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# The effects of risk and reward sharing on quality performance

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## ABSTRACT

**Purpose:** Firms face critical challenges in managing product quality in a global supply chain. In many cases, these challenges could be regarded as an agency problem which is a result of the goal conflict between the supply chain members. To address such agency problem, the purposes of this study are to explain how risk and reward sharing practices contribute to firms' quality performance in the supply chain, and to identify the drivers of applying risk and reward sharing.

**Design/Methodology/Approach:** The hypothesised model, based on agency theory, is empirically verified by original survey data of 200 Chinese manufacturing companies using the structural equations modelling approach in a context of product recall.

**Findings:** Supplier involvement and task programmability are two significant antecedents of risk and reward sharing. Further, the paper shows that risk and reward sharing have a positive effect on quality performance however in terms of contribution to quality performance, risk sharing and reward sharing may be substitution practices.

**Practical Implications:** This research explains how managers could embrace better preparedness for risk and reward sharing in their supply chains. It is also suggested that although risk and reward sharing are seen as efficient means to improve quality performance, such practices should not be treated as a bundle.

**Originality/Value:** Building on supply partnership literature, this paper contributes to agency theory by providing a solution to the agency problem i.e., risk and reward sharing and adding to the limited understanding of the antecedents of risk and reward sharing and examining the effects of risk and reward sharing on quality performance.

**Keywords** – Risk sharing; Reward sharing; Quality performance; Supplier involvement; Task programmability

**Article Classification:** Research paper

# 1. Introduction

Over the past few years the supply chain environment has become ever more complicated, making it more difficult to sustain quality performance, especially in suppliers' performance (Lyles *et al.*, 2008). To enhance quality assurance in the supply chain, many companies have established supply chain partnership (SCP) strategies. Recent literature has cited the importance of SCP to deal with quality uncertainty in the supply network (Mellat-Parast, 2015). Drawing from the key components of the SCP model (Lambert *et al.*, 1996), this study investigates the strategic roles of risk sharing and reward sharing in addressing the quality issues underpinned by agency problems that are inherent in the supply chain.

The literature argues that risk sharing is an appropriate method to mitigate the risk in the supply chain (Camuffo *et al.*, 2007; Fan *et al.*, 2016). Risk sharing practice could also be ideal for mitigating the quality issues raised in the supply chain. For example, where there is an appropriate recall cost sharing agreement, the focal firm and their suppliers can share the recall operation cost without either firm carrying the entire burden. Therefore, both parties can avoid the destructive consequences of a quality crisis. In supply chain management (SCM) literature, risk sharing refers to a type of supply chain risk management (SCRM) activity (Norrman and Jansson, 2004; Manuj and Mentzer, 2008); it is used to deal with unpredicted uncertainty in upstream supply risk in order to reduce loss in transaction (Camuffo *et al.*, 2007). Reward sharing often intertwines with risk sharing, since benefit is taken as an incentive to both parties to mitigate the supply chain risk together (Harland *et al.*, 2004). As an incentive mechanism approach aimed at cost-saving and improving product quality, reward sharing practice is helpful for achieving better firm performance when, for instance, a supplier incentivised by a cash refund from the buying firm might be more willing to improve effectiveness and guarantee the product quality (Zirpoli and Caputo, 2002).

Given that risk and reward sharing deal with the collaboration issues between the focal company and its suppliers (Eisenhardt, 1989), we argue that agency theory is an appropriate theoretical lens to investigate the risk and reward sharing practices. Scholars have made meticulous efforts to examine quality issues in the supply chain through the lens of agency theory in OM (Zsidisin and Ellram, 2003). For example, researchers have drawn on the perspective of agency theory to understand the governance mechanisms for improving supply

chain effectiveness and the nature of the supply chain quality problem (Zu and Kaynak, 2012). This supply chain quality problem can be explained by the agent's opportunistic behaviour; for example, the supplier may cut corners by using lower grade components, and eventually this may lead to a serious product recall scandal, such as the Kobe steel recall in 2017 (Masumi and Chikako, 2017).

In the existing SCM literature, there are two trends of studying the agency problems. *First*, some studies tend to focus on discussing the antecedents (Steinle *et al.*, 2014) and the consequences of agency problems (Yan and Kull, 2015). *Second*, another trend is to identify practices to manage the agency problems (Zsidisin and Ellram, 2003; Zu and Kaynak, 2012). For the second stream, a proposed solution is to form SCP, in which risk and reward sharing are two key constructs in the SCP model. Although existing literature have included risk and reward sharing in SCM frameworks such as, Mentzer *et al.* (2001), to date the antecedents of risk and reward sharing have not been fully scrutinised. According to the agency theory, collaboration characterised by low information asymmetry and high task programmability would be beneficial to the implementation of behaviour-based management techniques, such as risk sharing and reward sharing (Eisenhardt, 1989; Zsidisin and Ellram, 2003; Li *et al.*, 2015). Drawing from the agency theory, we propose task programmability and supplier involvement as two pivotal factors that affect both risk and reward sharing.

*First*, we argue that supplier involvement, which guaranteed good communication between the focal company and its supplier, could be a significant driver of implementing both risk and reward sharing. Harland *et al.* (2004) stress that an open dialogue is needed to agree on the allocation of risk between two parties. According to Yan and Kull (2015), supplier involvement can help to reduce the information asymmetry between the focal company and its supplier. Although supply chain researchers have shown great interest in supplier involvement, most related research focuses on its effect on firm performance (Carr and Pearson, 2002; Parker *et al.*, 2008), with limited attention paid to the association between supplier involvement and risk and reward sharing mechanism.

*Second*, by enhancing the observability of supplier's task, we propose task programmability would be positively associated with the adoption of risk and reward sharing. The literature suggests that the higher the specification in advance of appropriate agent behaviour (i.e., high

task programmability), the more easily the principal can assess and observe the behaviour of its agent (Eisenhardt, 1989). The recent SCM research places great emphasis on the importance of using agency theory to investigate the relationship between buying companies and their suppliers (Zu and Kaynak, 2012; Li *et al.*, 2015). Nevertheless, there has been only limited research to examine the role of task programmability in the implementation of SCM practices. Zu and Kaynak (2012) establish a proposition that when perceiving high task programmability of suppliers, buying firms tend to rely on the behaviour-based management practices. Zsidisin and Smith (2005) propose that buying companies can reduce supplier failures through programming and monitoring supplier task and accomplishment. However, previous studies have not empirically verified the theoretical propositions with a large-scale sample.

