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Abstract

Research has emphasized the emergence of buyer-supplier (vertical) and supplier-supplier (horizontal) alliances as a way to foster inter-organizational learning and cooperarive efforts in production systems. There is some controversy, however, regarding how those distinct alliances interact with each other. Some propose that supplier-supplier alliances reinforce the development of buyer-supplier alliances, or vice-versa. For instance, the inter-organizational learning that occurs at the horizontal level generates positive spillovers to the vertical alliance. Others propose instead a negative interplay: when crafting vertical alliances, for instance, buyers may inhibit the formation of horizontal alliances as a way to preserve their bargaining power *vis-à-vis* suppliers. We empirically test those competing views using survey data from the Brazilian auto-parts industry. In an attempt at reconciliation, we additionally propose that the interaction between buyer-supplier and supplier-supplier alliances will be positive or negative depending on a particular contingency: the extent to which supply components are subject to uncertain technological change. Our data reveal that the existence of vertical alliances inhibits the development of horizontal alliances, but only when technological uncertainty is relatively low. When components are subject to higher technological change, those two types of alliances do not seem to significantly affect one another. We discuss implications for theory and practice.

Resumo

Pesquisadores têm enfatizado a emergência de alianças entre compradores e supridores (verticais) e relações entre supridores (horizontais) como forme de promover aprendizado inter-organizacional e esforços cooperativos em sistemas de produção. Existem controvérsias, no entanto, sobre como estas formas distintas de aliança interagem entre si. Alguns propõem que relações horizontais reforçam o desenvolvimento de alianças verticais, ou vice-versa. Por exemplo, o aprendizado inter-organizacional que ocorre em nível horizontal pode gerar externalidades positivas para a aliança vertical. Outros propõem uma relação negativa: ao desenhar alianças verticais, por exemplo, compradores podem inibir a formação de alianças horizontais como forma de preservar o seu poder de barganha junto a supridores. Nós testamos empiricamente estas visões contraditórias usando dados de questionários na indústria de auto-partes brasileira. Como forma de reconciliar estas visões, nós propomos adicionalmente que a interação entre alianças verticais e horizontais será positiva ou negativa dependendo de uma contingência particular: o grau com que componentes são sujeitos a mudanças tecnológicas. Nossos dados revelam que a existência de alianças verticais inibe o desenvolvimento de alianças horizontais, mas somente quando a mudança tecnológica é baixa. Quanto componentes são sujeitos a alta mudança tecnológica, não parece haver interação significativa entre estes dois tipos de aliança. Nós discutimos implicações para a teoria e prática.

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Management scholars have devoted substantial attention to the study of buyer-supplier alliances and how they impact the performance of firms vertically linked in a supply chain. Thus, there is a great deal of evidence that through such vertical collaboration, buyers and suppliers are able to revamp production processes, reduce transaction costs and deliver better products to consumers (e.g. Asanuma, 1989; Dyer, 1997; Helper, 1991; Kotabe, Martin, & Domoto, 2003; Martin, Mitchell, & Swaminathan, 1995). More recently, scholars have also underscored the importance of supplier-supplier alliances, i.e., horizontal ties among suppliers themselves. According to this literature, suppliers are more and more engaging in value-enhancing collective efforts such as the exchange of best practices and joint product development (e.g. Brown & Hendry, 1998; Choi, Wu, Ellram, & Koka, 2002; Dyer & Nobeoka, 2000; Stuart, Deckert, McCutcheon, & Kunst, 1998). As a result, many inter-organizational networks have turned into "netchains", that is, layers of horizontally-linked suppliers which are also associated with buyers through vertical collaborative ties (Lazzarini, Chaddad, & Cook, 2001).

Although scholars have increasingly recognized the importance of simultaneously assessing buyer-supplier and supplier-supplier alliances, there is some controversy about how horizontal and vertical ties interact with one another and what consequences such an interaction brings. Some consider the formation of supplier-supplier alliances as a beneficial organizational effort to foster effective buyer-supplier collaboration or vice-versa. The canonical example supporting this view is Toyota's network of suppliers, which has been studied in great detail (Dyer & Nobeoka, 2000; Nishiguchi & Beaudet, 1998; Sako, 2004). By stimulating the formation of supplier associations and voluntary

learning teams, Toyota has effectively promoted the diffusion of knowledge and best practices among suppliers. The resulting improvements in processes and product configurations allow suppliers to be on the cutting edge in terms of production efficiency and innovation, which is in the best interest of Toyota. Moreover, collaboration between Toyota and individual suppliers (e.g., through problem-solving teams) helps them develop competencies that can be disseminated in their horizontal network. In this sense, supplier-supplier and buyer-supplier alliances reinforce one another.

There is, however, an opposite possibility: supplier-supplier alliances may undermine the development of stable buyer-supplier alliances, or vice-versa. For example, instead of engaging in value-enhancing practices that would otherwise benefit the network as a whole, suppliers may form horizontal associations to balance their relative dependence and power in negotiations with buyers (Choi *et al.*, 2002). Observing that suppliers are forming alliances with each other for that purpose, buyers may attempt to constrain the formation of supplier-supplier alliances when vertical alliances are in place. Reve (1992) finds empirical evidence that supplier-supplier and buyer-supplier alliances are negatively associated, and concludes that "rather than advocating the development of tightly structured alliances both horizontally and vertically, a trade-off between horizontal and vertical alliances is suggested" (p. 254). If this negative effect occurs, we should expect either supplier-supplier or buyer-supplier collaborations, not both (as in Toyota's case).

These diverging views invite further work attempting to theoretically and empirically examine whether horizontal and vertical alliances reinforce or undermine one another. This is the goal of our paper. We begin by providing theoretical underpinning to the

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opposing patterns of interaction between supplier-supplier and buyer-supplier alliances, leading to the development of testable competing hypotheses. We next attempt to reconcile these conflicting views by outlining a contingency that is likely to moderate the interaction between horizontal and vertical alliances: technological uncertainty (i.e., the extent to which products being exchanged exhibit constant change in specifications and new technologies). In a nutshell, our argument is as follows: subject to high technological uncertainty, supplier-supplier alliances are likely to foster learning and innovation among suppliers, thus generating a positive spillover on the vertical exchange. When technological uncertainty is low, however, this effect should be minimal; any supplier-supplier association may be interpreted by buyers as a way to balance power in the network, thereby yielding a negative interaction between horizontal and vertical alliances. We then test our hypotheses using survey-based data in the context of the auto-parts industry in Brazil. We conclude the paper by outlining implications for theory and practice, and suggesting some directions for further research.

