https://doi.org/10.1016/j.ijpe.2013.04.008



# Supplier Partnership and Cost Performance: The Moderating Roles of Specific Investments and Environmental Uncertainty

Dr Peter K. C. Lee*
Department of Logistics and Maritime Studies
The Hong Kong Polytechnic University
Hung Hom, Kowloon, Hong Kong
E-mail: lgtplee@inet.polyu.edu.com
*Corresponding Author
Tel.: (852) 2766 7415
Fax: (852) 2330 2704

Dr Kwong Yeung
Department of Logistics and Maritime Studies
The Hong Kong Polytechnic University
Hung Hom, Kowloon, Hong Kong
E-mail: lgtsunny@inet.polyu.edu.hk

Prof. Andy C. L. Yeung
Department of Logistics and Maritime Studies
The Hong Kong Polytechnic University
Hung Hom, Kowloon, Hong Kong
E-mail: lgtandyy@inet.polyu.edu.hk

Prof. T. C. E. Cheng
Department of Logistics and Maritime Studies
The Hong Kong Polytechnic University
Hung Hom, Kowloon, Hong Kong
E-mail: Edwin.Cheng@polyu.edu.hk

Abstract

Drawing on the perspective of transaction cost economics (TCE), we explain the operating contexts in which supplier partnership is likely to be an effective strategy to reduce operational costs in the manufacturing industry. We posit that supplier partnership, which falls in the category of hybrid governance, improves the operational cost performance of manufacturers and that its effectiveness is contingent on specific investments. We also posit that, in contrast with the traditional prediction of TCE, environmental uncertainty does not interact with specific investments to impact on the effectiveness of supplier partnership. We apply structural equation modeling (SEM) to empirically test the model using data from 175 Hong Kong electronics manufacturers. The results show that supplier partnership is positively and significantly related to operational cost performance. We also find that the relationship between supplier partnership and operational cost performance is positively moderated by specific investments. More importantly, the results reveal that the relationship between supplier partnership and operational cost performance is not moderated by: (1) environmental uncertainty and (2) the three-way interaction among supplier partnership, specific investments, and environmental uncertainty. Our findings provide theoretical and practical insights for selecting an appropriate mode of governance structure.

(193 words)

*Keywords*: Supplier partnership; transaction cost economics; specific investments; environmental uncertainty; operational cost performance

## 1. Introduction

As competition intensifies and the business environment is increasingly fast changing, manufacturers are under enormous pressure to enhance their operational performance. In addition to improving internal operations, many manufacturers look externally to seek competitiveness through the development of closer relationships with key suppliers (McCutcheon and Stuart, 2000; Wu and Choi, 2005; Yeung et al., 2012). Supplier partnership is widely accepted as an effective source of competitiveness among researchers, practitioners and consultants (Carr and Smeltzer, 1999; Chen et al., 2004). In this study we conceptualize supplier partnership as a long-term, mutually beneficial relationship between a buyer and a supplier, and interaction between them to develop and build commitment, cooperation, and dependence (Han et al., 2011; McCutcheon and Stuart, 2000).

Previous studies have found that collaborative supplier relationship provides organizations with multiple potential benefits, such as higher quality products, increased flexibility, lower inventory levels, and lower total cost (Ellram and Edis, 1996; Lamming, 1986). The direct performance impacts of supplier partnership (Cannon and Homburg, 2001; Li et al., 2006; Shin et al., 2000) or its elements (e.g., Krause et al., 2007; Wong et al., 2009; Yang et al., 2009) are well documented. However, the operating contexts in which the partnership will operate more effectively are relatively under-investigated (Donaldson, 2001). This study extends the existing literature by studying the implications of the operating contexts for operational cost performance of a firm that develops supplier partnership with its key supplier through the theoretical lens of the Transaction Cost Economics (TCE). Within operations management (OM), this study answers the call by researchers to offer a better understanding of the peculiar situations in which supplier partnership would be an appropriate strategy to enhance operational performance (Frazier et al., 2004).

