The impact of trust and contract on innovation performance: The moderating role of environmental uncertainty

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ABSTRACT

Research into two important control mechanisms for managing the supply chain relationship – contracts and trust – is on the rise. However, our understanding of how they influence innovation in a firm remains rather unclear. Thus, the primary objective of this study is to examine the individual and interactive effects of contracts and trust on firms’ innovation performance and the contingent effects of environmental uncertainty on those relationships in China. The empirical results from a survey of Chinese manufacturing firms indicate that there is a positive relationship between trust and firms’ innovation performance, an inverted U-shaped relationship between the use of contracts and firms’ innovation performance, and that contracts and trust are substitutes. Moreover, we find that environmental uncertainty enhances the effects of trust, but does not influence the impact of contracts on innovation performance.

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1. Introduction

In recent decades, some Chinese firms have heavily invested in research and development, and cost advantage is an insufficient reason to explain their positions in the global supply chain (Nassimbeni and Sartor, 2007; Su et al., 2008). Other than in-house investments and resources, researchers have noticed that innovation capability also relies on the supply chain partners’ resources (Song et al., 2003; Levin and Cross, 2004). Though many studies have shown that supplier collaboration is one way to enhance innovation performance (Petersen et al., 2005; Primo and Amundson, 2002), the arguments of transaction cost economics (TCE) have also shown that supply chain collaboration might be damaged by opportunistic behaviour, which has been described as “self-seeking with guile” (Williamson, 1985: 45).

Trust and contracts have been viewed as two important mechanisms to safeguard opportunistic behaviour and maintain cooperation (Jap and Ganesan, 2000). They tend to reduce goal incongruence and preference divergences amongst partners, and are widely acknowledged as essential to inter-firm collaboration (Geringer and Hebert, 1989). In particular, an effective contract prescribes appropriate behaviour for supplier chain partners in addition to routines for the distribution of outcomes (Luo, 2002). Trust describes the extent to which a firm believes that its exchange partner is honest and/or benevolent (Geyskens et al., 1998). Although the effectiveness of contracts and trust in governing inter-organizational and their effects on financial and cooperation performances have been widely studied (e.g. Luo, 2002; Poppo and Zenger, 2002; Li et al., 2010a), there is limited empirical evidence as to how they affect manufacturers’ innovation performance. Moreover, although many researchers have admitted that trust and contracts interact with each other, whether they are substitutes (e.g. Dyer and Singh, 1998; Faulkner, 2000; Gulati, 1995) or complements (e.g. Luo, 2002; Poppo and Zenger, 2002; Wuyts and Geyskens, 2005) is the subject of controversy. These conflicting views drive us to investigate the mechanisms of how trust and contracts work together to develop innovation capability.

Several studies have reported that environmental uncertainty moderates the effectiveness of control mechanisms (Poppo and Zenger, 2002; Cavusgil et al., 2004). Researchers have noted that transition economies such as China are characterized by a lack of well-established legal frameworks, which allow widespread opportunistic behaviour (Li et al., 2010a; Luo, 2007). Therefore, environmental uncertainty may discount the role of contracts and make trust a more important factor needed for collaboration between manufacturers and suppliers in China to occur. To date, however, little theoretical or empirical work has addressed this
issue. Therefore, this study aims to address two key research questions: (1) how do trust and contracts influence firms’ innovation performance? (2) How does environmental uncertainty moderate that influence? Theoretically, we contribute to the innovation and supply chain management literature by investigating the effects of supply chain control mechanisms on innovation performance. This study will provide empirical evidence on the different roles played by trust and contracts in supply chain collaborative innovation. Moreover, we take a contingency perspective on the impacts of control mechanisms on innovation, which will reveal how environmental uncertainty influences the effects of trust and contracts. Practically, our research will provide guidelines for managers to decide how to choose control mechanisms in managing supply chain collaborative innovation and devote their efforts and resources in improving innovation performance according to their business environment.

The remainder of this paper is organized as follows. We first review the literature on supply chain collaborative innovation and control mechanisms, develop our conceptual model, and derive our corresponding hypotheses, followed by a description of our methodology and the results of our empirical analysis. Other interesting findings related to the conceptual framework are discussed in Section 5. Section 6 concludes the study with key contributions for academics and practitioners, and mentions the limitations and points out the future research directions.

