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Drivers of green cooperation between Chinese manufacturers and their customers: An empirical analysis

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Opposed Reviewers:	
Response to Reviewers:	

Highlights

- Discusses how manufacturers can achieve effective green customer cooperation by adopting internal green process innovation and learning from their customers
- Multi-respondent data collected from 217 Chinese manufacturing firms
- Explains how such links are dependent upon senior management's calculative and affective commitment towards their customer firms
- Offer further insights into the effects of various types of commitment and the mechanisms that facilitate green customer cooperation

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Abstract

Although green customer cooperation can help manufacturers increase their overall performance, it is difficult for manufactures to effectively achieve green customer cooperation. This paper discusses how manufacturers can achieve green customer cooperation through the theoretical lens of capability-based view. It suggests that internal green process innovation and learning from their customers can lead to green customer cooperation and such positive relationships are dependent upon senior management's calculative and affective commitment towards the customer firms. Using multi-respondent data collected from 217 Chinese manufacturing firms, the results show that both green process innovation and learning from customers drive green customer cooperation. However, affective commitment counter-intuitively diminishes the positive effect of learning from customers on green customer cooperation, while calculative commitment further strengthens this effect. This paper contributes to green supply chain management literature by conceptually explaining and empirically proving the effects of green process innovation and learning from customers on green customer cooperation and the moderating role of calculative and affective commitments. Based on the research findings, the paper gives practical suggestions to Chinese manufacturers and their customer firms regarding green cooperation and the dynamics of senior management's commitment toward the customer firms.

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Abstract

Green customer cooperation signals that a manufacturer's green innovation is successful and increases its overall performance. Acknowledging its importance, this paper discusses how manufacturers can achieve effective green customer cooperation by adopting internal green process innovation and learning from their customers. It also explains how such links are dependent upon senior management's calculative and affective commitment to their customer firms. Using multi-respondent data collected from 217 Chinese manufacturing firms, the results show that both green process innovation and learning from customers drive green customer cooperation. However, the relationship between learning from customers and green customer cooperation is moderated differently by calculative and affective commitments. Counter-intuitively, affective commitment by senior management to their customer firms diminishes the positive effect of learning from customers on green customer cooperation. Calculative commitment, on the other hand, further strengthens this effect. The findings contribute to green supply chain management literature and offer further insights into the effects of various types of commitment to customers and the mechanisms that facilitate green customer cooperation. The research findings have practical implications for Chinese manufacturing firms and their customer firms, especially regarding the dynamics between the senior management teams of companies.

Keywords

Green customer cooperation; Learning from customers; Calculative commitment; Affective commitment; Chinese manufacturing firms; Multi-respondent survey

1. Introduction

Since the industrial revolution, ever intensifying manufacturing has led to increasing environmental pollution and damage to the world's environmental sustainability. To address this critical matter, manufacturers all over the world, in particular in China, are increasingly paying attention to green supply chain management (GSCM) practices (Geng et al., 2017). China has served as the world's manufacturing hub for almost two decades and inevitably suffered from the heaviest environmental damage due to overproduction (Sarkis, Zhu, & Lai, 2011). However, even as Chinese manufacturing companies take note of the need to address environmental issues, many still fail to engage their customer firms in green cooperation innovation, thus losing market share in a highly competitive environment (Zhu et al., 2013). For example, Jielong, Schaeffler's (a German automotive manufacturer) local Chinese sole supplier of needle bearings, lost its business from Schaeffler in 2017 because Jielong failed to meet the required green standard set by the Shanghai Environmental Protection Bureau and was fined heavily by the Chinese government. In a competitive market, manufacturers such as Jielong are quickly replaced by suppliers that are better at collaborating with customer firms in adopting green practices.

Existing GSCM literature tends to regard green customer cooperation as the most important element of GSCM because green customer cooperation signifies a holistic green system, showing a firm's ability to cooperate and being involved with customer firms in jointly planning for GSCM initiatives and environmental management practices such as eco-design, greener production, green packaging, and energy-efficient transportation from end to end (Zhu et al., 2012; Wu et al., 2012; Chavez et al., 2016). These practices improve the supply chain's environmental sustainability (Chan et al., 2012; Song & Yu, 2017). Previous research maintains that green customer cooperation can also improve a manufacturer's economic, environmental, and operational performance and hence its competitive position in the market (Geng et al., 2017).

Nevertheless, despite its essential role in GSCM, green customer cooperation has received scant research attention (Teixeira et al., 2016; Burki et al., 2018). In particular, our knowledge regarding the drivers of and mechanisms for achieving effective green customer cooperation is very limited (Geng et al., 2017). Only green training (Teixeira et al., 2016), green process innovation, and top management's green commitment (Burki et al., 2018) have been discussed as possible drivers of green customer cooperation. However, these studies did not really discuss or explain the relevance of the drivers from a theoretical angle.

Acknowledging this knowledge gap, this paper asks the specific research question: How can manufacturers achieve effective green customer cooperation? Combining the capability-based view and the customer-oriented approach, we present a framework to illustrate how effective green customer cooperation can be achieved by manufacturers. From a capability-based view, a firm's green capabilities can be developed through the adoption of green innovation (Zhu et al., 2013). Therefore, we argue that manufacturers that adopt green process innovations are more likely to engage in green customer cooperation as they are regarded as possessing better organisational capability on green innovation. Further, a customer-oriented approach requires an organisation to determine the needs and requirements of its customers and adapt to satisfy those needs better than its competitors (Saxe & Weitz, 1982). Learning from customer firms can help manufacturers better understand these firms' needs and requirements in terms of product and company-specific knowledge. This gives manufacturers a head-start in preparing themselves for further green collaborations and being able to suggest appropriate green innovation, such as an upgrading of green technologies in the production process and the provision of bespoke green packages that are tailored and appropriate to the customer firm's requirement and situation (Deshpandé, Farley, & Webster Jr, 1993).

