Reconsidering the affective character of relationships: strong ties and innovation in supplier-customer relations

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Abstract:

Scholars have found contradictory effects of strong ties in interfirm relations. They are considered both beneficial and detrimental for knowledge acquisition and innovation. In consequence, the debate on this paradox is flourishing.

We wish to contribute to the discussion using a construct -relational bonding- originally developed in studies on vertical interfirm relationships in business-to-business markets. The approach distinguishes between structural bonding and social bonding, which allows us to consider the two different components of tie strength put forward in Granovetter’s seminal work: respectively the behavioral -frequency of social interaction and reciprocal services characterizing the relationship - and the affective ones -the emotional intensity and the intimacy that characterize the tie.

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By explicitly measuring and appreciating also the more neglected affective component of tie strength, we show that strong ties with key customers - in their behavioral and affective components- positively impact on innovation of SMEs located in an high tech cluster in central Italy, with knowledge acquisition moderating the relation.

**Key words:** strong ties; innovation; knowledge acquisition; key customers
INTRODUCTION

Over the last decades there is a considerable increase of attention on the impact of inter-firm relationships on innovation of the individual organizations (Inkpen, 1998; Sammarra and Biggero 2008). Supplier-customer relationships are recognized as strategic by organizations for their impact on knowledge acquisition, innovation capability and competitive advantage (Dyer and Singh 1998; Lorenzoni and Lipparini, 1999; Dyer and Nobeoka 2000, Meschita et al, 2008).

In this study we particularly focus on the strength of the dyadic relationship between supplier and customer, investigating its impact on organization’s knowledge acquisition and innovation. Considering the seminal definition, tie strength is a combination of affective components – the emotional intensity and the intimacy that characterize the tie- and behavioral components - frequency of social interaction, and reciprocal services characterizing the relationship (Granovetter, 1973, 1974). Strong ties are considered both beneficial and detrimental for organizations: the same process that enables the firm to develop innovation might restrict the identification of new opportunities and their exploitation (Danneels 2003, Fredberg and Piller 2011).

Although previous research made a curvilinear prediction, empirical evidences are not homogeneous both in innovation studies and in social capital studies (Uzzi 1996; Lowik et Al, 2012, Rost, 2011; Yli-Renko et al 2001, Presutti et al 2007; Martines-Canas et al 2012). More recently authors have addressed the controversy by conditioning the effect of strength on organization to some specific conditions such as: the kind of innovation (Bonner and Walker 2004) and of the relationship (Tomlinson and Fai 2016), the degree of customers knowledge similarity (Bonner and Walker 2004) and the active or passive customer’s involvement in the innovation process (Fredberg and Piller 2011).

We intend to contribute to this debate going back to the seminal definition of tie strength by Granovetter and explicitly consider not only the behavioral components, but also the affective ones, which are more often disregarded in empirical studies (Krackhardt 2003). In fact, only recently scholars have started to appreciate the role of the affective components
of tie strength and related it to individual actors’ change resistance (Battilana and Casciaro 2013).

The affective component of tie strength, originally defined at the interpersonal level, was rarely measured and applied at the inter-firm level. We found an interesting exception in the literature on supplier-customer relationships in business-to-business markets where the construct “relational bonding” was originally developed and used to explain the stability and success of the relationship (Wilson, 1995). We consider this approach particularly suggestive because it explicitly considers and measures both the objective and behavioral elements of strong ties, defined as structural bonding, and the affective elements, defined as social bonding.

Using this conceptual approach we investigate both direct and indirect effects of the tie strength with key customers (in their different components) on supplier innovation, also considering the mediating role of knowledge acquisition. If the relationship among tie strength, knowledge acquisition and innovation has already been explored, our aim is to go further considering and disentangling the contributions of the two different components of tie strength.

Our empirical setting is based on high-tech SMEs belonging to a geographical cluster located in one of the most economically important areas in central Italy, the Tiburtina Valley. We focus on vertical strategic partnerships between these firms and their key customers located both within and outside the cluster. To identify these relationships we follow previous studies addressing similar research questions (Yli Renko, Autio, Sapienza, 2001; Presutti, Boari & Fratocchi, 2007, 2016).

We expect and confirm a positive impact of tie strength on innovation - both in terms of affective and behavioral components- with the mediating role of knowledge acquisition.

The paper has been structured as follows: first, we review previous research on the topic and propose hypotheses. Then we describe the empirical setting and results. Finally, findings are discussed, including implication for theory and practitioners, limitations and future research.
THEORETICAL FRAMEWORK

Innovation emerges through interactions (Ahuja, 2000) mainly based on external social relationships (Phelps, Heidl, Wadhwa, 2012). The relationships of organizations with other external actors have attracted a lot of attention as they might positively impact on firms' knowledge acquisition and innovation (Powel et al 1996).

In particular, research on vertical relationships have shown how investing on and managing these relationships benefit organizations in different ways, including innovation (Von Hippel 1998, Antonelli and Fassio 2015), knowledge acquisition (Kotabe et al 2003; Meschita et al 2008; Pirolo and Presutti, 2010) and competitive advantage (Dyer and Singh, 1998, Langfield-Smith and Greenwood, 1998; Lorenzoni and Lipparini, 1999; Dyer and Nobeoka 2000, Meschita et al, 2008).