Specifically, we pose the following research questions: (1) Is there any relationship between supplier partnership and operational cost performance? (2) Do specific investments

positively moderate the relationship between supplier partnership and operational cost performance? (3) Does environmental uncertainty moderate the relationship between supplier partnership and operational cost performance? (4) Does the three-way interaction among supplier partnership, specific investments, and environmental uncertainty moderate the relationship between supplier partnership and operational cost performance? Moderators are important to study, perhaps even as a requirement that they be studied, in psychological research (Frazier et al., 2004). We develop a research model grounded in the supplier partnership-cost performance paradigm and take Mathieu's (1992) approach to test the model by applying structural equation modeling (SEM) to empirical data collected from a survey of 175 firms in Hong Kong's electronics industry. To the best of our knowledge, this is the first study to fill this research gap.

The rest of the paper is organized as follows: In Section 2 we provide the research background, review the literature, and develop the research hypotheses. In Section 3 we introduce the research methodology, describe the data collection method, and discuss the development of the measurement scales. Then we present an analysis of the results in Section 4. In Section 5 we discuss the research findings and their implications, conclude the paper, and suggest topics for future research.

## 2. Theoretical background and hypothesis development

### 2.1 Theoretical background

The popularity of supplier partnership in the past decades has attracted the attention of many researchers. Shin et al. (2000) found that buyer-supplier collaborative practices are highly effective in improving delivery and quality performance. Similarly, Cannon and Homburg (2001) provided evidence to support the link between buyer-supplier relationship and cost performance. More recently, Li et al. (2006) found that strategic supplier relationship can lead to enhanced competitive advantage and improved organizational performance. In

addition, the direct performance impacts of some key elements of supplier partnerships have been explored by some researchers. Partnership elements such as cooperation, long-term commitment, and information sharing have been found to have direct and positive associations with various performance dimensions (e.g., Krause et al., 2000; Monczka et al., 1998). Nonetheless, empirical findings concerning supplier partnership are not always positive (Stuart, 1997). For instance, according to Anderson and Jap (2005), several studies have estimated the failure rate of inter-firm partnerships to be around 30-50%. Burnes and New (1997) concluded that supplier partnership may achieve successful partnering relationship only at the operational level, not at the strategic level. Robb et al. (2007) found that there is no significant linkage between supplier relationship and market performance.

These conflicting findings suggest that the management of supplier partnership should receive greater attention for efficient OM, particularly when and whom issue (Frazier et al., 2004). Given the strategic importance and the wide spread adoption of supplier partnership in practice, it is important to understand the peculiar situations in which supplier partnership is effective. Ireland et al. (2002:414) remarked that supplier partnership is "a significant challenge and an under-investigated phenomenon" warranting further study.

*Transaction Cost Economics and Supplier Partnership*

Transaction cost economics (TCE) (Coase, 1960; Williamson, 1975) is one of the first and most influential theoretical frameworks that specifies the situations in which firms should perform certain activities in-house (i.e., forming a hierarchy), as well as the situations in which certain operations should be outsourced (i.e., resorting to a market). In the early version of TCE, Williamson (1975) suggested that by judicially adopting either a hierarchy or a market as the mechanism of governance for exchanges, firms can minimize the transaction costs (relating to searching, planning, negotiating, writing, monitoring and enforcing) (Blomqvist et al. 2002; Ireland et al., 2002). Simply put, an appropriate alignment of

transactions with the corresponding governance structure can reduce cost.

Williamson (1985, 1991) later extended the hard "market and hierarchy" polarity to acknowledge the existence of "hybrid governance". The structure of "hybrid governance" pertains to the use of complex contracts and other forms of strategic alliances, including supplier partnership, to manage an exchange. The basic premise of TCE is the following: First, organizations should match simple transactions with simple governance mechanisms and more complex exchanges with more complex governance mechanisms. Second, the use of an appropriate governance method can reduce transaction costs and hence enhance performance (Williamson, 1985, 1991). Of the various performance dimensions of operations, operational cost is one of the most critical dimensions for OM managers, and it is more closely associated with transaction costs than other competitive priorities. Assuming a close association between transaction costs and operational cost performance, we hypothesize that

*Hypothesis 1: Supplier partnership is positively related to operational cost performance.*

*Specific Investments*

According to TCE, when selecting an appropriate form of mechanism for governing inter-firm relationships, the cost of transactions is a key determinant for organizations. Transaction cost becomes significant under certain conditions; in particular, in the presence of specific investments and environmental uncertainty. Specific investments refer to the assets that are significantly more valuable in a particular exchange than in any alternative exchange (Barney 1999). Although many of the activities of supplier partnership (e.g., supplier development) may inevitably involve specific investments, specific investments alone are unlikely to be a management decision that firms would take strategically in isolation. Instead, specific investments are often considered as a relationship characteristic (Williamson, 1985, 1991) or a determinant that affects partnership performance (e.g., Artz and Brush, 2000).

