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1. Introduction

Internal cross-functional integration is well established as critical to various dimensions of performance in organizations. Empirical research in operations management and other related management disciplines substantiates this to be the case in practice (c.f. Pagell 2004, Wu et al. 2004, Braunscheidel and Suresh 2009, Flynn et al. 2010, Zhao et al., 2011, Bendoly et al. 2012, etc.). Although not explicitly examined in all of these studies, an assumption is that such beneficial cross-functional integration can only be built on effective knowledge sharing between functions (Cheung and Lee, 2002; Hausman et al., 2002; Sawhney and Piper, 2002; Swink and Song 2007). Cross-functional knowledge sharing takes many forms, ranging from routine and often mandated exchange of information between the modules of an enterprise system, voluntary updates on work progresses and exchange of different perspectives in cross-functional meetings, to personal conversations between members of different functions that occur on a spasmodic and spontaneous basis.

The extant literature provides a strong foundation for considering the important distinction between formal mandatory, often in fact automated, exchanges and more discretionary sharing (Tatikonda and Montoya-Weis, 2001; Flynn and Flynn 1999). While mandated and routine knowledge exchange is surely important, non-routine voluntary knowledge exchange (i.e., exchange that is incidental and non-compulsory) is also crucial to performance (Bharadwaj et al., 2007, Stratman 2007). The focus of such past studies has been on broadly cultural and somewhat unilateral representations of voluntary knowledge sharing (i.e. “we share”). While of vital importance, we argue that additional value emerges from a more granular examination of specifically what is voluntarily shared, and the kind of opportunities, abilities and motivational mechanisms that can promote such sharing by two functional units composing a knowledge sharing dyad. The research questions driving the present study, therefore, ask what organizational antecedents drive voluntary knowledge exchange between two specific functional units – Production and Sales – and how Production-Sales voluntary knowledge exchange affects organizational performance. This research endeavor is grounded in our observation of

management practices.

Given the importance as well as challenge of promoting voluntary knowledge exchange between functions within the same organization, our study attempts to understand what organizational factors may encourage or hinder such exchange, and further, how (in)adequate voluntary knowledge exchange may affect firms' operational performance. We focus on the specific form of voluntary knowledge exchanged between Production and Sales units in organizations. Our choice of this dyad in particular is driven by its pivotal position in the value chain (c.f. Malhotra and Sharma, 2002; Parente 1998). In identifying theoretical drivers of and barriers to voluntary cross-functional knowledge exchange, we draw on the motivation-opportunity-ability (MOA) framework of industrial psychology. This framework has been used to guide the investigation of antecedents to knowledge sharing *between individuals* in organizations, in particular which of the three MOA antecedents may serve as bottleneck or "constraining factor" to sharing knowledge (Siemsen et al., 2008, 426). Siemsen et al. (2008) identify the constraining factor for each individual knowledge sender and show that MOA antecedents have a stronger effect on knowledge sharing attempts when they are constraining than when they are not. Siemsen et al.'s (2008) constraining factor theory can be applied broadly to explain knowledge sharing behaviors. Our study applies the basic logic of this theory and proposes a theoretical model for voluntary cross-functional knowledge exchange (Figure 1). This model extends Siemsen et al.'s (2008) constraining factor theory in two specific ways.

First, following recent examinations of knowledge-sharing antecedents such as motivation, opportunity and ability at a higher level of analysis (e.g., Argote et al. 2003; Clark et al. 2005; Wu et al. 2004), we rely on MOA to identify antecedents that affect knowledge sharing behaviors *between functions*. According to this framework, a functions' voluntary knowledge sharing is dependent not only on its ability, but also on its motivation and opportunity to share.

Second, we hold a bilateral view of cross-functional knowledge exchange; a view that emerges from the premise that different functional units, such as Production and Sales, face distinct operational

challenges, priorities, and incentives (Schmenner and Swink, 1998), and thus have distinct perspectives. This is unprecedented yet eminently logical for management practice. As one of our COO interviewees put it, "our sales and production departments clearly have different mindsets and different responsibilities; and their understanding of the firm's overall objectives and that of the importance of customers also differ." As a result our theoretical model accounts for MOA antecedents as well as performance outcomes of the two sides of knowledge sharing. In this model, Opportunity, representing the environmental or contextual mechanisms that enable voluntary knowledge exchange to occur, can be viewed as a largely shared factor (e.g., cross-functional rotation and training, and joint attendance at cross-functional meetings). In contrast, Motivation and Ability could have distinctions between the two sides of knowledge sharing depending on, for example, how incentives are structured and the knowledge base possessed.

To test this theoretical model, we collected survey data on the Sales-Production interface from a random sample of 182 Chinese electronic manufacturers in the prominent industrial Guangdong Province. This sampling restriction allows us to study the research questions on hand free of noise caused by industry, economic climate and culture. For each of the firms, we collected survey responses from the Sales, Production and executive-level managers in order to minimize common source bias. Our survey questions were constructed based on 27 in-depth interviews with managers in the same firm population. The findings of this study make a notable contribution to scholars and practitioners in operations management, by suggesting that the constraining factors in motivation and ability to exchange knowledge across the production-to-sales and sales-to-production interface are asymmetric: different departments have different drivers for knowledge sharing. Our study thus provides specific suggestions for the theory and practice of improving production-sales knowledge exchange.

2. Theory and Hypotheses

This study focuses on knowledge exchange between functional units that is incidental, non-compulsory, and beyond the scope of routine day-to-day interactions; i.e., what we refer to here as

"*voluntary*" exchanges. We specifically focus on the examination of Production-Sales knowledge exchange, the importance of which has been illustrated in the operations literature. Tatikonda and Montoya-Weiss (2001) for example integrate operations and marketing perspectives in their study of cross-functional drivers of product development performance. Gattiker (2007) argues that the manufacturing/marketing interface is still an understudied yet critical domain because of its link to performance-related outcomes, and de Vries and Boonstra (2010) illustrate the pivotal position of the Production-Sales interface in the context of ERP implementations. Turkulainen and Ketokivi (2012) further explicitly recommend more research on disaggregated perspectives of integration across operations and marketing/sales to further understand contingent effects on performance. Discussions of the importance of market orientation in the OM literature are equally well established (c.f. Klassen 2001, Narasimhan and Talluri 2009, Bendoly et al. 2012), emphasizing the importance of exchanges between these two functional units in supporting market performance while mitigating supply chain risk.

In order to identify specific activities and organizational policies that can drive effective P2S and S2P voluntary knowledge exchange, we set off to seek a theoretical framework that sheds light on the antecedents to performance of voluntary behaviors at the functional level in general. The MOA framework holds some promise in this regard. According to Siemsen et al. (2008), its origins can be traced to early 20th century debates among industrial and social psychologists on the relative importance of critical antecedents driving behavior and work performance, in particular deliberating the extent to which workers' performance is a function of their capabilities (ability) vs. their willingness to act (motivation). In other words, these discussions focused on the relevance of jointly considering both individual ability and motivation (cf. Vroom 1964; Maier 1955). Although the complementary nature of these factors is assumed in these discussions, Cummings and Schwab (1973) noted that their effects on performance might be captured equally well in a simple linear form. The work of Blumberg and Pringle (1982) was of seminal importance in creating the MOA framework because of its emphasis on the role of opportunity as a third pivotal element on which action and work performance was contingent..

