson (1975, p. 255) defines client opportunism as "partner behavior that is guided by the pursuit of their own interests in an unfair way or in any way that is detrimental to their partner." The variable was operationalized through the statement "The cooperative is sometimes opportunistic in relation to our company in order to meet their own objectives."

The indicator was adapted from Jap (1999) and ranged from "strongly disagree" to "totally agree".

Supplier flexibility is the effort made by the partner to respond adequately to changes of plan or how willing the partner is to make adjustments to help their associate when faced with special problems or circumstances (Kaufmann & Dant, 1992). The statement was: "The company is willing to make adjustments in the way of working, or put aside contractual terms to help the cooperative if it gets into difficulties." The item was adapted from Kaufmann and Dant (1992) and ranged from "strongly disagree" to "totally agree".

Client flexibility is the effort made by the partner to respond appropriately to changes of plans or how willing the partner is to make adjustments to help their partner when faced with special problems or circumstances (Kaufmann & Dant, 1992). The indicator was: "The company believes that the cooperative would be willing to put aside contractual terms or change the way of working in order to help our company or make the partnership with the company more effective." The reference for the indicator is the article by Kaufmann and Dant (1992), and the responses ranged from "strongly disagree" to "totally agree."

Formalization is related to the degree to which the relationship is guided by contractual rules and policies for the control of day-to-day operations involving association with a partner (Sivadas & Dwyer, 2000). The statement was: "How much does the company depend on contractual rules to control the relationship with the cooperative?" The question was adapted from Sivadas and Dwyer (2000) and ranged from "not dependent at all" to "highly dependent."

Client investment covers resources provided to the supplier and includes equipment, personnel management, and information systems (Williamson, 1983). Analysis was operationalized through the statement: "The cooperative carries out adjustments in processes and/or invests in preparing people in order for them to cope more effectively in the relationship with the company". The indicator was adapted from Rokkan, Heide, and Wathne (2003) and ranged from "strongly disagree" to "totally agree."

Partnership time refers to the length of the relationship (in years) (Jap, 1999; Johnson & Sohi, 2001). Based on Jap, the question was operationalized as follows: "How many years

has the company been working in partnership with the cooperative?" The supplier-lifespan variable (in years) is the time since the organization was founded, which was operationalized through the question: "How long has your company existed for?" Competitiveness in the suppliers' sector was measured with the following question: "How competitive is the sector that the company operates in?" The scale ranged from "not competitive" to "highly competitive."

This work chose to use simple indicators that were not multiple. Firstly, this option ran into the difficulty of trying to collect data by telephone from the suppliers. Many organizations questioned the size as well as the time to answer the survey. Secondly, the need to use multiple indicators to measure a construct has been debated in research on marketing (Bergkvist & Rossiter, 2007), where it is shown that measurement using multiple indicators generates higher correlations than measurement with only one indicator in each relationship construct. This is not supported by classic arguments of psychometrics (Churchill, 1979) that state that multiple-indicator measurements are more valid than those based on just one.

Analysis of the results

The variable related to the level of competition in the suppliers' sector allowed more than one response. Given this findings, the combination of the sectors in which the suppliers operate in showed a slightly higher percentage of occurrences in trade ($n = 66$, 54%), in the industry ($n = 30$, 24%), and a remainder in others. Supplier flexibility had a mean response (M) of 8.49 and a standard deviation (SD) of 1.95. Embedded ties had a mean response of 8.49 and standard deviation of 1.54. Formalization, M = 4.52 (SD = 3.88), and client investments in the supplier, M = 5.81 (SD = 3.47), both had lower response averages. Table 1 summarizes the average responses and standard deviation of the observed variables in the study. Time in partnership ranged from 0 to 40 years, mode value = 10, and the lifespan of the supplier ranged from 0 to 86 years, with a mode value = 20; sample = 126 companies.

Table 1
Description of data.

Variables	Mean	Standard deviation
Supplier lifespan	22.63	18.08
Time in partnership	9.93	7.95
Competitiveness in supplier sector	8.51	1.91
Supplier flexibility	8.49	1.95
Relationship Formalization	4.52	3.88
Embedded ties	8.49	1.54
Supplier innovation knowledge	8.02	2.19
Client innovation knowledge	7.75	2.59
Supplier innovation	6.66	3.23
Client flexibility	6.24	3.20
Client investment in supplier	5.81	3.47
Client opportunism	1.48	2.18

Table 2 shows the correlations among the variables. The fact that many variables have a correlation with supplier innovation and embedded ties is highlighted.