Furthermore, we incorporated the manufacturer's affective and calculative commitments (Gilliand & Bello, 2002) in our framework as critical elements in facilitating efficient business cooperation and relationships with customers (Kirca, Jayachandran, & Bearden, 2005; Lam et al., 2010; Morgan & Hunt, 1994; Barratt, 2004; Yen & Barnes, 2011). We argue that manufacturers' commitment to customer firms will strengthen the effects of green process innovation and learning from customers on green customer cooperation.

Using multi-respondent survey data collected from 217 Chinese manufacturing firms based in the Bohai Bay Economic Rim, our results show that green process innovation and learning from customers both drive green customer cooperation. Also, calculative commitment strengthens the effect of learning from customers on green customer cooperation, whereas affective commitment has a diminishing affect. Our contribution to GSCM literature is twofold: First, by conceptually explaining and empirically proving the impact of green process innovation and learning from customers on green customer cooperation and the moderating effects of calculative as well as affective commitments, this paper provides a holistic view on the mechanisms that promotes better green customer cooperation. Second, the paper reveals the differential effects of calculative and affective commitment on the link between learning from customers and green customer cooperation, offering a nuanced understanding on how the two commitments interact differently with learning from customers when driving green customer cooperation. Furthermore, this study provides managerial guidelines for Chinese manufacturing firms, elucidating how efforts and resources could be devoted to extending from internal process innovation to external green customer cooperation.

2. Green customer cooperation

Green customer cooperation refers to the collaboration efforts between manufacturing firms and their downstream customers in, for example, developing eco-friendly design, green packaging, cleaner production, and energy efficient transportation to reduce the negative environmental influence of its supply chain activities (Chan et al., 2012; Huang et al., 2012; Luo et al., 2014). An overview of the literature on green customer cooperation shows that earlier works (as shown in Table 1) tended to treat green customer cooperation as a sub-dimension of GSCM, which commonly includes green internal practices, supplier collaboration, green purchasing, investment recovery, and green customer cooperation (Zhu et al., 2005; Zhu et al., 2011). Later on, GSCM literature divided the former dimensions into internal and external practices, suggesting that internal practices are a prerequisite for external practices (Zhu et al., 2012; Zhu et al., 2013). The more recent works now discuss the difference between green supplier collaboration and green customer cooperation and highlight the importance of green customer cooperation over green supplier collaboration (Teixeira et al., 2016; Burki et al., 2018).

Insert Table 1 here

Zhu et al. (2005) explain the importance of green customer cooperation by arguing that the successful adoption of green customer cooperation enhances manufacturing firms' environmental, economic, and operational performance. Empirical studies by Zhu et al. (2012) and Zhu (2013) show that green customer cooperation can lead to a significant increase in Chinese manufacturers' environmental performance. Relying on a customer-oriented approach to supply chain management, green customer cooperation provides manufacturers with the opportunity to satisfy 'green' expectations from customers better than their competitors (Melander, 2018). In fact, Geng et al.'s (2017) meta-analysis of empirical GSCM papers shows that green customer cooperation has a significant and positive impact on economic ($r = 0.431$, $p = 0.000$), environmental ($r = 0.374$, $p = 0.000$), and operational ($r = 0.370$, $p = 0.000$) performance.

Although the importance of green customer cooperation is well-established in the GSCM literature, to the best of our knowledge, so far only a handful of studies touched upon the drivers of green customer cooperation, but without offering a comprehensive theoretical explanation on mechanisms to achieve effective green customer cooperation (Cf. Teixeira et al., 2016 and Burki et al., 2018). Relying on a relatively small sample of Brazilian firms, Teixeira et al. (2016) identified green training programmes as a driver of green customer cooperation, while Burki et al. (2018) found a positive and significant relationship between Turkish firms' process innovation and green customer cooperation.

3. Conceptual framework and hypothesis development

Relying on the capability-based view and the customer-oriented approach, the framework developed in this study (Figure 1) postulates that green process innovation and learning from customers drive green customer cooperation. Moreover, it postulates that the manufacturer's affective and calculative commitments to the customer firm strengthen the effects of green process innovation and learning from customers on green customer cooperation.