In this study, we develop a theoretical framework to help both practitioners and academics to devise strategies that will increase the efficiency of risk and reward sharing, and to promote quality performance by adopting risk and reward sharing practices. This paper aims to fill the current research gap by examining the following research questions (RQs):

*RQ1: What are the antecedent factors motivating focal companies to adopt risk and reward sharing practices with an ultimate aim to improve quality performance?*

*RQ2: How do risk and reward sharing practices influence focal companies' quality performance?*

To answer these two research questions, the SCP model is applied to explain the rationales of how the antecedent factors impact on risk and reward sharing, and how the quality performance is influenced by risk and reward sharing. We synthesise the findings from the literature to propose a risk and reward sharing conceptual model and then test it in the context of product recalls in China. This research focuses on China because it is the world's second-largest economy, has been the manufacturing centre of the world for the past three decades and has been involved in many high-profile product recall incidents (Jia and Rutherford, 2010). Moreover, the increasing number of product harm incidents in China indicates an urgent need to identify efficient management practices that will help companies to improve quality performance (Tse and Tan, 2012). Although China has been widely regarded as an ideal setting to research risk management or SCM, very few researches have explored the risk

and reward sharing practices in this context. In order to fill this gap, our proposed model is tested with a sample of 200 Chinese manufacturing companies.

This rest of the paper is structured as follows. The second section provides a literature review of risk and reward sharing and theoretical background of agency theory. The third section develops the hypotheses. The fourth section describes the characteristics of our collected sample and justifies the measurements of the theoretical constructs. The model testing is addressed in the fifth section and a discussion of the results is provided in the sixth section. Finally, the seventh section provides theoretical and practical contributions, describes limitation of this study and suggests the future research directions.

## **2. Literature review**

### **2.1. Risk sharing and reward sharing**

Risk management activities include avoidance, reduction, transfer, sharing or even taking the risk (Norrman and Jansson, 2004; Manuj and Mentzer, 2008) in order to reduce the probability and consequences of the incident (Norrman and Jansson, 2004). The use of pre-crisis agreements and improving collaboration can mitigate risks in a supply chain relationship. For example, buying firms might use contractual agreements which clarify the shared responsibility for managing external product failure costs to induce efforts on quality improvement (Chao *et al.*, 2009). Drawing from the SCP model, risk and reward sharing are regarded as the key components to make the supply chain relationship operational and help practitioners to obtain the benefits of partnership (Lambert *et al.*, 1996; Jia and Lamming, 2013). According to Lambert *et al.* (1996), risk and reward sharing are crucial; it is necessary to ensure that both the benefits and costs of partnering are shared, because “shared destiny” is the core of a SCP.

In this study, risk sharing “*pertains to the situation in which a firm aligns the obligations among supply chain members regarding how they share the duties to mitigate SCRs and face the consequences of SCRs in their supply chain*” (Li *et al.*, 2015: P84). Reward sharing refers to an incentive mechanism in which the buyer and the supplier share the bonus, cost savings and business opportunities from product development and cooperating activities that improve the manufacturing process (Cousins, 2005).

The adoption of risk and reward sharing is critical for company to manage supply chain risks (SCRs). According to Christopher (2000), today's businesses no longer compete as stand-alone entities; rather, companies need to compete as supply chains. This brings more challenges and complexity for managers to manage risks, as these risks will affect the whole supply chain rather than a single company. For companies competing in emerging markets such as China, the highly uncertain environment raises further the barriers regarding the management of SCRs (Tse *et al.*, 2016). Furthermore, although incentives for the excellent performance of business partners can be helpful to reduce the SCRs, incentive schemes in the supply chain are invariably badly designed (Narayanan and Raman, 2004). It can be argued that both the highly uncertain environment and the blurring of boundaries between supply chain members contribute to the high level of difficulty in clarifying responsibilities and rewards during the supply chain cooperation (Li *et al.*, 2015).

Although many researchers have recognised the importance of the risk sharing mechanism in the supply chain context, most of them treat it as a unidirectional approach conducted by the buyer, whereby the buyer absorbs the risks from the supplier. Echoing Zsidisin and Ellram (2003), who consider SCRs as a multidimensional concept, we examine risk sharing in a bidirectional way, in which both buyers and suppliers absorb risks from each other. We argue that the risk sharing mechanism can be achieved through establishing the contractual mechanism and through improved collaborations. According to Kim *et al.* (2010), the reciprocal risk sharing mechanism could help to maintain the cooperative relationship between the supply chain members. The risk sharing mechanism, which focuses on aligning the responsibilities and coordinating the behaviour of supply chain partners, is found to be more effective than single-firm focused risk management strategies (such as flexibility, buffering and postponement) (Fan *et al.*, 2017). Through specifying the responsibilities and obligations, the partnering companies would share a unified goal of mitigating the SCRs.

As a soft side of risk sharing mechanism, the role of reward sharing should not be ignored. Unlike risk sharing, which focuses on obligations and responsibilities, reward sharing is to do with the alignment of incentives between supply chain partners. Incentive alignment is a mechanism “*establishing the contracts that make the agent's compensation contingent on outcomes of his or her performance that are desired by the principal*” (Tosi *et al.*, 1997,



p.588). Ramanathan *et al.* (2011) indicate that incentive sharing is an important enhancer of supply chain collaboration. In this regard, reward sharing could be seen as an incentive mechanism that enhances the commitment of the supplier in collaborative projects and reduces the impact of conflict problems (Simatupang and Sridharan, 2008). For instance, the buying firm could provide the supplier with a cash refund equal to a portion of the cost saved when the supplier improves the accuracy of production or successfully collaborates with the buyer in product development projects. According to Radhakrishnan *et al.* (2012), the incentive sharing system can ensure that there is an equitable distribution of benefits so as to sustain the motivation for the business partners to participate in the collaborative project. Drawing on the case of British Petroleum's (BP) Andrew Alliance, Barlow (2000) finds that the importance of gain sharing (i.e., reward sharing) should not be underestimated, as *"it resulted in innovation, which reduced contractors' time input and therefore, their remuneration"* (p. 984).

#### **Table 1 about here**

Table 1 provides a comprehensive revision of the existing theoretical and empirical literature of risk and reward sharing. Although there is a growing interest in studying risk and reward sharing mechanisms, there has been little empirical examination of their antecedents and consequences. With regard to the consequences of applying risk sharing practices, Li *et al.* (2015) empirically examine the association between risk sharing mechanisms and financial performance. They argue that the effect of risk sharing on financial performance is strengthened by a shared understanding of SCRM. More recently, Fan *et al.* (2017) comprehensively propose and test the linkage of risk sharing with its antecedents and consequences. The factors of risk information sharing and risk analysis and assessment are found to be the significant drivers of the risk sharing mechanism (Fan *et al.*, 2017). Additionally, building on the research of Li *et al.* (2015), Fan *et al.* (2017) argue that risk sharing mechanisms can enhance firms' operational performance. However, while these empirical studies have started to examine the antecedents and consequences of the risk sharing mechanism, there remain at least two research gaps associated with this issue. *First*, the effect of risk sharing on firm's quality performance is not examined in the literature. *Second*, its relationship with supplier involvement and task programmability has not attracted researchers' interest.