Influential applications of these three factors have since extended into other domains such as Marketing and Operations (cf. MacInnis et al. 1991). Of particular relevance to the present article is Siemsen et al.'s (2008) insights using MOA to account for individual employees' knowledge sharing attempts with their colleagues within the same functional unit. A main message from this paper is the "bottleneck" or constraining antecedents determine individuals' knowledge sharing attempts. However, the application of MOA clearly has a place at the organizational level of analysis as well (Argote, et al. 2003); a point supported by a steady stream of literature that continues to consider motivation, ability and opportunity at an organizational level (c.f. Stajkovic et al. 2009, Park et al. 2014).

Accordingly, we propose the following general model for MOA applied to voluntary cross-functional knowledge exchange between two particular functional units in an organization (See Fig 1).

[Insert Figure 1 here]

At the center of the model is the adequacy of knowledge voluntarily exchanged from one function to another. We define "adequacy" of knowledge exchanged as sufficient and satisfactory, as per its Merriam-Webster definition. In this general model for cross-functional voluntary exchange, institutionalized opportunities for face-to-face interaction are fundamentally *shared* opportunities (O). Along with this shared factor, the motivation and ability of the first functional unit (M1, A1) drive the adequacy of knowledge voluntarily provided to the second functional unit (X12). A similar structure is used to model the antecedents (M2, A2) to exchange by function 2 towards functional unit 1 (X21). The adequacy of both exchanges ostensibly impact higher level organizational performance (Bendoly et al. 2012; Oliva & Watson 2011; Thome et al. 2014).

Three features of this model are worth noting. First, the model allows the level of knowledge adequacy to be different on the two sides of the bilateral exchange (X12 vs. X21). Second, it allows the relative importance of the antecedents of knowledge exchange adequacy to vary dependent upon the functional units in question (e.g., M1X can be of a different strength than M2X). This is critical since the two functions may differ in how the adequacy of their voluntary knowledge sharing changes in response

to alternative levels of MOA antecedents. To illustrate, one might find that X12 is insensitive to changes in a certain MOA antecedent, say ability; this may in turn indicate that ability is not a constraining factor for function 1 in sharing knowledge with function 2 (extending the logic of Siemsen et al., 2008). X21 on the other hand, may very well be quite reactive to changes in ability, possibly because ability is a constraining factor for function 2. Lastly, the model allows the two directions of knowledge exchange (X12, X21) to have differential effects on organizational performance. This accommodates a range of performance measures that may be more dependent on one side of the bilateral exchange in particular, depending on the context and functions involved (Bendoly et al., 2012).

2.1. Shared Cross-functional Opportunity for Exchange

In any MOA framework, opportunity represents the environmental and contextual mechanisms that generally allow for the specific form of action to take place. Without the opportunity to carry out an action, the action will not materialize. Concerning voluntary knowledge sharing, it is therefore absolutely critical to have opportunities through which spontaneous exchange can occur between the involved parties. Often it turns out these opportunities are part of an institutionalized structure (Lave and Wenger, 1991). Cross-functional planning meetings, training programs and rotations, and positions set specifically to facilitate cross-functional interactions, are emblematic of efforts targeted towards accomplishing these opportunities. Most notably, these cross-functional engagements assume the involvement of both parties (if A meets with B, B meets with A). Hence within a firm, institutionalized opportunities for cross-functional interactions can be viewed as a common shared resource that can ostensibly empower sharing by both sides in a bilateral exchange dyad.

H1: Institutionalized opportunity to engage in cross-functional interactions between production and sales functions promotes the adequacy of P2S and S2P voluntary knowledge exchange.

2.2. Functional Motivation for Exchange

Motivation is a critical element in the MOA framework as it represents the human impetus to take advantage of opportunities available (Cummings and Schwab, 1973). Yet motivation is notoriously

difficult to operationalize and measure, which is why it has lost a great deal of its former interest in the organizational behavior literature (Ambrose and Kulik, 1999). One of the most popular approaches posits that motivation is largely tied to key antecedents such as incentives (Siemsen et al., 2007). These incentives consist of both the performance rewards, as well as the extent to which individuals feel they have control over their realization of those rewards (and the extent to which they have high effort-to-performance expectancy). Drawing on control and expectancy theory and its application to behavioral approaches in operations management, if individuals feel they have little control over the performance for which they are rewarded, or if they have low effort-to-performance expectancy, they are unlikely to have a desire to act in non-compulsory ways that might promote that performance (Vroom 1964; Bonoma and Johnston, 1979; Bendoly et al. 2008; Chen et al. 2016). We therefore suggest:

H2a: Production's and Sales' perceived control over rewarded performance positively impacts the adequacy of P2S and S2P voluntary knowledge exchange, respectively.

We further expect the magnitude of this effect to vary between two sides of cross-functional knowledge flow. This is because the type of performance based on which incentives are determined is typically more controllable for Production than they can be for Sales. Sales functions are confronted with the task of appealing strongly to markets with fairly uncertain and often seasonally volatile response (Weitz, 1981). Production functions are certainly not strictly confronted with stable tasks, however they are usually given some advanced warning with regards to orders that need to be scheduled. Their primary directives often focus on maintaining production volume, utilization, quality, timing and cost, regardless of variable demands placed on them by Sales (Schmenner and Swink, 1998). They are thus in more of a position to control incentivized performance. Such differences in perceived control (antecedents of motivation) result in possible differences in how variation in perceived control serves as a constraining factor (Siemsen et al., 2008) on knowledge sharing. Distinctions in this sensitivity should therefore be observable between P2S and S2P knowledge exchange if production and sales functions have different levels of perceived control over rewarded performance.

H2b: The magnitude of the effect of perceived control over rewarded performance on the adequacy of voluntary knowledge exchange differs between P2S and S2P exchange.

2.3. Functional Ability to Exchange

Ability represents the extent to which individuals are skilled in executing tasks competently (Rothschild, 1999; MacInnis et al. 1991). With specific reference to cross-functional voluntary knowledge exchange, particularly essential is the ability to identify knowledge deemed important to the other party. Identification of such knowledge requires a recognition or *awareness* of the priorities of the other functional unit, an insight into the mental models held by the other party (Huber and Lewis, 2010, Bendoly 2014), and sound judgment on what knowledge may help the other function to meet its priorities. When one function does not understand the priorities of the other, it is unlikely that they will have the ability to make effective exchanges (Lovejoy and Ying, 2002).

As examples, consider the following two scenarios witnessed in practice. Following a meeting in which market share loss was emphasized, a firm's Production function develops the impression that Sales has been particularly charged with finding opportunities to increase customer satisfaction. Unfortunately, in reality the Sales function's main priority continues to be capturing and maintaining high-margin clients. Consequently, Production conveys to Sales knowledge that identifies improvement opportunities for new delivery offerings and service guarantees (e.g., R&D progress and quality program projections). It does not convey to Sales any cost related knowledge (such as certain orders requiring additional testing time and frequent machine setups), which could have helped Sales identify the least profitable clients. In another scenario, Sales discovers that a certain failure-prone product feature is not valued at all by the customers. Sales fail to communicate such knowledge, since it is not aware that Production's priorities include cost reduction through quality improvement efforts. In these examples, the adequacy of knowledge exchanges is therefore affected by the sender's awareness of the recipient's needs. We thus propose that awareness of the knowledge receiver's priorities enhances the adequacy of voluntary knowledge exchange.

H3a: Production's awareness of Sales' priorities and Sales' awareness of Production's priorities positively impacts the adequacy of P2S and S2P voluntary knowledge exchange, respectively.

We furthermore presume that differences in awareness of this type likely exist between production and sales functions. This stems largely from the nature of the Production-Sales-customer connections. In make-to-stock or make-to-order settings, such as those we will be investigating, the first line of communications with customers is Sales. The sales function has the most immediate visibility into consumer demands and how its own actions, and the effectiveness of those of Production, impacts that demand. In these settings, such information is typically imperfectly filtered through Sales before reaching Production (Parente et al., 2002). Due to its limited visibility into downstream activity, the production function may have insufficient ability to identify useful information to deliver to Sales (Ho and Tang, 2004). Sales on the other hand, being continuously on the receiving end of Production, is aware of its priorities and objectives.

