Supply chain information sharing: Who does it benefit more?

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Abstract
This study investigates how benefits of supply chain information sharing (SCIS) are allocated among supply chain parties. The results indicate that the receiving parties always benefit from IS, while the disclosing parties' benefits are contingent. The results also find a transferable effect of customers' IS with manufacturers on supplier performance.

Keywords: Supply chain information sharing, Innovation performance, Benefits allocation

INTRODUCTION

In recent years, some scholars in supply chain management recognized that there exists a "dark" side of supply chain collaborations (Cheung et al., 2011). Cheung et al. (2011) referred to this "dark" side as the problem of "pie sharing". However, most empirical studies only investigated the effect of IS on one party's performance (Prajogo & Olhager, 2012; Wu et al., 2014), or supply chain performance (Huo et al., 2014). This leads to a lack of understanding on whether all parties involved in IS gain equal benefits or one party extracts a larger fraction of the benefits.

This study intends to uncover this "pie sharing" issues in the context of supply chain information sharing (SCIS). Specifically, there are three research objectives in this study. First, IS between buyers and suppliers (two-level SCIS) has received extensive attention (e.g. Zhou & Benton, 2007). But our knowledge about how profits are shared between the two involved parties of IS is limited. Thus, our first objective is to find out the effect of IS on performance of both disclosing and receiving parties in two-level SCIS. Second, few studies have paid attention to three-level SCIS, which includes IS between suppliers, manufacturers, and customers. Since none of the entities in supply chains exits in isolation, one party's interaction with another party may be influenced by a third party. Thus, in three-level SCIS, disclosing and receiving parties may benefit differently, compared with those in two-level SCIS. So, our second objective is to find out the joint effect of two types of two-level SCIS on performance of disclosing and receiving parties in a three-level supply chain. Third, using the same logic of the bullwhip effect that downstream IS could influence upstream parties' decision-making about production plans and inventory levels (Lee et al. 1997), we argue that downstream IS could also influence

upstream parties' performance. We term this influence as the "transferable effect" of IS, which has been ignored by most of the extant research. Thus, the third objective of this study is to find out the transferable effect of downstream IS on performance of upstream parties.

To achieve these objectives, we will explore the following research questions: (1) In a manufacturer-supplier setting, how does manufacturers' IS with suppliers influence performance of manufacturers (IS disclosing parties) and suppliers (IS receiving parties), respectively? (2) In a customer-manufacturer-supplier setting, how does manufacturers' IS with suppliers influence performance of manufacturers (IS disclosing parties) and suppliers (IS receiving parties) in the presence of customers' IS with manufacturers? (3) How does customers' IS with manufacturers influence performance of suppliers?

THEORETICAL BACKGROUND AND RESEARCH HYPOTHESES

Supply Chain Information Sharing

SCIS refers to the extent to which critical and strategic information is shared among supply chain partners to satisfy final customers effectively and efficiently (Vanpoucke et al., 2009). There are two critical issues need to be addressed regarding SCIS. One is the participant of IS, and the other one is the direction of IS. For the participant of IS, previous studies mainly focused on buyer-supplier settings when referring to SCIS. However, the buyer-supplier setting does not adequately capture the essence of supply chains (Choi & Wu, 2009; Eckerd & Hill, 2012). Thus, our study first investigates the effect of IS on performance of two directly involved parties in a two-level supply chain. Then, we investigate the joint effect of two types of IS on performance of two parties in a three-level supply chain, to find out the differences between these two SCIS paradigms.

For the direction of IS, previous literature mainly focused on mutual IS between suppliers and buyers (e.g. Wu et al., 2014), and seldom distinguished the direction of IS. However, in reality, there are two directions of IS: backward IS indicates IS from buyers to suppliers and forward IS indicates IS from suppliers to buyers. These two directions of IS are different and different directions of IS result in different levels of performance for buyers and suppliers (Klein & Rai 2009; Cheung et al. 2011), which means that benefits may not be equally allocated between disclosing and receiving parties. In this study, we focus on backward IS, namely IS from downstream to upstream parties.