It is surprising that very few attempts have been made to operationalise individually the soft side of risk sharing, that is reward sharing, or to examine the antecedents and consequences of reward sharing. As shown in Table 1, the measurement of reward sharing is often mixed with that of risk sharing (or incentive alignment). Min and Mentzer (2004) measure the reward sharing in combination with risk sharing through a first order factor of SCM. Likewise, Min *et al.* (2007) operationalise the risk and reward sharing as a sub-dimension of SCM. The risk and reward sharing are also measured as a single item (i.e., single question) for measuring the supply chain collaboration (Cao *et al.*, 2010) and relationship outcome (Cousins and Lawson, 2007). The SCM literature also conceptualises the risk and reward sharing mechanism as a construct of incentive alignment, which focuses on both cost and benefit sharing (Wiengarten *et al.*, 2010; Zhang and Cao, 2018). Although reward sharing has been discussed by authors of SCP, we argue that the empirical research of investigating the reward sharing is insufficient. The antecedents and outcomes of reward sharing have still not been revealed. To fill the research gaps, we draw on the agency theory to examine two proposed antecedents of reward sharing: supplier involvement and task programmability.

## **2.2. Agency theory**

The agency theory focuses on a situation where one party appoints a second party to act on its behalf, also known as the principal-agent relationship (Eisenhardt, 1989; Zu and Kaynak, 2012). Specifically, in the context of the supply chain, the buyer can be regarded as the principal, who delegates the production of tangible products or service to the supplier (i.e. agent). Therefore, according to agency theory, both buying firms and suppliers are involved in the agency relationship (Zu and Kaynak, 2012).

Information asymmetry indicates a situation where one party has less or worse information than the other. The information asymmetry might encourage suppliers to exert opportunistic behaviour (Ekanayake, 2004; Zu and Kaynak, 2012). For instance, *moral hazard* is a problem related to agent's opportunistic behaviour in the situation of "*incomplete information*". Few people will deny that it is expensive and difficult for the buyers to constantly monitor the manufacturing process of suppliers. In the context of SCM, moral hazard arises when the suppliers do not keep promise in product quality improvement and even cheat in supply

product quality (i.e., a lack of effort on the part of agent) (Eisenhardt, 1989; Zu and Kaynak, 2012). We argue that through aligning and specifying the responsibilities and incentives, the risk and reward sharing mechanisms could help to reduce the harms associated with this agency problem. Although agency problem can never be entirely removed, using risk and reward sharing practices to unify the organisational interest could point the way to solving the agency problems in supply chains.

In accordance with Eisenhardt (1989) propositions, SCM researchers have paid considerable attention to proposing and verifying methods to solve the agency problems. These methods are generally summarised as behavioural-based mechanisms and outcome-based mechanisms. For example, Zsidisin and Ellram (2003) categorise SCRM as buffer-based management practices and behaviour-based practices. Specifically, the outcome-oriented practices aim at reducing the negative impact of the SCRs, while the behaviour-oriented practices aim at controlling supplier processes (Zsidisin and Ellram, 2003). The risk and reward sharing mechanisms can be regarded as behaviour-based practices, which are directly relevant to the agency theory because they are concerned with the process of sharing the duties and consequences of business partnering (Li *et al.*, 2015).

Furthermore, in the research of Zsidisin and Ellram (2003), we can find similar arguments to support our notion. The nature of target costing, which is classified by Zsidisin and Ellram (2003) as a behaviour-based approach to risk management, is matched with the concept of risk and reward sharing mechanism (Scott, 2001). Zsidisin and Ellram (2003) argue that the development of target costing with the supplier requires extensive communication between the buyer and supplier to “drive cost out”, which “*closely aligns the goals of the supplier with those of purchasing companies*” (p. 18). As indicated by Ellis (2003), it is crucial that the agency relationship is structured with an appropriate mix of incentives and penalties, thus motivating the agent to perform the delegated task in line with the principal’s interests.

Although behaviour-based practices can offer potential long-term benefits for the company, success in implementing those practices requires substantial investment and adequate information from the agent (Zu and Kaynak, 2012). The logic behind this is that the behaviour-based practices, such as the risk and reward sharing mechanism, aim to improve the supplier’s performance by focusing on the process rather than the outcomes (Zsidisin and

Ellram, 2003). Therefore, buying companies' ability to observe the behaviour of their suppliers determines the efficiency of conducting the risk and reward sharing. We propose that, through enhancing the observability of suppliers' behaviour, supplier involvement and task programmability would be two significant drivers of implementing risk and reward sharing.

Agency theory proposes that behaviour-based practices would be more effective when the company has lower information asymmetry and higher task programmability (Eisenhardt, 1989; Zsidisin and Ellram, 2003). According to Zu and Kaynak (2012), in the situation of low information asymmetry buyers would be more amenable to investing in the behaviour-based practices. Supplier involvement, which allows buyers to better verify the supplier's behaviour and to clearly understand the supplier's technological expertise (Zsidisin and Smith, 2005), can lower the information asymmetry between buyers and suppliers (Yan and Kull, 2015). Accordingly, based on the proposition of agency theory, we expect that higher supplier involvement could help companies to achieve more efficient risk and reward sharing mechanisms.

Task programmability, which refers to the degree to which the supplier's appropriate behaviour can be specified by the buyer in advance (Mahaney and Lederer, 2003), is another proposed antecedent of risk and reward sharing derived from the agency theory. Zsidisin and Ellram (2003) indicate that the success of behaviour-based practices requires the principal to have the ability to assess and observe the agent. Because high task programmability implies that the production process and information from the suppliers are standardised, the assessment and evaluation of the suppliers' abilities should be more efficient. Therefore, we argue, the more programmable the tasks that are delegated to the suppliers, the easier it should be for buyers to establish effective risk and reward sharing mechanisms.

Although forming SCP in the form of risk sharing and reward sharing is considered implicitly as a solution to the agency problem, we have not yet seen a comprehensive conceptual framework explaining the detailed mechanisms. According to our theoretical foundation, a conceptual model is developed as presented in Figure 1.

**Figure 1 About Here**

### 3. Hypotheses development

Given that risk sharing requires close coordination among buyers and suppliers, all supply chain partners should share an understanding of the supply chain vulnerabilities (Revilla and Saenz, 2017). Supplier involvement has been widely regarded as a critical practice to reduce product design error and improve the cost-efficiency of production (Chang *et al.*, 2006). If suppliers are involved early in the manufacturing or design process, buyers can obtain more information about the manufacturing process; hence, both buyers and suppliers can promote better resource utilisation, and the development and sharing of technological expertise (Birou and Fawcett, 1994). Zsidisin and Smith (2005) suggest that supplier involvement enables buyers to better monitor their suppliers' behaviour and activities. We argue that a high level of supplier involvement promotes better understanding of the supplier's capacity, which in turn helps to improve the accuracy and efficiency of the risk sharing.