Table 3 presents an analysis of the regressions and the hypotheses' examination of the model's variables. The results were made through regression analysis using structural equation modeling. To examine the regression variables, variables were transformed into z-scores, standardizing the data in the same way as Ahearne et al. (2010). A z-score generates zero for average and one for standard deviation, reducing the effects of multicollinearity in regression analysis (Ahearne, Mathieu, & Rapp, 2005). Three models were analyzed: (1) complete model without moderation effects; (2) complete model with moderation effects; and (3) a re-specified model with the exclusion of two covariates that had no significant effect.

Examination of hypotheses

The adjustments of the structural model (model 1) were χ^2/d.f. = 1.85; goodness-of-fit index (GFI) = 0.91; adjusted-goodness-of-fit index (AGFI) = 0.85; the root mean square error of approximation (RMSEA) = 0.08, and Akaike information criterion = 149.21. The results show a significant and positive

Table 2
Correlation matrix of variables.

Variables	1	2	3	4	5	6	7	8	9	10	11
1: Supplier innovation	1										
2: Knowledge for supplier innovation	0.359**	1									
3: Innovation knowledge from client	0.242**	0.337**	1								
4: Supplier flexibility	0.226*	0.168	0.049	1							
5: Customer flexibility	0.320**	0.171	0.215*	0.535**	1						
6: Relationship formalization	0.120	0.065	−0.080	0.015	−0.055	1					
7: Client investment in supplier	0.371**	0.222*	0.431**	0.289**	0.553**	0.074	1				
8: Client opportunism	0.036	−0.054	−0.032	−0.021	0.064	0.116	−0.015	1			
9: Embedded ties	0.310**	0.080	0.166	0.362**	0.363**	−0.019	0.272**	0.014	1		
10: Time in partnership	0.040	0.027	−0.168	−0.069	−0.097	−0.023	−0.088	−0.005	−0.130	1	
11: Supplier lifespan	0.028	0.109	−0.126	−0.052	−0.002	0.015	−0.029	−0.122	−0.230**	0.322**	1
12. Competition in supplier sector	0.011	0.127	0.070	0.059	−0.080	−0.093	−0.047	−0.148	0.123	0.042	−0.134

* $p < 0.05$.
** $p < 0.01$.

Table 3
Analysis results of regressions and examination of hypotheses.

Hyp.	Independent variable		Dependent variable	1	2	3
Direct effects						
H_1	Embedded ties	→	Supplier innovation	0.27***	−0.15*	−0.15*
H_2	Client opportunism	→	Embedded ties	−0.02	−0.02	−0.01
H_3	Client investment in supplier	→	Supplier knowledge innovation	0.09	0.09	0.22**
H_4	Client investment in supplier	→	Embedded ties	0.10	0.10	0.10
H_5	Relationship formalization	→	Embedded ties	−0.01	−0.01	−0.01
H_{6a}	Client flexibility	→	Embedded ties	0.19†	0.19†	0.19†
H_{6b}	Supplier flexibility	→	Embedded ties	0.21**	0.21**	0.22**
	Client innovation knowledge	→	Supplier innovation	0.09	0.17*	0.17*
	Innovation knowledge for supplier	→	Supplier innovation	0.31***	−0.47**	−0.47***
Covariates						
	Time in partnership	→	Embedded ties	0.00	0.00	
	Supplier lifespan	→	Embedded ties	−0.21**	−0.21**	−0.21**
	Competitiveness level	→	Embedded ties	0.04	0.04	
Moderation						
H_{7a}	Supplier innovation knowledge × Embedded ties	→	Supplier innovation		0.04***	0.04***
H_{7b}	Client innovation knowledge × Embedded ties	→	Supplier innovation		0.00	0.00
Explained variance						
R^2	Embedded ties			0.20	0.21	0.09
R^2	Supplier innovation			0.20	0.60	0.10
R^2	Innovation knowledge for supplier			0.01	0.01	−0.01

Note: $N = 126$.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.
† $p < 0.10$.

relationship between embedded ties and supplier innovation ($\beta = 0.27$; $p < 0.01$). Such evidence supports hypothesis H_1. Given this value, the association between embedded ties and development of supplier innovation was supported, indicating that the stronger the embedded ties, the greater the development of innovations for the suppliers. These findings are consistent with Day (1994) and Noordhoff et al. (2011), who foresaw the association between embedded ties and innovation. The result is also consistent with the research of Anderson and Weitz (1989), Rindfleisch and Moorman (2001), Reagans and McEvily (2003), and Uzzi and Lancaster (2003). One possible explanation for this finding is that more involved partners with stronger embedded ties tend to want to exchange more knowledge and private information in order to generate new solutions in the form of products and processes.