THEORY AND HYPOTHESES

Inter-organizational alliances are commonly conceptualized as collaborative, interdependent efforts between two or more firms (Contractor & Lorange, 1988; Gulati, 1998). Moving beyond traditional arm's-length transactions, alliances are characterized by the joint deployment of financial resources, knowledge, and infra-structure in such a way to increase the performance of products and processes in a particular exchange. As each individual firm associates itself with several other partners, these firms end up forming a network of alliances. Research has found that, through such alliance networks,

firms can benefit from knowledge generated by exchange partners (Kale, Singh, & Perlmutter, 2000; Liebeskind, Oliver, Zucker, & Brewer, 1996; Powell, Koput, & Smith-Doerr, 1996) and promote relationship-specific investments without the need of costly vertical integration (Dyer, 1997; Holmstrom & Roberts, 1998; Jarillo, 1988). Stimulated by the success of Japanese manufacturing companies, scholars have paid particular attention to the management of *buyer-supplier* or *vertical* alliances along the supply chain (Asanuma, 1989; Dyer & Ouchi, 1993; Helper & Sako, 1995). For instance, buyers and suppliers may collaborate to reduce inventory and promote timely delivery (e.g., just-in-time production). Also, a buyer can engage a group of suppliers in the process of designing a new product or improving existing ones. Such vertical alliances have been found to positively influence the performance of buyers and suppliers, in terms of both production efficiencies and innovation (Clark, 1989; Cusumano & Takeishi, 1991; Kotabe *et al.*, 2003).

Another parallel research stream has analyzed the emergence of *supplier-supplier* or *horizontal* alliances between peers. The idea that firms in the same industry can create competitive advantage through mutual collaboration has been extensively discussed by the literature on regional clusters and industrial districts, which has explained the emergence of such patterns of collaboration as a way to economize on the provision of collective resources such as skilled labor, service providers, capital, infrastructure and other factors of production (e.g. Marshall, 1920; Piore & Sabel, 1984; Schmitz & Nadvi, 1999). Horizontal collaboration, however, may occur beyond the bounds of a particular location. Suppliers may create broad, representative associations providing collective

services such as market information, lobbying with governments, and training (Altenburg & Meyer-Stamer, 1999; Harrison, 1992; Lane & Bachmann, 1996).

Suppliers may also go beyond their simple participation in such associations to form narrower collaborative dealings and extensive horizontal supplier networks (Dyer & Nobeoka, 2000; Stuart *et al.*, 1998)—which is the focus of our study. Thus, suppliers can form committees and learning groups to exchange best practices and help one another to solve specific problems in their production processes In addition, suppliers can jointly market products, develop new distribution channels, and share resources (such as contacts and infra-structure) to reach new markets. Several authors have noted that alliances among competitors have become increasingly frequent in a broad range of industries (Dussauge, Garrette, & Mitchell, 2000; Gomes-Casseres, 1994; Hamel, Doz, & Prahalad, 1989).

More recently, scholars have tried to integrate these distinct research streams by offering a simultaneous assessment of buyer-supplier and supplier-supplier alliances. Reve (1992) analyzes the emergence of horizontal and vertical relationships in distribution channels. Brown & Hendry (1998) infuse elements of supply chain analysis to discuss forms of inter organizational learning in industrial districts, often said to exhibit collaborations of a horizontal kind. Lazzarini, Chaddad & Cook (2001) discuss how supply chains have evolved into "netchains" comprised of horizontal networks of suppliers vertically linked with buyers. They propose that the analysis of horizontal and vertical ties cannot be divorced, because the formation of supplier-supplier alliances may have consequences for the performance of buyer-supplier alliances, and vice-versa. Choi, Wu, Ellram & Koka (2002) offer a taxonomy of supplier-supplier alliances and

deliver several propositions regarding how such alliances may impact the performance of buyers and suppliers.

Despite these recent advances in the literature, there is still some controversy regarding how buyer-supplier and supplier-supplier alliances interact with each other. In fact, distinct theoretical arguments accommodate opposing views. On the one hand, the formation of supplier-supplier alliances may reinforce existing buyer-supplier alliances or prompt their formation, or vice-versa. In this case, we should expect the joint occurrence of buyer-supplier and supplier-supplier alliances in a particular industry context. On the other hand, the formation of vertical collaborations may constrain the development of horizontal ties among suppliers, or vice-versa. If this effect holds, then we should expect less supplier-supplier alliances when buyer-supplier alliances deepen. We discuss each possibility next.

Buyer-supplier and supplier-supplier alliances reinforcing one another

The view that buyer-supplier and supplier-supplier alliances reinforce one another can be supported by at least two distinct theoretical arguments. First, the inter-organizational learning that occurs in buyer-supplier and supplier-supplier alliances may be complementary. Research in organizational learning has stressed the importance of acquiring knowledge and innovative ideas based on a network of relationships (Appleyard, 1996; Liebeskind *et al.*, 1996; Powell, 1996). By tapping into the external knowledge of its suppliers, a manufacturer can improve the performance of product components and develop new product configurations to customers. To do so, however, both buyers and suppliers will need to jointly invest in knowledge generation and sharing through successive interactions (Dyer & Nobeoka, 2000; Kale *et al.*, 2000). Therefore,

suppliers involved in collaborations with buyers will likely create themselves routines and know-how that can be useful to support other relationships, including relationships with peers. Using Cohen and Levinthal's (1990) term, alliances with buyers will equip suppliers with an "absorptive capacity" through which they can value and understand external knowledge from horizontal partners. Consequently, the formation of a vertical tie between a buyer and a supplier is likely to facilitate the formation of new collaborative ties between that supplier and its peers.