In addition, supplier involvement in product development projects can be set up to encourage both parties in an agency relationship to investigate cost-saving ideas (e.g., new product design and production problem solutions) (Zirpoli and Caputo, 2002), which in turn motivate the reward sharing mechanism. As an example, the automobile manufacturer Fiat rewarded its suppliers for their suggestions with a cash refund equal to 50 percent of the cost saved during the first year of applicability (Zirpoli and Caputo, 2002). The saving of cost can be considered as a reward shared between buyers and suppliers. Moreover, according to Tosi *et al.* (1997), when the principal can accurately assess the agent's behaviour and obtain the agent's information, the agent's compensations can be designed in ways that align the interests of both agents and principals. Given that involving the supplier in the product development project makes it easier for the buyer to obtain and monitor the supplier's behaviour and information, the effectiveness of the reward sharing mechanism can be improved. In this regard, we propose:

H1a: High level supplier involvement motivates buyers to implement risk sharing.

H1b: High level supplier involvement motivates buyers to implement reward sharing.

The second set of hypotheses examines the relationships among task programmability, and risk and reward sharing practices. In buyer-supplier relationships, the programmable tasks refer to all supplier activities and sequences fully specified by standard operating procedures. From the perspective of agency theory, establishing the programmable tasks allows the

principal to specify the behaviours that the agent needs to perform (Eisenhardt, 1989; Ekanayake, 2004). The buying companies can monitor suppliers' operations by keeping track of the documents or statistical process control data of each manufacturing task as they are sent back from the supplier (Aron *et al.*, 2008). Therefore, we argue that an organisation with high task programmability can investigate the production data in each task, then clearly and fairly allocate the responsibility for any failure and loss.

In the context of the buyer-supplier relationship, the buying companies concentrates primarily on the development and implementation of performance measures (Melnik *et al.*, 2004), including behaviour-related performance measures, information systems and other control systems to monitor and manage the interface with its agents (Eisenhardt, 1989). According to Camuffo *et al.* (2007), task programmability can help to reduce the information asymmetry. A high level of task programmability, where the buyer specifies in advance what will constitute appropriate behaviour on the part of the supplier, means that the buyer can allocate appropriate rewards to the supplier based on its performance. Therefore, higher levels of task programmability enable better implementation of reward sharing. Hence, we hypothesise:

H2a: High levels of task programmability result in high levels of risk sharing practice.

H2b: High levels of task programmability result in high levels of reward sharing practice.

Quality performance refers to the degree to which manufacturers consistently achieve conformance to specifications and fitness for use (Kristal *et al.*, 2010). As an agency problem in the supply chain relationship, moral hazard refers to the situation where suppliers exert less effort than expected with regard to the product quality improvement (Zu and Kaynak, 2012). In the context of SCM, moral hazard represents a great challenge that must be overcome in order to ensure the quality performance (Steven and Britto, 2016). We argue that risk sharing can help supply chain partners to make shared understanding of the potential consequences of product quality failure. Such shared understanding of the quality risk is related to the perception of risk, which guides the decision making (Ellis *et al.*, 2010). Therefore, when enacting the mechanisms for reducing the harms of quality risk, a shared understanding of product quality issues is important (Ellis *et al.*, 2011; Revilla and Saenz, 2017). If the supplier realises the consequences and costs of product quality failure, the likelihood of moral hazard will be decreased and will result in better quality performance. Previous research also suggests that the risk sharing mechanism can significantly contribute

to firm's performance through resolving the conflicting objectives between buyers and suppliers, better anticipating and coordinating the supply and demand, and allocating costs related with the quality risks more appropriately (Li *et al.*, 2015; Fan *et al.*, 2017).

To ensure that agents do not engage in behaviour that would lead to moral hazard, but act according to the mutual interest of both parties, the principal needs to increase incentives for the achievement made by the agent (Ekanayake, 2004). We argue that reward sharing could help to mitigate the threat of moral hazard by creating a mutual goal and providing expected incentives for improving product quality. This argument is supported by the agency theory that aligning incentives and goals can help to address the moral hazard problem faced by the principal (Chao, 2011). According to Nyaga *et al.* (2013), when a partner offers a reward to other partners in a supply chain relationship, it is likely to encourage more positive perceptions on the part of those who receive the rewards or benefits and result in closer relationships and better performance. Moreover, the reward sharing mechanism can be seen as a motivator of the buyer-supplier relationship by enhancing the notion of reciprocity, which means that the recipient of the reward will feel obligated to satisfy the expectation of the reward dispenser (Nyaga *et al.*, 2013). To ensure the continuous rewards, the firm must keep collaborating with its partners and continue to improve product quality. Thus, we hypothesise:

H3<sub>a</sub>: Risk sharing practice positively affects quality performance.

H3<sub>b</sub>: Reward sharing practice positively affects quality performance.

Researchers view the risk and reward sharing function as a bilateral practice that can improve the firm's performance (Min *et al.*, 2007). Narasimhan *et al.* (2013) suggest that risk and reward sharing have a visible financial impact on supply relationships, and is a major factor that can mitigate opportunistic behaviour of suppliers. The risk and reward sharing can serve jointly to shift risk to the agent (Handley and Angst, 2015). Specifically, reward sharing is the practice that promotes excellent performance, while risk sharing demotivates suppliers away from poor performance. When the rewards and punishments for a mission are clearly specified, the benefits derived from accomplishing the specific task outweigh the net costs of not doing so. In other words, an agent that has entered into an agreement in which undesired operations attract punishment, may perceive the rewards provided by the principal as having more value than would an agent who has not entered into such an agreement. Therefore, there

is a complementary relationship between the risk and reward sharing. Matopoulos *et al.* (2007) argue that it is critical to balance the risk and reward sharing to enhance the collaboration attitude of both parties to avoid supply chain failures.

Xu and Beamon (2006) indicate that if the risk and reward sharing is under the fair condition, the risk costs (such as coordination cost, opportunistic risk cost and operational cost) will be reduced. Suppliers that agree to share more risk with the buyers will be guaranteed to receive more benefits from the buyer-supplier relationship. If the suppliers agree to share the risks related to the product quality, the focal company will be free from certain costs; for example, they will be able to reduce the time spent on supplier quality inspection. In this case, the suppliers could receive a guarantee from the focal company that it will receive more benefits during or after the transaction. This can be regarded as a complementary effect of implementing both risk and reward sharing practices that clearly specify the reward and punishment at the same time. Moreover, Meng and Gallagher (2012) find that incentives combined with disincentives have more effect on project performance. We therefore argue that the perceived value of rewards for quality improvement can be strengthened by informing the partners of the punishment (i.e., risk sharing) and sharing the norms of jointly handling the quality failures (i.e., net cost). Thus, we hypothesise:

H4: The quality performance is stronger when risk and reward sharing are used jointly than when they are used separately.