2. Literature review and research hypotheses

2.1. Supply chain collaborative innovation

Innovation is a highly structured, knowledge-intensive activity embedded in networks that span organizational boundaries (Cao and Zhang, 2010). Suppliers are important sources of innovative ideas and critical technologies (Bonaccorsi and Lipparini, 1994). Thus, innovation is no longer a component of firms’ internal activities, and suppliers should be treated as part of a firm’s business and technical functions (Koufteros et al., 2005). Supply chain collaboration has been viewed as an important way to improve firms’ ability to innovate (Karniouchina et al., 2006). Researchers have also found empirical evidence supporting the positive relationship between inter-organizational collaboration and innovation performance. For example, the earlier and more extensive involvement of suppliers in product development is argued to be one of the ways to enhance innovation performance in terms of productivity, speed, product quality, and time-to-market (Clark, 1989; Primo and Amundson, 2002; Ragatz et al., 2002). Moreover, some studies have also shown that the buyer–supplier co-design partnership (Bonaccorsi and Lipparini, 1994; Zirpoli and Caputo, 2002) not only align conflicts and different interpretations of goals and tasks across the supply chain, but also facilitate new technology adoption (Handfield et al., 1999; Dougherty, 1992). Furthermore, collaboration with suppliers in innovation can stimulate creativity and effectively address the inter-dependencies that exist among market choices, product design, process design, and supply chain design decisions (Petersen et al., 2005). In this way, design glitches can be identified before the production ramp-up and product engineering changes can be greatly reduced (Rupak et al., 2008).

2.2. Control mechanisms

Opportunism includes lying and cheating, as well as more subtle forms of deceit such as violating implicit agreements (Rindfleisch and Heide, 1997). In the supply chain context, it is reflected in such forms of behaviour as offering proprietary information to competitors, not adhering to promises or reducing efforts undertaken in joint tasks (Blumberg, 2001). In response to opportunistic behaviour, TCE suggested that managers should establish and utilize control mechanisms for successful collaborative relationships to thrive (Das and Teng, 1998).

Contracts are formal, written agreements between two or more business partners that provide a legally bound, institutional framework in which each party’s rights, duties and responsibilities are specified (Luo, 2002). It explicitly prescribes roles and obligations, determines the content of the exchange and the division of outcomes, and specifies penalties for violating contractual specifications (Poppo and Zenger, 2002; Dyer, 1997). Sufficiently elaborate and carefully constructed contracts will provide a framework for behaviour, determine the pattern of outcome distribution, state the punishment for violating contractual agreements and prescribe appropriate behaviour in the supply chain relationship, along with each partner’s roles and obligations (Poppo and Zenger, 2002; Wuys and Geyskens, 2005). Thus, contracts are hypothesized to play a critical role in supply chain relationships (Antia and Frazier, 2001; Liu et al., 2009a).

Trust refers to the decision to rely on a partner with the expectation that the partner will act according to common agreements (Inkpen and Currall, 2004). In a risky situation, a party’s trust is signified by a decision to take action that puts his or her fate in the hands of the other party. Trust engenders cooperation within the supply chain and has been viewed as a useful lubricant or a fundamental ingredient in avoiding conflict and contributing to the long-term stability of a supply chain (Morgan and Hunt, 1994; Yeung et al., 2009). Empirically, researchers have found that trust amongst supply chain partners directly affected capability development (Narasimhan and Nair, 2005), supply chain integration (Yeung et al., 2009), supply chain collaboration (Chong et al., 2009), innovativeness (Panayides and Lun, 2009), relationship performance (Liu et al., 2009a) and financial performance (Laaksonen et al., 2009).

2.3. Research hypotheses

2.3.1. Contract and innovation performance

We argue that contracts can curb opportunism in manufacturer–supplier collaboration, which facilitates knowledge transfer and improves innovation performance. In particular, by providing a legal and institutional framework, contracts can constrain opportunistic behaviour with clearly articulated clauses that specify punishments and by increasing the costs of self-interest activities (Luo, 2002). Well-specified contracts state how various future situations will be handled (Lusch and Brown, 1996), thereby decreasing uncertainty about behaviour and outcomes by providing formal rules and procedures to maintain the relationship. Hence, contracts narrow the domain and severity of risk to which an exchange is exposed and thereby encourage subsequent cooperation (Poppo and Zenger, 2002). Furthermore, contracts also provide a way to manage conflict during knowledge transfer. When a dispute arises, the clause that enforces the terms of a contract determines what precisely is lawful (Ring and Van de Ven, 1994). Thus, the costs and risks associated with knowledge exchange and with collaborative innovation across the supply chain are reduced.