The argument also works in reverse: the formation of supplier-supplier alliances may increase the inter-organizational learning that occurs in buyer-supplier alliances. Even in cases where suppliers are competitors, they will likely present differentiated knowledge based on their particular experiences and investments in product design and process improvements (Hamel *et al.*, 1989; Schilling, 2000). Buyers can therefore stimulate alliances between suppliers as a way to exploit the knowledge diversity that resides in the supplier network (Feldman & Audretsch, 1999; Kogut, 2000). For instance, the performance of an alliance between a buyer and a supplier may increase if that supplier learns from another supplier how to manage process flows and promote continuous improvements in components. As suppliers share knowledge about best practices and get involved in collaborations with themselves, they become more and more capable of forging valuable collaborative ties with buyers and meeting high standards of quality and innovation. This argument has been used to explain why Toyota encourages suppliers to form extensive horizontal ties with each other (Dyer & Nobeoka, 2000; Sako, 2004).

A second theoretical argument supporting a complementary interaction between vertical and horizontal alliances is based on the idea that supplier networks may increase

the commitment of the buyer to its vertical relationships, therefore favoring the formation of buyer-supplier alliances. Fundamentally, this argument is based on Coleman's (1988) view of network ties as conduits of information about the behavior of partners. Because vertical alliances may require substantial relationship-specific investments, including the knowledge that will be generate through inter-organizational learning (Bureth, Wolff, & Zanfei, 1997), suppliers may be reluctant to engage in vertical collaborative agreements if they fear that their clients will adversely renegotiate terms of those agreements or switch to alternative suppliers (Holmstrom & Roberts, 1998; Williamson, 1985). Horizontal ties among suppliers may guarantee that any opportunistic behavior by the buyer will likely be disseminated in the network and trigger retaliation (e.g., suppliers may avoid transacting with or devoting high effort in exchanges with that buyer). Anticipating this effect, buyers are likely to avoid reneging existing agreements or switching suppliers at will. In contrast, in the absence of supplier-supplier alliances, any past opportunistic action by the buyer may remain undetected (except by the offended supplier). Also using Toyota's production network as an example, Kreps (2004: 605-608) employs this logic to explain why buyers may find it advantageous to stimulate the formation of supplier-supplier alliances as a way to develop and commit to a cooperative buyer-supplier alliance.

Collectively, these distinct theoretical arguments lead to:

Hypothesis 1: There is a positive association between vertical (buyer-supplier) and horizontal (supplier-supplier) alliances: if a supplier develops a vertical alliance with a buyer, it will more likely develop a horizontal alliance with another supplier, or vice-versa.

Buyer-supplier and supplier-supplier alliances undermining one another

Essentially, the arguments above consider that buyer-supplier and supplier-supplier alliances will be created for efficiency purposes—either to increase inter-organizational learning, or to create incentives for cooperation in the exchange. Rather than a means to increase efficiency in the system, however, vertical and horizontal collaborations may be structured to influence the position of buyers and suppliers in their negotiations. Resource dependence theory (e.g. Oliver, 1991; Pfeffer & Salancik, 1978) and social exchange theory (e.g. Blau, 1964; Emerson, 1962) provide underpinning for this view, given their emphasis on how actors in an exchange balance their dependence and power. Such considerations support the prediction that the formation of buyer-supplier alliances will constrain the formation of supplier-supplier alliances, or vice-versa, for two reasons.

First, the formation of vertical alliances may reduce suppliers' autonomy to engage in other types of alliances. As noted before, most learning and performance-enhancing investments that occur in inter-organizational alliances tend to be relationship-specific. Although those specific assets have transactional value (Dyer, 1997; Madhok & Tallman, 1998), by definition they are less valuable when applied to alternative uses or users (Williamson, 1985). Thus, if a supplier develops a vertical alliance to engage in product design, the knowledge generated in the exchange may be mostly applicable to the buyer with whom the supplier is collaborating, thereby constraining the development of other ties (Blau, 1964; Galaskiewicz, 1985; Oliver, 1991)—including ties of a horizontal kind. Conversely, the formation of supplier-supplier alliances may undermine the formation of vertical collaborations. If suppliers anticipate that the formation of vertical alliances will increase their dependence on a particular buyer (Laamanen, 2005; Singh & Mitchell,

1996), they may reduce their resource commitments to *that* particular buyer and, instead, focus on horizontal collaborations which may allow them to apply the resulting know-how to a broader range of clients. Thus, Stuart et al. (1998: 91) suggest that horizontal networks may focus on "holistic learning and organizational advancement, not necessarily tied to the products sold to a particular buyer."

A second and related argument suggests that supplier-supplier alliances may be deliberately formed to increase suppliers' bargaining power relative to buyers. For instance, suppliers engaged in horizontal alliances may jointly negotiate the terms of exchanges with common buyers (such as prices or exclusivity clauses). Consequently, when crafting their vertical alliances, buyers may attempt to inhibit the development of horizontal alliances as a way to avoid supplier collusion (Choi *et al.*, 2002). This logic implies that the presence of buyer-supplier alliances will inhibit the emergence of suppliers-supplier alliances. It is also possible, however, that the *absence* of collaborative vertical alliances will prompt the emergence of supplier-supplier alliances. Lacking a collaborative orientation, buyer-suppliers negotiations will tend to be strictly price-driven and, to a large extent, impersonal (Dwyer, Schurr, & Oh, 1987; Macneil, 1978). This environment should prompt suppliers to form alliances among themselves to create, using Galbraith's (1956) terminology, countervailing power in their vertical negotiations. By doing so, suppliers should reduce their direct competition and pose constraints on buyers' ability to benefit from multiple, unarticulated actors (Burt, 1992; Emerson, 1962). As proposed by Reve (1992: 238), "organizations facing external constraints in one direction (e.g., vis-à-vis their customers) may strengthen their external

ties in other directions (e.g., vis-à-vis their competitors) with the objective of influencing the first sector as well."