The major problem of specific investments is that the resultant safeguards against

opportunism will increase transaction costs (Rindfleisch and Heide, 1997). TCE predicts that when specific assets are at a low level (e.g.,, the purchased items are standardized products readily available in the market), the dependency between parties is relative low and market governance (i.e., short-term business relationships) should be the form to determine the terms of the transactions. Under such circumstances, TCE assumes that competition in the product market is an effective mechanism to protect the transacting parties against opportunistic behaviours.

After dealing with supplier for a long period of time smoothly, a buyer will have greater confidence in making specific investments, owing to its past experiences (c.f. Han et al. 2011). However, when specific investments become substantial, the resultant dependency may induce one of the parties to act opportunistically. TCE suggests that the long-term business relationship and the alignment in incentives entailed by supplier partnership (i.e., a hybrid governance method) should reduce the hazard of opportunistic behaviours by the supplier and prevent the buyer that has made substantial investments from being exploited (Williamson, 1991). In short, TCE predicts that in a supplier relationship characterized by a substantial amount of specific investments, supplier partnership is an effective governance method to reduce transaction costs. More specifically, the degree of specific investments is a moderating variable that alters the direction or strength of the relation between supplier partnership and operational cost performance (Baron and Kenny, 1986). Our second hypothesis is therefore the following

*Hypothesis 2: Specific investments positively moderate the relationship between supplier partnership and operational cost performance.*

*Environmental Uncertainty*

Environmental uncertainty is defined as the rate of change and the degree of instability in the environment (Wang et al., 2011). Although the positive association between uncertainty

and supplier alliances has received some empirical support (e.g., Klein et al., 1990), other previous studies have also pointed out that the impact of environmental uncertainty on governance decisions is ambiguous (David and Han, 2004; Rindfleisch and Heide, 1997).

Following the reasoning of TCE, the direct effect of environmental uncertainty is that it results in an inability to write a comprehensive contract (Williamson, 1985). The fundamental problem under market governance is that even the best contract is incomplete. When the environment is highly uncertain, suppliers need to be willing to adapt to changes. If such adaptation results in problems, it would lead to increased transaction cost associated with renegotiation of business agreements, and with modifying and enforcing contract terms (Rindfleisch and Heide, 1997).

Since market governance is characterized by a short-term and adversarial attitude in transactions, it offers no incentive to suppliers to resolve such adaptation problems, implying that market is unlikely to be an efficient mechanism to govern supplier relationships in uncertain environments. Thus, in the context of a buyer-supplier relationship, the long-term nature of supplier partnership will motivate the supplier to be more willing to adapt to changes, stop performing opportunistically, and consider mutual benefits in the long run. Wei et al. (2012) proposed that firms should develop partnerships through improved communication and information sharing to ease the adversary impact of environmental uncertainty.

Traditional TCE contends that the role of an uncertain environment as a favourable situation for the adoption of supplier partnership is subject to the presence of specific investments (Rindfleisch and Heide, 1997). If specific investments are not required in the exchanges, adaptation problems can be solved by replacing the existing supplier with a new one (i.e., the adoption of short-term relationships – market governance). Simply put, TCE predicts that the presence of a highly uncertain environment alone would not make supplier partnership an effective relationship governance method in reducing transaction costs.

Therefore, we formulate the following hypothesis

*Hypothesis 3: Environmental uncertainty alone does not moderate the relationship between supplier partnership and operational cost performance.*

Traditional TCE proposes that when the environment is highly uncertain and a high level of specific investments is required in the transactions, supplier partnership should be effective in reducing transaction costs. Zhou et al. (2008) found that computer equipment and electronic equipment manufacturing firms in China rely on relational ties to govern their complex exchanges at high levels of asset specificity and uncertainty. However, recent studies criticize and refine the traditional TCE literature. Ellram et al. (2008) found that "in highly uncertain markets, firms prefer to perform a task internally, believing that they can favourably respond to the whims of the market more readily than their suppliers".