Hypothesis H_2 was rejected because there was no relationship between client opportunism and embedded ties ($\beta = -0.02$; $p = NS$). Analyzing the bivariate correlation matrix, there was also no association between client opportunism and embedded ties ($r = 0.01$; $p = NS$). In fact, the result emphasizes that there is no impact of unilateral issues involving opportunism in the relationship between the agents (Holloway & Parmigiani, 2014).

The next two assumptions deal with the effects of investment in the dyad. First, hypothesis H_3 was not supported because there was no significant impact from investments made by the client in the supplier and supplier knowledge ($\beta = 0.09$; $p = NS$). This indicates that the investments that the client makes in their supplier do not influence the supplier's knowledge for innovation. This finding rejects the thesis of Noordhoff et al. (2011),

which suggests that client investment in suppliers are so strong and pertinent that these attenuate the negative effects of embedded ties in the relationship, with the consequent favoring of the client sharing information with the supplier. It is worth noting that hypothesis H_3 was supported in model 3, where the moderation of embedded ties in the equation was found ($\beta = 0.22$; $p < 0.01$). Two elucidations are made from the find.

First, the rejection of the explanation lies in the structural model that simultaneously employs multiple regressions, generating statistical interference in order to find the result. The bivariate correlation matrix shows that there is a positive impact from investments made by the client in the supplier and supplier knowledge ($r = 0.22$; $p < 0.01$), supporting the hypothesis and being consistent with the arguments of Williamson (1983, 1991). However, multiple equations could be generating a negative effect because of colinearity. Second, the association between these variables can also be seen through a quadratic equation ($\beta_{quadratic} = 0.21$; $p < 0.14$), which better explains the dependent variable than a linear equation would. Therefore, the result of the quadratic equation is positive and consistent with the hypothesis.

The relationship between investment made by the client in the supplier and embedded ties was not accepted, which rejects hypothesis H_4 ($\beta = 0.10$; $p = NS$). This finding is contrary to the assumptions of Anderson and Weitz (1989), Noordhoff et al. (2011), Wathne and Heide (2000), and Williamson (1983).

Hypothesis H_5 was rejected because no significant impact between the formalization of relationships and embedded ties was encountered ($\beta = -0.01$; $p = NS$). It is worth noting that Noordhoff et al. (2011) found no such association. The finding
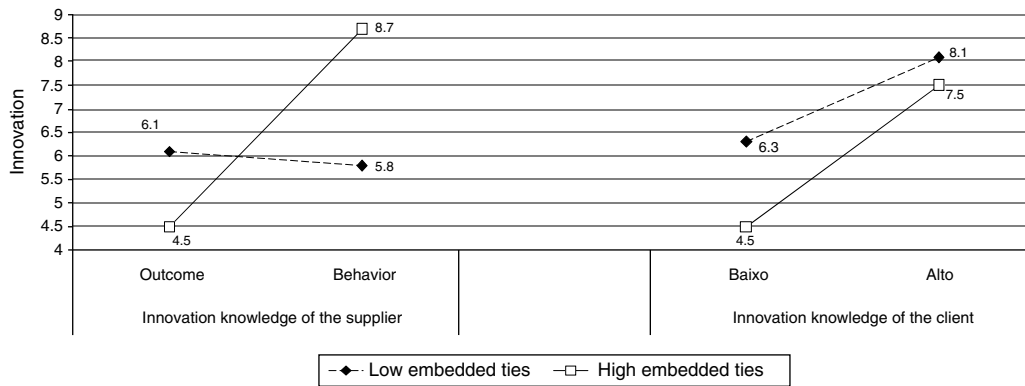
Fig. 2. Moderating effect of embedded ties on innovation from client knowledge.

discovered here is therefore divergent from that of Sivadas and Dwyer (2000). Considering this divergence, future work could produce studies along this line.

It was noted that client flexibility positively effects embedded ties ($\beta = 0.19$; $p < 0.07$). This finding supports the assumption of Sivadas and Dwyer (2000) and confirms H_{6a}. Client flexibility is the effort made by a partner to respond appropriately to changes of plan or how willing the partner is to make adjustments to help their partner when faced with special problems or circumstances (Kaufmann & Dant, 1992).

The relationship in hypothesis H_{6b} was found, supporting the association between supplier flexibility and embedded ties ($\beta = 0.21$; $p = 0.01$). For Sivadas and Dwyer (2000), rigid relationship formalization – contrary to flexibility – has negative effects for the association because, in excess, formalization limits flexibility in relationships.