These arguments lead to our second hypothesis, which competes with the first hypothesis outlined before:

> *Hypothesis 2: There is a negative association between vertical (buyer-supplier) and horizontal (supplier-supplier) alliances: if a supplier develops a vertical alliance with a buyer, it will less likely develop a horizontal alliance with another supplier, or vice-versa.*

The contingent effect of technological uncertainty

The two competing views outlined before identify a tradeoff for the establishment of horizontal and vertical alliances. From the point of the view of buyers, stimulating its supplier partners to form horizontal alliances is likely to augment inter-organizational learning and promote cooperation; but it is also likely to reduce buyers' bargaining position in the vertical tie. From the point of view of suppliers, crafting collaborative vertical alliances is likely to allow them to develop know-how that can be applied to other exchanges; but it is also likely to mandate a substantial commitment of specific resources, possibly constraining the formation of alternative ties. Therefore, the interplay between buyer-supplier and supplier-supplier alliances may be negative or positive depending on the relative magnitude of those opposing effects. This discussion invites the use of some contingency that might influence the relative benefits and costs of forming horizontal alliances when vertical alliances are in place, or vice-versa (Choi *et al.*, 2002).

We adopt an environmental variable that has been widely adopted in contingency-based theory (Burns & Stalker, 1961; Thompson, 1967) and in the literature on inter-organizational alliances (Afuah, 2000; Harrigan, 1988; Poppo & Zenger, 2002):

technological uncertainty. Supply components which display constant change in specifications and new technological breakthroughs will create an environment where technological uncertainty is at a high degree. For instance, in the auto industry, fuel injection systems are normally considered as supplies involving constant innovations, while clutches constitute an example of standardized product with mature, well-known technology (Swaminathan, Hoetker, & Mitchell, 2002). Thus, depending on the type of products and components being exchanged, a network will exhibit heterogeneity in terms of the technological uncertainty that surrounds transacting partners. And this heterogeneity will likely moderate the interplay between horizontal and vertical alliances.

When technological uncertainty is high, the need for inter-organizational learning at the supplier level will escalate. Exchange of best practices and even joint development of technologies through supplier-supplier alliances will be crucial to keep suppliers on the cutting edge and generate valuable product or process innovations (Stuart *et al.*, 1998). To accomplish innovations that are useful for buyers, suppliers will also likely need to promote relationship-specific investments, which will demand high commitment levels in the vertical exchange. As discussed before, horizontal alliances among suppliers should increase their confidence that buyers will not renege on existing agreements. Thus, from the point of the view of buyers, the positive effect of supplier-supplier alliances will likely outweigh the negative effect associated with increased supplier power when technological uncertainty is high. This effect should also hold in from the point of view of suppliers: vertical collaborations with buyers will improve their ability to develop valuable, innovative alliances elsewhere. In contrast, when technological uncertainty is low, there should be no need for inter-organizational learning and accompanying

investments in relationship-specific assets. Buyers may be reluctant to accept favorably the formation of supplier-supplier alliances because they may be interpreted as a way to increase supplier bargaining power without sizable compensating benefits in terms of learning or cooperation. Consequently, low technological uncertainty should lead to a negative effect of supplier-supplier alliances on buyer-supplier alliances (or vice-versa). In other words:

> *Hypothesis 3a: When technological uncertainty is high, there is a positive association between vertical (buyer-supplier) and horizontal (supplier-supplier) alliances.*

> *Hypothesis 3b: When technological uncertainty is low, there is a negative association between vertical (buyer-supplier) and horizontal (supplier-supplier) alliances.*

DATA AND METHODS

We tested our hypotheses by surveying suppliers of automobile parts in Brazil. The auto industry in Brazil is an appropriate empirical setting for our study. This industry has a history of alliances not only between suppliers and automobile manufacturers, but also among suppliers themselves (Addis, 1999). We focused our survey instrument on suppliers (instead of manufacturers) because their population is much larger than the population of manufacturers. Moreover, they are well-organized through a business association (Sindipeças, *Sindicato Nacional da Indústria de Componentes para Veículos Automotores*), whose members contribute with over 90% of revenues of the parts sector in Brazil. Sindipeças granted us access to its directory of members and helped us in the procedures to implement the survey.

Research design and data collection

Our survey data collection processes mostly followed Dillman's (2000) procedures. We initially developed a questionnaire by identifying construct items used in previous

studies. We also obtained the help of other academics and managers to develop items where the literature was silent, to refine survey wording, and to check the overall validity of questions *vis-à-vis* the industry environment. We compiled a mailing list of approximately 450 firms, using a list of Sindipeças members. As noted above, the Sindipeças' member directory is representative of the population as a whole, as it covers over 90% of the parts made in Brazil. Through Sindipeças, we identified the key respondents—either general or division manager. These managers are most knowledgeable about their firm's relationships with other suppliers and with auto-manufacturers, as well as about company-specific information. We then administered the questionnaires from July 2004 to March 2005. Our response rate was just above 40% (184 responses)—though, because of missing values, a total of 105 observations were effectively used in our regressions. We assessed non-respondent bias by comparing early with late respondents through a *t*-test (see e.g. Armstrong & Overton, 1977). We found no significant differences.

In the questionnaire, we asked respondents about the prior three years of their firm's activities to avoid biased responses due to specific aberrant experiences. In the survey, we asked respondents to assess vertical and horizontal alliances. In the case of vertical alliances, we asked respondents to focus on "a customer that the respondent was most knowledgeable about." We also asked questions related to each firm's relationship with another supplier. Respondents were asked to select a company that supplies a similar or complementary product to the buyer (customer) that the respondent previously identified. To facilitate responses, our questionnaire focused on a particular product that represented most of the firm's revenues.

Our sample includes both large and small firms, as well as domestic and multinational ones. Nearly half (45%) of the firms surveyed were subsidiaries of foreign multinationals. Moreover, our sample appears to exhibit a diversity of firms in terms of size. Measured by sales volume in millions of dollars, 7% of them had sales that were

less than US$2.5 million, 25% had sales between $2.5 million and $10 million, 36% had sales between $10 million and $40 million, 22% had sales between $40 million and $200 million, 6% had sales between $200 million and $400 million, and 8% had sales of more than $400 million.

Variables

We describe below four sets of variables: alliance-based variables (used to measure the extent of vertical and horizontal alliance activity), determinants of vertical alliances, determinants of horizontal alliances, and common variables influencing both alliances (including our measure of technological uncertainty and control variables). Variables based on measurement scales are described in Table 1. All the measurement instruments that used multi-item scales followed a 5-point Likert scale in which "1" represented "low degree" and "5" represented "high degree". Table 2 presents the descriptive statistics of our variables.