In this paper we focus on the strength of ties in explaining knowledge acquisition and innovation by suppliers involved in downstream relationships with key customers. Granovetter (1973, p.1361) defined tie strength, initially intended for interpersonal relationships, as a “combination of the amount of time, the emotional intensity, the intimacy (mutual confiding) and the reciprocal services which characterize the tie”. His approach greatly influenced innovation studies where the role of tie strength is evaluated in terms of knowledge acquisition and innovation of individuals and organizations, as it was widely adapted to the inter-firm context

Strong ties enable the development of trust between buyer and supplier, benefit firms from lowered transaction costs, greater commitment, collaboration, improves efficiency in the relationship (Villena et al, 2016). Strong ties can favor the exchange of complex and tacit knowledge, fine-grained information transfer and joint problem solving arrangements (Uzzi 1996). These advantages encourage companies to continue existing relationship (Kim, Oh, & Swaminathan , 2006; Li, Madhok, Plaschka, & Verma, 2006).

However, these ongoing relationships can be counterproductive in many respects transforming strong ties from assets to liabilities. In other words, there is a dark side in strong ties. Sometimes, trust could cover or hide the supplier's misconduct. Alternatively,
the buyer may fear a disruption due to its reputational consequences (Gulati, 1995). In addition, the buyer/seller can tolerate the opportunism of suppliers/buyer if it is a less costly response in comparison to the negative consequences of the breakdown of relations (Seggie, Griffith, & Jap, 2013). Contrary to what happens for weak ties, strong ties might restrict actions outside of the relation and constrain the access to other resources and opportunities. Accordingly the risk to limit firm’s knowledge-base is also increased and the innovation restrained. (Marsden & Campbell, 1984; Brown and Konrad, 2001).

With strong ties considered both as assets and as liabilities, some scholars found a curvilinear relation with knowledge acquisition by firms (Uzzi 1996; McFadyen and Cannella, 2004) theorizing the benefits of a dual network structure combining both strong and weak ties (Capaldo, 2007; Tiwana, 2008). Other authors found evidences of a persistent positive relationship between strong ties, at the dyad level, and knowledge acquisition, even within networks rich of weak ties (Lowik et Al, 2012, Rost, 2011). Similar contrasting results can also be found in studies based on the social capital approach to innovation where Granovetter’s seminal contribution on tie strength was deeply assimilated (Yli-renko et al 2001; Presutti et al 2007; Martinez-Canas et al 2012).

The paradox concerning both the beneficial and the detrimental impact of strong ties on knowledge acquisition and innovation (Danneels 2003) has been addressed considering the interactive role of different factors, such as the kind of innovation (radical and incremental) (Bonner and Walker 2004), the relationship being downstream or upstream (Tomlinson and Fai 2016), the customer knowledge similarity (Bonner and Walker 2004) and the active or passive customer’s involvement in the innovation process (Fredberg and Piller 2011).

We intend to contribute to this debate going back to Granovetter’s definition of strong ties also considering the more affective elements of strong ties and incorporating it in previous studies. Two of the characteristics of strong ties, emotional intensity and intimacy, are considered by Granovetter (1973) as strongly motivating actors to invest time and resources in sharing any kind of knowledge. This makes organizational scholars recognize that the informational and knowledge benefits of strong ties are a consequence of the affective link between them. Krackhardt (2003, p. 217) asks for studies which appreciate both the behavioral and the affective components of tie strength claiming that Granovetter’s theory
draws on the psychological theory of balance but “we seldom see the affective dimensions
in the operationalization of strong ties”. There is a growing interest for the role of the
emotional intensity of strong ties. For example the affective component of strong ties is
found enabling actors to overcome change resistance (Battilana and Casciaro 2013).

With the affective component of tie strength originally developed at the interpersonal level,
we rarely find it applied to the inter-organizational level. For the context of our research we
propose a construct originally developed in the literature on supplier- customer
relationships in business to business markets and use it to analyze the impact of strong ties
on knowledge acquisition and innovation (Wilson, 1995) Accordingly with this perspective
the starting point for the development of a relationship between two firms is the
interdependence between them (Hakansson, 1982). Interdependence is based on the need to
access resources, knowledge and capabilities of other organizations, delivered in the form
of products or services (Pfeffer and Salancik, 1978). Within this framework, the
development of supplier-customer relationships can be seen as an evolutionary process in
terms of increasing experience, reduction of uncertainty, perceived commitment, formal
and informal adaptations and investments (Ford, 1980).

Incremental investments and adaptation activities may create relational bonding, between
supplier and customer (Han, 1991; Rodriguez and Wilson 2002). What is defined as
relational bonding describes the strength of a relationship (Easton and Araujo, 1986) and
can be considered as the degree of resistance of that relationship to disruption. Relational
bonding can thus be considered an expression of tie strength between collaborating
partners. Relationships based on high level of relational bonding are more likely to be
successful (Sarkar et al., 1998) and become more stable (Wilson and Mummalaneni, 1986).
We claim that relational bonding might also enhance the access and acquisition of
knowledge from collaborating partners.

We find this perspective particularly attractive because it clearly considers all the
components of strong ties. On the one hand two more objective and behavioral elements–
frequency of interaction and reciprocal services- defined as structural bonding and on the
other one, two more affective elements—emotional intensity and intimacy—defined as social bonding.