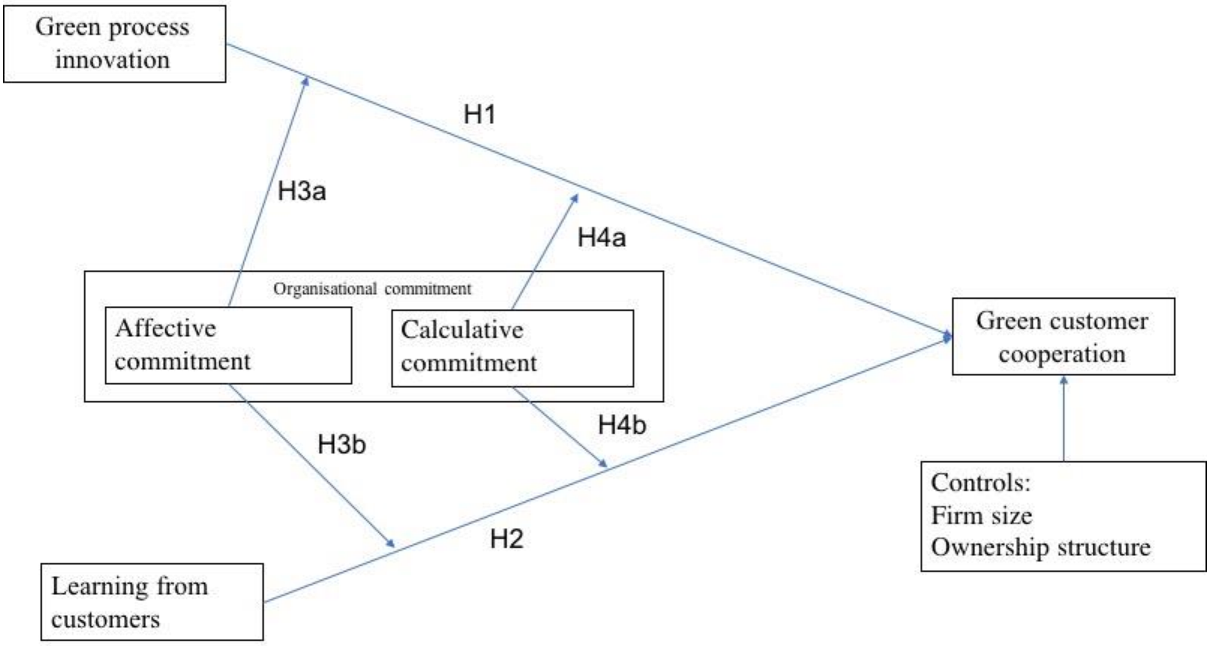

Figure 1. The conceptual framework

3.1 Green process innovation and green customer cooperation

Green process innovation has been recognised as a set of practices that generate new ideas, goods, services, processes, and management systems that affect the environment (Li et al., 2018). Green process innovation refers to the modifications made during manufacturing processes to ensure energy efficiency and to reduce environmental pollution produced during the manufacturing process, production, transportation, and recycling (Chan, 2005; Kunapatarawong & Martínez-Ros, 2016).

The capability-based view explains that a firm's capability reflects its ability to use relevant resources in a given task (Hoopes & Madsen, 2008). Thus, capability is considered the key to achieving a sustainable competitive advantage, as it is difficult for competitors to imitate (Grant, 1991). Green process innovation signifies a firm's green capability in the manufacturing process, reflecting its ability to engage in relevant practices to reduce negative environmental impact during material acquisition, production, and transportation. For instance, Chen et al. (2006) and Chen (2008) show that green process innovation such as using less hazardous materials and cleaner energy in the manufacturing process help to differentiate the company's environmental performance against competitors', leading to improved competitive advantage and market reputation.

Supply chain management literature argues that green process innovation contributes to green customer cooperation from two perspectives: information sharing and strategic collaboration (Zhao et al., 2011). In terms of information sharing, a manufacturer with a higher green process innovation capability may be more ready to share its internal green practices with customer firms, since the manufacturer is more familiar with environmentally friendly/green practices (Zhu et al., 2013). From the perspective of strategic collaboration, a manufacturer that has better green process innovation capability is more likely to include a green agenda in its own strategic orientation, which positions the manufacturer better to engage and collaborate with customer firms vis-à-vis competitors that have not acquired the practices internally (Zhao et al., 2011).

We argue that manufacturers that adopt green process innovations are more likely to engage in green customer cooperation as they are regarded as possessing better organisational capability on green innovation (Koufteros et al., 2005). For instance, Buraki et al. (2018) empirically show that green process innovation has a positive, significant effect on customer cooperation ($\beta = 0.45$). By showcasing their own green track records and successes, those firms will have a greater chance of persuading their customer firms to join their green agenda. Also, compared to competitors that have not adopted much green innovation, manufacturers with higher levels of green process innovation will find it easier to appreciate the value of GSCM strategically and have better green knowledge (Cohen & Levinthal, 2000). While manufacturers with better green process innovation are in a more favourable position to be considered valuable supply chain partners for possible green collaborations by customer firms, we postulate that established green process innovation leads to higher levels of green customer cooperation:

H1: The adoption of green process innovations is positively related to green customer cooperation.

3.2 Learning from customers and green customer cooperation

The ability to learn faster than competitors is a key source of a firm's sustainable competitive advantage (Dickson, 1992). For manufacturers, key customer firms are considered strategically important because they contribute to a substantial amount of their business volume. Embracing the marketing concept, manufacturers are therefore advised to take on a customer-oriented approach to understand and satisfy their customers' needs and requirements (Deshpandé et al., 1993). Organisational learning is a process that comprises information acquisition, information dissemination, shared interpretation, and finally the ability to store and access prior lessons, turning information into relevant and stored organisational knowledge (Sinkula, 1994; Slater & Narver, 1995; Zhou et al., 2005).

In supply chain management, learning from customers refers to a mechanism through which a supplier adopts specific actions to obtain, interpret, and implement product-related knowledge from its customer firms (Wang et al., 2016; Cheung et al., 2010). Previous research suggests that learning from customers can help a manufacturer modify and tailor its products to better satisfy customer needs to gain a more favourable market advantage (Lee, 2011; Wuyts et al., 2004). Acquiring product and company-specific knowledge through learning gives the manufacturer an advantageous position because it understands customers' explicit needs and requirements well (Zhou et al., 2005). This means that the manufacturer is able to offer more suitable suggestions to satisfy its customer firm's needs, bearing in mind the resources and capabilities of the customer firm (Im & Workman, 2004; Zhou et al., 2016). Such knowledge also helps the manufacturer in proposing and explaining new green technologies to its customers, since it understands how new technologies could be employed to efficiently reduce the customer firm's operational costs, thus improving product efficiency (Takeishi, 2001). Learning from customer firms therefore gives manufacturers a head-start in preparing themselves for further green cooperation. Having an explicit understanding of its customer firm's requirement means that the manufacturer would be able to suggest appropriate green innovations, such as an upgrading of green technologies in the production process and the provision of bespoke green packages that are tailored and appropriate to the customer firm's requirement and situation. Taken together, we therefore hypothesise that:

H2: Learning from customers is positively related to green customer cooperation.

3.3 Moderating role of organisational commitment

Commitment is an attitudinal construct that reflects one organisation's bond to another organisation. Commitment has received significant research attention in the fields of business relationships, channel member management, and supply chain collaboration. For example, Morgan and Hunt (1994) point out that commitment is essential for relationship marketing and as such commitment is often employed as a construct that signifies the quality of inter-organisational relationships (Hennig-Thurau, Gwinner, & Gremler, 2002), leading to more efficient coordination, long-term cooperation, and profitability (Barratt, 2004; Holm, Eriksson, & Johanson, 1996; Yen & Barnes, 2011). Organisations contain various actors who are connected and mutually influenced by one another. Nevertheless, previous research highlights that senior management commitment is the strongest predictor of a firm's market orientation and has the most influence on shaping the organisational culture, explaining how commitment could be disseminated from senior management to the rest of the organisation through social learning (Kirca, Jayachandran, & Bearden, 2005).