[Tables 1 and 2 about here]

Alliance-based variables

We measured alliances through the actions of parties in fostering joint activities (Heide & Miner, 1992; Lusch & Brown, 1996). Alliance-based variables are a multidimensional construct, where each variable was measured using 7 items involving a 5-point Likert scale. Specifically, we gauged the extent to which the respondent has engaged in joint activities with its selected customer (buyer) and peer (another supplier of the selected customer). We asked the respondent to report whether the alliances involved any form of coordinated action in areas such as: marketing and exports related activities; new product and process development; sharing of equipment and other resources; joint purchase of inputs; and joint representation at governmental agencies. We thus created the variables *Buyer-supplier alliance* and *Supplier-supplier alliances* as the unweighted average of the items (Cronbach alphas, respectively, equal to 0.70 and 0.81). Therefore,

our alliance-based variables measure the intensity of collaboration among parties in their vertical or horizontal exchange.

Variables influencing the emergence of buyer-supplier alliances

Relational norms in the vertical exchange. This variable measures the extent of information sharing and the behavioral norms associated with the buyer-supplier alliance (Anderson & Narus, 1990). In general, we tried to measure respondents' perception of whether negotiations are fair and the resulting commitments will be sustained, as well as whether there is trust and collaborative orientation among parties. As widely discussed in the literature, relational norms support the emergence and stability of inter-organizational alliances because they allow parties to economize on the costs of contracting and mutually adapt to changing circumstances (Dwyer *et al.*, 1987; Dyer, 1997). Since those relational norms are likely developed trough repeated interaction in past transactions (Gulati, 1995; Poppo, 1995), they are commonly considered as determinants of inter-organizational collaborations. The score of the perceptions about relational norms was computed as the unweighted average of the measurement items (Cronbach alpha = 0.82).

Specific investments. This variable measures the extent to which an investment was made specifically for the customer (buyer) indicated by the respondent in the last 5 years. The investments could be in terms of production processes, sales, procurement or logistics, research and development, and physical assets (e.g., hardware and industrial facilities). Past specific investments of that sort can influence the emergence and stability of alliances because they signal commitment to the exchange (Anderson & Weitz, 1992) and support joint action (Dyer, 1997). For instance, if the supplier invests in facilities close to its client, inter-partner exchange of knowledge will be largely facilitated. The score of the perceptions about specific investments in the vertical exchange was calculated as the unweighted average of the items indicating possible investments that could be accomplished (Crobnach alpha = 0.73).

Variables influencing the emergence of supplier-supplier alliances

Relational norms in the horizontal exchange. This variable was measured in the exact same way as the variable *Relational norms in the vertical exchange*. Respondents were asked to refer to another supplier who transacts with the selected customer (Cronbach alpha = 0.95). As in the case of vertical alliances, we expect that relational norms among suppliers facilitate the formation of horizontal alliances.

Participation in supplier association. Several authors have noted that, through their participation in business associations, firms can forge specific contacts and alliances (Lane & Bachmann, 1996; Rosenkopf, Metiu, & George, 2001). Thus, the effective involvement of suppliers in their main business association (Sindipeças) could be an antecedent of horizontal ties. Sindipeças was singled out for special focus because both the literature and preliminary work on the survey confirmed that this organization is the dominant institution for parts firms (e.g. Addis, 1999). Because we sent questionnaires to all Sindipeças' members, we needed to measure not only whether suppliers were involved in their association, but also the intensity of their involvement. In this sense, we tried to gauge respondents' assessments of the effectiveness of Sindipeças in supporting their activities as a way to assess the extent to which they were engaged in the association. We thus crafted a multi-dimensional construct, where respondents indicated in a 5-point Likert scale the degree to which the agreed that Sindipeças was effective to organize and supply technical training, develop economic/technical studies, hold social events to gather members, support collective negotiations with the government, and so forth. The score of the perceptions about the association was calculated as the unweighted average of the items (Cronbach alpha = 0.81)

Common variables influencing the formation of both vertical and horizontal alliances

Technological uncertainty. As a result of volatile market demand and technological breakthroughs, some components are likely to exhibit changing specifications and embodied technologies. An environment with high technological uncertainty should not only favor the formation of alliances in general (Rowley, Behrens, & Krackhardt, 2000),

but also, as discussed before, moderate the interplay between horizontal and vertical alliances. We thus asked respondents to assess, through a Likert scale, whether their main product has been subject to constant technological change and variations in customers' needs. The score of the perceptions about technological uncertainty was calculated as the unweighted average of the items (Cronbach alpha = 0.76).

R&D. We asked in the questionnaire the percentage of annual revenues that the company usually spends in R&D. Firms with large investments in R&D should have greater capacity and/or propensity to build alliances to improve processes and products, both horizontally and vertically (Powell *et al.*, 1996).

Multinational. This dummy variable is coded 1 if the supplier is foreign-controlled, and 0 otherwise. One might suggest that foreign-owned companies are more likely to form alliances, given their global influence and reach.

Firm age. We asked respondents to indicate the number of years their companies have been working in the auto-part sector. Older firms may be more knowledgeable of other firms in the industry, thus favoring the formation of alliances.

Valued-added. We asked respondents to report the 3-year average yearly revenues of their firm, and then divided this number by the total number of employees to compute the variable *Value-added*. This variable intends to control for the type of products manufactured by the supplier. For instance, high-tech firms that do not employ intensive labor in the production processes may have superior capabilities to form alliances in general.

Number of employees (in thousands). Larger firms may possess a superior pool of resources and scale necessary to invest in cooperative efforts with other suppliers and customers. Thus, we asked respondents to indicate the current total number of employees in their company as a measure of supplier size.