However, the impact of contracts on firms’ innovation performance is unlikely to remain linear within the whole collaborative process. When a contract becomes excessively detailed, it becomes inflexible and monitoring compliance becomes very costly. In practice, overly specific terms may cause rigidity, while overly
There is a positive relationship between trust and Hypothesis 2. Therefore, we propose that when a high level of trust is main-

2.3.3. Interaction of contract and trust and its effects on innovation performance

2.3.2. Trust and innovation performance

According to TCE, the presence of trust makes a firm believe that its partner possesses the credibility of the other partners and would like to collaborate with it, even though there may be risks (Yeung et al., 2009). Possessing trust would lower transaction costs and prevent opportunistic behaviour in inter-firm collaboration (Laaksonen et al., 2009), so firms can put more energy and resources into absorbing and utilizing knowledge (Lane et al., 2001). Trust enables firms to reduce dependence on equity structures to govern the relationships (Gulati, 1995) and reduces negotiation costs resulting from collaboration, thus allowing firms to invest more resources into collaborative innovation activities (Zaheer et al., 1998). Furthermore, trust lowers the costs associated with complex adaptation, thereby allowing partners to adjust the agreement “on the fly” to respond to unforeseen market changes (Uzzi, 1997). Finally, trust can minimize transaction costs over the long-run, because those costs are not subject to the time limitations of contracts (Dyer and Singh, 1998).

Trust can increase the transparency and initiative of inter-

organizational learning (Lane et al., 2001; Gulati, 1995). Symmetric mutual trust, respect and friendship among partners may significantly affect the ability of a firm to successfully manage the dual objectives of learning from its suppliers and protecting its own core proprietary assets from them (Kale et al., 2000). Thus, with the potential opportunistic or self-serving behaviour by the business partner(s) being counteracted by trust, the managers will no longer worry about the risk of losing their core proprietary assets to the partner. Transparency and the initiation of inter-

organizational learning increase and the exchange of information and knowledge becomes smoother, which is especially important to facilitate the transfer of tacit knowledge between manufacturer and supplier (Kale et al., 2000; Nonaka and Takeuchi, 1995). Therefore, we propose that when a high level of trust is maintained between firms, knowledge, ideas and information can flow smoothly to help enhance firms’ innovation performance.

Hypothesis 2. There is a positive relationship between trust and a firm’s innovation performance.

2.3.3. Interaction of contract and trust and its effects on innovation performance

There are two competing views on the joint effects of contracts and trust on firms’ innovation performance. Some scholars suggested that contracts and trust can complement each other’s inadequacies and limitations. Scholars empirically observed that trust and contracts function as complements in achieving higher exchange performance and in constraining opportunism (Poppo and Zenger, 2002; Cavusgil et al., 2004; Liu et al., 2009a). However, others have generally viewed trust as a substitute for a complex, explicit contract (Gulati, 1995; Dyer and Singh, 1998).

The complement view regards trust as filling in the holes of contracts and vice versa. For example, Ring and Van de Ven (1994) suggested that formal contracts lead to greater levels of trust by co-evolution. Cannon et al. (2000) argued that the process of negotiation and drawing up contracts can promote information exchange between manufacturer and suppliers, which will establish a realistic basis for the development of trust. Additionally, through the formal specification of a long-term commitment to exchange, and with clearly articulated clauses that specify punishments, contracts can limit the gains that stem from opportunistic behaviour and promote expectations that the other party will behave cooperatively, all of which contributes to trust development (Poppo and Zenger, 2002).

Both contracts and trust have inadequacies and limitations. Regardless of how explicit a contract is, it can never anticipate every potential possibility (Wuyts and Geyskens, 2005). Hence, managers cannot predict and contractually resolve every future contingency. When disturbances arise, contracts alone are unable to maintain the continuity of the relationship. In general, trust control is broadly defined and is more flexible and adaptable, so it can overcome the adaptive limits of contracts and complement it by fostering continuance and bilateralism when change and conflict arise (Macneil, 1978). However, trust cannot be formally codified; ambiguous expectations and misunderstandings will arise, which undermines coordination and even results in opportunism (Weitz and Jap, 1995). Therefore, contracts can overcome the informal limitations of trust and complement it through the formal specification of unspoken assumptions that help establish a solid basis for the development of trust. Trust is also very important for the enforcement of contracts, and a certain level of inter-firm trust is indispensable for any inter-firm collaboration to be formed and to function (Das and Teng, 1998). Moreover, the continuity and cooperation encouraged by trust may generate contractual refinements and further support greater cooperation (Poppo and Zenger, 2002). Therefore, we propose that firms that rely on both contract and trust can achieve higher innovation performance.

Hypothesis 3a. Contracts and trust are complementary in promoting a firm’s innovation performance.

In contrast, the substitution view regards a contract as redundant and even counter-effective to trust (e.g. Dyer and Singh, 1998; Uzzi, 1997). A common underlying rationale for this substitution view is that because trust reduces the need for specifying and monitoring contractual clauses, it makes contractual safeguards redundant (Gulati, 1995). Dyer (1997) argued that trust itself should be viewed as an efficient governance mechanism in inter-

firm relationships, which reduces transaction costs by replacing contracts, and the more trust one has, the less control one needs over a partner. Similarly, Faulkner (2000) argued that less control is needed when trust is well developed.