Burki et al. (2018) show that senior management's commitment to green innovations has the potential to strengthen the supplier's ecological performance and to improve its customer cooperation and financial performance. Different from commitment to green innovation, in this paper, organisational commitment refers to senior management's psychological attachment to its key customer firms, which includes 'an instrumental realisation of the benefits of staying and the costs of leaving and a sentiment of allegiance and faithfulness' (Gilliand & Bello, 2002: 52). Whether commitment is composed of pragmatic reasoning based on a careful calculation of possible gain versus potential loss or of emotional bonds established through continuous social interactions that over time turn into sentimental loyalty (Geyskens et al., 1996), an organisation's commitment to its customer firms is often multifaceted in that it considers both economical and emotional forms of attachment (Wu et al., 2004). In the Chinese context, such commitment is often established more on a personal basis (Luo, 2000; Yen, Barnes, & Yu, 2007), especially between the senior management teams of the partnering firms, since power difference is very much exercised in the Chinese context.

3.3.1 Affective commitment

Following the work of Gilliand and Bello (2002), we divide organisational commitment into affective commitment and calculative commitment. Affective commitment refers to the extent of senior management's attachment (its allegiance and faithfulness) to its customer firms (Gilliand & Bello, 2002), focusing on the manufacturer's affection and obligation to its customer firms rather than on economic motivations (Kalleberg & Reve, 1993). Affective commitment towards customer firms demonstrates the senior management's emotional motivation to stay in a relationship and enables partners to achieve mutual goals that are considered beneficial for both (Geyskens et al., 1996). While a manufacturer with higher levels of internal green process innovation is more likely to engage its customers in effective green customer cooperation from a capability-based view, this positive relationship may be further strengthened and facilitated by senior management's sense of belonging and emotional attachment towards the customer firm (Geyskens et al., 1996). Thus, when senior management are wholeheartedly committed to a customer firm, they are more likely to want to develop and implement policies that are conducive to internal and external green innovations, and they play a more active role in further advancing the green collaboration (Gilliand & Bello, 2002). Based on the above, we argue that affective commitment to the customer is likely to strengthen the impact of green process innovation on green customer cooperation. Hence:

H3a: The relationship between green process innovation and green customer cooperation is positively moderated by affective commitment.

Furthermore, a firm's affective commitment to its customer firms serves as the foundation of the buyer-supplier relationship by fostering effort and commitment during cooperative activities (Tsai & Ghoshal, 1998; Sinkula et al., 1997). Highly committed partners tend to ignore short-term benefits and subordinate their interests to promote mutual benefits and maintain long-term partnerships (Kalleberg & Reve, 1993). In this regard, when a firm's senior management is highly committed to a customer firm, such affective commitment can foster the relationship between learning from customers and green customer cooperation by strengthening the learning behaviour patterns through emotionally committed stable relationships (Lusch & Brown, 1996). By staying loyal and committed, a manufacturer may find it easier to engage its customer in green customer cooperation, since the customer may be more willing to share information, promote learning and knowledge sharing, and exchange activities with the supplier that is deemed more affectionate than others (Elnes & Sallis, 2003). Thus, we postulate:

H3b: The relationship between learning from customers and green customer cooperation is positively moderated by affective commitment.

3.3.2 Calculative commitment

Calculative commitment refers to the task-oriented attachment of a firm that bonds itself to its customer firms (Gilliand & Bello, 2002). Different from affective commitment, which emphasises the affective and emotional bond between the business partners, calculative commitment is much more economical and rational (Gilliand & Bello, 2002), taking a more careful and measured approach before pledging relationship continuity (Dwyer et al., 1987). Calculative commitment is often discussed in association with switching cost, indicating a rational decision after weighing the possibility of switching and discontinuing the relationship (Geyskan et al., 1996). Thus, calculative commitment normally occurs after a firm weighs the costs and benefits associated with that relationship on a pragmatic basis and realises that it is more profitable to stay than not to stay (Mellashi et al., 2010).

Calculative commitment is likely to prevent the manufacturer from behaving opportunistically because their opportunistic actions may result in punitive consequences that they cannot afford, e.g. termination of the relationship. While the cost of upsetting the customer firm is higher than the benefits it brings, calculative commitment is likely to inhibit the manufacturer from engaging in opportunistic behaviour. Instead, calculative commitment is likely to promote more cooperative behaviour, including actions and practices that are regarded as beneficial to both parties (Wang et al., 2016; Eriksson & Johanson, 1996). When a manufacturer's senior management are committed to its customer firms in a calculative manner, they are more likely to appreciate and emphasise a customer firm's strategic importance from an economic point of view and to promote collaborative practices in dealing with the specific customer firm. Such realisation may drive senior management in deploying resources to support policies and practices that are beneficial to the facilitation of green customer cooperation. This explains why Chinese firms tend to share and introduce new technology that produces green products and packaging to key customer firms and develop more efficient distribution methods that consume less carbon dioxide for the key customer firms. They realise that helping these key customer firms is also beneficial for their own success and performance (Zhu et al., 2013) and are likely to be more supportive in facilitating the mechanisms that drive green customer cooperation (Wu et al., 2004). Therefore, we argue that when an organisation's senior management is highly committed to its customer firms based on clear and deliberate rationales, the relationship between internal green process innovations and green customer cooperation is likely to be further strengthened.

H4a: The relationship between green process innovation and green customer cooperation is positively moderated by calculative commitment

Moreover, calculative commitment facilitates better coordination and interactions between business partners (Gilliand & Bello, 2002). Therefore, when senior management realises that staying with the customer is more profitable than ending the relationship, actions that drive green customer cooperation is likely to be better prioritised and resourced (Wang et al., 2016). Such calculative commitment may lead to the development and implementation of policies and mechanisms that facilitate and maximise the effect of learning from customers on green customer cooperation. While a firm is fully committed following calculative measures, we argue that the relationship between learning from customers and green customer cooperation will be further strengthened and facilitated. We therefore propose the following hypothesis:

H4b: The relationship between learning from customers and green customer cooperation is positively moderated by calculative commitment.