Although the two components are highly interrelated they may vary in different ways, and it is therefore interesting to analyze them separately. This is particularly relevant in business to business markets where interfaces (digital and/or personal) with customers play a critical role in managing the relationship and, we claim, in allowing the creation and maintenance of proper conditions for knowledge exchange and innovative performance. We will use the relational bonding construct— in terms of structural and social bonding—to rise separated hypotheses on the role of a firm’s tie strength with customer on its knowledge acquisition and innovation.

**Relational bonding and knowledge acquisition**

Relational bonding develops at two different levels: the structural and the social levels. Particularly, structural bonding is based on task interdependences between supplier and customer and reflects investments, contractual conditions, obligations and expectations (Han 1991). It represents the degree to which certain ties link and hold a customer and a supplier in an economic, strategic, and organizational sense, regardless of personal or emotional matters. Structural bonding in a supplier-customer relationship can come with and from economic effects for that relationship. These effects are recognized to increased efficiency and effectiveness in operations and value-creation shared by both partners (Rodríguez and Wilson 2002).

We claim that a main performance implication for the involved organizations refers to the knowledge access and acquisition, for two main reasons. Structural bonding may motivate and enable an organization to access and acquire external knowledge. Structural bonding with a customer motivates the supplier to address customer’s needs and therefore to identify and access from that customer all the needed information and knowledge (Dyer and Nobeoka 2000; Rowley, Behrens, and Krackhardt 2000). Moreover, as the firm becomes highly interdependent with a customer, it also develops knowledge-enhancing practices that favor the transfer, recombination and creation of knowledge. This was found
true for different firms, both at the dyad and at the network level (Lipparini et al 2014). We expect that the more structural bonding a firm develops with its customer, the more likely it is to acquire knowledge from it. We express this in a formal way:

Hypothesis 1: The greater the level of structural bonding between a firm and its key customer, the greater the knowledge the firm acquires from it.

On the other hand social bonding refers to the degree to which a relation between a buyer and a seller is linked closely in a personal (emotional) sense through friendship, familiarity, social support, staying in touch, self-disclosure and any other interpersonal interactions (Han, 1991; Rodriguez and Wilson, 2002). In supplier-customer relationships personal contacts occur between various individuals, groups and at different hierarchical levels. Through these personal contacts information is exchanged, negotiations are performed, adaptations are settled, crises are overcome and relational bonding develops and so on.

Competitiveness has been found, to some extent, depending on how this interface with customers is managed and how the human resources involved are distributed and coordinated among different types of customers and among different members of their purchasing decision-making unit. Buyers and sellers who have a strong personal relationships are more committed to maintaining the relationship than less socially bonded partners (Mummalaneni and Wilson,1991; Kachra and White, 2008). At the intra-organizational level it was found that frequent contacts and emotional closeness among product development team members enhance the amount of complex knowledge transferred among team members (Hansen 1999).

Moreover, research on other intra-organizational settings shows that information and knowledge exchange is highly dependent on the degree of emotional closeness among social actors (Krackhardt, 1992). Commitment and trust may arise and may lower fears of opportunism (Rindfleisch and Moorman 2001), expectation of reciprocity emerges (Kachra and White 2008), and transfer of complex, sensitive and even tacit knowledge can easily
occur (Hansen 1999; Reagans and McEvily 2003). Therefore we extend these reasonings at the interorganizational level and expect that social bonding in a supplier-customer relationship enables the knowledge access and acquisition from the customer. We can express this proposition as follows:

Hypothesis 2: *The greater the level of social bonding between a firm and its key customer, the greater the knowledge the firm acquires from it.*

**Knowledge acquisition and innovation**

According to previous research, external knowledge acquisition provides opportunities for integration with a firm’s already existing knowledge, thus creating new knowledge (Yli-Renko et al. 2001), and increasing the relevant knowledge base in the firm (Galunic and Rodan 1998). Thus, knowledge acquisition favors identification and assimilation of relevant knowledge for firms, particularly new ideas that improve the ability to create future innovations and to exploit them in a more effective and efficient way (Cohen and Levinthal 1990). In fact, a number of recent studies have supported the positive effect of external knowledge acquisition on innovation performance (for instance, Chen and Huang, 2009), particularly in terms of product innovation (Yli-Renko et al. 2001). Companies may combine external knowledge with already existing knowledge with positive impact on innovation (Dyer and Singh, 1998; Lane and Lubatkin, 1998; Larsson et al., 1998).

The positive implication of the acquisition of knowledge on innovative performance has already been exhaustively proved in the literature (among others, Ahuja and Katila 2001; Chen and Huang 2009; Yli-Renko et al., 2001). Although, we consider this causal relation as a base-line hypothesis, it is important to propose it in order to complete our conceptual framework. We express the positive implication of the external knowledge as follows:

Hypothesis 3: *The knowledge acquired from key customer is positively associated with firm’s innovative performance.*
The mediating effect of knowledge acquisition

According to our hypotheses 1 and 2 we are expecting that relational bonding in its two components facilitates the exchange of knowledge between different partners of a relationship. However, relational bonding might not be sufficient condition to enhance the innovation. In fact, bonding can be considered as a prerequisite for the innovation through knowledge acquisition (Capaldo, 2007). Firms vary in terms of their ability to understand and exploit the advantages of relational bonding, and exhibit various capacities to acquire and learn from the valuable knowledge in the relationship. For instance, Fredberg and Piller (2011) in a longitudinal study on customer relationships for innovation, argued that a strong tie does not automatically lead to better innovation: it depends on the firm’s co-creation capabilities.). Thus, we consider that acquired knowledge is a basic explanatory factor that links relational bonding to innovative performance. We are expecting that relational bonding has in fact an indirect effect on innovation through the acquisition of knowledge from key customer.