Overall, to develop a better understanding of the definition of SCIS, this study responds to the above two issues by incorporating customers' IS with manufacturers (CISM) and manufacturers' IS with suppliers (MISS). CISM and MISS individually can be viewed as a similar concept. In this study we view CISM as downstream IS and MISS as upstream IS according to their relative positions to manufacturers.

The Impact of SCIS on Innovation Performance

Innovation has been deemed as an important weapon to compete in the modern business world characterized by rapidly changing markets and short product cycle time (Fosfuri & Tribó, 2008). Hence, one new requirement for supply chains to be competitive is to maintain innovative and quickly provide new products to changing markets. We term this concept as innovation performance, which is different with innovation strategies or activities that companies may

pursue (Modi & Mabert, 2010). Instead, innovation performance stresses on the outcomes of innovation, which is to meet customers' requirements and quickly provide new products to changing markets (Goodale et al., 2011). This would be one of the most valuable benefits of SCIS in this dramatically changing environment. Thus, in this study, we focus on innovation performance to examine the effects of SCIS.

Gupta and Govindarajan (2000) argued that the greater the value of the information shared by one party, the greater the benefit to the other. Specifically, MISS mainly shares information about production plan, demand forecast, and inventory level, which enables suppliers to align strategic actions and adjust their plans and resource positions (Klein & Rai, 2009). More importantly, IS is always accompanied with knowledge transfer. Thus, besides demand and inventory information, suppliers may acquire and absorb knowledge from manufacturers (Huo et al., 2014), which can serve as an external resource for suppliers to enhance their innovation performance (Laursen & Salter, 2006). Therefore, we propose:

H1a. MISS is positively related to supplier innovation performance

MISS could also influence manufacturers because IS represents a close tie between manufacturers and suppliers which could help manufacturers improve their innovation performance (Roy et al., 2004). Specifically, MISS shows manufacturers' commitment to the relationship, suppliers perceiving this commitment would involve themselves in manufacturers' new product development in return (Carr & Kaynak, 2007). The more information shared by manufacturers, the earlier stages suppliers are involved. This enables suppliers to offer suggestions regarding product or component simplification (Forza & Filippini, 1998). Thus, manufacturer innovation performance is enhanced. Therefore, we propose:

H1b. MISS is positively related to manufacturer innovation performance

Few studies have investigated the effect of IS on a third supply chain party. Because the aim of engaging in supply chains is to satisfy final customers efficiently and effectively, it is possible that supply chain partners are not only influenced by their direct customers but also by other downstream parties. Recent studies found that suppliers and customers do not exist in isolation. One party could influence the role the other party plays. For example, Flynn et al. (2010) reported that supplier and customer integration moderate each other's effect in improving performance. This provides valid evidences that customers' activities could influence suppliers' activities, and vice versa. Specifically, CISM enables manufacturers to have a better knowledge of customer requirements, which would ultimately be interpreted as the manufacturers' requirements for suppliers. From this perspective, CISM serves as an input for the suppliers to better satisfy their direct customers with new products and responsiveness. Therefore, we propose:

H2a. CISM is positively related to supplier innovation performance

Similar to MISS, CISM also has a positive impact on the performance of receiving parties, namely manufacturers. Specifically, CISM shares market and demand information with manufacturers. These kinds of information enable manufacturers to react more quickly to customers' changing needs, and help them to offer more customized products and services. In addition, downstream IS could reduce uncertainties for upstream parties (Cheung et al., 2011). Thus, manufacturers could put their extra efforts into innovation activities other than dealing with uncertainties. Therefore, we propose:

H2b. CISM is positively related to manufacturer innovation performance

Figure 1 presents the conceptual model with the hypotheses about MISS, CISM, and supplier and manufacturer innovation performance.