In summary, we maintain that production and sales functions may vary in their awareness of the other function's priorities and objectives. This translates into differences in how constraining such awareness is (Siemsen et al. 2008), and thus impacts how important such awareness is in affecting voluntary knowledge exchange to the other function.

H3b: The magnitude of the effect of a function's awareness of the other function's priorities on the adequacy of voluntary knowledge exchange differs between P2S and S2P exchange.

2.4. Knowledge Exchange and Higher Level Performance

Exchanges that are adequate, with regards to fulfilling the specific contextual needs of a given organizational function, make augmented alignment between the source and the recipient functions and hence reduce task uncertainty for both (Galbraith, 1977; Sethi, 2000; Hansen and Nohria, 2004; Bendoly et al., 2009). For example, for Production, adequate knowledge from Sales allows it to better design and schedule cost effective production runs that simultaneously meet the needs of Sales (Lee et al., 1997; Oliva and Watson 2009). For Sales, adequate knowledge from Production can help Sales

account for planned maintenance, supply problems or even excess stock that might be capitalized on in promotional efforts; hence avoiding requests to Production for changes that could be disruptive (Bharadwaj et al., 2007). In accordance with Organizational Information Processing Theory (OIPT; Galbraith 1973), particularly in a context in which distinct organizational functions necessarily interact, adequate information or knowledge exchange by each side can therefore enhance performance across various dimensions (Galbraith 1973; Flynn and Flynn 1999; Gattiker and Goodhue 2005) and in particular between sales or marketing and operations departments (Bendoly et al. 2012; Oliva & Watson 2011; Thome et al. 2014). Hence the impact of such exchange is best thought of with regards to multi-dimensional indices of performance rather than any single isolated measure, for which sensitivity to knowledge sharing might otherwise be idiosyncratic to a given firm (Bharadwaj et al.2007).

As a still finer point, it is not a foregone conclusion that knowledge exchange, even if deemed adequate by production and sales functions, will be perfectly aligned with higher level organizational needs. OIPT would suggest that the over-arching organizational context, in which both the Production and Sales functions exists, has its own broader agenda that may or may not equally reflect the agendas of the Production and Sales functions. The likely existence of contrasting agendas can dampen benefits gained through even the strongest knowledge exchange mechanisms; a point alluded to in recent studies, such as that of Bharadwaj et al. (2007) (lack of cross-functional coordination derailing the benefits of IT-driven exchange capability). As a result, each function may be willing to take informed actions with empirically observable distinctions concerning their impact on higher level performance. We therefore pose two parallel but distinct hypotheses as below.

H4a: Adequacy of P2S voluntary knowledge exchange positively affects operating performance.

H4b: Adequacy of S2P voluntary knowledge exchange positively affects operating performance.

3. Data and Methods

As part of a more comprehensive examination of the industry in that region this study is based on data collected from electronics manufacturers registered in Guangdong Province, China. According

to Guangdong Statistics Bureau, Guangdong Province is the most populous Chinese province and produces the highest total GDP among all of its provinces. Electronics manufacturing is one of its leading industries and it produced 45.8%, 39.8%, 16.2%, and 13.8% of China's air conditioners, television sets, household refrigerators, and microcomputers, respectively in year 2011 (see http://www.gdstats.gov.cn).

Historically, electronics manufacturers in Guangdong depended heavily on exports and mass standardized production outnumbered small-scaled customized production. Research and development functions were usually undertaken in developed countries. Financial success mainly owed to cheap labor and environmental costs as well as an undervalued local currency. However, the business environment has changed drastically in the past decade. First, more strict environmental and labor laws have been enforced by the Chinese government, raising labor and environmental costs significantly. Second, manufacturing firms struggle with attracting and retaining a young Chinese workforce who can seize more opportunities than their parents' generation. Third, the exchange rate between the Chinese RMB and USD has gone up by roughly 22% since 2006, leaving Chinese products less competitive in the international markets. As a result, many electronics manufactures, especially those located in coastal areas of China (including Guangdong Province) went bankrupt. The surviving firms face various challenges daily including labor "famine," more demanding international and domestic customers, squeezing profit margin and a volatile environment (Eloot et al., 2013). Hence a focus on performance and profitability through cross-functional coordination and knowledge exchange had become much more salient for firms operating in this context when our survey was conducted.

To qualify for consideration in our study, each firm needed to satisfy three conditions: (1) it possessed both production and sales departments; (2) had no less than 100 employees; and (3) was profitable in the year of 2011. Sampling firms from a single industry and located in the same geo-cultural area, our goal was to help control for potentially unobserved heterogeneity. This allowed us to study effects of differences in organizational policy and activity across firms without having to account

for variances caused by industry, economic climate and culture. As cautioned by Ketokivi and Schroeder (2004) and Venkatraman and Grant (1986), correlated errors could bias the underlying construct relationships when both independent and dependent variables are taken from the same informant. To overcome common source bias, we elicited responses from three separate managers in each firm: production manager, sales manager, and executive (CEO, COO or the vice president) to whom both production and sales managers report (thereafter executives). Responses from production and sales managers were used to measure S2P and P2S knowledge exchange, respectively, from the *receiver's* perspective. Their responses were also used to measure the three antecedents to voluntary cross-functional exchange. Responses from executives were the source of our operational performance measures and control variables.

3.1. Preliminary Interviews and Piloting

Prior to the main survey, we conducted one to three-hour interviews with 27 managers from nine firms of various sizes in a targeted population (not part of our main sample). The initial interview protocols were written in English but the interviews carried out in Chinese. The interviews consisted of both open-ended and closed-ended questions. The main purpose of the interviews was to identify common attributes across firms in our survey population. This included specifying types of important knowledge exchanged between Production and Sales, performance measures used to evaluate production and sales managers, critical priorities held by either functions, and aspects deemed important when evaluating operational performance. This provided specification for our final instrument.

Following a retrospective analysis of the interviews, we constructed and carefully back-translated into Chinese (following Brislin 1970) a survey instrument for each of the three managers. We then invited 12 managers from four firms to pilot-test the survey instruments for clarity and appropriateness. Revisions were made based on feedback provided by the managers. The interview protocol and the final versions of the survey instrument are available at:

http://www.experimental-instruments.com/Interview_protocol.pdf
http://www.experimental-instruments.com/Survey_instrument.pdf

3.2. Main Survey Collection

We targeted two subgroups of electronics manufacturers registered in Guangdong Province. The first subgroup consisted of 58 public firms listed on the Shenzhen and Shanghai Stock Exchanges. We contacted all 58 firms and the final response rate was 56.9%. The second subgroup consisted of private firms registered by the provincial tax agency. We randomly selected 1/6 of these firms (421 in total) to contact and the final response rate was 35.6%. For each firm we elicited, we identified a contact and sent three survey packages to that contact (e.g. secretary of the board of directors or the chief accountant). The contact then distributed the survey packages to the corresponding managers. After the surveys were completed, the respondents each individually mailed the surveys back to one of the authors in self-addressed envelopes. To increase response, we followed the survey implementation procedures by Frohlich (2002) and Dillman et al. (2009) by sending out pre-notices to contacts before mailing the first survey, reminder postcards two weeks after, replacement surveys to non-respondents four weeks later, and phoning a week after sending out the replacements.