Method

A straightforward way to test our hypotheses would be to run simple regressions where *Buyer-supplier alliance* is a dependent variable and *Supplier-supplier alliance* is an independent variable, and then vice-versa. A critical problem with this approach is that vertical and horizontal alliances are likely endogenously determined, based on a host of unobserved factors. For instance, a firm may have distinctive capabilities to form and manage alliances *in general*, thus increasing its propensity to form both vertical and horizontal alliances for a reason that is distinct from the arguments supporting Hypothesis 1. Alternatively, the interaction between buyer-supplier and supplier-supplier alliances may be negative not due to the effect of one type of alliance on the other per se, as proposed by Hypothesis 2, but due to firms' *own* limitations in physical, financial or human resources impeding the simultaneous management of a portfolio of vertical and horizontal alliances. Failing to control for this joint determination should lead to biased and inconsistent estimates. Indeed, a Wu-Hausman test applied to our data revealed the existence of simultaneity involving vertical and horizontal alliances.

We thus employ the three-stage least squares method (e.g. Greene, 2000; Poppo & Zenger, 2002) to correct for simultaneity by jointly estimating two regressions: one where *Buyer-supplier alliance* is the dependent variable and *Supplier-supplier alliance* is an independent variable, and another where these variables switch their position. Support for Hypothesis 1 can be found either if the coefficient of *Supplier-supplier alliance* is significantly positive in the regression where *Buyer-supplier alliance* is in the left-hand side, or if the coefficient of *Buyer-supplier alliance* is significantly positive in the regression where *Supplier-supplier alliance* is the dependent variable. Hypothesis 2 is supported if one of the alliance-based variables exhibits a significantly negative coefficient. To identify the system of equations, when *Buyer-supplier alliance* is in the left-hand side we use as instruments the variables influencing the formation of vertical alliances, discussed before, and exclude them in the other regression. We do the same in the regression where *Supplier-supplier alliance* is in the left-hand side, using as

instruments the variables influencing horizontal alliances. In both equations, we add the common variables discussed before.

The three-stage least squares method is particularly attractive because the coefficients of two regressions are jointly estimated considering a possible correlation between the error terms in each equation. This feature tends to increase the efficiency of parameter estimates. Another attractive feature of the method is that it allows us not only to observe whether buyer-supplier and supplier-supplier alliances display a positive or negative interaction, but also the *direction* of their association (e.g., whether vertical alliances affect horizontal alliances, or vice-versa).

To test Hypotheses 3a and 3b, in turn, we need to assess whether the coefficients of *Buyer-supplier alliance* and *Supplier-supplier alliance* vary depending on the level of the variable *Technological uncertainty*. A usual way to observe this effect is to create multiplicative terms involving the contingency variable and the main variables of interest. The problem of using this approach in our context is that the three-stage least squares method assumes linearity of the endogenous variables, therefore failing to accommodate interactions. To overcome this limitation, we adopt a simple approach of splitting the data into two sub-samples: one in which *Technological uncertainty* is above or equal to its mean, and another in which this variable is below its mean. This procedure allows us to examine how the coefficients of the alliance-based variables change according to two conditions: high and low technological uncertainty. Hypothesis 3a and 3b are supported, respectively, if the coefficients of the alliance-based variables are positive in the sub-sample where technological uncertainty is perceived to be high, and negative in the sub-sample where technological uncertainty is perceived to be low.

RESULTS AND DISCUSSION

Table 3 presents the results of the three-stage least squares estimation. Models (1a) and (1b) are jointly estimated based on the whole sample of suppliers, and hence are used

to test the competing hypotheses 1 and 2. Although the coefficient of *Supplier-supplier alliance* in the regression using *Buyer-supplier alliance* as a dependent variable is insignificant, the coefficient of *Buyer-supplier alliance* in the regression where *Supplier-supplier alliance* is in the right-hand side is significant ($p < 0.05$) and indicates a negative effect of the vertical alliance on the horizontal alliance. Thus, Hypothesis 2 is supported and Hypothesis 1 is not supported: on average, buyer-supplier and supplier-supplier alliances appear to display a *negative* interaction. Furthermore, the effect is unidirectional: vertical alliances constrain horizontal ones, but not conversely. When forming vertical alliances, suppliers commit specific resources to their joint collaboration with buyers and, doing so, they apparently reduce their autonomy to form other ties (including ties with peers). Alternatively, buyers may deliberately influence their vertical partners not to form a horizontal tie in order to avoid a loss in bargaining power. These two explanations are consistent with the results presented in models (1a) and (1b).

[Insert Table 3 about here]

Hypotheses 3a and 3b imply differential effects of buyer-supplier on supplier alliances (or vice-versa) depending on the level of technological uncertainty involving supply components. As discussed before, the test of two differential effects is performed by splitting the sample into two conditions: where *Technological uncertainty* is below its mean (models (2a) and (2b)), and where it is above its mean (models (3a) and (3b)). Supporting Hypothesis 3b, we find a significantly negative effect of *Buyer-supplier alliance* on *Supplier-supplier alliance* ($p < 0.01$, model (2b)) when technological uncertainty is low, in a magnitude that is apparently larger than in the regression involving the whole sample. This effect, however, is insignificant in the sub-sample where technological uncertainty is high (model (3b)). Thus, Hypothesis 3a is not supported: we do not find any positive interaction between horizontal and vertical alliances when components are subject to high technological change. As before, we find

no significant result involving the effect of *Supplier-supplier alliance* on *Buyer-supplier alliance*.

Together, these results provide mixed support for our contingency-based prediction on the interplay between buyer-supplier and supplier-supplier alliances. On the one hand, the negative interaction among those two types of alliances is found *only* when technological uncertainty is low, which supports our argument that the efficiency-based benefits of supplier-supplier alliances should decline when the need for supplier inter-organizational learning is scant. In this condition, when forming vertical alliances with suppliers, buyers will likely view the formation of horizontal alliances in a negative way. On the other hand, we do not find a positive interaction between horizontal and vertical alliances when technological uncertainty is high. Indeed, we find no significant interaction in this condition whatsoever. Apparently, when technological uncertainty is high, vertical and horizontal alliances can be formed without any direct consequence for each other. Because we fail to find any significant and positive interaction between buyer-supplier and supplier-supplier alliances when technological uncertainty is high, the discriminating effect of this contingency is weaker than we initially hypothesized.