Some scholars also suggest that contracts may undermine the development of trust. Making detailed contracts and relying more strongly on them may be interpreted as a sign of distrust (Goshal and Moran, 1996), which might encourage the very opportunistic behaviour they are designed to discourage (Wuyts and Geyskens, 2005). Furthermore, it has been argued that trust can undermine the effectiveness of a contract, because it can stand in the way of effective enforcement of contractual details (Antia and Frazier, 2001). In China, building informal personal relationships is an important precondition for firms to develop collaborative

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relationships and respond to unforeseen contingencies (Luo, 2002; Zhou et al., 2003; Zhao et al., 2006). Most manufacturer–supplier relationships need interpersonal relationships, as the legal system is relatively weak, which limits the role of contracts (Poppo and Zenger, 2002). Thus, when individual relationships and trust between individuals are well formulated, firms’ reliance on contracts will be reduced (Xin and Pearce, 1996). Therefore, we propose:

**Hypothesis 3b.** Contracts and trust are substitutes in promoting a firm’s innovation performance.

2.3.4. **Moderating effect of environment uncertainty**

Environmental uncertainty refers to the rate of change and the degree of instability in the environment (Dess and Beard, 1984). Dynamic environments may be characterized by changes in technologies, variations in customer preferences, and fluctuations in product demand and/or the supply of materials. For inter-firm collaboration, environmental uncertainty cannot be ignored, and the effect of trust and contracts on a firm’s innovation performance may vary under the high pressure of environmental uncertainty.

We know that business partners cannot predict and stipulate every potential contingency because of the bounded rationality (Williamson, 1985). Even though some potential contingencies may be considered in advance and placed in a contract, that alone is deficient in ensuring evolving adaptation during the whole collaborative process (Luo, 2002). In fact, the more complete a contract is, the less flexible and adaptable it is. When the environmental uncertainty is high, many unexpected contingencies may arise, so the role of the contract will be discounted. Therefore, we propose:

**Hypothesis 4a.** Environmental uncertainty negatively moderates the relationship between contracts and a firm’s innovation performance.

In contrast, trust may overcome the inflexibility disadvantages of contractual-based governance in a turbulent environment. Zhou et al. (2003) argued that the high uncertainty characteristic of transitional economies like that of China is likely to reinforce the cultivation of trust between business partners. Dyer and Singh (1998) contended that as a self-enforcing safeguard, the presence of trust between business partners based on mutual commitment and shared values is a more effective and less costly alternative to creating a contract. Trust provides the flexibility to cope with inevitable uncertainties that arise in a long-term exchange. This flexibility helps mitigate exchange hazards under uncertainty and strengthens bilateral commitment to exchange-specific investments (Luo, 2002). Thus, flexibility enables firms to adapt to unforeseeable technological and market changes. Therefore, we propose the following hypothesis. The overall research framework is shown in Fig. 1.

**Hypothesis 4b.** Environmental uncertainty positively moderates the relationship between trust and a firm’s innovation performance.

3. **Research methodology**

3.1. **Data and sample**

Data used in this research were taken from a large questionnaire data collection project, which covered multiple topics, including innovation, inter-firm cooperation, and strategy (Li et al., 2010b). A combination of interview approach and survey method was used in data collection. Particularly, a research team, which included six Ph.D. students majored in operations management and had good knowledge on supply chain management, asked the respondents questions and recorded their responses in face-to-face meetings. Interviews took 90 min on average. The research team went through 10 h of training on the main objectives of this study, the interviewing techniques, and the exact meaning of each question in the questionnaire in advance. So, they were able to answer any questions the respondents might have as they filled out the questionnaire. A pilot study was conducted with 15 firms (excluded from the final sample of this study), which suggested that CEO or the senior managers and executives in charge of buyer–supplier relationships (e.g., purchasing managers or supply chain management managers) should be chosen as respondents. Additionally, in the face-to-face interviews, the respondents were asked to consult with other managers (e.g., R&D manager) when she/he encountered any questions that she/he didn’t know.