4. Methodology

4.1 Research setting

Our empirical setting features the transitions of green process innovation to green customer firms' collaboration in the manufacturing sector in the Bohai Bay Economic Rim in China, using a multiple respondent survey. As the 'world's factory' that suffers from serious environmental damage (Geng, Mansouri, Aktas, & Yen, 2017), China is eager to embrace GSCM and was therefore selected as the research context. The Bohai Bay area, on the coast of the Yellow Sea, south-east of Beijing, is suitable for examining our hypotheses among the focal constructs for two reasons. First, this area is the home base of many large manufacturing companies that serve worldwide production demands (Zhu et al., 2017b). Second, the environmental issues are pervasive in this area. For instance, Bohai is the largest steel producing region and has been home to six out of the 10 most polluted cities in China since 2013 (China Daily, 2017).

To reduce the potential of common method bias in this study, we used a multiple informant design and collected information from a variety of sources by targeting three informants in each firm (Guide & Ketokivi, 2015; Ketokivi & McIntosh, 2017). We collected data related to learning from customers from marketing/sales managers regarding their major customer firms. Data relating to organisational commitment were collected from top/senior managers due to their involvement in strategic business relationships. Finally, data relating to internal green process innovation and green customer cooperation were collected from supply chain/operation managers, as they are deemed most knowledgeable on the company's green innovation and their customer green cooperation from the supply chain management perspective.

4.2 Data collection

We used a snowball/chain sampling approach for the data collection (Hair, 2015). We created an online knowledge 'co-sharing' group with local manufacturing firms and academic experts in the Bohai Bay Economic Rim. A total of 124 business managers joined this knowledge sharing group. Then, our trained research assistants approached each of the managers to request their support in introducing other potential firms in their business networks to participate in our survey. By doing so, we obtained a contact list of a total sample of 324 managers working in the manufacturing sector of the Bohai Bay Economic Rim. Next, the research assistants asked the 324 managers for help with data collection by identifying and approaching the supply chain/operation managers, marketing director/sale managers, and the top/senior manager at his/her firm, regardless of his/her position. Based on the referrals from the 324 managers, the other managers in the same firm were generally willing to participate in the study. Subsequently, the assistants scheduled appointments with those who agreed to participate, using the interviewer-administrated method. They collected survey data from the supply chain/operation managers, marketing director/sale managers, and the top/senior manager in an organisation, and each respondent was asked to answer the questions based on their firm's relationship with their largest customer firm (based on sales).

We employed measures to obtain valid and reliable information and to avoid social desirability. By doing so, all respondents were assured of the confidentiality of their responses and the academic purpose of the project. While the fieldwork was in process, we randomly visited four sites to perform a quality control review. Moreover, we regularly checked 10% of the sample to ensure that the assistants followed stipulated procedures and to confirm that the survey had been properly conducted. We eventually obtained 217 complete and usable responses, which is a 66.9% response rate. In terms of the characteristics of the sample, most of the respondents were from private domestic manufacturing companies with either 20-299 or more than 1,000 full-time employees (see Table 2 for more information).

Insert Table 2 here

4.3 Measures

We first developed our questionnaire in English by adopting/adapting validated measures from previous literature. Because this study was conducted in China, we translated the questionnaire from English into Chinese. Then we employed a professional translator who was unfamiliar with our study to translate back into English to ensure conceptual equivalence (Hair, 2015). No semantic discrepancies emerged when the back-translated questionnaire was compared with the original English version.

We measured green process innovation using the four-item scale developed by Zhu et al. (2017a). Together they describe to what extent green technology has been employed to reduce waste, select materials, ensure energy efficiency, and reduce environmental pollution during the manufacturing process. We assessed green customer cooperation with three items adapted from Zhu et al. (2005) and two items from Chan et al. (2012), regarding the extent to which a manufacturer cooperates with its customer firms, from transportation to production return. We adopted the scales from Gilliland and Bello (2002) to measure affective and calculative commitment, about the extent to which the manufacturer is committed to their major customer. For learning from customers, we adapted the three items from Wang et al. (2016) to measure the extent to which the manufacturer learns about the product and gains company knowledge related to their major customer firms.

To account for the effects of extraneous variables, we included two control variables: firm size and ownership type. Thus, we controlled for the firm size with the guidance provided by the Chinese Ministry of Industry and Information Technology (National Bureau of Statistics, 2006) and also the ownership type by adopting the categorisation developed by Zhu et al. (2012), namely, foreign owners or joint ventures, private domestic manufacturers, and state-owned enterprises. Firm size and ownership types are listed as control variables because existing research shows that larger firms are regarded as more resourceful and often have better capability in handling environmental issues (Zhu and Sarkis, 2007; Geng et al., 2017), whilst a firm's green capability may also be dependent upon its ownership type (Zhu et al., 2012).

4.4 Common method bias and endogeneity

The possibility of endogeneity was addressed in both theoretical and statistical ways. The issue of endogeneity may come from measurement error, simultaneity, and reverse causality (Guide & Ketokivi, 2015; Ketokivi & McIntosh, 2017; Sande & Gosh, 2018). To address this, we collected data from multiple respondents in each firm and separated independent, dependent, and moderator variables to reduce the measurement error that might threaten the validity between the measures. According to Podsakoff et al. (2003), creating separation between variables can reduce such common method bias, which is a main threat for endogeneity. Therefore, we tested empirically whether endogeneity was an issue by conducting the Durbin-Wu-Hausman test by performing an augmented regression (Antonakis et al. 2014; Zaefarian et al., 2017; Sande & Gosh, 2018; Gretz & Malshe, 2019). In doing so, we first regressed green process innovation and learning from customers on all controls, and then used the residual of this regression as an additional item in our hypothesised equations. The results show that the parameters estimated for the residuals in the augmented regression were not statistically significantly different from zero. The residuals for green process innovation ($p = 0.692$) and learning from customers ($p = 0.571$) were insignificant, indicating that green process innovation and learning from customers are exogenous in our setting (Zaefarian et al., 2017; Sande & Gosh, 2018; Gretz & Malshe, 2019), consistent with their conceptualisation. The result suggests that the issue of endogeneity is not a major concern in our study.