In the electronics industry, technological innovations may give rise to competence-destroying technological changes, which in turn make all specific investments obsolete. Emerging new technologies may re-shape the competitive landscape. Subsequently, the buyer may call for vertical integration and make large R&D investments to set standards, launch new products faster, and limit competitor access, e.g., the mobile electronics industry. The resultant advantages may include: (1) saving the transaction costs needed to educate external partners, (2) reducing the inherent risks of hold-up, (3) reducing the information leakage risk and the associated costs, and (4) quickening decisions in response to rapid changes. Therefore, we argue that supplier partnership may not be particularly effective for industries characterized by a high degree of asset specificity and of environmental uncertainty (c.f. Blomqvist et al. 2002). All these theoretical arguments suggest the following hypothesis

*Hypothesis 4: The three-way interaction among supplier partnership, specific investments, and environmental uncertainty does not positively moderate the relationship between supplier partnership and operational cost performance.*

## 3. Methodology

The empirical setting for this study is the electronics industry of Hong Kong. The electronics industry accounted for more than 55% of Hong Kong's total exports and the gross export of the industry was HK$1,850,680 million (US$237,000 million) in 2011. Hong Kong was the world's third largest exporter of radios and video cameras, the second largest exporter of calculators, computer accessories, and video recording apparatus, and the largest exporter of telephone sets and sound recording apparatus in value terms in 2009 (Hong Kong Trade Development Council, 2012). The success of Hong Kong's electronics industry lies in efficient alliance management against the whims of dynamic markets.

The advantage of employing data from Hong Kong's electronics industry is three-fold. First, using data from a single industry helps us better control for heterogeneity and avoid other complications inherent in inter-industry analysis (Ward and Duray, 2000). Previous rigorous studies in the OM literature have employed single-industry databases for analysis (e.g., Fynes et al., 2008; Panayides and Lun, 2009; Veloso and Benner, 2007; Yeung et al., 2006). Second, the electronics industry of Hong Kong has similar characteristics (e.g., export-oriented, highly competitive, and fast-changing etc.) as many other manufacturing industries and the findings of this study can be used for benchmarking (Carr and Smeltzer, 1999). Third, many Hong Kong electronics manufacturers are likely to be small and medium-sized enterprises (SMEs). Supplier partnership is one of the effective approaches for SMEs to improve their competitive positions (Beekman and Robinson, 2004) in ways such as accessing critical resources, obtaining the needed legitimacy, and learning about current benchmarks as well as about future opportunities (Arend, 2006). With respect to SMEs' importance in different manufacturing industries, its predominant role has been well noted by OM researchers (e.g., Grando and Belvedere, 2006; Koh and Saad, 2006; Mezgár et al., 2000). By employing a sample comprising a significant percentage of SMEs, this study will shed

new light on when SMEs could adopt supplier partnership to improve their competitiveness.

### 3.1 Sample and data collection procedures

We developed a preliminary version of our survey questionnaire based on an extensive review of the literature on operations, marketing, and supply management. We conducted a pilot-test of the draft questionnaire with eight purchasing management practitioners and three experienced researchers to verify the relevance of the items to their respective constructs, the appropriateness of the wording, and the clarity of the instructions. Based on the comments obtained from the pilot-test, we made several minor changes to the questionnaire to improve its validity and readability.

We then contacted 900 firms listed in the 1999 Annual Directory of the Hong Kong Electronics Industry (The Hong Kong Electronic Industries Association Limited, 1999). We successfully invited 618 of the firms to participate in the survey. We mailed a package that included a covering letter, a questionnaire, and a postage-paid envelope to these firms. For each firm, we first invited a senior manager with direct responsibilities for purchasing and supply management to answer the questions on supplier partnership and specific investments, with a focus on the one supplier they considered most crucial to their firms' operational cost performance. Subsequently, we invited another senior executive with direct responsibilities for OM to answer the rest of the items (concerning environmental uncertainty and operational costs). This helps alleviate the single-respondent bias (Forza, 2002).

At the end of the survey, we collected a total of 175 usable questionnaires, yielding an effective response rate of 28.3% (i.e., 175/618). Our response rate was higher than those of previous studies as we had identified the appropriate senior managers before sending out the questionnaires so that we could follow up directly with them to do the survey. We evaluated the non-response bias by using Armstrong and Overton's (1977) procedure. Using independent sample *t*-tests, we compared the answers to 25 randomly selected questions of

the first 30 returned questionnaires with those of the last 30 returned questionnaires. Since there are no significant differences between the two samples ($p < 0.05$), non-response bias does not appear to be a problem. Table 1 shows the sample profile.