This effect has been operationalized as the mediator effect (Baron and Kenny, 1986). Accordingly, we formulate the following hypotheses for innovative performance and for the two dimensions of the relational bonding, that is structural and social bonding.

Hypothesis 4: The knowledge that a firm acquires from its key customer positively mediates the relationship between the level of structural bonding with the customer and its innovative performance.

Hypothesis 5: The knowledge that a firm acquires from its key customer positively mediates the relationship between the level of social bonding with the customer and its innovative performance.

The Table 1 formalizes and summarizes the research’s hypotheses and Figure 1 describes the hypothesized model.
Table 1 Research’s hypotheses

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Expected effect</th>
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<tr>
<td><strong>Direct effects</strong></td>
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<tr>
<td>Structural bonding on knowledge acquisition</td>
<td>H1</td>
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<tr>
<td>Social bonding on knowledge acquisition</td>
<td>H2</td>
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<td>Knowledge acquisition on innovative performance</td>
<td>H3</td>
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<td><strong>Indirect effects</strong></td>
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<tr>
<td>Structural bonding on innovative performance through knowledge acquisition</td>
<td>H4</td>
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<tr>
<td>Social bonding on innovative performance through knowledge acquisition</td>
<td>H5</td>
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METHODS

Sample and data

The field setting of this research consists of a geographical cluster of small and medium-sized high-tech firms located in one of the most important economical areas in central Italy, the Tiburtina Valley, which is approximately 14 kilometres from the centre of Rome. As in Silicon Valley in the US, the high-tech firms located in this restricted urban context have
created a homogeneous agglomeration that currently represents the most typical example of a high-tech metropolitan cluster in Italy (Majocchi, Odorici, Presutti, 2016). This cluster is also known for its high export rates also due to the presence of several important foreign multinationals. The high number of specialised firms located in this small area has led to the development of new businesses and the rapid diffusion of knowledge among local actors.

At the beginning of our data collection (June 2015), the sectors represented in this area were 1) electronics (370 firms); 2) media (250 firms); and 3) new economy (e.g., manufacturers of new hardware, firms in the information services industry, Internet access providers, and telecommunication network managers; 350 firms). We focused on the electronics sector, which, according to the definition of the National Federation of Electronics Firms, consists of the computer industry, electronics in the strictest sense, and telecommunications.

To ensure that all electronic firms in our sample were involved in innovation activities, we checked their business descriptions in the source database provided by the Chamber of Commerce of Rome. Electronic firms with no internal R&D activity or who only offered non-technical services were excluded from the study. This process left a total of 275 firms, 130 of which accepted our request for a personal interview to complete the questionnaire (47% response rate). A comparison of differences in the mean values of the responding and non-responding firms revealed no statistically significant response bias in terms of their 3-year average sales revenues, firm age, or number of employees. Our empirical research focuses on the strategic vertical relationships between each high-tech SME located in the cluster and its main customers. In this respect, we implemented Yli-Renko et al.’s (2001) suggestion to give entrepreneurs the freedom to list their main customers, imposing a maximum of 10 partners per company. The final relational map of the adopted sample (130 companies) is composed of 511 main customers spontaneously listed by the interviewed entrepreneurs (3.9 customers on average).

The firms in our sample belong to the “specialized suppliers” category according to the Pavitt classification in that they primarily produce and offer technology and services to their industrial customers. In this case, customers also access technology through the
acquisition of products from suppliers (Yanez et al., 2010). Thus, for both customers and suppliers, firm knowledge acquisition and innovation processes depend to a great extent on interactive learning between them. This situation encourages local firms to become increasingly specialised, resulting in strong differentiation in their internal knowledge bases. The R&D activity and the scope and extent of new products launched from these firms are strongly conditioned by knowledge acquired from their customers because new products need to be in line with customers’ specific requirements (Dyer and Sing 1998).

The data to test our hypotheses come from a direct survey using a specially designed questionnaire. Our key informant was the entrepreneur. Firms were contacted by telephone to obtain the names of potential respondents (the entrepreneurs) and to determine whether they would agree to complete the survey through face-to-face interviews. Questionnaire was pre-tested on five randomly selected sample firms. The data collection process started at the beginning of 2016 and lasted approximately five months. As the questionnaire constitutes the primary data source for this research, in some cases, we even conducted a second interview when necessary to complete the questionnaire.

Overall, the firms in the sample developed an average of 8 new products per year (range 1-23). The average sales of the respondent firms amounted to €810,000, with an average age of 18 years. In addition, the average R&D expenditure in relation to total sales was 3.5% (range 0.01-15%). The key customers are similar in age to their suppliers (M = 18.16 years) but were on average smaller (Msales = €510.15). Table 2 reports the descriptive statistics for the untransformed variables.