5. Analyses and findings

5.1 Measurement model

Following Anderson and Gerbing (1988), we first assessed the measurement model properties and then analysed the structural model using maximum likelihood estimation (MLE) with LISREL (Jöreskog & Sörbom, 2006). We assessed all the measures of convergent validity by performing a confirmatory factor analysis and calculating the average variance extracted (AVE) (Fornell & Larcker, 1981) for all the constructs. All the AVE values were greater than 0.5, indicating convergent validity. We assessed the constructs for internal consistency by calculating construct reliability (CR) (Bagozzi, 1980). All the constructs met the suggested minimum value for composite reliability (Hair et al., 2010). We assessed the individual items' reliabilities by examining the standardised loadings of items on their corresponding constructs.

All the items loaded on their specified constructs, and each loading was sufficiently large (0.5 is the minimum accepted value) and significant, which implies that all items converged on a common construct (Gerbing & Anderson, 1988). We determined the corresponding Cronbach's alpha values for all constructs, as shown in Table 3. All values were greater than 0.8, indicating high reliability and consistency for the entire scale (0.6 is the lower limit for Cronbach's alpha) (Hair et al., 2010).

Insert Table 3 here

To test for discriminant validity, we compared the AVE for the indicators of each latent construct and the square of the correlation estimate of the latent constructs (Fornell & Larcker, 1981). The AVE should be greater than the squared correlation estimate: that is, the latent construct should explain more of the variance in its item. We conducted this test for all latent constructs in the same conceptual domains. In all cases, the AVE values were greater than the squared correlation estimate (Table 4).

Insert Table 4 here

5.2 Structural model

In stage two, a full structural equation model using LISREL was performed to assess the hypothesised main effects among green process innovation, learning from customers, and green customer cooperation. In this model, we controlled for size and ownership type of the companies. All the indices indicated that the hypothesised model had adequate fit with the data ($\chi 2$ = 78.56 (57 d.f., p = 0.03); RMSEA = 0.042; NFI = 0.98; NNFI = 0.99; CFI = 0.99; IFI = 0.99; GFI = 0.95).

Table 5 reports the results from the path model. H1 is supported by the data, suggesting a positive effect of green process innovation on green customer cooperation ($\beta = 0.74$, $p < 0.01$). The results also confirm a positive effect of learning from customers on green customer cooperation ($\beta = 0.21$, $p < 0.01$), confirming H2.

Insert Table 5 here

In the next step, we used Ping's (1995) approach for the evaluation of structural models with interactive terms to estimate the moderating effect of organisational commitment constructs (affective and calculative commitment to customers) on the link between green process innovation/learning from customers and green customer cooperation (H3 & H4). Accordingly, we computed the required multiplicative terms and entered them into the structural model. To diminish potential problems of multicollinearity associated with the inclusion of interaction terms in the model, first we mean-centred the raw scores of the predictor variables involved in the interactions (learning from customers, green process innovation, affective and calculative commitment to customers) (Aiken & West, 1991). We used single indicants to estimate interactions between latent constructs (Ping 1995). We computed single indicants for learning from customers, green process innovation, and affective and calculative commitment to customers via averaging the corresponding measurement items (Table 3). We then used Ping's (1995) equations to calculate the item loadings and error variances of the interaction terms by running a confirmatory factor analysis model in which the dependent latent construct and all the latent constructs involved in the interactions were included.

We then re-ran the structural model where the direct effects and interaction terms were estimated freely. The fit indexes associated with the model were still satisfactory.[1] Table 5 shows that in the presence of the moderator, calculative commitment to the customer, the effect of learning from customers on green customer cooperation has been strengthened ($\beta = 0.24$, $p < 0.01$), confirming H4b. Interestingly, as opposed to H4a, the results show that affective commitment to customer weakens the effect of learning from customers on green customer

[1] $\chi^2 = 107.70$ (89 d.f., p = 0.08); RMSEA = .031; NFI = 0.97; NNFI = .99; CFI = .99; IFI = 0.99; GFI = 0.94.

cooperation (β = - 0.15, $p < 0.05$). Table 5 shows a non-significant effect of our moderators on the link between green process innovation and green customer cooperation, rejecting H3a/b. Likewise, none of our control variables, namely size of the company and type of ownership, had a significant effect on green customer cooperation.

6. Discussion and implications

We developed a framework to investigate the effects of green process innovation and learning from customers on green customer cooperation. Moreover, we examined whether senior management's affective and calculative commitment to customer firms strengthen the above links. Our results confirm that out of the six proposed hypotheses, four are supported.

In particular, green process innovation proves to have a very strong and positive effect on green customer cooperation (β = 0.74, $p < 0.01$). In comparison, although significant too, learning from customers has a weaker influence on green customer cooperation (β = 0.21, $p < 0.01$). By showing that green process innovation has a strong and significant impact on green customer cooperation, ignoring the moderation effect of either loyalty or calculative commitment, this paper affirms green process innovation's importance in driving green customer cooperation (Zhao et al., 2011). It confirms the previous assumption that firms with better green process innovation are more likely to engage in successful green customer cooperation from a capability-based view (Koufteros et al., 2005), showing that it is essential to work on internal green capability before seeking external green collaborations.

The findings also confirm the effect of learning from customers on green customer cooperation, showing that when a manufacturer takes on a customer-oriented approach to learn from its customers, the manufacturer is more likely to proceed with successful green customer cooperation. As hypothesised, learning from customers helps manufacturers modify their products to gain a more favourable market advantage (e.g. Lee, 2011; Wuyts et al., 2004), which leads to successful green customer cooperation (Wang et al., 2016). Furthermore, the findings also demonstrate that organisational commitment has no effect on the relation between green process innovation and green customer cooperation, while having a significant moderating effect on the relationship between learning from customers and green customer cooperation.