Some comments about the instrumental and control variables are in order. As expected, *Relational norms in the exchange* is always strongly significant and positively influences the emergence of both buyer-supplier and supplier-supplier alliances ($p < 0.01$), thus confirming that trust and a general propensity to collaborate support deeper inter-organizational ties, either vertical or horizontal. This effect remains significant even in the split-sample regressions.

Also as expected, *Specific investments* accomplished by suppliers to support their exchanges with buyers are positively correlated with stronger vertical collaborations. Interestingly, the effect of *Specific investments* varies according to the different sub-samples. This variable displays a strongly significant and positive coefficient when technological uncertainty is high ($p < 0.01$); however, it is insignificant when

technological uncertainty is low. A possible explanation is that conditions involving high technological uncertainty mandate a broader range of specific investments to support inter-organizational learning, which is by itself specific to the exchange. For instance, suppliers may need to invest in facilities close to the buyer to support the joint design of products. In contrast, when technological uncertainty is low, no profound inter-organizational learning needs to occur, thereby reducing the need of other accompanying investments.

The last instrumental variable, *Participation in supplier association,* exhibits mixed results. In the whole sample, the significantly positive coefficient of that variable indicates that Brazilian auto-parts suppliers' involvement in their supplier association (Sindipeças) positively influences the formation of horizontal ties ($p < 0.05$). This result confirms that business associations serve not only as a way to supply collective resources, but also as a networking mechanism through which members can forge specific alliances with one another. *Participation*, however, becomes insignificant in the split-sample regressions. Given that this variable is significantly positive in the whole sample, its lack of significance in the sub-samples may be a result of the reduced degrees of freedom in models (2) and (3).

As a final note, it is worth observing that common variables for the two regressions are in general insignificant, indicating that most explanatory power of the models is coming from the hypothesized and instrumental variables. In particular, although *Technological uncertainty* appears to influence the effect of buyer-supplier on supplier-alliance alliances, it has no direct effect on the formation of those alliances in general. Strong effects are found only with *Firm age* in model (2a) (indicating that older suppliers are more likely to form vertical alliances when technological uncertainty is low) and *Multinational* in model (3b) (indicating that foreign-owned suppliers are more likely to develop horizontal collaborations when technological uncertainty is high).

CONCLUDING REMARKS

Our paper contributes to the literature by theoretically and empirically examining the interplay between buyer-supplier (vertical) and supplier-supplier (horizontal) alliances in production systems. Although scholars have increasingly stressed the importance of the simultaneous assessment of vertical and horizontal alliances, distinct theoretical arguments have led to different predictions regarding the nature of their interaction. In this paper, we not only outline those distinct arguments, but also provide an attempt at reconciliation. Basically, we propose that the interaction between buyer-supplier and supplier-supplier alliances will be positive or negative depending on a particular contingency: the extent to which supply components are subject to uncertain technological change. Our data reveal that vertical alliances negatively affect the development of horizontal alliances, but only when technological uncertainty is relatively low. When components are subject to higher technological change, those two types of alliances do not appear to significantly affect one another.

Although aligned with the results reported in Reve (1992), the absence of a positive effect of supplier-supplier on buyer-supplier alliances (and vice-versa) in our data is inconsistent with existing work suggesting that horizontal alliances complement vertical forms of collaboration in supply chains from an inter-organizational learning perspective (e.g. Dyer & Nobeoka, 2000; Stuart *et al.*, 1998). On the contrary, our results indicate that, through the development of ties in one dimension, actors apparently want to maintain their autonomy in the other dimension—especially when supply components are not subject to high technological change. Thus, in general, deep horizontal and vertical alliances should not be frequently observed coexisting in inter-organizational networks. Given the growing interest in Japanese production systems emphasizing a mix of horizontal and vertical alliances, the practical relevance of our results becomes salient.

Our study, however, presents several limitations. Our database is focused on a single industry and a single country, therefore lacking heterogeneity in terms of technology and

institutional features. For instance, it may be the case that horizontal and vertical alliances coexist to a higher degree in Japan because of the greater role of networks as conduits of information about partners' behavior in that country (e.g. Hagen & Choe, 1998). In contrast, although inter-organizational networks have been commonly observed in the Brazilian auto industry, their social role appears to have declined over the years, in part due to increasing entry of foreign firms replacing existing, well-connected actors (Addis, 1999). Future research should therefore attempt to evaluate the interplay between horizontal and vertical alliances in a broader range of industries and institutional contexts.

A related limitation of our study refers to the way we treat technological uncertainty. Since we are focusing on a single industry and a single country, the only feature that guarantees variation with respect to this variable in our study is the apparent heterogeneity of supply components in the sample. Other industries, however, may exhibit even greater variation in technological uncertainty. Thus, the products in our sample may not have a rate of technological change that is high enough to augment the benefits of inter-organizational learning and lead to a positive interaction between vertical and horizontal alliances. A possible way to increase the heterogeneity with respect to this contingency in future work is to collect data from different industries showing polar levels of perceived uncertainty (e.g. Rowley *et al.*, 2000).

Finally, we focus on the interplay between buyer-supplier and supplier-supplier alliances without any consideration about the impact of those alliances on the performance of buyers and suppliers. Yet, performance considerations are critical to inform managers about the possible costs and benefits to form vertical and horizontal alliances. Thus, in conditions where those alliances are negatively related, suppliers must ascertain whether they should invest in vertical alliances with buyers (which will likely constrain the development of horizontal ties) or invest in horizontal alliances with peers (thus refraining from forming deep vertical ties). This choice will depend on the relative

contributions of buyer-supplier and supplier-supplier alliances for the economic and operational performance of firms. Future research examining how horizontal and vertical alliances interact with each other *and* influence firm performance would be of great importance.