The sample was drawn from the government directories of manufacturing firms in Shaanxi, Henan, Shanghai, Guangdong, Liaoning, Sichuan, Shandong and Shanxi provinces of China and 850 firms were randomly selected. We contacted the potential respondents by telephone to obtain their preliminary agreement to participate. An introductory letter explaining our objectives and assuring confidentiality and access to our aggregated survey results was then sent to these firms. Of the 850 firms contacted, 607 companies provided all the necessary data for the study, thus resulting in an effective return rate of 71.41% (607/850). In the questionnaire, the respondent was asked the length of the relationship with suppliers. The results showed that out of the 607 manufacturers, 315 have long-term relationships with suppliers. The average length for a relationship to be included was 7.17 years. We screened out the companies only working with suppliers for short periods because strategic collaborative activities, such as relationship building and supplier involvement in design, demand long-term commitment (Swink et al., 2007). As a result, a subsample of 315 firms was selected for further analysis. A profile of them is provided in Table 1.

Two issues commonly raised concerning survey methodology are non-response bias and common method variance (Lambert and Harrington, 1990; Podsakoff and Organ, 1986). The ownership status and sales revenue of 83 non-responding firms were obtained, and the responding and non-responding firms were compared to these major firm attributes using t-tests. All t-statistics were insignificant. Furthermore, by means of χ² test of independence (i.e., firm size, ownership status, and age), the responding firms were compared to the non-responding firms; again, no significant differences were found.

The possibility of common method variance was examined via Harman’s one-factor test for all variables in the study (Podsakoff and Organ, 1986). A factor analysis of the dependent and independent variables yielded four factors with eigenvalues greater than 1, accounting for 71.63% of the variance, and the first factor accounted for 25% of the variance. Hence, neither a
single factor nor a general factor that could account for the majority of the covariance in the measures emerged.

3.2. Measures

Multi-item measures were developed based on existing scales identified in the literature and made some minor modifications to suit our research purpose and context. All multi-item measures were based on 7-point Likert scales, from 1 (strongly disagree) to 7 (strongly agree). The items are reported in Table 3.

The items for contracts described the level of contract completeness and role of the contract in the manufacturer-supplier relationship. It was composed of three items based on the scales reported in the studies of Jap and Ganesan (2000). Trust was measured by four items and reflected the confidence firms had in their suppliers’ reliability and integrity (Jap and Ganesan, 2000; Zaheer et al., 1998). Innovation performance included a relatively complete innovation level of a firm by using three items to capture the product innovation, process innovation and managerial innovation (Damanpour, 1991). Environmental uncertainty was captured by four items describing the difficulty and inability to accurately forecast the changes in the market and technological environment (Bstieler, 2005).

Firm size, cultural distance and cooperation duration were included as control variables. Firm size may influence innovation performance, because different sizes may exhibit different organizational characteristics and resource deployments. Larger firms may have more slack resources, which is an important contributor to innovation (Liu et al., 2009b). Therefore, we used firm size, measured by the number of firm employees, as a control variable. Cultural distance was controlled for, because it proxies for the level of conflict that arises from differing forms of normative behaviour and probably has a negative impact on knowledge sharing (Lyles and Salk, 1996). We asked the respondents to assess the cultural difference between them and their suppliers. Prior studies suggest that with increasing relationship duration, parties have more opportunities to learn about each other and develop better mutual understanding (Kotabe et al., 2003). They may thus develop a relatively high level of joint action (Heide and Miner, 1992). We measured relationship duration by counting the number of years since the relationship was formed. In Table 2, we present the descriptive statistics and zero order correlations among the variables used in the regression analyses.

3.3. Construct validity

Following Anderson and Gerbing (1988), we refined the perceptual measures and assessed their construct validity by running a confirmatory factor analysis (CFA) with structural equation modelling. The CFA shows that each of the 24 indicators loads significantly on its intended factor, indicating convergent validity among the items of each scale. As shown in Table 3, the composite reliability coefficients ranged from 0.83 to 0.95, well above the 0.50 cut-off (Fornell and Larcker, 1981). As shown in Table 3, the composite reliability coefficients ranged from 0.83 to 0.95, well above the usual 0.70 benchmark. The average variance extracted for every construct was above the 0.50 cut-off (Fornell and Larcker, 1981). Thus, these measures demonstrate adequate convergent validity.

Discriminant validity was tested in two ways. First, we ran pairwise, chi-square difference tests for all the four latent constructs to assess whether the restricted model (in which the correlation was fixed as 1.0) fit the data significantly worse than the freely estimated model (in which the correlated was estimated freely).

Table 1
Profile of respondent firms.