<table>
<thead>
<tr>
<th></th>
<th>Average</th>
<th>S.D.</th>
<th>Min</th>
<th>Max</th>
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<tbody>
<tr>
<td>Innovative performance</td>
<td>8</td>
<td>7.2</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>Firm Size</td>
<td>810.10</td>
<td>1108.95</td>
<td>100</td>
<td>10,000</td>
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</table>
CustSize | 510.15 | 542-34 | 121 | 3,000  
CustAge | 18.01 | 12.86 | 2   | 90     
FirmAge | 18    | 14.44 | 6   | 70     
R&D expenditure | 3.5  | 3.04 | 0.08 | 0.15   
Structural bonding | 5.5  | 4.9  | 1   | 7      
Social bonding | 5     | 4.5  | 1   | 7      

Measures

The individual measurement items for the study’s dependent, independent, and control variables are listed in Table 4; the construction of the measures is explained in the following section. All statement-style items were measured on a scale from 1 = do not agree to 7 = completely agree.

**Dependent variable**

**Innovative performance**

We measured innovative performance following the work of Rindfleisch and Moorman (2001). Specifically 4 items assessed the firms’ opinion about the innovativeness of their products developed as a result of the key customer relationships. The entrepreneurs were asked to evaluate the extent to which the new products developed as a result of their key customer relationships developed in the past three years were novel to the industry and offered new ideas.
**Independent variable**

**Knowledge acquisition in the relationship**

We measured knowledge acquisition with two statements reflecting the technological and market knowledge that a firm may acquire from the key customer. The items were based on Nooteboom et al. (1997) and Von Hippel (1988) and have previously been used effectively by several authors (i.e. Simonin, 1997; Zander and Kogut, 1995; Zahra et al., 2000; Yli-Renko and Autio, 1998).

**Structural bonding**

We adopted the Han’s (1991) definition of structural bonding as the degree to which certain ties link and hold a customer and supplier in an economic, strategic, and organizational sense, regardless of personal [emotional] matters. Structural bonding was assessed through a two-item 7-point Likert scale according to Han (1991) and Koenig and Van Wijk (1991).

**Social bonding**

In this research we defined social bonding as the degree to which certain ties link and hold a customer and supplier together closely in a personal [emotional] sense according to Han (1991). Social bonding was assessed through a two-item 7-point Likert scale according to Han (1991) and Sullivan and Peterson (1982).

**Control variable**

We included some control variables to isolate the effect of the independent variables in the model. First, an important factor influencing innovation activity is the size of the involved partners (Acs and Audretsch, 1991; Tsai and Ghoshal, 1998), in line with the idea that larger firms may invest more resources in R&D activities. As several studies suggest (e.g., Kogut and Zander, 1992), both superior resources and economies of scale allow larger firms to exploit external knowledge successfully for their innovation process. We controlled
for the effects of size by including the total sales of both the firms (Size) and their customers (CustSize).

Moreover, we included two additional control variables to evaluate the age of the firm (FirmAge) and that of its customers (CustAge). We assume that these elements will have an influence on the firm’s learning ability and its knowledge exploitation process (Zahra et al., 1999). We computed the age of the firms and of the customers as the number of years since their foundation. We used the log of these values to account for declining effects at higher values. Finally, in the analysis we use R&D spending as a control variable for a firm’s willingness to invest in absorptive capacities useful to its knowledge acquisition from its key customer. Following other recent research on measuring absorptive capacity (e.g., Cohen and Levinthal, 1990; Meeus et al., 2001), this parameter was measured by considering the log value of the average ratio between R&D expenditures and total sales for the previous three years.

Table 3 reports the descriptive statistics of the variables and their correlations.

Table 2. Descriptive statistics and correlations

<table>
<thead>
<tr>
<th>Variables</th>
<th>1</th>
<th>2</th>
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<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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<tbody>
<tr>
<td>1. Firm size</td>
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<td>2. Customer size</td>
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<td>3. Firm age</td>
<td>0.40</td>
<td>0.18</td>
<td></td>
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<td>4. Customer age</td>
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<td>0.15</td>
<td>0.07</td>
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<td>5. R&amp;D spending</td>
<td>0.31</td>
<td>0.04</td>
<td>0.14</td>
<td>0.11</td>
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<tr>
<td>6 Structural bonding</td>
<td>0.24</td>
<td>0.22</td>
<td>0.18</td>
<td>0.17</td>
<td>0.23</td>
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<tr>
<td>7 Social bonding</td>
<td>0.16</td>
<td>0.13</td>
<td>0.30</td>
<td>0.24</td>
<td>0.20</td>
<td>0.33</td>
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<tr>
<td>8 Knowledge acquisition</td>
<td>0.15</td>
<td>0.08</td>
<td>0.12</td>
<td>0.03</td>
<td>0.28</td>
<td>0.40</td>
<td>0.27</td>
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9. Number of new products developed

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<tr>
<th></th>
<th>0.11</th>
<th>0.13</th>
<th>0.01</th>
<th>0.03</th>
<th>0.03</th>
<th>0.28</th>
<th>0.31</th>
<th>0.45**</th>
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10. Innovative performance

<table>
<thead>
<tr>
<th></th>
<th>0.01</th>
<th>0.03</th>
<th>0.01</th>
<th>0.22</th>
<th>0.13</th>
<th>0.31</th>
<th>0.29</th>
<th>0.40**</th>
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* p-value at the 10% level. ** p-value at the 5% level. *** p-value at the 1% level.