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Table 1. Description of variables involving measurement scales

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Buyer-supplier alliance ($\alpha = 0.70$) and *Supplier-supplier alliance* ($\alpha = 0.81$)*
To what extent your company is developing the activities (listed below) together with your selected supplier/customer:
1. Marketing and export-related activities
2. New product and process development
3. Sharing of equipment and other production machinery
4. Joint purchases
5. Joint negotiations with governmental agencies
6. Sharing of investments, responsibilities and efforts
7. Sharing the burden and the outcomes of joint initiatives

Relational norms in the vertical exchange ($\alpha = 0.82$) and *in the horizontal exchange* ($\alpha = 0.95$)*
To what extent your relationship with your selected supplier/customer is characterized by the following elements:
1. Fluid exchange of information
2. Exchange of information about production costs
3. Exchange of information about plans, programs and schedules
4. Transparent negotiations
5. Helping each other in implementing programs of inventory management (e.g. just-in-time)
6. Problem-solving approach rather than mutual conflict
7. Mutual trust and commitment
8. Flexibility to make adjustments when difficult situations unfold

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Participation in supplier associations ($\alpha = 0.81$)
The degree to which your company uses specialized support from the business association (Sindipeças) for:
1. Technical training
2. Technical and economic information
3. Social events
4. Political lobbying for the industry as a whole
5. Political lobbying for your company or group of companies
6. Support for collective actions among associates (e.g. collective procurement, marketing)
7. Advising and monitoring collective norms and standards (e.g. quality)

Specific investments in the vertical exchange ($\alpha = 0.73$)
To what extent your company invested in the following routines and specific assets to deal with your customer:
1. Research and development, product design and facilities for R&D
2. Production process, machinery and equipment
3. Sales and procurement systems, logistics and inventory management
4. New production plants and warehouses
5. Computer hardware and software

Technological uncertainty ($\alpha = 0.81$)
To what extent your business is characterized by:
1. Frequent introduction of new products or innovations in the existing products
2. Constant need to fulfill the technological needs of customers
3. Frequent variation in demanded over the years
4. Frequent technological change

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* There were two different blocks of questions in the questionnaire: one for the supplier-supplier alliance, and another for the buyer-supplier alliance.

Table 2. Descriptive statistics

	1	2	3	4	5	6	7	8	9	10	11	12
1.*Buyer-supplier alliance*	1.00											
2.*Supplier-supplier alliance*	-0.13	1.00										
3.*Relational norms (vertical)*	0.54	-0.15	1.00									
4.*Specific investments*	0.16	0.04	0.06	1.00								
5.*Relational norms (horizontal)*	-0.11	0.75	-0.11	0.07	1.00							
6.*Participation in supplier association*	0.17	0.15	0.16	-0.04	0.14	1.00						
7.*Technological uncertainty*	0.10	-0.05	0.17	0.21	-0.02	0.05	1.00					
8.*R&D*	-0.16	0.08	-0.20	0.08	0.06	0.00	0.12	1.00				
9.*Multinational*	0.06	0.03	-0.17	-0.06	-0.06	-0.01	-0.17	0.01	1.00			
10.*Firm age*	-0.02	0.06	-0.12	-0.05	0.06	-0.09	-0.06	0.10	0.05	1.00		
11.*Value-added*	-0.03	-0.01	-0.07	-0.06	0.10	0.05	-0.06	-0.11	-0.02	-0.05	1.00	
12.*Number of employees*	0.25	-0.08	0.05	0.10	0.02	0.00	0.01	-0.03	0.06	0.00	-0.08	1.00
Mean	2.25	1.42	3.28	3.54	1.67	3.06	3.10	4.22	0.44	30.71	0.58	0.74
Std. Dev.	0.61	0.64	0.77	0.78	0.98	0.71	0.80	3.43	0.50	17.58	1.64	1.48

N = 105

Table 3. Determinants of buyer-supplier (vertical) and supplier-supplier (horizontal) alliances: three-stage least squares estimation

	Whole sample		Low technological uncertainty		High technological uncertainty	
	Buyer-supplier alliance (1a)	Supplier-supplier alliance (1b)	Buyer-supplier alliance (2a)	Supplier-supplier alliance (2b)	Buyer-supplier alliance (3a)	Supplier-supplier alliance (3b)
Buyer-supplier alliance		-0.201*		-0.392**		-0.065
		(0.120)		(0.167)		(0.154)
Supplier-supplier alliance	-0.050		0.191		-0.195	
	(0.098)		(0.145)		(0.159)	
Relational norms in the	0.457**		0.513**		0.490**	
vertical exchange	(0.066)		(0.109)		(0.077)	
Specific investments	0.123*		-0.011		0.200**	
	(0.061)		(0.094)		(0.071)	
Relational norms in the		0.461**		0.508**		0.434**
horizontal exchange		(0.041)		(0.055)		(0.074)
Participation in supplier		0.103*		0.114		0.092
association		(0.060)		(0.080)		(0.079)
Technological uncertainty	0.038	-0.026	0.066	-0.064	-0.190	-0.002
	(0.061)	(0.052)	(0.179)	(0.139)	(0.140)	(0.147)
R&D	-0.011	0.000	0.009	-0.016	-0.019	0.007
	(0.013)	(0.011)	(0.030)	(0.023)	(0.013)	(0.014)
Multinational	0.138	0.102	0.313	-0.030	0.065	0.237*
	(0.103)	(0.085)	(0.196)	(0.140)	(0.121)	(0.117)
Firm age	0.004	0.003	0.009*	0.002	0.003	0.004
	(0.002)	(0.002)	(0.004)	(0.003)	(0.003)	(0.003)
Value-added	-0.059	0.008	0.150	0.137	-0.102	0.033
	(0.066)	(0.055)	(0.246)	(0.192)	(0.063)	(0.058)
Number of employees	0.063†	0.034	0.105†	-0.077†	0.058	0.024
	(0.034)	(0.032)	(0.054)	(0.045)	(0.043)	(0.045)
Intercept	0.099	0.759*	-0.521	1.269**	0.880	0.266
	(0.385)	(0.305)	(0.699)	(0.447)	(0.725)	(0.779)
N	105	105	52	52	53	53
R^2	0.425	0.611	0.361	0.671	0.573	0.605
χ^2	77.52**	168.26**	31.78**	113.51**	76.08**	81.93**

** $p < .01$ * $p < .05$ † $p < .10$ (one-tailed tests for hypothesized effects, including instruments). The table shows parameter estimates and standard errors in parenthesis. Models (2) and (3) involve sub-samples dichotomized based on the mean value of the variable *Technological uncertainty*.