<table>
<thead>
<tr>
<th>Firm size</th>
<th>Percent</th>
<th>Ownership</th>
<th>Percent</th>
<th>Area</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 50</td>
<td>7.6</td>
<td>State-owned enterprises</td>
<td>28.3</td>
<td>Guangdong</td>
<td>16.2</td>
</tr>
<tr>
<td>51–200</td>
<td>23.2</td>
<td>Joint ventures</td>
<td>9.8</td>
<td>Henan</td>
<td>31.1</td>
</tr>
<tr>
<td>201–500</td>
<td>18.1</td>
<td>Limited companies</td>
<td>42.5</td>
<td>Liaoning</td>
<td>8.9</td>
</tr>
<tr>
<td>501–1000</td>
<td>18.7</td>
<td>Private companies</td>
<td>12.7</td>
<td>Sichuan</td>
<td>8.3</td>
</tr>
<tr>
<td>&gt; 1000</td>
<td>32.4</td>
<td>Collective-owned enterprises</td>
<td>4.4</td>
<td>Shandong</td>
<td>16.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Others (e.g., Township Enterprises)</td>
<td>2.3</td>
<td>Shanghai</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Shanxi</td>
<td>5.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Shaanxi</td>
<td>9.5</td>
</tr>
</tbody>
</table>

* Number of employee.

Table 2
Descriptive statistics and Pearson correlation matrix.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>S.D.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Trust</td>
<td>5.12</td>
<td>1.27</td>
<td>(0.800)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Contract</td>
<td>4.48</td>
<td>1.27</td>
<td>0.507**</td>
<td>(0.680)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Innovation performance</td>
<td>4.76</td>
<td>1.24</td>
<td>0.492***</td>
<td>0.384***</td>
<td>(0.780)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Uncertainty</td>
<td>4.09</td>
<td>0.93</td>
<td>0.031</td>
<td>0.057</td>
<td>0.075</td>
<td>(0.570)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Firm size</td>
<td>2.28</td>
<td>0.81</td>
<td>−0.091</td>
<td>−0.081</td>
<td>−0.055</td>
<td>−0.018</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Cultural distance</td>
<td>4.60</td>
<td>1.54</td>
<td>0.178**</td>
<td>0.184**</td>
<td>0.169**</td>
<td>0.084</td>
<td>−0.057</td>
<td></td>
</tr>
<tr>
<td>7. Cooperation duration</td>
<td>7.17</td>
<td>5.42</td>
<td>0.126*</td>
<td>0.088</td>
<td>0.024</td>
<td>0.038</td>
<td>−0.22***</td>
<td>−0.019</td>
</tr>
</tbody>
</table>

* Significance level: *p < 0.05.
** Significance level: *p < 0.01.
*** Significance level: *p < 0.001.
All the $\chi^2$ differences were significant ($p < 0.05$), which is evidence of discriminant validity (Gerbing and Anderson, 1988). Second, we performed a more stringent test to determine whether the square root of the average variance extracted (i.e., the diagonals in Table 2) is greater than the correlations among constructs (i.e., the off-diagonal elements in Table 2) (Fornell and Larcker, 1981). An examination of Table 2 reveals that the diagonal elements of this matrix are significantly greater than the off-diagonal elements, indicating that each construct shares more variance with its measures than with other constructs. This result provides strong evidence of discriminant validity among the theoretical constructs.

4. Analysis and results

We applied multiple moderated regressions to test the proposed model (Liu et al., 2009b). Prior to the creation of the interaction terms in Model 4 (Table 4), we mean centred the independent variables to reduce multicollinearity (Aiken and West, 1991). We also calculated variance inflation factors (VIF) for every regression equation. The maximum VIF within the models was 3.194, which is well below the rule-of-thumb cut-off of 10 (Neter et al., 1990).

The baseline models (Models 1, Table 4) contain control variables. Additional regression analyses after removing multicollinearity between independent variables (Model 2, Table 4) demonstrate that contract and trust also have a main effect on firms’ innovation performance ($p < 0.01$ or lower). Including these two variables significantly increases the predictive power of Model 2 ($\Delta R^2 = 0.239$, $F = 19.444$, $p < 0.001$), in explaining the variance of firms’ innovation performance.

Model 3 illustrates the quadratic effects of contract and trust in relation to firms’ innovation performance. The contract squared parameter is negative and significant ($p < 0.001$), indicating that the contract has an inverted U-shaped effect on firms’ innovation performance, and thus Hypothesis 1 is supported. The effect from the trust square term, however, is non-significant. This evidence suggests that the contribution of contract to firms’ innovation performance declines as control intensity increases. The positive influence of trust on firms’ innovation performance, however, is not decreased. That is, it remains linear as trust progresses, which lends support to Hypothesis 2.