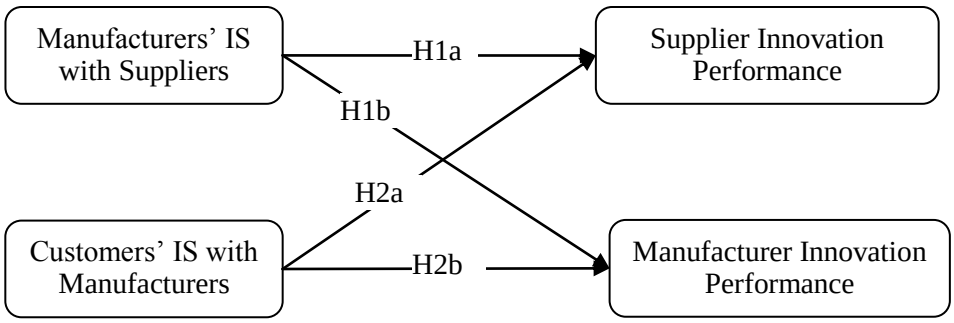

Figure 1 — Conceptual Model

RESEARCH METHODOLOGY

Sampling and Data Collection

Data were collected from five unevenly developed cities in China: Chongqing, Tianjin, Guangzhou, Shanghai and Hong Kong. To obtain a representative sample, we randomly selected companies from the yellow pages of China Telecom for the four mainland China cities and from the Chinese Manufacturers Association Directory for Hong Kong. The selected companies were first contacted by telephone to obtain the contact details of key informants and their preliminary agreement to participate in the survey. Supply chain manager, CEO/president, vice president or director in charge of marketing and purchasing were targeted as respondents since they were knowledgeable about the company's internal and external processes. Out of the 4,569 companies contacted, 1,356 agreed to participate. 617 valid questionnaires were received in the end. Based on the number of companies initially contacted, the response rate was 13.5%.

83.2% of the respondents had been in their position for 3 years or more. Thus, they were familiar with their companies and had sufficient knowledge to complete the survey. The respondent companies covered a wide range of industries. The highest percentage (25.5%) of companies were reported in metals, mechanical, and engineering industries, followed by textiles and apparel industries (17.9%). Regarding company size, the median number of employees was approximately 100. Although median annual sales were between HK$10 million and HK$20 million, companies with sales of less than HK$5 million accounted for 32% of all reporting companies, and 25% of companies had annual sales of more than HK$50 million. Approximately one-third of the companies were small with less than 50 employees, one-third were medium-sized companies with 50-200 employees, and one-third were large-sized companies with more than 200 employees. Such a sample represents a wide range of companies in China.

We used Harman's one-factor test (Podsakoff & Organ, 1986) to check the potential common method bias. The EFA results revealed four distinct factors for the variables, suggesting that common method bias was not an issue.

To test non-response bias, we compared physical assets, annual sales, number of employees, and all variables used in this study, between early and late responses (Handfield & Bechtel, 2002). No statistical differences were found between them at the 0.05 significance level, suggesting that non-response bias was not a major concern in this study.

Questionnaire Design

All items were adapted from previous studies. The measures for MISS were adapted from

those of Frohlich and Westbrook (2001), and Devaraj et al. (2007). The measures for CISM were adapted from those of Cachon and Lariviere (2001), and Frohlich and Westbrook (2001). The measures for supplier and manufacturer innovation performance were adapted from those of Laursen and Salter (2006) and Goodale et al. (2011). Each measurement item was rated on a 7-point Likert scale. All items are presented in Table1.

Since the scales were developed from English literature, the first version of the questionnaire was in English and then translated into Chinese by an OM professor in China. The Chinese version was then translated back into English by another OM professor. This translated English version was then checked against the original English version for accuracy. The Chinese version was used in the mainland Chinese cities and a bilingual version was used in Hong Kong.