Reliability, validity and endogeneity

We took several steps to ensure data validity and reliability. First, we pretested the survey with 5 entrepreneurs and asked them to closely review the survey. We then revised any potentially confusing items following the received suggestions. Second, we used previously validated measurement items wherever possible to help ensure the validity of our measures. Third, multiple-item measures were used for most constructs to enhance content coverage. We measured these items on the questionnaire using 7-point Likert scales. As a first step of measure validation, to assess the unidimensionality of the research constructs (Churchill, 1979), we factor analysed the final scales using the principal axis method, positing a single factor (exploratory factor analysis). After exploring the factor structure of the data, we submitted the data to confirmatory factor analysis. The results of this analysis verify that the measurement model performed well because the selected constructs demonstrate good internal consistency and reliability: the standardised factors are all above the recommended minimum of 0.40, and the average variances extracted are all above the recommended minimum of 0.50 (range 0.55–0.69). All of our multiple-item constructs achieved Cronbach alphas of 0.71 or higher, indicating strong internal consistency (Table 4).

Finally, we consider in this study also the endogeneity problem. In particular, to identify the endogeneity of the explanatory variables, we use the Durbin–Wu–Hausman test (Wooldridge, 2012). Table 5 illustrates the test results, which reveal that the two selected explanatory variables do not suffer from an endogeneity problem when both knowledge acquisition and product innovativeness are used as the dependent variables (Table 5).
Table 4. Measurement model

<table>
<thead>
<tr>
<th>Factor name</th>
<th>Measurement item</th>
<th>Standardised loading</th>
<th>Cronbach’s alpha</th>
<th>Average variance extracted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural bonding</td>
<td>Since time your company needs to have close relationship with this customer, regardless of your personal relationships?</td>
<td>0.65**</td>
<td>0.85</td>
<td>0.59</td>
</tr>
<tr>
<td></td>
<td>In an economic sense, to what extent does your company need to have a close relationship with this customer?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.70**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social bonding</td>
<td>On a personal sense, how close are your relationships with this customer?</td>
<td>0.78***</td>
<td>0.81</td>
<td>0.63</td>
</tr>
<tr>
<td></td>
<td>I have excellent social relationships with this customer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.71**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge acquisition</td>
<td>Since we supply to this customer we are able to obtain a tremendous amount of market and technical knowledge We get most of our valuable information on customer needs and trends from this customer</td>
<td>0.76**</td>
<td>0.85</td>
<td>0.69</td>
</tr>
<tr>
<td></td>
<td>0.59*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Innovative performance</td>
<td>The new product is very novel in our industry</td>
<td>0.81***</td>
<td>0.78</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td>The new product offers new ideas in our industry</td>
<td>0.61*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>This new product is creative</td>
<td>0.55*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
This new product is capable of generating ideas for other products

***p >0.001

Table 5. Results of Durbin–Wu–Hausman test.

<table>
<thead>
<tr>
<th>Knowledge acquisition</th>
<th>Innovative performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural bonding</td>
<td>183.5</td>
</tr>
<tr>
<td>Social bonding</td>
<td>160.1</td>
</tr>
</tbody>
</table>

Chi-square values are present in this table.

RESULTS

The hypotheses are tested using structural equation model. As the hypotheses involves the testing of mediation effects, a series of nested models were compared to select the one with the best fit. Nested model tests help internally validate a hypothesized model by comparing the chi-squares of models that differ in the number of paths hypothesized; nested models can be derived by adding or deleting paths. A significant difference in chi-square indicates that the more complex model provides a better fit with the data. The three nested models are (1) the direct effect model which consists of only the direct relationships among variables; (2) the indirect model which considers only the indirect effects of social and structural bonding through knowledge acquisition; 3) the hypothesized mediation model, which includes both the direct effect of social, structural bonding on the dependent variable and indirect effects through knowledge acquisition. The fit indices are shown in Table 6. Based on the fit indices, all of the models showed reasonably good fit with the data. Model
had the highest goodness of fit indices in general ($\text{Chi}^2 = 423.28; \text{Chi}^2 / \text{df} = 1.36, p<0.01; \text{RMSEA}=0.06; \text{CFI}=0.94; \text{IFI}=0.94; \text{TLI}=0.92$). Akaike’s information criterion revealed a relatively better fit with the data for Model 3. A Chi-square difference test also suggested that Model 3 had a significantly better fit than the direct effect model (Model 2) ($\Delta\text{Chi}^2 = 38.18 (2), p<0.01$) and Model 1 ($\Delta\text{Chi}^2 = 12.13 (4), p<0.05$). Therefore the results of Model 3 are reported in Table 7 to test our hypotheses.

Table 6. Nested model testing sequence and difference tests

<table>
<thead>
<tr>
<th>Models</th>
<th>$\text{Chi}^2$ (df)</th>
<th>IFI</th>
<th>TLI</th>
<th>CFI</th>
<th>RMSEA</th>
<th>AIC</th>
<th>$\Delta\text{Chi}^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td>461.45</td>
<td>0.901</td>
<td>0.881</td>
<td>0.911</td>
<td>0.069</td>
<td>581.32</td>
<td>38.18 (2)</td>
</tr>
<tr>
<td>Model 2</td>
<td>435.41</td>
<td>0.910</td>
<td>0.911</td>
<td>0.910</td>
<td>0.062</td>
<td>562.40</td>
<td>12.13 (4)</td>
</tr>
<tr>
<td>Model 3</td>
<td>423.28</td>
<td>0.941</td>
<td>0.921</td>
<td>0.941</td>
<td>0.060</td>
<td>553.13</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: $\Delta\text{Chi}^2$ statistics are based on the comparing model 3 with the other two models. Models 1 and 2 demonstrated significantly poorer fit than Model 3 ($p<0.01$).