Hypothesis H_{7b} examines the moderating role of embedded ties in the relationship between knowledge from the client and innovation. It is believed that embedded ties with clients boost the capability of client expertise in the use of information for the development and implementation of innovations (Rindfleisch & Moorman, 2001). The moderating effect of embedded ties in the association between knowledge for innovation and effective development of innovation has a theoretical base on the work of Rowley et al. (2000) and Day (1994). The findings showed that the moderating relationship has no effect when compared to the direct and simple association ($\beta_{\text{client knowledge} \times \text{embedded ties}} = 0.00$; $p = \text{NS}$ vs. $\beta_{\text{direct effect}} = 0.17$; $p < 0.01$). Therefore, the coefficient is not significant and cannot support the amplifier role of embedded ties from the knowledge. Fig. 2 (on the right) shows no significant effect of embedded ties.

Hypothesis H_{7a} examines the moderating role of embedded ties in relation to innovation knowledge for the supplier and innovation. The moderating role of the embedded ties was suggested by Noordhoff et al. (2011), although they had a negative effect. In this work, the moderating effect was positive and maintains the assumption of enhancing results. Initially, a significant association between innovation knowledge for supplier and innovation was found ($\beta = -0.47$; $p < 0.01$). Subsequently, when testing the moderating effect of embedded ties in relation to relationships, the results show an amplification of the result

($\beta = 0.04$; $p < 0.001$), which had the strongest impact. Therefore, the association is more intense, increasing the explanatory power of the supplier-innovation variable. Hypothesis H_{7a} is therefore confirmed. The findings of Rindfleisch and Moorman (2001) and Day (1994) also demonstrate that embedded ties positively influence information sharing between the customer and supplier, resulting in innovation. Fig. 2 (left) shows the magnified effect of embedded ties.

Perspectives on the mediating effect of embedded ties

The theoretical model shows that embedded ties in industrial relationships interfere in relations exercised on two knowledge levels (e.g., supplier and client) in the development of innovation, causing a moderating effect. The findings supported one of the hypothesis from the two tested. In fact, Noordhoff et al. (2011) point out that under certain conditions embedded ties favor the development of innovation, but in others it causes harm.

Nevertheless, proposals that suggest a mediating effect of embedded ties in associations that explain the development of innovation were found in the literature. Therefore, it is not known if embedded ties have such a significant effect on the development of innovation in the dyad or whether they block the effects of the existing variables of flexibility, investments, knowledge, formalization, and opportunism. If the mediating effect is significant, it is inferred that embedded ties become so relevant that they tend to block (i.e., full mediation) or tend to reduce (i.e., partial mediation) (Baron & Kenny, 1982) already known variables' impacts on industrial relations that favor innovation development.

Aiming to examine the mediating role of embedded ties in relations suggested in the theoretical model, various tests were used according to that advocated by Baron and Kenny (1986) and Sobel (1982). Moreover, mediation tests have been done using the four models suggested by Hayes (2013) with three covariates being controlled. The results presented in Table 4 show that there was a significant mediating effect of embedded ties in the relationship between client flexibility and innovation ($z = 2.22$; $p < 0.05$), supplier flexibility and innovation ($z = 2.43$; $p < 0.05$), and investment and innovation ($z = 2.04$; $p < 0.05$). In these three relationships, the direct effect of the independent variable is reduced when there is a new condition in the equation – i.e.,

Table 4
Mediation analysis of embedded ties.

Variables	Sobel's Z test	p-Value	Direct effect	Indirect effect
Customer flexibility	2.22	0.026[*]	0.33	0.24
Supplier flexibility	2.43	0.015[*]	0.28	0.21
Customer investment in supplier	2.04	0.040[*]	0.36	0.29
Customer opportunism	−0.16	0.860	0.05	0.06
Formalization	−0.18	0.85	0.10	0.10
Innovation knowledge for supplier	1.08	0.27	0.53	0.49
Client innovation knowledge	1.34	0.17	0.32	0.27

[*] $p < 0.05$.

embedded ties – supporting its mediating role in the conceptual model.

Final considerations

Conclusions

First, it was discovered that the presence of embedded ties positively influences the innovation of the agro-industrial cooperative's suppliers. Such a conclusion is given by the influence of embedded ties both directly on innovation and indirectly, as it enhances knowledge capabilities and then turns into supplier innovation. This initial finding is consistent with other studies that have shown the benefits of embedded ties in creating a mutual-assistance network (Borgatti & Foster, 2003), and indicates that highly embedded networks provide the capability for incremental innovation (Chen & Chang, 2004).