Table 1 — The EFA Results

Items	**Factor loading**			
	MISS	SIP	MIP	CISM
The level of market information shared by our major customer	0.199	0.090	0.115	**0.754**
Our major customer shares point of sales information with us	0.220	0.071	0.150	**0.859**
Our major customer shares demand forecasts with us	0.271	0.122	0.187	**0.800**
Our company has the ability to quickly modify products to meet customers' requirements	0.016	0.316	**0.777**	0.148
Our company could quickly introduce new products into markets	0.069	0.205	**0.853**	0.143
Our company could respond quickly to market change	0.136	0.218	**0.836**	0.168
We share our production plans with our major supplier	**0.874**	0.122	0.070	0.220
We share our demand forecasts with our major supplier	**0.833**	0.146	0.093	0.267
We share our inventory levels with our major supplier	**0.870**	0.160	0.062	0.224
Our major supplier has the ability to quickly modify products to meet our requirements	0.084	**0.854**	0.197	0.088
Our major supplier could quickly introduce new products into markets	0.169	**0.818**	0.267	0.092
Our major supplier could respond quickly to market change	0.194	**0.831**	0.275	0.114
Eigenvalues	2.474	2.367	2.305	2.215
Total Variance Explained	78.008%			

Measurement Development

We followed the two-step method suggested by Narasimhan and Jayaram (1998) to test construct reliability. First, exploratory factor analysis (EFA) was performed to ensure the unidimensionality of the scales. In the second step, Cronbach's alpha was calculated to assess the reliability of each construct. The result of EFA is presented in Table 1, revealing that all items had strong loadings on the constructs that they were supposed to measure and had lower loadings on the constructs that they were not supposed to measure. The results demonstrated construct unidimensionality. Table 2 shows that all four Cronbach's alpha values were above 0.80, suggesting that the scales were reliable.

Table 2 — Correlation and Reliability Tests

Construct	**Mean**	**SD**	**MISS**	**CISM**	**SIP**	**Cronbach's α**
Manufacturers' IS with suppliers (MISS)	3.32	1.65	-			0.891
Customers' IS with manufacturers (CISM)	3.95	1.56	0.53*	-		0.817

Supplier innovation performance (SIP)	4.71	1.31	0.36*	0.30*	-	0.867
Manufacturer innovation performance (MIP)	5.20	1.19	0.25*	0.38*	0.56*	0.846

**p<0.01.*

In the convergent validity test, each item was linked to its corresponding construct and the covariance among the constructs was freely estimated. The model fit indices ($\chi 2$ = 269.98 with d.f. = 48, RMSEA = 0.088, NNFI = 0.95, CFI = 0.97, SRMR = 0.033) indicated that the model was acceptable (Hu & Bentler, 1999). In addition, all factor loadings were higher than 0.50 and all t-values were greater than 2.0, which confirmed the convergent validity of the scale (Chau, 1997). To test discriminant validity, we built a constrained CFA model for each possible pair of latent constructs, in which the correlation between the paired constructs was fixed to 1.0 (O'Leary-Kelly & Vokurka, 1998). The results were compared with those of the original unconstrained model, in which the correlations were freely estimated. All Chi-square differences were found to be significant at the 0.01 level, demonstrating discriminant validity.

RESULTS

Structural Equation Modeling Results

SEM estimates were generated using LISREL 8.54 with the maximum likelihood estimation method. The fit indices for our model were: $\chi 2$ = 202.61 with d.f. = 47, RMSEA = 0.074, NNFI = 0.97, CFI = 0.98, and SRMR=0.034, which suggested that the model is acceptable (Hu & Bentler, 1999). Figure 2 shows the SEM results with standardized coefficients for the paths that were significant at the 0.05 level.