We received in total 556 responses, out of which we created 183 complete firm records. We identified one firm as outlier due to normality issues and incomplete answers, and excluded it from the following analysis. Out of the 182 firms102 voluntarily provided financial data while 78 (all of which were private firms) did not. We subsequently obtained their financial data from the provincial tax agency. Table 1 presents sample characteristics. The median total assets, sales revenue and operating profit were USD35.37 million, USD38.04 million and USD3.11 million respectively. The median number of employees was 565.

[Insert Table 1 here]

We tested non-response bias by comparing early and late responses across all variables of interest as well as size variables (Armstrong and Overton, 1977). One-way analysis of variance (ANOVA) showed no significant differences at p=0.10 level except for perceived performance control by production managers. On average, production managers indicated higher controllability among early

responding firms than among late. This may be because managers who felt more in control of their performance were more likely to have time to respond to our survey soon after they received the survey packages. We also assessed sample representativeness of the population. We compared responding and non-responding firms in the province in terms of total assets, employee number, sales revenue and operating income. ANOVA showed no significant differences at p=0.10 level.

3.3. Measures for Variables

Table 2 summarizes all measured variables, mapped with the corresponding theoretical constructs presented in Figure 1.

[Insert Table 2 here]

3.3.1. Voluntary Cross-Functional Knowledge Exchange – Adequacy of Knowledge Exchanged

Based on the preliminary interviews, we identified both routine and non-routine or voluntary knowledge items that were commonly exchanged between the production and sales departments and were deemed important by the receiving function. A sample routine item is "information related to the ability to accept new orders: such as production capacity, distribution of capacity, and the improvement of capacity" for P2S exchange and "information used to project sales/production volume: such as periodic sales plans, sales forecasts and market forecasts" for S2P exchange. A sample non-routine voluntary item is "potential problems with the production department: such as the stability of its work force, employee morale, cohesion within its management team, and others" for P2S exchange, and "information about the company's competitive advantage and the industry at large" for S2P exchange. In total, six commonly reoccurring types were identified for P2S exchange. Four of these were classified as "voluntary". Seven types were identified for S2P exchange, six of which could be classified as "voluntary".

In responding to the survey, production and sales managers were asked to rate the adequacy of each knowledge type *from the receiver's perspective*. For each knowledge type, they rated the extent to which they received adequate amount of such knowledge from the other department (1: received no

such info; 7: received adequate amount of such knowledge). We then averaged the adequacy ratings for voluntary items, one for P2S and one for S2P. We also asked the receiving department managers as well as the executives to rate the usefulness (1: not at all useful; 7: extremely useful) of the knowledge items. For all knowledge items, routine and non-routine, the mean perceived usefulness was greater than mid-point of four ($t>10.28$, $p<0.01$), which suggests that we indeed identified important knowledge items for the two functions.

3.3.2. Opportunity – Institutionalized Production-Sales Interaction

We used three items to measure the extent to which frequent interactions between the two functions were institutionalized. Specifically, production and sales managers rated on 7-point Likert scales the extent to which within their firm, there existed (1) opportunities for employees to rotate between the two departments, (2) cross-functional training on skills/knowledge between the two departments, and (3) specific position(s) charged with coordination between the two departments. Exploratory factor analysis (EFA) results suggest that all three items loaded on one factor and all factor loadings were significant and greater than 0.55. Because the ratings by the two managers targeted the same shared opportunities for interactions and the two scale scores were highly correlated ($\rho=0.47$, $p<0.01$), we combined the two scale scores to measure Institutionalized Interaction (Cronbach's α was 0.76 for the combined scale).

3.3.3. Motivation – Controllability of Rewarded Performance

To minimize response bias, we adopted a relatively "objective" approach, adapted from Bouwens and Van Lent (2007), to measuring performance control. Specifically, we first identified, via the interviews, lists of common measures used to evaluate production and sales managers' performance in our firm population (e.g., timeliness of delivery for production managers, sales revenue for sales managers). These performance measures were provided in the survey. For each performance measure, production and sales managers were asked to (1) indicate the weight in percentage they believed their supervisor gave to that measure in their periodic evaluation, bonus determination and career progress,

and (2) on a 7-point scale, the extent to which they could control this performance measure (1: completely not under my control; 7: completely under my control).

We structured Controllability of Performance using the sum product of weight assigned to the individual measures and their perceived controllability. Using Vroom's (1964) expectancy theory framework, the weight of performance measures reflects valence, and controllability of these measures reflects expectancy. Thus, the sum product of weight and controllability acts as an important antecedent to motivation to achieve high performance. Although managers of each function are the source of responses on this measure, their responses are emblematic of each respective function as a whole. Since lead managers of each function have the best impression of the criteria by which the function's performance is judged, as well as the control the function has over these measures, their responses are viewed as the best available estimates of collective motivation of each function (Mudambi et al. 2007). Furthermore, managers usually have major influence or control over their subordinates' behaviors. Thus, the motivation of functional managers should critical shape the motivation of the entire function.

3.3.4. Ability – (Lack of) Awareness about Other Function's Priorities

Based on the interviews, we identified lists of key priorities common to the two departments in our firm population (e.g., hiring, training, and retaining employees for production managers and entering new markets for sales managers). These lists were provided in the survey. From the lists, production and sales managers were asked to identify and rank the top three priorities for their own department and then for the other department. The priority ranking for production department by the production manager was used as a benchmark to gauge the sales manager's (lack of) awareness about the production department, and vice versa. We constructed Lack of Awareness about Other Function's Priorities by adding two scores: (1) failing to identify any of the top-3 ranked priorities of the other function, and (2) mixed-ordering the top-3 priorities in their ranking. If the two managers' ranking matches perfectly, the Lack of Awareness score is zero. We use this measure to represent the (in)ability of functions to be aware of the types of knowledge needed to achieve the other function's valued goals.

Presumably, the higher a function's awareness about the other's work priorities, the more capable it is to provide useful information. We argue that this overall measure of awareness held by the function's managerial lead is an adequate proxy for at least the upper limit of collective ability in this regard for the function as a whole (Stajkovic et al. 2009).

3.3.5. Operational Performance – Subjective Ratings by the Executive

Based on the preliminary interviews, we identified seven dimensions that are deemed important in assessing operational performance in our firm population: (1) Flexibility in responding to customers' specific needs, (2) Customer satisfaction and loyalty, (3) Cost saving and efficiency, (4) On-time delivery, (5) Defect rate, (6) Innovation, and (7) Capacity management. In the survey, the executive respondents rated the firms' performance relative to the industry average along these seven dimensions on 7-point Likert scales (1: Significantly below average; 7: Leader of the Industry). EFA results suggest that all except one dimension (i.e., defect rate) loaded significantly on one factor and the lowest factor loading was 0.59. The executives also rated the overall operational performance. With the exception of defect rate, the six dimensions correlated significantly with this overall rating ($\rho>0.41$). To measure Operational Performance, we thus excluded the rating on defect rate and used the sum score of the other six dimensions (Cronbach's $\alpha=0.79$).

3.3.6. Operational Performance – Operating Profit Margin

From the executives (for the 104 responding firms) and the tax agency (for the 78 non-responding firms), we obtained information on revenue and operating income for year 2011. This allowed us to compute operating profit margin (=operating income/ revenue), as an objective measure of operational performance (log value used in statistical analysis).

3.3.7. Control Variables

Bigger firms tend to have more resources to promote voluntary cross-functional knowledge exchange, which may result in greater opportunity and ability for such knowledge exchange. However, exchange is also likely to be stifled by the bureaucracy commonly seen in bigger organizations.