Second, the presence of embedded ties negatively influences innovation for the cooperative suppliers when their moderating effect is accounted for. The interaction of embedded ties with knowledge for supplier innovation and innovation from client knowledge generated a negative result, which is endorsed by Anderson and Jap (2005), Granovetter (1985, 2005), Moorman, Zaltman, and Deshpande (1992), and Selnes and Sallis (2003). These investigations demonstrate that embedded ties can cause partner accommodation that maintains the status quo in associate relationships, which reduces innovation.

Third, it was noted that client flexibility and supplier flexibility leverage embedded ties. The flexibility process tends to be productive for the dyad, positive for the generation of innovation, and dynamic for radial and incremental innovation, which are able to improve embedded ties. Supplier flexibility improves the quality of ties and capability for enhancing the innovation process, a finding that is consistent with Castro and Baldi (2010).

Fourth, client investment in suppliers generates the highest score for supplier knowledge. This result is congruent to that suggested by Noordhoff et al. (2011) and Saxenian (1996). Thus, investment tends to enhance capability building for know-how and new information for product development processes by strengthening the relationship with the dyad.

Fifth, the positive effects of client flexibility, supplier flexibility, and client investment on supplier innovation are felt via embedded ties. These indirect results show that embedded ties have a mediating role in the relationship between these variables. The indirect effects of flexibility and investment on

innovation show that the orientation process is by proximity created through embedded ties and shows a new way of understanding the development of innovation.

Research limitations

First, considering that the respondents are part of the top management of the supplier companies, the need for brevity in data collection was imperative. To meet this brevity in the questionnaire, just one question for each variable was employed. Therefore, there is a limitation of using variables with single indicators (Bergkvist & Rossiter, 2007).

Second, respondents were informed about the anonymity and confidentiality of responses. Approximately one third of the interviews (33%) were obtained voluntarily and anonymously in electronic form, and there was no significant difference with these and responses collected via telephone. However, a possible bias in the responses due to respondent embarrassment about being asked questions on client opportunism should not be ruled out. In this sense, other measures for opportunism could be suggested, which would measure through the company instead of the supplier.

Third, the survey interviewed suppliers that supplied the highest average quantity of goods per month in terms of transactions (e.g., sales) for the last six months (from the time of research). Higher transaction frequency tends to signal suppliers with stronger embedded-tie relationships. A limitation of the research is the use of the highest frequency and most recent suppliers per month in terms of transactions (e.g. sales) in the last six months (as selection process), as other ways of making the sample could have been used. Thus, certain suppliers could have been left out of the sample. The existence of a service contract with different supply averages, as well as indicating the presence of embedded ties, would allow inferences about other characteristics relevant to the study of the association, such as the clients' dependence on suppliers and relationship formalization.

Suggestions for future studies

For future studies, the inclusion of new variables that expand the analysis of the effects of embedded ties on the relationship between companies is recommended. For example, consider the existence of *ex-ante* and *ex-post* agreements between the client and the supplier that allow for the comparison of embedded ties and their effect on developing innovation performance.

This occurs because the governance mechanism of an *ex-ante* contract, if poorly designed, can influence the main agent's requirement of how to proceed in terms of *ex-post* monitoring.

Second, finding the negative role of embedded ties in the association between suppliers and partners can be a potential field of study. In relation to long partnerships, embedded ties can have a negative effect on the results of organizations, generating agent opportunism. Noordhoff et al. (2011) showed that embedded ties have a dark-side effect in the relationship between consumer knowledge for innovation and supplier innovation, but that time in the relationship, relationship formation, and specific investments can turn this negative into a positive effect. Future work could study other elements that could soften the negative role of embedded ties.

Third, the form of innovation development could be key to improving business performance. Specifically, analysis of co-production in the relationship between the supplier and partners can be a possible area of investigation. Co-production is a joint production of solutions, services, and products that help organizations gain competitiveness, differentiation, and performance. Therefore, co-production could be a predictor of innovation.

Fourth, although the possibility of mediation has not been elaborated on, the mediating role of embedded ties in relationships suggested in theoretical model was proven. Future research could better understand the mechanism behind the effect that embedded ties have on independent variables with a view of reducing their impacts. Mediation means that when there are embedded ties defined in the dyad, the magnitude and effects of relationships on supplier innovation are reduced, given the blocking effect of mediation.

Conflicts of interest

Acknowledgements

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