Model 4 shows interactive effects between contract and trust on innovation performance and the moderating effect of environmental uncertainty. First, we find that the interactions between contract and trust ($X2*X3$) are significantly and negatively associated with firms’ innovation performance ($p < 0.001$), which lend support to H3b (i.e., the substitute relationship) but not to H3a (i.e., the complement relationship). Furthermore, we find mixed support for the moderating role of environmental uncertainty. We find support for H4b that environmental uncertainty enhances the effectiveness of trust in improving firms’ innovation performance ($p < 0.001$), but we do not find support for H4a that environmental uncertainty reduces the effectiveness of contract ($p > 0.10$). Collectively, the interaction effects account for a significant increase in $R^2$ from 0.306 to 0.374. The control variable is not significant ($p > 0.10$).

5. Discussion

Our study underscores the fact that both contracts and trust can control opportunistic behaviour and increase openness and transparency in the manufacturer–supplier relationship, which will provide reasonable assurance for collaborative innovation. In general, this is consistent with the existing studies on the effects of trust and contracts on manufacturers’ performance and capability improvement (e.g. Liu et al., 2009a; Yeung et al., 2009; Luo, 2002; Poppo and Zenger, 2002). Moreover, our results suggest that contract and trust are substitutes, and trust is more important for improving innovation. This result seems to contradict Liu et al. (2009a), which argues that contracts are more statistically powerful in alleviating opportunism than is trust, and when trust...
A growing body of law is already quite sizable, the legal systems works and market structures (Zhou et al., 2003). Though China’s and comprehensive changes in its political systems, legal frame-based economy and is, therefore, experiencing fundamental now moving away from a centrally planned economy to a market-isomorphic pressure from an institutional environment. China is gated to rely on trust to resolve conflicts, as in the case of relationships are heavily emphasized, most firms appear obli-

ment (Tjosvold et al., 2006). Thus, in an environment where view as an obstacle to pre-existing trust relationship enhance-

interpersonal hostility, so solving conflicts by contracts has been partner. Chinese culture perceives open conflicts as indicators of institutional tradition, formal and predetermined procedures substitutes for a contract. To be specific, influenced by business and is more important for the specific task at hand.

The degree of information asymmetry in innovation is high, which makes trust more important. Therefore, we argue that contract and trust can be either complements or substitutes—it depends on the object of collaboration. Managers should analyse the goals of collaboration to determine which control mechanism is more important for the specific task at hand.

Chinese culture can also help us understand why trust substi-

tutes for a contract. To be specific, influenced by business and institutional tradition, formal and predetermined procedures often were viewed as a sign of being distrustful of a business partner. Chinese culture perceives open conflicts as indicators of interpersonal hostility, so solving conflicts by contracts has been viewed as an obstacle to pre-existing trust relationship enhance-

ment (Tjosvold et al., 2006). Thus, in an environment where relationships are heavily emphasized, most firms appear obli-

ated to rely on trust to resolve conflicts, as in the case of isomorphic pressure from an institutional environment. China is now moving away from a centrally planned economy to a market-based economy and is, therefore, experiencing fundamental and comprehensive changes in its political systems, legal frameworks and market structures (Zhou et al., 2003). Though China’s growing body of law is already quite sizable, the legal systems are still weak and contract enforcement is either absent or ineffective (Luo, 2007; Zhou and Poppo, 2010). The long cycle time, low execution rate and lack of judicial independence make arbitration the most popular means for resolving commercial disputes (Pattison and Herron, 2003). Moreover, westerners view contract formation as the culmination of a negotiating process, while from the Chinese perspective, the “final” contract only signals the beginning of real contract negotiations (Pattison and Herron, 2003). In China, as the partnership matures, trust will substitute for the contracts and become the dominant relationship governance means, and the contract will be pushed into the background.

Although trust plays a more important role in managing the supply chain relationship, we want to emphasize that contracts are also important in the early stage of partnership. Simple and straightforward contracts are treated as the basis or as a way to initiate a partnership in China upon which trust is developed. Firms have to rely much more on contracts to control their suppliers because they are not familiar with each other (Luo, 2002). Hence, this offers some important implications for Chinese managers—they should flexibly combine the contract and trust according to the actual status of the manufacturer–supplier relationship.

As the environment is changing quickly, it becomes almost impossible to either specify the contingencies in advance or to monitor the execution of the contract, especially for innovative projects (Lusch and Brown, 1996; Poppo and Zenger, 2002). Trust becomes the main control mechanism used to cope with inevitable uncertainties that arise in a long-term exchange, because trust is self-enforcing and flexible enough to manage unforeseeable situations (Dyer and Singh, 1998). Along with the fact that trust and contracts are substitutes, it is very possible that mangers will not use contracts in highly uncertain environments. This is perhaps why environmental uncertainty only moderates the effectiveness of trust on innovation. Therefore, our results suggest that the managers should consider the environmental contingency when making decisions about which control mechanism should be used to manage collaborative innovation.