Moreover, when the firm faces uncertain operational environment and/or when it produces highly customized products, the need for voluntary knowledge exchange between Sales and Production is more acute. We thus controlled for the effects of Size, Environmental Uncertainty and Customization on exchange adequacy and on operational performance in our analysis. Specifically, executives provided data on total assets, number of employees, and sales revenue. Since they were highly correlated (ρ>0.81), we standardized their logarithm scores and used the sum standardized score to measure Size. Executives also assessed Environmental Uncertainty by answering Khandwalla's (1976) four-item scale (e.g., the external environment is "very risky, one false step can mean the firm's undoing") and evaluated the level of Customization by indicating the percentage of products that are standardized, semi-customized and completely customized (Bouwens and Abernethy 2000).

4. Analysis and Results

Table 3 presents the means, standard deviations, theoretical and actual ranges of the variables. On average, P2S voluntary Knowledge Adequacy (mean=4.61, sd=0.92) and S2P voluntary Knowledge Adequacy (mean=4.56, sd=1.09) are significantly greater than the mid-point four ($t=8.91$, $p<0.01$ for P2S and $t=6.94$, $p<0.01$ for S2P). However, a significant number of managers gave low ratings to the adequacy of certain knowledge items (e.g. 25% of the sales and 30% of the production managers rated the adequacy of "strategic and long-term issues related" knowledge received to be lower than 4).

[Insert Table 3 here]

Production's Controllability of Performance was significantly higher than Sales' Controllability of Performance ($p<0.01$). In addition, Production had marginally less awareness about Sales' priorities than Sales had about Production's priorities ($p=0.07$). The Institutionalized Production-Sales Interaction scale score (mean=23.68) was at an average level, not significantly different from the mid-point of 24 ($t=0.69$, $p=0.49$). Table 4 presents the summary correlations. The correlation between P2S and S2P voluntary exchange adequacy is at a moderate level (ρ =0.38,$p<0.01$), suggesting the possibility that the adequacy differs between the two directions of the knowledge exchange at least for some firms. The low

correlation between subjective operational performance rating and profit margin (ρ =0.10, p=0.17) could be caused by two factors[1]. First, the subjective performance measure may be susceptible to optimism bias while the operating profit margin may be susceptible to conservatism bias[2]. Second, it is possible that better-than-average operating performance may not be successfully transferred to profitability. This is not inconsistent with the recent trend of expansion without profitability (i.e., so-called "growing bigger but not stronger") in China (Gao, 2009; Zheng, 2008).

[Insert Table 4 here]

We evaluated the measurement model as recommended by Anderson and Gerbing (1988). Details of the evaluation can be found in an on-line supplement: http://www.experimental-instruments.com/analysis_Supplement.pdf. Since most of our variables were designed as either composite indices or single-item measures, as opposed to multi-item scales, we used path analysis[3], rather than structural equation modeling to test the relationships among the variables. For constructs measured by multi-item scales (i.e., Institutionalized Interaction and Subjective Operational Performance), we used sum scores for path analysis. Factor scores yield similar results. We employed AMOS 20 and used maximum likelihood estimation method. Following Shah and Goldstein's (2006) suggestion, we tested the univariate normality of all measures prior to the path analysis and used both absolute fit measures (i.e., χ^2, RMSEA, and SRMR) and incremental fit measures (i.e., χ^2/df and CFI) to assess the model fit.

We estimated the theoretical model based on the structure depicted in Figure 1. Aside from the path coefficients used to test the hypotheses, we also estimated the following control links: the paths from three control variables (i.e., Size, Environmental Uncertainty, and Customization) to both

[1] We thank an anonymous reviewer for his/her insights on this issue.

[2] Our analysis shows that compared with firms that self-reported financial data, those firms that the tax agent provided financial data on had a lower profit margin on average (F-ratio=3.36, p=0.07). Also, firms that the tax agent provided data on also had an even lower correlation between subjective operational performance and profit margin (ρ = 0.07, p = 0.55). This suggests that firms in our sample may have the tendency to under-report their profitability due to concerns for tax burdens.

[3] Although we build on the argumentation by Siemsen et al. (2008) about constraining factors, we used basic linear model to test our hypotheses. Moreover, as per a reviewer's suggestion, in our online supplement, we also present regression analyses results in predicting P2S and S2P knowledge-sharing.

Knowledge Adequacy and performance variables (Operational Performance and Profit Margin), and the direct paths from antecedent variables to performance variables. In addition, all the antecedent variables and control variables were allowed to co-vary. Since we did not predict *ex ante* the control links and covariances, all insignificant control links and covariances were dropped (or constrained to zero) to increase parsimony. The derived path model, as depicted in Figure 2, has adequate model fit ($\chi^2(df=38) = 46.29$, $p=0.17$, $\chi^2/df=1.22$, CFI=0.97, RMSEA=0.04, SRMR=0.07). We used the estimated regression coefficients estimated from this model (see Figure 2 and Table 5) to test the hypotheses.

[Insert Table 5 and Figure 2 here]

Institutionalized Interaction, the measure of opportunity, has significant effect on both P2S ($\beta=0.45$, $p<0.01$) and S2P ($\beta=0.49$, $p<0.01$) Knowledge Adequacy. H1 is supported. Indeed, the path coefficients of Institutionalized Interaction are the largest among the three MOA predictors. This suggests that the institutional environment is crucial in predicting both directions of the voluntary knowledge exchange behavior. Controllability of Performance has a significant impact on Knowledge Adequacy only for S2P ($\beta=0.17$, $p<0.01$) but not for P2S ($\beta=0.03$, $p=0.67$) Knowledge Adequacy, suggesting that H2a is only partially supported. The difference in the two coefficients is significant ($t=2.14$, $p=0.03$), which supports H2b. Lack of Awareness about the other function's priorities has a marginally significant effect on Knowledge Adequacy only for P2S ($\beta=-0.11$, $p=0.09$) but not for S2P ($\beta=0.00$, $p=0.99$) Knowledge Adequacy, indicating that H3a is partially supported. The difference in the two coefficients is not significant ($t=0.62$, $p=0.53$; H3b not supported).

P2S Knowledge Adequacy significantly affects both Operational Performance ($\beta=0.26$, $p<0.01$) and Profit Margin ($\beta=0.22$, $p<0.01$). Surprisingly, S2P Knowledge Adequacy does not significantly affect performance ($\beta=0.09$, $p=0.22$ for Operational Performance, and $\beta=-0.07$, $p=0.34$ for Profit Margin). Thus, H4a is supported but H4b is not. The differences between the functions in the coefficients on Operational Performance ($t=5.09$, $p<0.01$) and on Profit Margin ($t=3.10$, $p<0.01$) are both significant.

Additional interpretation of control link estimates and supplemental robustness assessment can be found in the on-line supplement.

5. Discussion

5.1. Contributions to Research

5.1.1. Overview of theoretical and empirical contributions

The present study demonstrates that the MOA framework is proving both theoretically and empirically useful for understanding cross-functional knowledge sharing. This is because the MOA antecedents in our study together explain a significant portion of the variance in knowledge sharing between Sales and Production. However, based on our analyses, we propose two critical extensions to this framework. First, we find that the MOA antecedents differ in their contribution to accounting for variance in knowledge sharing depending on whose MOA antecedents we are talking about; Sales's or Production's. This is an important contrast to previous applications of MOA in which the specific MOA antecedents (say motivation for example) were examined for different individuals or different teams of people by pooling their respective motivation levels together in the MOA framework, and examining each MOA antecedent as one variable across individuals or teams. This may be too simplistic, because different individuals or teams can and indeed do differ in motivation, opportunity, or ability to exchange knowledge. Second, we find that the MOA antecedents in our study are more important, or in other words deterministic for knowledge sharing, when they are at a comparatively lower level than when they are at a high level, depending on the function in question. This is consistent with the general notion of the constraining factor theory proposed by Siemsen et al. (2008).