## **4. Method**

### **4.1 Data collection**

The target population for our study consisted of supply chain managers and senior managers (i.e., CEO, Operations director) from the manufacturing sectors in China, as these informants are the decision-makers who can assess firm's strategic information. As the level of industrial development varies across different regions, we strategically focus on the Pearl River Delta (PDR), which is a well-known highly developed manufacturing region in China. To test the model, data were collected through a large-scale email survey. We made two email contacts with each of the targeted respondents, including a pre-notice letter and a primary invitation letter with an online survey link. A merged contact mail list purchased from a marketing company containing contact information of 2440 manufacturing companies in China was used. Before distributing the questionnaires, we screened out the possible target respondents



in the first stage. The criteria for selecting the sample firms were: (1) selected sample firms should have experienced some degree of product recall or withdrawal; (2) they have adopted both formal risk and reward sharing practice. The sample size of this study is comparable to the prior research in the field of risk management (Zsidisin and Smith, 2005), and the survey result from firms that adopt a formal risk and reward sharing approach can be considered worthy of trust. Overall, we obtained 200 valid responses representing their individual company, equalling an effective response rate of 8.2%. The demographic information of the sample firms and their representativeness is presented in Table 2. In addition, a chi-square ( $X^2$ ) test was adopted to examine the non-response bias. The insignificant result indicates that there is no difference between the response group and non-response group in terms of firm size ( $X^2=3.913$ ), degree of freedom ( $df=2$ ,  $p=0.141$ ) and the annual revenue ( $X^2=5.803$ ,  $df=3$ ,  $p=0.122$ ) at the level of 0.1. Thus, non-response bias is not a threat to this study.

#### **Table 2 About Here**

### **4.2 Measurements**

According to the accepted procedures of item generation, the survey items for measuring supplier involvement, task programmability and quality performance were identified and modified from previous literature. Although there are some previous studies adopting questionnaire method to measure risk and reward sharing, most of them used the single-item measurements or treated them as one single construct. For example, Min and Mentzer (2004) propose simple measurement item - *“Our supply chain members share risks and rewards”* to measure the level of the adoption of “Risk & Reward Sharing”. This research extends the previous works by developing two sets of multiple items to measure the risk and reward sharing individually based upon the literature review and related theoretical foundations that were presented in the previous section and tend to be conceptual or case-based in nature.

Given that the measurement items of risk and reward sharing in previous research suffer from the drawback of being too generic (Min and Mentzer, 2004), we specify that the risk sharing mechanism focuses on the quality risks in the supply materials, while the reward sharing mechanism concerns the rewards from supply chain cooperation. To evaluate the applicability and clarity of the questionnaire, pilot tests were conducted. Five academics and five practitioners were carefully selected to assess the content of the questionnaire and the adequacy of the research design. It is important to note that, as pointed out by the expert

panel, in a real-world situation it is difficult for practitioners to identify supplier activities that can be rewarded for “outstanding performance”, except in the case of product development projects, which can be a focus for additional rewards. In response to these comments from the expert panel, the reward sharing concept is adjusted to focus on the rewards from product development projects.<sup>1</sup> This adjustment is further supported by the fact that, according to Griffin and Page (1996), a failed product development project could result in production and design errors, and ultimately to product recall. Therefore, a concept of reward sharing that looks at the product development process should be valid.

According to Podsakoff *et al.* (2003), because this study uses the seven-point Likert scale and single informants, it is necessary to consider the potential problem of common method bias (CMB). However, the Harman’s one-factor test resulted in six distinct factors and the first factor accounted for just 16.011%, which was not the majority of the total variance of 68.547%. Therefore, we can claim that CMB is not a threat for this study. Moreover, the confirmatory factor analysis (CFA) for a single factor showed a poor model fit ( $X^2/df = 7.269$ , CFI = 0.404, IFI=0.410, GFI=0.544 and RMSEA = 0.177), which means that the single factor model is not acceptable. Therefore, the CMB problem is not a concern.

## **5. Results**

### **5.1 Construct reliability**

To assess the construct reliability, this study adopted a two-step procedure suggested by Narasimhan and Jayaram (1998). In the first step, we applied exploratory factor analysis (EFA) to check the unidimensionality of the constructs. The EFA was conducted using the principal component method with varimax rotation and without specifying the number of factors. Based on the EFA results, we obtained five distinct factors with eigenvalues larger than 1, which explain 68.547% of the total variance. The acceptable model fit indices for this six-factor result in CFA also support the unidimensionality. Next, composite reliability ( $p_c$ ) was calculated to assess the reliability of the seven factors generated from the EFA. According to Hair (2010), 0.70 is the minimum recommended value for  $p_c$ . In other words, for those constructs with  $p_c$  greater than 0.7, the reliability is confirmed. As shown in Appendix, all seven  $p_c$  were above 0.814, which indicates that the measurements of this study are reliable.

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<sup>1</sup> The definition of reward sharing is also refined based on the comments of expert panel.

## 5.2 Convergent and discriminant validity

To examine the convergent and discriminant validity, this study applied CFA (O'Leary-Kelly and Vokurka, 1998). First, the convergent validity was confirmed, because of the acceptable measurement model fit and the highly significant factor loadings. Specifically, in the measurement model, the comparative fit index (CFI) of 0.937, incremental fit index (IFI) of 0.938, non-normed fit index (NNFI) of 0.925 and goodness-fit-index (GFI) of 0.885, are all above the acceptable values as suggested by Hair *et al.* (2006). The root mean square error of approximation (RMSEA) is 0.060, and the value of  $X^2/df$  (273.049/160) is 1.707, which are less than the recommended maximum values of 0.1 and 5 respectively. Therefore, the model fit indices as presented above all demonstrate a good fit for the measurement model. Moreover, APPENDIX shows that the factor loadings, which range from 0.616 to 0.846, are higher than the minimum acceptable value of 0.50 and are all statistically significant (i.e., t-value greater than 2.0). Hence, the convergent validity is further supported (Bollen, 1989). In addition, this study adopted the average variance extracted (AVE) and inter-construct correlations comparison method to assess the discriminant validity. According to Chin (1998), to achieve discriminant validity, the square root of AVE for each construct should be greater than its correlations with other constructs. All six constructs' square root of AVE are greater than their correlations with other constructs, which means that the discriminant validity is confirmed. The detailed discriminant validity results are available from the authors.

## 5.3 Structural model

In order to explore the interaction effect between risk and reward sharing with structural equation modelling (SEM), this study adopted the method suggested by Li *et al.* (2010) to generate the interaction construct (Hair, 2010). The interaction construct was also added into the proposed model and tested simultaneously with other constructs (Li *et al.*, 2010). Using AMOS 22, the SEM was run to assess the support of the conceptual model and hypotheses. Table 4 presents the results of the structural model, where all the entries are standardised regression weight. Although the RMSEA of 0.085 for our structural model is slightly higher than the good fit benchmark of 0.08, it is still below the acceptable value of 0.1 (Flynn *et al.*, 2010). Overall, the fit of the structural model (Table 3) is acceptable.