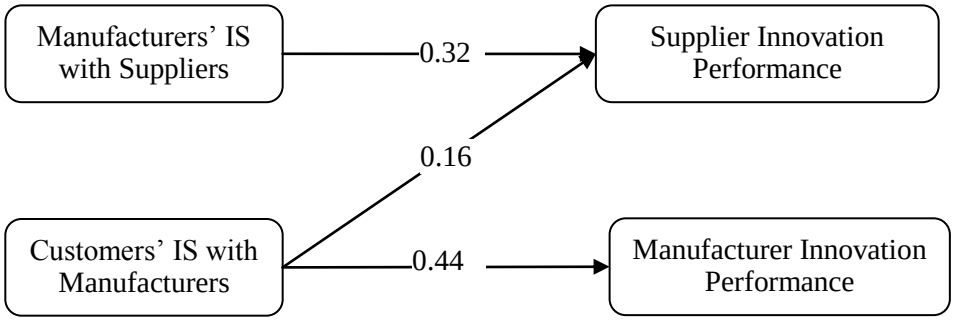

Figure 2 — SEM Results

Regression Results

We performed a series of regression analyses to further explore the relationship between SCIS and performance, and more importantly, to explore the differences between two-level and three-level SCIS (Table 3). In model 0, the result indicates that CISM has a significantly positive effect on supplier and manufacturer innovation performance. Specifically, in model 1, the results indicate that in a manufacturer-supplier dyad, MISS benefits both suppliers and manufacturers. Model 2 including both CISM and MISS is similar to the SEM model that represents three-level SCIS. These regression models also produce the similar results as those of the SEM model, that MISS is only positively related to supplier innovation performance, while CISM is positively

related to both supplier and manufacturer innovation performance. The R-square change from Model 1 to Model 2 is significant (0.017, 0.088 respectively), indicating that the three-level SCIS has more explanatory power than the two-level SCIS. We also tested the interactive effect of CISM and MISS in Model 3. The results show one significantly positive and one marginally significantly positive interactive effect. This means that when MISS and CISM are simultaneously implemented, both suppliers and manufacturers benefit more from IS.

Table 3 — The Regression Results

	Dependent Variable							
Independent	Supplier innovation performance				Manufacturer innovation performance			
Variable	Mode 0	Model 1	Model 2	Model 3	Model 0	Model 1	Model 2	Model 3
Constant	3.71**	3.78**	3.47**	3.37**	4.05**	4.61**	4.00**	3.95**
CISM	0.25**		0.13**	0.15**	0.29**		0.27**	0.28**
MISS		0.28**	0.22**	0.20**		0.18**	0.05	0.04
MISS*CISM				0.07**				0.03*
R^2	0.091	0.128	0.145	0.164	0.147	0.062	0.150	0.154
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Change in R^2	-	-	0.017	0.019	-	-	0.088	0.005
Change in F	-	-	12.392	14.055	-	-	63.399	3.368
p-value (change)	-	-	0.000	0.000	-	-	0.000	0.067

$^{**}p<0.05$; $^{*}p<0.1$

DISCUSSION AND MANAGERIAL IMPLICATIONS

Backward IS: Whom Does It Benefit More?

Our regression results find that in two-level SCIS, MISS is positively related to both supplier and manufacturer innovation performance, indicating that both receiving and disclosing parties benefit from two-level SCIS. This finding is consistent with those of previous research (Klein & Rai 2009; Cheung et al. 2011). Our regression and SEM results also find that in three-level SCIS, when CISM is considered, MISS only has a positive impact on supplier innovation performance, indicating that only receiving parties benefit from three-level SCIS, disclosing parties do not. In addition, there exists a complementary effect between CISM and MISS in improving manufacturer performance. Though manufacturer performance is mainly improved by CISM, MISS also plays a role in influencing manufacturer performance through enhancing the effect of CISM. In this regard, our study indicates that the effect of SCIS on supply chain partners' performance can only be fully understood through examining three-level SCIS.