5.1.2. The Role of Ability in Production's Voluntary Information Exchange

In our study we operationalize *ability* to capture how well a particular function is equipped to identify priorities of the other function. In our analysis, such awareness and hence ability possessed by Production influences the adequacy of its communication to Sales. Possession of this ability by Sales however does not appear to impact the adequacy of the knowledge it voluntarily provides to Production.

The insignificant relationship between Sales' ability and S2P Knowledge Sharing can be explained by the constraining factor argument proposed by Siemsen et al. (2008). In our data this ability held by Sales is slightly higher on average than that possessed by Production, a result that fits the boundary-spanning role of the Sales function in organisations (Lysonski and Johnson, 1983). Yet if Production is not completely or adequately able to identify the customer needs and associated priorities as established by Sales by (Production's *ability*), design costs can increase (von Hippel, 1998), adversely affecting performance. As our evidence suggests, the negative consequences of Production's insufficient awareness of the priorities of Sales constrain its ability to exchange knowledge with Sales, and thus translate into negative impacts on voluntary knowledge exchange and eventually on overall operational performance.

5.1.3. The Role of Motivation for Sales' Voluntary Knowledge Exchange

In this study, *motivation* is based on individuals' evaluation of valence and controllability of the measures based on which their performance is assessed. Controllability – people's belief that they have control over a given behavior and that taking up that behavior, or not, is up to their own volition – is one of the key predictors of whether or not people actually engage in a particular behavior (Ajzen, 2002). The finding that only Sales' higher level of motivation positively influences S2P voluntary knowledge exchange and that Production's higher level of motivation does not increase P2S knowledge sharing, we argue, is based on our nuanced articulation of Siemsen et al.'s (2008) constraining factor model: in particular, Sales' perceived controllability is lower than Production's.

Reflecting on this insight further, we argue that the controllability difference between Sales and Production is also confirmed by our observation that Sales tend to have more outward-looking objectives while Production more internally-focused perspective. Among most firms we interviewed, the sales and production managers identified rather different strategic foci of their firms. Specifically, we asked them what they believed to be the strategic foci of their firm in the upcoming year or two. The sales managers tended to identify outward-looking objectives: e.g., enlarging customer bases,

developing new markets, internationalization, and going public. In contrast, productions managers tended to focus on inward-looking objectives such as technology advancement, product development, process improvement and cost reduction. One may argue that outcomes on inward-looking objectives are more controllable than those on outward-looking objectives.

We suspect that the finding of non-significance in the relationship between the S2P voluntary exchange and operational performance has to do with the fact that Production's performance evaluation largely hinges on the internal aspects of the operations (such as efficiency and quality control) vs. the external outcomes of the operations (such as meeting diverse customer needs and innovation). As a result, the voluntary knowledge provided by Sales to Production (e.g., diverse customer needs and recent market trends), while deemed adequate by Production, may not be enthusiastically leveraged by Production to improve operation and eventually profit margin. For example, in capitalizing on market opportunities indicated by Sales in its exchange, Production may face greater production variance, and thus higher cost and lower efficiency (which does not align with its incentives). Thus, we suspect that the positive effect of S2P communication may be compromised due to production's hesitation to fully utilize the knowledge provided by sales. Future research may benefit from measuring motivation to *utilize* knowledge exchanged between functions, which we do not measure directly in the current study.

5.2. Implications for Practice

This study provides new insights into the differential drivers of cross-functional voluntary knowledge exchange between Sales and Production units, and how such exchange ultimately contributes to performance. The value of paying particular attention to the different nature and scope of different functional units when designing performance targets is highlighted in this research. As our empirical results show, firms should consider designing performance targets that Sales functions will not only perceive as important but also believe they have considerable control over their achievement. This is because such motivation can lead to significantly higher levels of adequate knowledge shared by Sales with other functions.

In addition, managers should carefully evaluate internal training and development initiatives in terms of the functional units involved. Our evidence suggests that targeted investments to increase the Production function's awareness about Sales' priorities may translate into higher levels of knowledge sharing and in turn better operational performance. Moreover, an investment in institutionalized knowledge exchanges between Production and Sales (e.g., increasing cross-functional training and rotation opportunities) should prove fruitful since our findings suggest that the shared opportunities for knowledge sharing is the most important antecedent to both P2S and S2P knowledge exchange.

5.3. Limitations and suggestions for follow-up research

We chose a Chinese sample in response to a call for more research evidence from China from operations management scholars, highlighting the unique opportunities presented there to sample large significant industries (Zhao et al. 2006), and to examine and extend information management theories developed predominately in the western literature (Li and Fe 2014). While we have focused on firms operating in a single geo-cultural region, we suggest that the results of this study are relevant for theory-building across geographical, cultural and industry boundaries. Validating this claim however requires additional data collection. Cultural differences, for example, clearly impact operations management behaviors (Pagell et al. 2005; Cagliano et al. 2011), and may play an important role in affecting information sharing practices (Li and Ye 2014) and in particular cross-functional knowledge exchange. One might posit that a more collectivist culture might be more likely to accentuate cross-functional knowledge exchanges. However, there is some speculation that in collectivist cultures such as China, identification with a collective such as one's work function can stymie cross-functional interaction (Triandis, 1989); however more research is needed to examine our insights further in a cross-cultural context.

We also note bias in our data towards managers that perceive higher levels of control over their functional performance. While this more aptly represents our practitioner audience than would the converse, it nevertheless limits the robust generalizability of our findings. Our focus in this study also

lead us to operationalize the elements of the MOA model in very specific ways, with the intent of capitalizing on multiple sources of data and using measures that are as objective as possible. Moreover, in our path models, the error terms associated with the two knowledge adequacy measures were correlated (ρ=0.17, p=0.04), which suggests that unknown common third variables (e.g., reciprocity) may have caused variances of both sides of the exchange. Follow-up tests should employ longitudinal data examining both sides of the knowledge exchange at different times.

6. Conclusion

This study makes the following contributions to theory and practice in operations management. First, our empirical findings provide broad evidence in support of our theoretical model for voluntary knowledge exchange between functions, suggesting that it makes theoretical and empirical sense to extend the basic MOA framework in explaining variance in motivation, opportunity, and ability to exchange knowledge between different departments, in particular by allowing for asymmetry in antecedents and performance outcomes of knowledge-exchange behaviors at the Sales-Production interface. Second, the results of path modeling show consistent support for the role of institutionalized knowledge exchange *opportunities* in support of exchanges of voluntary information in both sides of the Production-Sales dyad – i.e., P2S and S2P. In contrast, differences in the relevance of motivation and ability as bottleneck antecedents, or constraining factors, influencing knowledge exchange were also observed between the two sides. Third, at a practical level, our results suggest that raising *opportunities* for voluntary knowledge exchanges may be an effective strategy for improving both P2S and S2P information flows. In addition, in order to improve P2S voluntary knowledge sharing, managers may benefit from concentrating efforts on increasing their production teams' *ability* to exchange knowledge. In contrast, further improvements to S2P voluntary sharing may emerge through a focus on improving the sales functions' *motivation* for knowledge exchange.