**Table 3 About Here**

The model was assessed by examining the variance explained ( $R^2$ ) of the endogenous construct or dependent variables and the intensity of the path coefficients ( $\beta$ ). The maximum value of  $R^2$  is 31% for reward sharing practice and the minimum is 18% for quality performance.  $H_{1a}$  and  $H_{1b}$  hypothesise positive relationships between supplier involvement and risk management practice. We find strong support for both  $H_{1a}$  and  $H_{1b}$ . Risk sharing ( $\beta=0.447$ ,  $t=7.237$ ) and reward sharing ( $\beta=0.184$ ,  $t=3.108$ ) are positively impacted by the level of supplier involvement. The paths also support the relationships of  $H_{2a}$  and  $H_{2b}$ . This implies that task programmability is a critical predictor of reward sharing ( $\beta=0.507$ ,  $t=8.566$ ) and risk sharing ( $\beta=0.184$ ,  $t=2.974$ ). Regarding the impact on quality performance, we find that the reward sharing approach is significantly associated with quality performance ( $\beta=0.361$ ,  $t=4.094$ ), supporting  $H_{3b}$ , while risk sharing is marginally associated with quality performance ( $\beta=0.128$ ,  $t=1.875$ ). In addition, the negative impact of interaction between risk and reward sharing on quality performance is also marginally significant ( $\beta=-0.118$ ,  $t=-1.822$ ). Thus, the results of our moderating analysis reject  $H_4$ , which predicted that risk and reward sharing have complementary effect on the quality performance. This result is surprising and offers a completely different view to that of the risk and reward sharing literature.

## 6. Discussion

Our results reveal that supplier involvement significantly and positively contributes to risk and reward sharing (supporting  $H_{1a}$ ,  $H_{1b}$ ). In line with the agency theory, our results support the notion that to increase the efficiency of behavioural practices, i.e., risk and reward sharing, companies should have a low level of information asymmetry in their supply chain. We also find that the effect of supplier involvement on risk sharing is greater than that on reward sharing. A possible explanation for this result is that supplier involvement allows buyers to clarify their suppliers' capability, function and performance; thus, the buying firms can more easily design and implement effective risk sharing with their suppliers. Birou and Fawcett (1994) argue that supplier involvement promotes better resource utilisation, and the sharing of technological expertise. Supplier involvement, as a form of vertical cooperation in which manufacturers involve suppliers at an early stage in the product development process, could be a foundational element for risk and reward sharing practice, transferring faster and more effective information of the supplier to the buyer, to establish a more accurate risk and reward

sharing program. The hypotheses H2a and H2b were both supported, showing significant and positive relationships between task programmability and risk and reward sharing. As the other antecedent factor, task programmability assists the buying firm to specify the supplier's production tasks and thereby enables the buyer to recognise the strengths and weaknesses of their business partners. According to the agency theory, task programmability has significant and positive effect on the efficiency of behaviour-based practices (Eisenhardt, 1989). Our finding suggest that the task programmability significantly contributes to both risk and reward sharing further supports this proposition.

Our findings support the hypothesis that risk sharing practice positively influences firms' quality performance (H3a). This finding is consistent with a recent study conducted by Fan *et al.* (2016), which suggest that the risk sharing mechanism is a significant factor of contributing firm's performance. This practice, designed to share the burden of loss, requires the supplier to bear part of the responsibility when unpredictable quality risk occurs. Where a risk sharing contract allocates the burden of loss from external product failure cost to both buyers and suppliers, the suppliers are motivated to maintain and even improve the manufacturing process and quality of product. Hence, risk sharing practice should be pursued to achieve high levels of quality performance.

We also find that reward sharing practice has positive impact on quality performance (H3<sub>b</sub>). When the buyer shares the benefits and rewards of product quality improvement with the supplier, a goal alignment occurs such that the supplier shares the buyer's goal to sustain the product quality. This research finding contributes to the agency theory literature, supporting the view with empirical evidence that reward sharing could be an effective practice to solve the agency problems in buyer-supplier relationships, such as goal conflict between buyers and suppliers (Zu and Kaynak, 2012). Our research findings support the conceptual argument by Simatupang and Sridharan (2008), in which process of sharing benefits amongst the business partners can motivate the mutual decision making that is optimal for the overall supply chain performance.

The test for H4 yields an unexpected and interesting result. The interaction effect of risk and reward sharing is negative. That is, adopting both risk and reward simultaneously weakens their positive effect on quality performance. This indicates the existence of a substitution

effect rather than a complementary effect of risk and reward sharing on quality performance. The research findings of the substitution effect suggest that when the incentives of product improvement have been clarified, the norms of risk sharing in the supply chain relationship may be downplayed but are implicitly embedded in the relationship. This finding implies that managers should prioritise the reward sharing practice rather than enhancing the norms of risk sharing to improve quality performance. This is an interesting finding in a Chinese context, in which Chinese cultural values such as *mianzi* or face (social capital in the form of social status) play important roles in business relationships (Luo, 1997; Jia and Zsidisin, 2014; Jia *et al.*, 2016). Business people tend to downplay the negative wording in the language used while interacting. Risk sharing is seen as negative, threatening and therefore the last resort rather than a strategic action by Chinese businessmen.

Another possible explanation is that the reward sharing may eliminate the need for risk sharing. The rewards promised in the *ex-ante* contract (i.e., reward sharing) might counteract the benefits achieved from opportunistic behaviour, such as unjustified gains from cutting corners. In this case, there is no need for the buyer to adopt a disincentive mechanism (i.e., risk sharing) to promote the quality performance, since the supplier does not need to engage in opportunistic behaviour to earn the benefits covered by the rewards sharing. In addition, according to the nature of the practices, risk sharing aims at demotivating poor performance, while rewards sharing aims at motivating above average performance. By providing rewards such as economic benefits or the transfer of technical knowledge, buyers can motivate suppliers to contribute more innovative or improvement ideas (Yeung *et al.*, 2007). In contrast, risk sharing ensures only that the product meets the “bottom-line” quality standard. Therefore, if the reward sharing is effective in improving product quality, the effect of the risk sharing might be weakened.

## 7. Conclusions

At the outset of the paper, we develop two research questions: 1) *What are the antecedent factors motivating focal companies to adopt risk and reward sharing practices in an effective manner?* 2) *How do risk and reward sharing practices influence focal companies' quality performance?*

We answer them by developing and testing a model with empirical data from 200 manufacturers in China. Specifically, we find both risk sharing and reward sharing positively affect quality performance individually. In other words, risk and reward sharing reduce the quality risk which is inherent in the supply network and eventually could be the means of mitigating the threat of product recalls. However, when risk and reward sharing are used together, the quality performance is weakened in a Chinese context. We also identify and support the existence of two antecedents to risk and reward sharing i.e., task programmability and supplier involvement.