### Table 4

<table>
<thead>
<tr>
<th>Variables</th>
<th>Innovation performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
</tr>
<tr>
<td>Control variables</td>
<td></td>
</tr>
<tr>
<td>Firm size</td>
<td>0.041</td>
</tr>
<tr>
<td>Cultural distance</td>
<td>0.167***</td>
</tr>
<tr>
<td>Cooperation duration</td>
<td>0.018</td>
</tr>
<tr>
<td>Independent variables</td>
<td></td>
</tr>
<tr>
<td>Environmental uncertainty</td>
<td>0.049</td>
</tr>
<tr>
<td>Trust (X2)</td>
<td>0.397***</td>
</tr>
<tr>
<td>Contract (X3)</td>
<td>0.172**</td>
</tr>
<tr>
<td>X2^2</td>
<td>0.052</td>
</tr>
<tr>
<td>X3^2</td>
<td>-0.293††</td>
</tr>
<tr>
<td>Interaction terms</td>
<td></td>
</tr>
<tr>
<td>X1’X2</td>
<td>0.231***</td>
</tr>
<tr>
<td>X1’X3</td>
<td>-0.070</td>
</tr>
<tr>
<td>X2’X3</td>
<td>-0.383***</td>
</tr>
<tr>
<td>Adjusted R^2</td>
<td>0.022</td>
</tr>
<tr>
<td>Δ Adjusted R^2</td>
<td></td>
</tr>
<tr>
<td>F-value</td>
<td>3.310</td>
</tr>
<tr>
<td>P-value</td>
<td>0.020</td>
</tr>
</tbody>
</table>

N=315.

1 Significance level: p < 0.1.
2 Significance level: p < 0.05.
3 Significance level: p < 0.01.
*** Significance level: p < 0.001.
If they face a highly uncertain environment, trust instead of a contract should be used to manage the supply chain relationship.

6. Conclusions

The main objective of this study is to investigate the impact of supply chain control mechanisms (i.e., contracts and trust) on firms' innovation performance. Using a database of 315 manufacturer-supplier relationships in China, we examined the direct impact of trust and contracts on firms’ innovation performance, and their interaction, and how these effects are moderated by environmental uncertainty. Our analysis results show there is an inverted U-shaped relationship between contracts and firms’ innovation, and trust has a positive and linear relationship with innovation performance. We also found that contracts and trust are substitutes in promoting firms’ innovation performance. Finally, the results suggest that the positive effect of trust on firms’ innovation is further strengthened when environmental uncertainty is higher. However, the impact of contracts is not affected by environmental uncertainty.

The study contributes to the innovation literature by providing empirical evidence regarding the mechanisms of how trust and contracts influence firms’ innovation performance both individually and jointly. This analysis will help researchers and practitioners to focus on the control mechanism that matters most and adjust the governance mechanism and investment decisions in collaborative innovation in the supply chain. To be specific, managers who are interested in improving innovation performance should use a moderate level of contracting and rely heavily on trust to control and manage the supply chain relationship. Moreover, we also investigate how environmental uncertainty influences the relationship between control mechanisms and innovation performance. This helps to answer the question of under what conditions trust/contracts are more important. Our analysis indicates that the impacts of trust on innovation performance is enhanced by environmental uncertainty, which suggests that the contingency theory instead of the “best practice” perspective should be used in research into collaborative innovation in the supply chain. In practice, this means that managers should rely on trust instead of contracts in uncertain environments.

Our study also contributes to the supply chain management literature by revealing that the impact of contracts on innovation performance is nonlinear. This indicates that investigating the role of contracts using linear models might bias the analysis and conceal the real relationship. Thus, we suggest that researchers apply nonlinear methods in contract studies. We also find that contracts and trust are substitutes in improving innovation performance. This reveals that these two control mechanisms are not independent. Researchers should explicitly model the relationships and consider their interdependence to gain the full picture of how they work together.

This study has several limitations that also suggest directions for future research. First, the results are context-specific to Chinese manufacturing firms. Although China shares many characteristics with other emerging economies and emerging industries in developed economies in terms of technology development, supply chain management, and market conditions (Zhao et al., 2006), it also possesses some idiosyncrasies. This may limit the generalizability of our findings. Therefore, another useful extension would be to conduct studies in other countries. Second, our findings are based on data gathered from one side of the dyadic relationship, namely, the manufacturers. A research design that includes information from both sides would enable cross-validation of the effects of control mechanisms. Finally, the environment in which these manufacturer-supplier relationships are embedded may be evolving in China. Hence, to fully understand the dynamics of the relationship amongst contracts, trust, and firms’ innovation performance, relationships should be examined over time. Thus, longitudinal data or experimental methods are needed to fully test the dynamics of these complex relationships.

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