## 3.2 Variable measures

We adapt the measures used in this study from well-established instruments in the supply chain management and OM literature. The appendix shows the complete list of the survey questions. All the survey questions use the seven-point Likert scale and they were found to be the most relevant to the current context in the pilot study.

### 3.2.1. Supplier partnership

Supplier partnership is generally accepted as an effective source of competitiveness (Carr and Smeltzer, 1999; Chen et al., 2004). Three elements, namely long-term commitment (e.g. Shin et al., 2000), cooperation (Prahinski and Benton, 2004), and information sharing (Wei et al., 2012), are largely considered as the key constituents of supplier partnership. We thus use a three-item scale, namely COMMIT, COOP, and INFO, to assess supplier partnership. It should be noted that these three elements are latent variables and we outline their sources as follows:

*Long-term commitment.* It refers to the belief that the buyer-supplier relationship will continue into the future and will benefit both participating firms in the long run (Ganesan, 1994). Ireland et al. (2002) found that firms with long-term commitment and dedicated function achieved a 25% higher long-term success rate and lower transaction costs with partners than firms without them. Thus, we derive five items from Ganesan (1994) and Prahinski and Benton (2004), including “We believe that, in the long run, our relationship with this supplier will be profitable”, “Maintaining a long-term relationship with this supplier is important to us”, “We focus on long-term goals in this relationship”, “We are only concerned with our benefits in this relationship”, and “We expect this

supplier to be working with us for a long time" to measure the extent of long-term commitment in the partnership. The Cronbach alpha is 0.864, so the construct is reliable. In line with Mathieu et al. (1992) and Ping (1995), we add these five items together to form a composite "COMMIT". Its mean is 27.84 and standard deviation is 4.85.

*Cooperation.* Partner cooperation is helpful for firms to overcome operational difficulties and surmount environmental uncertainty in the exchange. In order to recover from the specific investments, partner firms should share pains and gains, work together collaboratively, and emphasize joint benefits (Wei et al., 2012).. Therefore, we adapt three items from Prahinski and Benton (2004), including "No matter who is at fault, all problems are the joint responsibility of our company and this supplier", "Requests from our company have often been responded to cooperatively", and "Our company and this supplier are concerned with each other's profitability" to assess the extent of cooperation in the partnership. The Cronbach alpha is 0.735, so the construct is reliable. We add these three items together to form a composite "COOP" (Mathieu et al., 1992; Ping, 1995). Its mean is 15.55 and standard deviation is 2.85.

*Information sharing.* Information sharing is crucial to improving cost and service performance (Wei et al., 2012). Without information sharing, opportunism or self-interest with guile behaviour will occur, which in turn increases the transaction costs in the exchange because these behaviours are costly to detect and monitor (Williamson, 1975). Therefore, we use five items from Young-Ybarra & Wiersema (1999), including "We and this supplier keep each other informed about events that mutually affect each other", "We and this supplier often have informal exchanges of information", "We and this supplier are expected to provide each other with any information that may be of help", "We and this supplier inform each other in advance of any changes in our needs", and "Exchanges of information in this relationship takes place in a timely manner" to evaluate the extent of communication and information sharing in the partnership. The

Cronbach alpha is 0.882, so the construct is reliable. We add these five items together to form a composite “INFO” (Mathieu et al., 1992; Ping, 1995). Its mean is 27.11 and standard deviation is 4.68.

### 3.2.2. Operational cost performance

Operational cost has long been regarded as one of the important competitive priorities (Skinner, 1969) and is most related to transaction cost. We develop three items for measuring the costs associated production, inventory, and poor quality products of the buying firm in this study. We derive three items from Choi and Eboch (1998), and Wong et al. (2011).

### 3.2.3 Specific investments

Specific investments describe the degree to which the manufacturer will tailor-make its operating processes to deal with the supplier, and the level of investments made by the manufacturer in such areas as providing training and performing evaluation activities for that particular supplier (Joshi and Stump, 1999). Williamson (1985) identified human, site, and physical and dedicate assets specificity as specific investments. Therefore, we adapt three items from Heide and John (1988), and Joshi and Stump (1999) to measure human and dedicate assets specificity in this study.