### *Theoretical contributions*

This empirical study yields three important theoretical contributions. *First*, being anchored in a SCP model, this paper explicitly proposes that risk and reward sharing offer an important solution to address agency problems. In SCP literature, risk and reward sharing are viewed as a pair of key activities that help both buyer and supplier to obtain the mutual benefits in their partnership (Lambert *et al.*, 1996). Although the SCP has been found to be a group of excellent management practices to improve firm performance, there has been insufficient investigation of each key activity within the partnership model, especially for risk and reward sharing. To close this gap, we examine the effects of risk and reward sharing in detail. Specifically, previous studies provide limited empirical evidence to support the argument that risk and reward sharing practice exert an impact on quality performance. This may be one of the first studies to provide empirical evidence that both risk and reward sharing positively affect quality performance.

*Second*, given that the empirical research of risk and reward sharing is limited, there is very little prior research that has attempted to identify the antecedent factors of risk and reward sharing. Although recent research has started to identify the drivers of risk sharing mechanisms (e.g., Fan *et al.*, 2017), surprisingly, potential drivers such as supplier involvement and task programmability have received limited attention from OM scholars. Additionally, to the best of our knowledge, no research has attempted to identify the antecedents of reward sharing. Drawing from agency theory, we add to the existing literature by scrutinising the effects of task programmability and supplier involvement on risk and reward sharing. This study finds that by enhancing the observability of the supplier's tasks and reducing the information asymmetry between the supply chain members, supplier

involvement and task programmability positively and significantly impact on the risk and reward sharing.

*Third*, another key finding is that only one of the risk and reward sharing practices should be adopted at one time, rather than them being applied simultaneously. Previous researches have generally viewed risk and reward sharing as synonymous, or at least as a combined concept, in the framework of supply chain collaboration (Lambert *et al.*, 1996). Importantly, several recent OM studies have adopted this view to conceptualise both risk and reward sharing in a single theoretical construct (Min and Mentzer, 2004; Wiengarten *et al.*, 2010; Fan *et al.*, 2016). However, our result for the interaction effect between the risk and reward sharing emphasises the need to operationalise the concepts individually.

#### *Practical contributions*

Our theoretical model represents a reasonable initial guide for organisations considering implementing programmed tasks and supplier involvement and provides a general framework for organisations to utilise when modifying current risk management practice to improve their performance. The findings will assist managers to realise the strategic roles of risk and reward sharing in improving quality performance. However, this study recommends that managers should distinguish the characteristics of risk and reward sharing. This is because our results suggest that if they are used together or applied as a bundle, quality performance might be weakened. In addition, to ensure the success of risk and reward sharing, this study highlights the need for practitioners to involve suppliers in the early stages of the manufacturing process. Drawing from the significant effects of task programmability, we would like to remind managers that specifying the level of the suppliers' tasks determines the comprehensiveness of the risk and reward sharing mechanism.

#### *Limitations*

This paper is not exempt from limitations, which need to be considered when interpreting the findings and conducting further research. *First*, a potential limitation of this study is that two relationships were only marginally significant ( $p < 0.1$ ), i.e., the effects of risk sharing and interaction term on quality performance. Although recent empirical research in OM claims that “0.1 level effect” can still be a significant research finding (Marodin *et al.*, 2017; Tamayo-Torres *et al.*, 2017), we recommend that future research should re-examine the



underlying effects using a larger sample to increase the statistical power. *Second*, size of the sampled firms is unbalanced. A large proportion of data from small or medium-sized companies resulted in limited information content, which only reflects the existing performance in a certain small group. In contrast to small or medium enterprises, large scale enterprises possessing more resources can more easily attract their supplier firms to be involved in the early manufacturing process and conduct task programmability. Such differences impact the effectiveness of risk sharing and reward sharing practice, which in turn affect firm performance. *Third*, this research focuses only on China. Since different countries have different views on risk management practice, this also affects the result. In view of these limitations, it is recommended that the survey should be replicated in large or well-developed companies in a range of countries and industries.

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**Appendix Table About Here**

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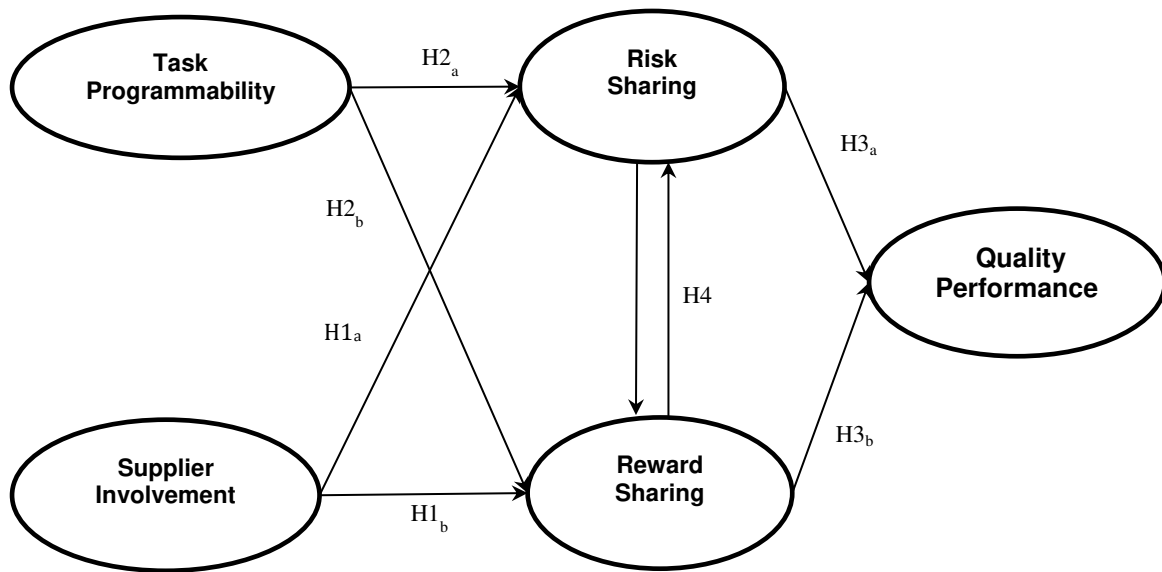
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**Figure 1. Conceptual Model**