In particular, calculative commitment is proven to have a positive effect that further strengthens the relation between learning from customers and green customer cooperation, while affective commitment shows a negative impact on the hypothesised relation between learning from customers and green customer cooperation. The results illustrate the difference between affective and calculative commitment, supporting the argument of Gilliand and Bello (2002) to look at commitment from different perspectives. Interestingly, it shows that commitment derived from a rational calculation of pros and cons tends to be more stable and enforcing (Wu et al., 2004), which further strengthens the hypothesised relation. On the other hand, commitment established on the basis of an affective bond between senior managements weakens the relation between learning from customers and green customer cooperation, rejecting our previous assumption of seeing both types of commitment as positive moderators.

Although counter-intuitive, the findings offer some evidence for the dark side of the relationship commitment debate (Ganesan et al., 2010), showing that senior management's affective commitment towards the customer firm does not necessarily encourage the relationship between learning from customers and green customer cooperation. Maybe by staying loyal and affectively committed to its customer firms, senior management become more relaxed in promoting organisational learning from customer firms to drive green customer cooperation, since the company is likely to be rewarded for its loyalty towards its customer firms anyway (Dwyer et al., 1987). Similarly, such an atmosphere may be picked up by the marketing/sales managers who then feel less of a need to work on learning from customer firms in driving green customer cooperation, since the senior management have already worked on further demonstrating the firm's commitment to the customer firms.

Our findings have several theoretical and managerial implications. Theoretically, this paper contributes to existing GSCM literature in at least two ways. It is a first attempt to conceptually explain and empirically validate the mechanisms that manufacturers could adopt to drive more effective green customer cooperation. The findings show that green customer cooperation could be achieved through green process innovation and learning from customers, with the moderation effect of loyalty as well as calculative commitment on the relation between learning from customers and green customer cooperation. By addressing the how-to question of green customer cooperation, this paper extends the previous understanding of GSCM and, more specifically, of green customer cooperation (Zhu et al., 2013). By empirically proving that affective and calculative commitment have significant but different effects on the relation between learning from customers and green customer cooperation, this paper affirms the previous understanding of commitment (Gilliand & Bellow, 2002). By illustrating how calculative commitment strengthens the effect of learning from customers on green customer cooperation, yet affective commitment weakens such an effect, this paper sheds new light on the understanding of affective commitment and its possible *dark* side in facilitating green customer cooperation.

Besides theoretical contributions, the paper also has several practical implications for businesses, especially for manufacturing suppliers that are keen to embrace green process innovation and green customer cooperation. First, since our findings show that green process innovation is essential to green customer cooperation, firms are recommended to work on taking initiatives to employ green practices internally as the very first step towards GSCM (Chan, 2005; Barratt & Barratt, 2011). Enhancing their own green capabilities will give them a head-start in participating and engaging in green customer cooperation, against competitors that are less advanced in adopting green innovation practices internally at the firm level. Furthermore, learning from customers and knowledge exchanges with customer firms should be encouraged by senior management, as this will help manufacturing firms better to understand and manage their customer firms' expectations on green internal practices, leading to a win-win collaboration. This is particularly important when the customer is deemed irreplaceable since the switching costs involved in leaving the customer is higher than staying in the relationship (Ganesen et al., 2010).

For businesses who are sourcing from Chinese manufacturing suppliers, the findings also provide important insights. For large multinational enterprises and global firms that are keen to collaborate with suppliers for greener supply chain practices, they are advised to select Chinese suppliers that have already engaged in green internal practices, as such suppliers are more likely to collaborate and welcome green customer cooperation. However, this does not mean that existing Chinese suppliers that are behind on green process innovation cannot be nudged into better adoption of green customer cooperation, as the findings show that organisation commitment plays an important role that affects the relation between learning from customers and green customer cooperation. Once the Chinese suppliers are committed to the buyer-supplier relationship following a rational calculation of the costs and benefits involved, they will be willing to work with their customer firms for green cooperation, even if this initiative is not considered as a priority in their own goals.

7. Limitations and future research directions

While our study illustrates the mechanism that drives green customer cooperation, it is not without limitations. Future research is recommended to better consider the cultural context of China (Yen & Abosag, 2016) by including the Chinese cultural-specific notion of *guanxi*, which can be translated as 'interpersonal ties', in discussing GSCM (Geng, Mansouri, Atkas,

& Yen, 2017). For instance, it may be useful to explore how and to what extent the effect between green process innovation and external green customer cooperation may be dependent upon *guanxi* between the channel members. Furthermore, although we have employed the multi-respondent approach as a data collection strategy, the data only reflects the view of the manufacturers. Hence, we encourage future studies to consider the collection of dyadic data to better measure green customer cooperation from the customer's perspective (Barnes, Naudé, & Michell, 2007). This is likely to yield a more insightful comparison and produce a more comprehensive picture of GSCM.

Additionally, future research may also consider including other control variables such as firm age and industry sub-sector, as there may be considerable differences amongst industry sub-sectors and firm age regarding green customer cooperation. For instance, Dangelico et al. (2007) showed that firm's age could have a negative effect on firm's environmental performance, whilst Yen and Barnes (2011) revealed that firm's age has a positive effect on firm's collaborative relationship performance. Whilst existing research has not reached a consensus view regarding the effect of firm's age on firm's performance (Dangelico and Pontrandolfo, 2015; Younis and Sundarakani, 2019), future research is recommended to consider including firm's age as a control variable, when testing the performance of green customer cooperation. Besides firm age, future empirical research is also suggested to consider including industry sub-sector (e.g. high-tech versus low-tech) in their explanatory model, to see if a firm's green innovation and capability (Menguc & Auh, 2010; Weber & Heidenreich, 2018) may be affected by its industry sector, providing an in-depth understanding of green customer cooperation.