### 3.2.4. Environmental uncertainty

Environmental uncertainty is a central concept in organizational and management research (Merschmann et al., 2011). It comprises unforeseen, exogenous disturbance, as well as behavioural uncertainty. When environmental uncertainty is high, many unexpected contingencies may arise because of bounded rationality (Williamson, 1985). The environmental uncertainty of Hong Kong’s electronics industry is high because it is characterized by fast-changing consumer patterns, short product life cycle, and rapid changes

in technologies (Hong Kong Trade Development Council, 2012). We develop three items from Vickery et al. (1999), and Sanchez and Perez (2005) to measure the environmental uncertainty of Hong Kong's electronics industry.

We apply a rigorous process to develop and validate the survey instrument. Adopting a two-step method to test construct reliability (Narasimhan and Jayaram, 1998), we first use Cronbach's alphas and the corrected item-total correlation (CITC) reliability test to assess the constructs' reliability, then use exploratory factor analysis (EFA) to cross check their unidimensionality. Table 2 shows that all the measures have a Cronbach's alpha of 0.7 or above (Nunnally and Bernstein, 1994). All the CITC values are larger than 0.5, higher than the minimum acceptable value of 0.30 (Kerlinger, 1986). Based on the Cronbach's alpha and CITC values, we conclude that the scales are reliable.

We conduct the EFA at the cross-factor level. We perform the principal component analysis with varimax rotation with Kaiser normalization on all the measurement items to determine the main constructs and their related measurement items (Loehlin, 1998). The cross-factor level EFA results in four eigenvalues that are greater than 1. The "scree" test suggests that four factors are appropriate as the difference between the fifth largest eigenvalue (0.573) and the sixth largest eigenvalue (0.511) is significant. The total variance explained by the five factors is 75.2%. Table 3 shows that each item is well loaded on a single construct (Jambulingam et al., 2005; Kathuia, 2000). Therefore, the factors extracted from EFA represent their corresponding items well, so they are unidimensional.

Table 4 shows the correlations of the indicators. According to Kline (1998), inspection of the correlation matrix shows only bivariate multicollinearity, whereas inspection of the variance inflation factor (VIF) reveals multivariate multicollinearity. When VIF is 4 or above, there is high multivariate multicollinearity and the beta coefficients will not be stable. All the VIF values in this study are smaller 4, which is the common cut-off criterion, indicating no

multicollinearity problem or serious threat to the study, so we do not report them.

## 4. Data Analysis and Results

### 4.1. Measurement model results

We adopt Anderson and Gerbing's (1988) two-step approach to estimate a measurement model prior to creating a structural model. To test the fit of the models, we use LISREL 8.5 (Jöreskog and Sörbom, 2001) to perform structural equation modeling (SEM) based on the maximum likelihood methods, with the correlation matrix of the indicators as input. In what follows, we present the results of the measurement model analysis, structural model analysis, and hypothesis testing.

We test the construct convergent and discriminant validity using the method outlined in Fornell and Larcker (1981), and Chau (1997). For the convergent validity test, we link each item to its corresponding construct and estimate the covariance among the constructs freely. Confirmatory factor analysis (CFA) yields $\chi^2_{(48,\, N = 175)} = 96.28$, $\chi^2/df = 2.0$, non-normed fit index (NNFI) = 0.93, comparative fit index (CFI) = 0.95, and root mean squared error of approximation (RMSEA) = 0.075. The $\chi^2 / df$ is a fit index that weights the $\chi^2$ statistics by the degree of freedom, where a value of 2.0 suggests a good fit to the model (Hu and Bentler, 1999). All the absolute goodness of fit values are well above 0.90, which suggests a good fit between the implied covariance in the model and the observed covariance from the data. The comparative fit measures are also well above the thresholds, providing evidence against the null hypothesis. All these measures suggest that the measurement model has a good fit. Besides, all the constructs have eigenvalues exceeding 1.0. All the factor loadings exceed the minimum value of 0.30 and are significant at $p < 0.001$. Both provide further evidence of convergent validity of the constructs (Hair et al., 2006; Reines-Eudy, 2000).