Hypotheses 1 and 2 propose that structural and social bonding have a significantly positive association with knowledge acquisition. The results indicate that the standardized regression weights between structural and social bonding and knowledge acquisition were significant and positive with coefficients of 0.58 (bias-corrected $p<0.01$) and 0.54 (bias-corrected $p<0.01$) respectively (Table 7). Thus the two hypotheses are confirmed.

Hypothesis 3 is concerned with the relationship between knowledge acquisition and product innovativeness. The results indicate that the standardized regression weights
between knowledge acquisition and product innovativeness were significant and positive with coefficient of 0.49 (bias-corrected p<0.01). Therefore hypothesis 3 is supported.

H4 suggests significant indirect effects of structural bonding on product innovativeness. As predicted, the indirect paths through knowledge acquisition from structural bonding to product innovativeness (β=0.399, bias-corrected p<0.01) were significant. As no direct effects of structural bonding on product innovativeness were found, full mediation of knowledge acquisition in the relationships was in evidence, in support of hypothesis 4.

In a similar vein, the results disclosed no significant direct effect of social bonding on product innovativeness, but social bonding had indirect significant effects through knowledge acquisition on product innovativeness (β=0.31, bias-corrected p<0.01). Thus, Hypothesis 5 was supported.

Finally, the only significant relationship between a control variable and our mediating variable is the positive association between R&D and knowledge acquisition (Table 7). In terms of innovation, we may observe that product innovativeness is positively related to both R&D spending and firm size. The not significant effect of age variable can be probably explained by the evidence that there are not differences of age among customers and suppliers; moreover the evidence that all customers are quite smaller than their suppliers can explain why the size variable is not significant in our model. The Figure 2 show the results of the model.
Figure 2: Results of the model

Social bonding

Knowledge acquisition

Structural bonding

Innovative performance

0.58
0.54
0.29
0.31
0.49
0.39
0.19
Table 7 Structural equation modelling results

<table>
<thead>
<tr>
<th></th>
<th>Standardized estimate</th>
<th>P value</th>
<th>Hypothesis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structural bonding on innovative performance</td>
<td>0.17</td>
<td>n.s.</td>
<td></td>
</tr>
<tr>
<td>Social bonding on innovative performance</td>
<td>0.29</td>
<td>n.s.</td>
<td></td>
</tr>
<tr>
<td>Structural bonding on knowledge acquisition</td>
<td>0.58</td>
<td>&lt;0.01</td>
<td>H1</td>
</tr>
<tr>
<td>Social bonding on knowledge acquisition</td>
<td>0.54</td>
<td>&lt; 0.01</td>
<td>H2</td>
</tr>
<tr>
<td>Knowledge acquisition on innovative performance</td>
<td>0.9</td>
<td>&lt; 0.01</td>
<td>H3</td>
</tr>
<tr>
<td><strong>Indirect effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structural bonding on innovative performance via knowledge acquisition</td>
<td>0.39</td>
<td>&lt;0.01</td>
<td>H4</td>
</tr>
<tr>
<td>Social bonding on innovative performance via knowledge acquisition</td>
<td>0.31</td>
<td>&lt;0.01</td>
<td>H5</td>
</tr>
<tr>
<td><strong>Control variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firm size on knowledge acquisition</td>
<td>0.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firm size on innovative performance</td>
<td>0.28</td>
<td>&lt;0.01</td>
<td></td>
</tr>
<tr>
<td>Customer size on knowledge</td>
<td>0.33</td>
<td>n.s.</td>
<td></td>
</tr>
</tbody>
</table>
acquisition

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Customer size on innovative performance</strong></td>
<td>0.19</td>
<td>n.s.</td>
</tr>
<tr>
<td><strong>Firm age on knowledge acquisition</strong></td>
<td>0.19</td>
<td>n.s.</td>
</tr>
<tr>
<td><strong>Firm age on innovative performance</strong></td>
<td>0.28</td>
<td>n.s.</td>
</tr>
<tr>
<td><strong>Customer age on knowledge acquisition</strong></td>
<td>0.21</td>
<td>n.s.</td>
</tr>
<tr>
<td><strong>Customer age on product innovativeness</strong></td>
<td>0.015</td>
<td>n.s.</td>
</tr>
<tr>
<td><strong>R&amp;D on knowledge acquisition</strong></td>
<td>0.39</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td><strong>R&amp;D on innovative performance</strong></td>
<td>0.5</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

**DISCUSSION**

The strength of tie in supplier-customer relationships, and particularly its role on focal firm’s knowledge acquisition and innovation has attracted a lot of attention in the last decades. Although the seminal definition of strong ties contains a combination of different elements (Granovetter 1973), the majority of later papers tend to overlook the affective component (Krackhardt, 2003). We claim that by addressing this shortcoming we can contribute to the debate about the role of strong ties on knowledge acquisition and innovation in vertical relations. With this aim, we benefit from the literature on supplier-customer relationships in business-to-business markets where the construct “relational bonding” was originally developed and used. This approach distinguishes between structural bonding -the more objective and behavioral elements of strong ties - and social bonding –the more affective one.
In this study we focused on the direct/indirect effects of structural and social bonding on innovation by considering the mediating role of knowledge acquisition. We have empirically analyzed the vertical partnerships between SMEs and their key customers.

Our results indicate that both structural and social bonding are positively related to knowledge acquisition. We also find support for the mediating role of knowledge acquisition between structural/social bonding and knowledge exploitation in terms of innovation.