<b>Authors</b>	<b>Measurements – Risk / Reward Sharing</b>	<b>Definition or Description of Risk / Reward Sharing</b>	<b>Method</b>	<b>Key Findings</b>
Lee and Kim (1999)	Two question items were adopted to measure both risk and reward sharing.	Degree of articulation and agreement on benefit and risk between partners.	Survey	Risk and reward sharing have significant positive impact on outsourcing success, business success and user success.
Matopoulos et al. (2007)	Not specified	The balance of risk and reward sharing is a critical factor that guides companies toward close collaboration.	Case study	The proposition that power asymmetry amplifies the imbalance of risk-benefit sharing among partnering companies is rejected.
Min and Mentzer (2004)	Three question items were adopted to measure both risk and reward sharing.	Effective SCM requires mutually sharing risk and rewards that generate a competitive advantage.	Survey	Risk and reward sharing is a first order factor of SCM that positively impacts on firm performance.
Li et al. (2015)	Five question items were adopted to measure risk sharing mechanism.	Risk sharing mechanism refers to the situation in which supply chain members use more formal policies and arrangements (e.g., agreements and contracts) to share the obligations and responsibilities in	Survey	The positive effect of risk sharing mechanism on financial performance is significant. Shared SCRM understanding positively moderates the effect of risk sharing mechanism on financial performance.



		activities and/or resources relating to supply chain risk management (SCRM).		
Fan et al. (2016)	Five question items were adopted to measure risk sharing mechanism.	Risk sharing mechanism refers to the formal policies and arrangements (e.g., agreements and contracts) through which supply chain partners share the obligations and duties for mitigating SCRs and dealing with the consequences of the SCRs in their supply chains.	Survey	<p>1. Risk information sharing and risk analysis and assessment are two significant drivers of risk sharing mechanism.</p> <p>2. Firm's operational performance is positively influenced by the risk sharing mechanism.</p>
Wiengarten et al. (2010)	Three question items were adopted to measure the incentive alignment mechanism (or risk and reward sharing).	The degree to which supply chain members share costs, risks and benefits.	Survey	The incentive alignment positively impacts on the operational performance. The incentive alignment has a stronger positive effect on operational performance when the exchanged information is characterised by high quality.
Zhang and Cao (2018)	Four question items were adopted to	The process by which supply chain partners	Survey	1. The incentive alignment is a first order

	measure the incentive alignment mechanism (or risk and reward sharing).	share costs, risks, and benefits. It includes determining costs, risks, and benefits as well as developing incentive schemes.		factor of supply chain collaboration, which is operationalised as a second order factor. 2. IOS appropriation and collaborative culture are the significant drivers of supply chain collaboration.
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**Table 1. Key Studies of Risk and Reward Sharing**

<b>Classification</b>	<b>N</b>	<b>Percentage</b>
<i>Supply Chain Position</i>		
Downstream (close to customer)	72	36.0%
Midstream	79	39.5%
Upstream (close to supplier)	49	24.5%
<i>Number of Employees</i>		
<50	61	30.5%
50-200	68	34%
>201	71	35.5%
<i>Annual Revenue</i>		
<RMB10 million	60	30.0%
>RMB10 million-RMB50 million	81	40.5%
>RMB50 million-RMB200 million	32	16.0%
>RMB200 million	27	13.5%
<i>Industry Sectors</i>		
Electronic/electrical	102	51%
Fabrics, Clothing and its alternatives	15	7.5%
Plastic and Rubber Products	41	20.5%
Furniture	34	17%
Others	8	4%

**Table 2. Company Profile**

	Risk Sharing	Reward Sharing	Quality Performance
Independent Variables			
Task Programmability	0.184***	0.507***	
Supplier Involvement	0.447***	0.184***	
Risk Sharing (RIS)			0.128*
Reward Sharing (RES)			0.263***
Interaction (RIS*RES) <i>i.e. Complementary effects</i>			-0.118*
Model Fitness			
Chi-square/d.f.	2.453		
p-value	0.012		
CFI	0.941		
GFI	0.977		
RMSEA	0.085		
IFI	0.947		
The entries in the table are standardised path coefficients. *p<0.1 **p<0.05 ***p<0.01			

**Table 3. The results of the structural model**

#### Appendix: Measurement scales and loadings

The respondents were asked to indicate the extent to which they agree or disagree with the below statements as applicable to their firm: (1 = strongly disagree – 7 = strongly agree)

		Factor Loading	Reference
Supplier Involvement ( $p_c=0.866$ ; AVE=0.619)			
SIN1	We often communicate with suppliers about quality considerations and design changes.	0.795	(Primo and Amundson, 2002)
SIN2	We develop a good cooperative relationship with suppliers.	0.735	
SIN3	The company strives to establish long-term relationships with suppliers.	0.845	
SIN4	The supplier often provides a lot of input in the new product development (NPD) process.	0.767	
Task Programmability ( $p_c=0.814$ ; AVE=0.525)			
TP1	My company invests capital to suppliers and jointly designs the production process to improve suppliers' product quality.	0.671	(Camuffo et al., 2007; Zsidisin and Ellram, 2003)
TP2	In order to ensure products meet standard requirements, my company always specifies the individual tasks.	0.800	
TP3	My company always cooperates with suppliers to establish task programmability.	0.795	
TP4	In order to monitor suppliers' product quality, we always request that suppliers provide information related to product quality such as error rate, defect rate and SPC.	0.615	
Risk Sharing ( $p_c=0.850$ ; AVE=0.654)			

RIS1	When there are any problems in the supply materials (or product), our company and suppliers will cooperate with each other to tackle the issue.	0.770	(Camuffo <i>et al.</i> , 2007; Mentzer <i>et al.</i> , 2001)
RIS2	When there are any problems in the supply materials (or product), our company and suppliers will cooperate with each other to share the related costs.	0.830	
RIS3	When there are any problems in the supply materials (or product), our company and supplier will mutually bear the responsibility.	0.825	
Reward Sharing ( $p_c=0.821$ ; AVE=0.535)			
RES1	With regard to product development, our company and suppliers always share the rewards with each other, hence achieve cost minimisation.	0.748	(Bindemann, 1999; Giannoccaro and Pontrandolfo, 2004; Yeung <i>et al.</i> , 2007; Zirpoli and Caputo, 2002)
RES2	Our company and suppliers always share the cooperation rewards.	0.706	
RES3	Our company has an effective document that clearly states the rewards for each party when there are economic benefits earned from product development.	0.702	
RES4	Our company has specified in the commercial agreement various rewards that will be shared with suppliers (such as the new knowledge of product development to supplier).	0.767	
Quality Performance ( $p_c=0.851$ ; AVE=0.535)			
QP1	With regard to product reliability, my company's product achieves higher customer satisfaction when compared to our competitors'.	0.815	(Kristal <i>et al.</i> , 2010)
QP2	With regard to product safety, my company's product achieves higher customer satisfaction when compared to our competitors' products.	0.799	
QP3	With regard to product durability, my company's product achieves higher customer satisfaction when compared to our competitors'.	0.723	
QP4	The number of complaints regarding our product has been decreasing over the last three years.	0.651	
QP5	The number of product litigation claims has been decreasing over the last three years.	0.651	