We test discriminant validity by fixing the correlation between any pair of related

constructs at 1.0, prior to re-estimating the modified model (Chau 1997; Li et al., 2007). A significant difference in the chi-square statistics between the fixed and unconstrained models indicates high discriminant validity. For the four constructs, we conducted a total of six different discriminant validity checks. By fixing the correlation between any pair of related constructs in the measurement model to the perfect correlation of 1.0, the chi-square value increases from 105.12 to 197.97 (see Table 5). With an increase in one degree of freedom, this chi-square value is highly significant at $p = 0.01$ ($\Delta\chi^2 \geq 6.635$). Therefore, discriminant validity is achieved. Table 6 presents estimations of the measurement model parameters.

4.2. Structural model results and hypotheses testing

Bagozzi et al. (1992) suggested that if a moderator variable is measured as continuous, we should model moderated variable effects as multiplicative interactions to retain the full information contained in continuous variables. Besides, a median split into groups may create groups that do not exist. Baron and Kenny (1986) also stated that if moderator variables are continuous, it is possible to model their effect using the interaction term in a manner similar to that used in multiple regression. The interaction term is not a variable with any conceptual meaning but a tool for examining a particular pattern of relationships among other variables (Cortina et al., 2001). If a strong correlation exists between the independent variable and the moderating variable, the interaction term may create severe multicollinearity problems. In order to reduce the possible impact of multicollinearity, we take Mathieu et al.'s (1992) approach to create four interaction terms by standardizing the composites of supplier partnership, specific investments, and environmental uncertainty, before multiplying them (see Mathieu, 1992 in detail). Subsequently, we create three two-way and one three-way interaction terms.

Although hierarchical multiple regression is generally used to test moderating effects, its power to detect interaction effects is low (Aguinis et al., 2001). Moreover, it is inappropriate

if any of the following conditions exist: (1) the model is nonrecursive with reciprocal relationships, (2) the model has correlated residuals, and (3) the model has latent variables. On the contrary, SEM can: (1) separate out the confounding aspects of reciprocal effects, (2) make allowances for errors in the measurement model, and (3) generate solutions for a model in which the latent variables are measured by multiple indicators (Pedhazur, 1982). We therefore adopt SEM to test the moderating effects, which is more rigorous.

When the independent variable, moderator, and dependent variable are continuous, the following statistical analyses would be appropriate for hypothesis testing (Baron and Kenny, 1986). First, supplier partnership is entered into model 1 to test its main effect on operational cost performance. Second, specific investments are entered into model 2 to test its main effect. It is followed by the interaction term (i.e., supplier partnership*specific investments) in model 3. An insignificant interaction term with a significant direct effect would indicate that the variable is simply an independent predictor variable, not a moderator (Sharma et al., 1981).

The relatively small sample size ($n$ = 175) precludes the estimation of both the measurement and structural models simultaneously. We therefore take the procedure suggested by Mathieu et al. (1992), which is the simplest to implement and the easiest to understand (Cortina et al., 2001). First, we sum up the indicators of each of these component variables and standardizing each of these composites. Second, we multiply these standardized scale scores together to form the "latent" product. Third, we fix the measurement properties for these latent products such as the lambdas and theta values. Finally, we test the model with or without the path from the latent product to the criterion variable by comparing their $\chi^2$ difference in fit between the models analyzed.

According to Mathieu (1992) and Ping (1995), to avoid under-identification problems in the structural model, we should use scale reliabilities to fix the relationships between the indicators and their corresponding latent constructs, as well as the error variance of each variable. The path coefficient (lambda) from a latent variable to its indicator is equal to the

square root of the reliability of the observed score. Besides, the associated amount of random error variance (theta) is equal to one minus the reliability of the observed score times the variance of the observed score. For instance, we set the reliability of specific investments to 0.86 and its error variance to 0.14 accordingly. After standardizing all the exogenous variables, we can calculate the reliability of the interaction term by using the following formula in Bohrnstedt and Marwell (1978)

$$\rho_{xz} = \frac{r_{xz}^2 + \rho_x \rho_z}{r_{xz}^2 + 1},$$

where *rho* is the reliability and *r* is the correlation. For supplier partnership and specific investments, it yields a value of 0.537 (see Cortina et al. (2001) for more details).

Given the under-identification problems and the relative lack of advantages associated with a large number of indicators for a latent product, a single indicator is usually sufficient. It makes the calculations relatively straightforward and more user-friendly (Cortina et al., 2001). Anderson and Gerbing (1988) suggested that a conservative approach of assuming a reliability of 0.9 for single-item measures. We thus use a more stringent value of 0.95 as the reliability of the three-way interaction term.