Our theory and findings advance the research on the role of tie strength on knowledge acquisition and innovation. The positive correlation between structural bonding and knowledge acquisition, sustains the role of interdependence between focal firm and its key customers in motivating the supplier to fulfill customers’ need and develop useful routines for learning. The positive association between social bonding and knowledge acquisition is consistent with the assumptions that learning between different business partners is aided by personal and affective relationships built through interpersonal exchange. With reference to the relation with key customers we find that what was proved true at the interpersonal level is also true at the inter-organizational level (Tsai and Ghoshal, 1998).

Both elements of tie strength -the behavioral and the affective- seem supporting knowledge acquisition of focal firms involved in relationships with their key customers. This contributes to address the recent request for more studies on how different level of embeddedness between supplier and customers impact on knowledge and innovation (Lipparini et al 2014).

In addition, our results also complement the more recent research that addressed the so-called paradox of strong ties suggesting different factors (such as kind of innovation, of relationship and of involvement in the innovation process and customer knowledge similarity) that might interact with tie strength and produce different results in terms of innovation (Bonner and Walker 2004; Fredberg and Piller 2011; Tomlinson and Fai 2016). We suggest that the impact of tie strength can also depend on how we measure it. With reference to key customers our study shows that strong ties, both in their behavioral and affective components, represent for focal firms an opportunity in terms of knowledge acquisition and innovation and the paradox fades away.
We also show that knowledge acquisition mediates the relationship between social/structural bonding and knowledge exploitation in terms of innovation, confirming the essential role of knowledge acquisition in transforming the potential benefits of strong ties into concrete innovation outcomes. While structural and social bonding inside vertical relationships are unable to directly influence the innovation activity, our study highlights the essential role of knowledge as a key mechanism by which the relationship with key customers is leveraged for the development of new products. Accordingly, these results confirm that knowledge is the most strategically significant resource of a SME for its innovation activity, justifying a growing interest on how organizations can acquire knowledge from their partners (Burgelman and Hitt, 2007; Davidsson, 2005; Smith and Cao, 2007; Woolley and Rottner, 2008). Moreover we find a support to the idea that strong ties with key customers represent an enabling environment for innovation, but routines and other mechanisms have to be created to enable knowledge exchange and acquisition and sustain the co-creation of innovation (Fredberg and Piller 2011).

The paper also contributes to social network studies, considering a larger set of tie strength components, in particular operationalizing the affective element. We participate with the idea that it is “not simply a question for the methodological curious. It is an important part of the theory itself, since the theory itself makes a curvilinear prediction” and we need to understand how different components count toward tie strength (Krackhardt (2003, p.216-217). The fact that we did not find evidences of curvilinear relation could be ascribed, in our opinion, to a combination of contingencies: the downstream relationships we observe (Tomlinson and Fai 2016) and their role to sustain the incremental innovation that mainly characterizes our firms (Bonner and Walker 2004).

We also provide new evidences of the beneficial effect of the affective component of strong ties for knowledge search and acquisition at the inter-organizational level. This complements evidences in social network studies on the informational benefits of strong ties in affective bonding at the intra-organizational level (Hansen 1999). Finally, we contribute to business-to-business studies showing that relational bonding between supplier and key customers can have a positive impact not only on the efficiency and stability of the relationship, but also in term of innovation.
MANAGERIAL IMPLICATIONS, LIMITATIONS AND FUTURE RESEARCH

Apart from the theory contributions, in our opinion, a set of managerial implications arise from this study. First, as relationships with key customers give access to resources and knowledge not otherwise available for innovation, this implies a need of competence to coordinate and utilize a set of interrelated profitable relationships, that is, to derive value from a differentiated set of customer relationships. As key customer relationships are specific and differ from one another, a supplier firm may have several relationships, providing various experience, resources and skills, but the strength of the relationship is likely to determine whether they are able to share each other’s resources and knowledge. Furthermore, knowledge-exchanging relationships based on strength ties can form the basis for profitable relationships that may eventually lead to even greater innovation opportunities. This requires management based on professional competences able to develop networks characterized by strength ties with a significant number of key customers. Hence, the ability of managers to leverage external strength networks can be considered as a core competence.

In summary, with reference to vertical relations in BtoB industrial markets, our study suggests to suppliers to invest in strong ties with key customers, developing both task interdependence and affective bonds with them to foster innovation. To do that, organizations could establish and sustain ongoing interpersonal relationships with key customers, if necessary involving different organizational levels.

Finally, our research also suggests that firms need to invest in routines and mechanisms to enable the exchange and acquisition of knowledge with key customers to transform the strong tie with them in a source of opportunities and resources for innovation.

Some limitations of our study must be discussed to pinpoint opportunities for further research. First, our results refer to high-tech firms that are “specialized suppliers”. What we find could not be generalizable to other industries and to less specialized firms. Second, our definition of innovative performance is limited to the typology of products and services developed by these firms, regardless of the drivers of innovation (customer, process, design, etc.) and with no distinction between different types of innovation (i.e., disruptive
and incremental). Third, we focused on the role of strong ties with key customers. We cannot generalize our results for relationships involving less strategic partners. In consequence, further research should try to overcome these limitations. Researchers could also combine in their models other significant boundary conditions that might influence the importance of strong ties- in their behavioral and affective components- for knowledge acquisition and innovation.

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