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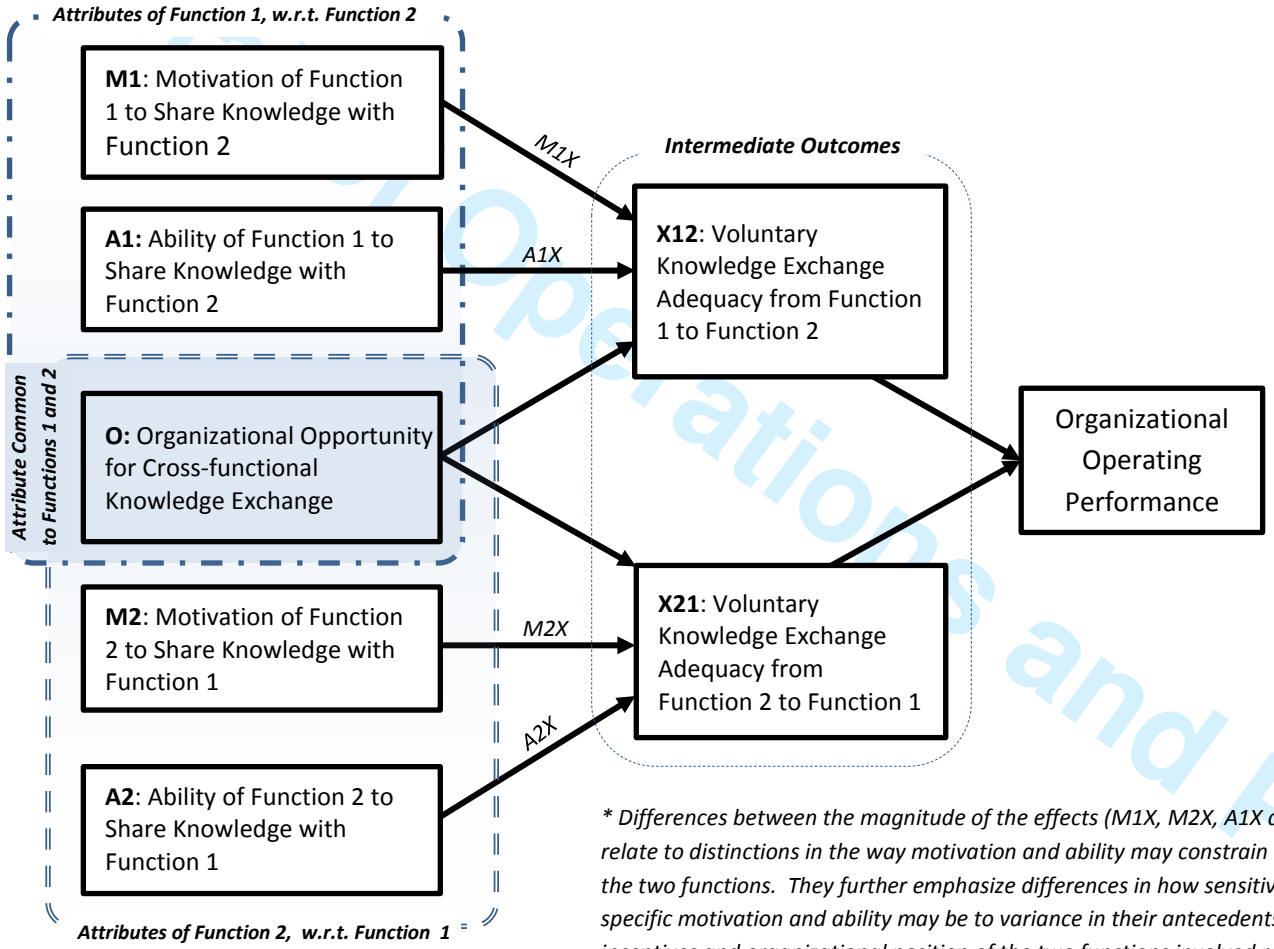
Figure 1: Theoretical Framework for Voluntary Cross-Functional Knowledge Exchange



** Differences between the magnitude of the effects (M1X, M2X, A1X and A2X) relate to distinctions in the way motivation and ability may constrain action for the two functions. They further emphasize differences in how sensitive function-specific motivation and ability may be to variance in their antecedents (e.g. incentives and organizational position of the two functions involved respectively).*

Table 1: Characteristics of Responding Firms (ns=182*)

	Median	Mean	Stdev	Range
Total Assets as of 12/31/2011 ($M USD)	35.37	241.10	1328.60	0.19-13,526
Sales Revenue in year 2011 ($M USD)	38.04	212.40	1216.54	0.56-13,257
Operating Profit in year 2011 ($M USD)	3.11	13.69	57.71	0.05-721
Number of Employees	565	1967	6987	100-72,671

*: 102 of the firms' financial data were self-reported by the CEO respondents, and 74 were obtained from the tax agency of Guangdong Province.

Table 2: Mapping of Theoretical Constructs and Measured Variables

Theoretical Construct	Measured Variable	Source of Measure	Description of Variable	Cronbach's α *
Voluntary Knowledge Exchange from Function 1 to 2	Production-to-Sales Adequacy of Voluntary Knowledge Exchange	Sales manager	Average adequacy rating across four voluntary knowledge types	0.88
Voluntary Knowledge Exchange from Function 2 to 1	Sales-to-Production Adequacy of Voluntary Knowledge Exchange	Production Manager	Average adequacy rating across six voluntary knowledge types	0.73
Organizational Opportunity for X-Function Exchange	Institutionalized Production-Sales Interaction	Production and Sales Managers	Average rating on a three-item scale measuring the extent to which frequent interactions were institutionalized	0.76
Motivation of Function 1 to Share Knowledge with Function 2	Production's Controllability of Rewarded Performance	Production Manager	Sum product of weight assigned to individual performance measures and their perceived controllability	N/A
Ability of Function 1 to Share Knowledge with Function 2	Production's (Lack of) Awareness of Sales' Priorities	Production and Sales Managers	Index score reflecting production manager's failure to identify top-3 ranked priorities of Sales and the mixed-ordering of the top-3 priorities	N/A
Motivation of Function 2 to Share Knowledge with Function 1	Sales' Controllability of Rewarded Performance	Sales manager	Sum product of weight assigned to individual performance measures and their perceived controllability	N/A
Ability of Function 2 to Share Knowledge with Function 1	Sales' (Lack of) Awareness of Production's Priorities	Production and Sales Managers	Index score reflecting sales manager's failure to identify top-3 ranked priorities of Production and the mixed-ordering of the top-3 priorities	N/A
Organizational Operating Performance	Subjective Operational Performance	Executive	Sum ratings on six dimensions of the firm's operational performance relative to industry average	0.79
	Operating Profit Margin	Executive	Firm's operating income divided by revenue for year 2011	N/A
Control variables	Size	Executive	Sum standardized logarithm scores of total assets, no. of employees and sales revenue for end of 2011	0.94
	Environmental Uncertainty	Executive	Khandwalla's (1976) four-item scale	0.64
	Customization	Executive	Percentage of customized products (Bouwens & Abernethy 2000)	N/A

*: Cronbach's alpha is only computed for multi-item measures, but not for composite indices or single-item measures.