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Tables

Table 1. Literature review of green customer cooperation

Paper	Sample	Theory	Position
Zhu et al., 2005	Chinese manufacturing	x	Green customer cooperation (GCC) is a sub-dimension of GSCM. GSCM is influenced by regulation, suppliers' advice, market, competitors; leads to environmental, economic, and operational performance.
Zhu, et al., 2011	Chinese manufacturing	Ecological modernisation theory (EMT), examines the awareness of regulations and policies of GSCM.	GCC is a sub-dimension of GSCM. GSCM is influenced by awareness of regulations, moderated by pressures from regulations.
Zhu et al., 2012	Chinese manufacturing	Coordination theory, explains why external GSCM moderates internal performance	GSCM has internal and external dimensions. GCC is a sub-dimension of external GSCM. External GSCM is influenced by regulations, market, competitors; leads to environmental, economic, and operational performance.
Zhu et al., 2013	Chinese manufacturing	Institutional theory, explains drivers of three institutional isomorphic pressures, namely normative, coercive, and mimetic pressure	GCC is a sub-dimension of external GSCM. External GSCM is influenced by institutional pressures (environmental regulations, market, competitors). External GSCM leads to environmental, economic, and operational performance.
Yu et al., 2014	Chinese manufacturing	x	GCC is an independent construct. Together with internal and supplier GSCM, they lead to operational performance (flexibility, delivery, quality, and cost).
Teixeira et al., 2016	Brazilian manufacturing	x	GCC is an independent construct. Green training affects both GCC and green purchasing.
Burki et a., 2018.	Turkish manufacturing	x	GCC is an independent construct, influenced by top management commitment.

Table 2. Sample characteristics

Characteristic	Percentage
Firm size (full-time employees)	
• < 20	6.9
• 20-299	35.9
• 300-999	21.2
• ≥ 1000	35.9
Ownership structure	
• Foreign owned	26.7
• Joint owners	9.7
• Private	42.9
• State-owned	20.7

Table 3. Items, reliability, and variance extracted

Construct and items	Factor Loadings
Learning from customers (Scale: 1 = strongly disagree and 7 = strongly agree) (AVE = 0.67, CR = 0.85, α = 0.80)	
ML1 Our firm has spent a great deal of time learning product or company specific knowledge from this customer firm.	0.74
ML2 Our firm has acquired company-specific or product-specific knowledge from this customer firm to adequately manufacture the product.	0.97
ML3 Our firm's approach to the product has been custom-tailored based on the capabilities and resources of the customer firm.	0.60
Green process innovation (Scale: 1 = strongly disagree and 7 = strongly agree) (AVE = 0.53, CR = 0.68, α = 0.90)	
Gpr1 During production and product transportation, our company uses cleaner or renewable technology to lower consumption of energy (e.g. electricity, gas, and fuel).	0.85
Gpr2 During disposal, our company uses cleaner or renewable technology to lower consumption of energy (e.g. water, electricity, gas, and petrol).	0.87
Gpr3 Our company uses recycled, reused, and remanufactured materials or parts.	0.62
Gpr4 Our company reduces the use of hazardous raw materials in the manufacturing process.	0.81
Organisational commitment to customers (Scale: 1 = strongly disagree and 7 = strongly agree)	
Affective commitment (AVE = 0.74, CR = 0.89, α = 0.88)	
OC4 Our loyalty to this customer firm is a major reason why we continue to work with them.	0.88
OC5 We want to stay associated with this customer firm because of our allegiance to this company.	0.87
OC6 Given all the things we have gone through with this customer firm together over the years, we ought to continue our relationship.	0.77
Calculative Commitment (AVE = 0.77, CR = 0.91, α = 0.88)	
OC1 Losing this customer firm would be too disruptive for our business, so we continue to work with this one.	0.80
OC2 Even if we wanted to shift business away from this customer firm, we could not, as our losses could be high.	0.90
OC3 We need to keep working with this customer firm since leaving would create hardship.	0.82
Green customer cooperation[1] (Scale: 1 = strongly disagree and 7 = strongly agree) (AVE = 0.85, CR = 0.96, α = 0.93)	
GCC1 Our company cooperates with this customer firm for eco-design (eco-design is a practice that aims to reduce the environmental impact of a product over the product lifecycle).	0.85
GCC2 Our company cooperates with this customer firm for cleaner production (cleaner production is a practice that aims to minimise waste and emissions and maximise product output).	0.89
GCC3 Our company cooperates with this customer firm for green packaging (green packaging reduces environmental impact and ecological footprint during the development and use of packaging).	0.89

GCC4 In term of transportation, our company cooperates with this customer firm for using a lower amount of energy during transportation.	0.85

Notes: AVE = average variance extracted (Fornell & Larcker, 1981); CR = construct reliability (Bagozzi, 1980); α = Cronbach's coefficient alpha; [1]We removed the following item due to its low factor loading (0.42): Our company provides a logistics service to facilitate product returns by customer firms.

Table 4. Correlations, means, standard deviations, and variance extracted

Constructs/Variables	Mean	SD	1	2	3	4	5
1. Learning from customers	3.91	0.76	**0.82**				
2. Green process innovation	4.14	0.63	0.40**	**0.73**			
3. Affective commitment to customers	3.59	0.85	0.33**	0.40**	**0.86**		
4. Calculative commitment to customers	3.65	0.75	0.17**	0.26**	0.57**	**0.88**	
5. Green customer cooperation	4.02	0.63	0.48**	0.75**	0.40**	0.27**	**0.92**

Notes: **Correlation is significant at the 0.01 level (2-tailed). SD = standard deviation. Diagonal figures (in bold) are the square root of the variance extracted

Table 5. Standardised path coefficients

Dependent variable	Predictor	Coefficient	*t*-values[a]	Conclusion
Green customer cooperation	Green process innovation (H_1)	0.74	11.24	Significant
	Learning from customers (H_2)	0.21	4.00	Significant
Green customer cooperation	Green process innovation x Affective commitment to customers (H_{3a})	0.08	1.23	Non-Significant
	Green process innovation x Calculative commitment to customers (H_{3b})	-0.12	-1.57	Non-Significant
	Learning from customers x Affective commitment to customers (H_{4a})	-0.15	-2.48	Significant
	Learning from customers x Calculative commitment to customers (H_{4b})	0.24	3.25	Significant

Notes: [a]Critical t-value (5%, two-tailed) = 1.96; critical t-value (1%, two-tailed) = 2.58.

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