Considering the results reported in both two- and three-level SCIS, our research concludes that benefits achieved from IS are not equally allocated among supply chain partners and that the receiving parties extract more benefits from SCIS than the disclosing parties. This uncovers the "pie sharing" issues of supply chain collaboration. From this perspective, our study takes a further step examining the "dark side" of SCIS, that due to the competition for profits, supply chain members do not always gain positive outcomes when they devote to their supply chain relationships. More importantly, our study finds that from two-level SCIS to three-level SCIS, the benefits of manufacturers are reduced from positive to none, indicating that too much involvement in SCIS may hurt company benefits. This reflects another "dark" of SCIS, that there

exists a domain for collaboration and IS to generate positive outcomes, beyond which, too much involvement is SCIS would approach a "neutral zone" (Narayanan et al., 2015), in which none benefits would be achieved.

These results provide significant managerial guidelines for companies involved in SCIS. Managers should understand the complex mechanism of benefiting from SCIS. First, devoting information and resources to supply chain partners cannot guarantee positive outcomes. However, it is still necessary to share information and collaborate because it is a method of showing goodwill which is beneficial to the long-term cooperative relationships with supply chain parties and it is critical for company performance in the long run. Second, managers should understand there are "dark sides" of SCIS. Supply chain members competing for profits is on the one hand, on the other hand, involving too much in SCIS may lead to nothing but costs. Therefore, supply chain managers should carefully control the extent of their involvement in supply chains and the amount of information they share.

The Transferable Effect of Backward IS

Our findings also indicate that CISM is positively related to supplier innovation performance. This is consistent with those of previous research. For example, Lau et al. (2004) revealed that retailers' IS with distributors can help manufacturers decrease their operational cost. This result demonstrates the transferable effect of downstream IS. Specifically, customers sharing information with manufacturers is a downstream activity, it increases manufacturer and supplier innovation performance. From this perspective, the positive effect of downstream IS could transfer backward along the supply chain. This finding illustrates the significant role of downstream IS that IS does not only influence the direct receiving party, but also other upstream parties.

Previous studies did not pay enough attention to the transferable effect of SCIS. We argue that it is the transferable effect that determines the value of SCIS and all the other supply chain activities. Specifically, companies engaged in supply chains expect to respond quickly to the changing markets with better products and service. This could only happen if downstream parties share strategic market information to their upstream partners and this information transfers further back along the supply chains. This reflects the true value of supply chains that a supply chain serves as a resource pool and every member in the supply chain could leverage these resources and benefit from any information flow happening within the supply chain. From this perspective, our study adds to the knowledge of the value of supply chains and provides novel perspectives regarding the effect of SCIS.

Overall, our empirical results suggest that downstream IS (CISM) results in greater benefits and its positive effect could transfer backward along supply chains. This finding provides significant practical implications for supply chain managers. Specifically, every company is facing upstream suppliers and downstream customers. Managers should aware that customers' IS could help them and their suppliers improve innovation performance. Thus, companies should make efforts to provide incentives for customers to share information. From this perspective, we recommend supply chain managers to take a systematic view towards supply chains. Specifically, they should understand that companies in supply chains do not exist in isolation. On the contrary, they would influence and be influenced by other companies along the supply chains. Therefore, when initiating an innovation or sharing information, companies should consider the effect they may exert on other supply chain parties and try to maximize the overall profits. Likewise, supply

chain managers should always inspect the behaviors of other supply chain parties to avoid their bad influence and hold on to the good ones.

CONCLUSIONS AND LIMITATIONS

This study tests the effect of backward IS on different parties' innovation performance in both two- and three-level SCIS contexts based on information processing theory and the relational view. Specifically, the research finds that benefits of SCIS are not equally allocated among supply chain parties, with upstream parties benefit more from backward SCIS than downstream parties and there exist a transferable effect of backward IS along supply chains.

Though our studies have significant contributions theoretically and practically, there are still some limitations that provide directions for future research. First, we did not include customer performance in the model. Future research could include all three parties' performance to examine the effect of IS. Second, we only tested backward IS. Future studies could test the effect of forward IS and find out the differences of the two directions of IS.

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