Table 3: Descriptive Statistics (ns=182)

	Measured Variable	Mean	Stdev.	Theoretical Range	Actual Range
1	Production's Controllability of Performance	5.30	0.61	1-7	3.8-6.8
2	Sales' Controllability of Performance	5.12	0.56	1-7	3.5-6.4
3	Production's Lack of Awareness of Sales	2.60	1.23	0-6	0-4.5
4	Sales' Lack of Awareness of Production	2.37	1.23	0-6	0-4.5
5	Institutionalized Production-Sales Interaction	23.68	6.27	6-42	6-39
6	Production-to-Sales Knowledge Adequacy	4.61	0.92	1-7	2.25-7
7	Sales-to-Production Knowledge Adequacy	4.56	1.09	1-7	1.5-7
8	Subjective Operational Performance	32.78	4.27	6-42	18-41
9	Operating Profit Margin	11.11%	0.11	>0	0-74%
10	Environmental Uncertainty	18.55%	3.72	4-28	8-28
11	Customization	41.29%	0.28	0-100%	0-100%

Table 4: Pearson Correlations among Variables (ns=182)

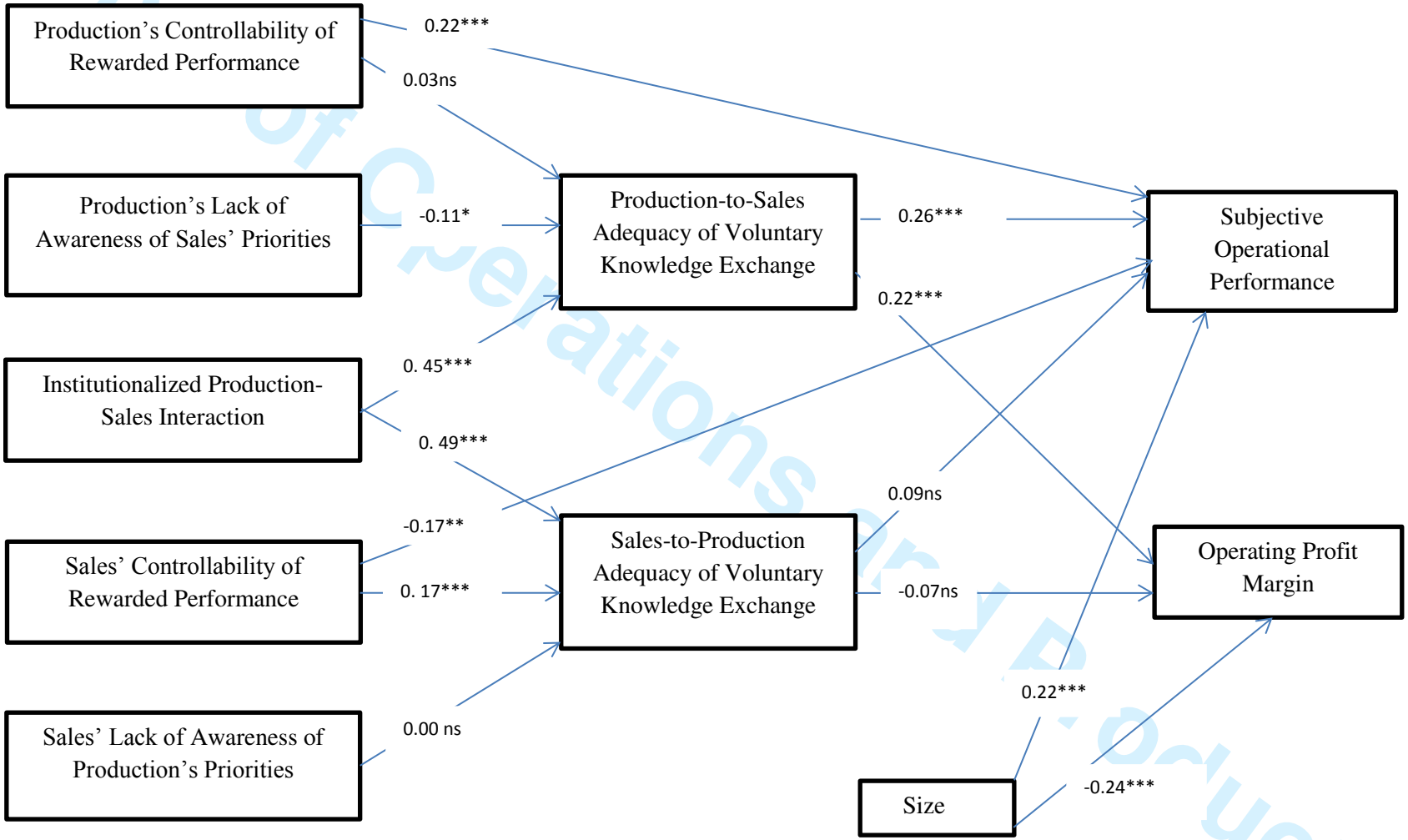
	Measured Variable	1	2	3	4	5	6	7	8	9	10	11
1	Production's Controllability of Performance											
2	Sales' Controllability of Performance	0.33***										
3	Production's Lack of Awareness of Sales	0.01	-0.07									
4	Sales' Lack of Awareness of Production	-0.10	-0.13	0.26***								
5	Institutionalized Production-Sales Interaction	0.10	0.12	-0.08	-0.16**							
6	Production-to-Sales Knowledge Adequacy	0.11	0.16**	-0.15**	-0.24***	0.46***						
7	Sales-to-Production Knowledge Adequacy	0.32***	0.24***	-0.05	-0.12*	0.51***	0.38***					
8	Subjective Operational Performance	0.20***	0.02	0.09	-0.04	0.26***	0.30***	0.23***				
9	Operating Profit Margin (logarithm value)	<0.01	0.01	<0.01	-0.16	0.07	0.23***	0.05	0.10			
10	Size (sum standardized logarithm value)	0.00	0.13*	-0.01	-0.05	0.15**	0.10	0.04	0.23***	-0.15 **		
11	Environmental Uncertainty	-0.07	0.09	0.07	0.00	-0.08	-0.07	0.01	0.12*	-0.12*	0.02	
12	Customization	0.09	0.25**	0.04	-0.18**	0.10	0.10	0.11	0.11	0.10	0.29 ***	-0.04

*: two-tailed alpha < 0.10; **: two-tailed alpha <0.05; ***: two-tailed alpha <0.01.

Table 5: Estimated Path Coefficients from the Path Analysis Model Shown in Figure 2

	Path	β	t	p
Hypothesis 1	Institutionalized Production-Sales Interaction → Production-to-Sales Knowledge Adequacy	0.45	6.79	<0.01
	Institutionalized Production-Sales Interaction → Sales-to-Production Knowledge Adequacy	0.49	7.61	<0.01
Hypothesis 2	Production's Controllability of Performance → Production-to-Sales Knowledge Adequacy	0.03	0.43	0.67
	Sales' Controllability of Performance → Sales-to-Production Knowledge Adequacy	0.17	2.68	<0.01
Hypothesis 3	Production's Lack of Awareness of Sales → Production-to-Sales Knowledge Adequacy	-0.11	-1.71	0.09
	Sales' Lack of Awareness of Production → Sales-to-Production Knowledge Adequacy	0.00	0.02	0.99
Hypothesis 4	Production-to-Sales Knowledge Adequacy → Operational Performance	0.26	3.72	<0.01
	Production-to-Sales Knowledge Adequacy → Operating Profit Margin	0.22	2.84	<0.01
	Sales-to-Production Knowledge Adequacy → Operational Performance	0.09	1.23	0.22
	Sales-to-Production Knowledge Adequacy → Operating Profit Margin	-0.07	-0.95	0.34
Control Links	Production's Controllability of Performance→ Operational Performance	0.22	3.01	<0.01
	Sales' Controllability of Performance→ Operational Performance	-0.17	-2.37	0.02
	Size → Operational Performance	0.22	3.36	<0.01
	Size → Operating Profit Margin	-0.24	-3.18	<0.01

Figure 2: Results of a Path Model for Sales-Production Voluntary Knowledge Exchange



Fit indices: $\chi^2(df=38)=46.29$, $p=0.17$, $\chi^2/df=1.22$, CFI=0.97, RMSEA=0.04, SRMR=0.07.

*: two-tailed alpha < 0.10; **: two-tailed alpha <0.05; ***: two-tailed alpha <0.01.