Moderator effects are best detected when the relation between the predictor and outcome (i.e., Hypothesis 1) is substantial and can be examined by using the results of model 1 (Frazier et al., 2004). The moderating effect of specific investments on the association between supplier partnership and cost performance (i.e., Hypothesis 2) can be examined by checking the significance of the interaction term in model 3. Table 7presents the fit measures of the three models for Hypotheses 1 and 2. Figure 1 presents the conceptual model, and Table 8 presents the path coefficient estimates, *t* values, $\chi^2$, degrees of freedoms, and $R^2$ of the models analyzed. Model 1 indicates that there is a positive and significant relationship between supplier partnership and operational cost performance ($b$ = 0.49; $p$ < 0.01) and $\chi^2$

= 7.31. Therefore, Hypothesis 1 is supported and consistent with prior studies. Ireland et al. (2002) stated that effective partnership management can reduce coordination and integration costs. Thus we have detected the moderator effect (Frazier et al., 2004).

In model 2, we add specific investments in the analysis. The results indicate that specific investments are negatively and significantly related to operational cost performance ($b$ = -0.35; $p < 0.01$) and $\chi^2$ = 15.80. In model 3, we add the interaction term \ in the analysis. Both specific investments and its interaction term with supplier partnership are significantly related to operational cost performance ($b$ = -0.39; $p < 0.01$ and $b$ = 0.16; $p < 0.10$, respectively). With an increase in eight degrees of freedoms, $\Delta\chi^2$ is 25.15 and significant at $p$ = 0.01 ($\Delta\chi^2 \geq 20.09$). The goodness-of-fit test yields $\chi^2_{(16,\ N = 175)}$ = 32.46, $\chi^2/df$ = 2.0, non-normed fit index (NNFI) = 0.92, comparative fit index (CFI) = 0.96, and root mean squared error of approximation (RMSEA) = 0.076. However, Baron and Kenny (1986) pointed out that to test whether the interaction term has a moderating effect, one needs to check whether the change in $R^2$ is statistically significant. We cross checked the change in $R^2$, which is also significant (0.42 - 0.24 = 0.18). Therefore, we find support for Hypothesis 2 that specific investments are a moderator and they enhance the effectiveness of supplier partnership in improving firms' operational cost performance ($b$ = 0.16) at 90 % confidence level. It is consistent with prior study (e.g., Wei et al. 2012).

Figure 2 presents the conceptual model, and Table 9 presents the path coefficient estimates, $t$ values, $\chi^2$, degrees of freedoms, and $R^2$ of the models analyzed. Model 1 is the same as discussed above. In model 2, we add environmental uncertainty in the analysis. The results indicate that supplier partnership is positively related to operational cost performance ($b$ = 0.52; $p < 0.01$) and environmental uncertainty is negatively related to operational cost performance ($b$ = -0.13; $p < 0.10$).

In model 3, we add the interaction term. Environmental uncertainty is significantly and

negatively related to cost operational performance ($b$ = -0.13; $p$ < 0.10) but not its interaction term with supplier partnership ($b$ = 0.003). The goodness-of-fit test yields $\chi^2_{(16,\ N\ =\ 175)}$ = 15.23, $\chi^2/df$ = 1.0, non-normed fit index (NNFI) = 0.99, comparative fit index (CFI) = 0.99, and root mean squared error of approximation (RMSEA) = 0.02. With an increase in eight degrees of freedoms, $\Delta\chi^2$ is 7.92 and insignificant at $p$ = 0.01 ($\Delta\chi^2 \geq 20.09$). $\Delta R^2$ = 0.02 is also insignificant. The results of model 3 indicate a lack of any moderating effect from environmental uncertainty on the effectiveness of supplier partnership on operational cost performance. Hypothesis 3 is supported and consistent with previous studies (e.g., Song et al., 2005).

In order to examine Hypothesis 4, we test whether or not the three-way interaction among supplier partnership, environmental uncertainty, and specific investments influences operational cost performance positively (Aiken and West, 1991). Figure 3 presents the conceptual model, and Table 10 presents the path coefficient estimates, $t$ values, $\chi^2$, degrees of freedoms, and $R^2$ of the models analyzed. According to Aiken and West (1991), it is necessary to enter all the two-way interaction terms to identify the true three-way effect and interpret it. Therefore, we test the direct effects of supplier partnership, environmental uncertainty, specific investments, and test the three interaction terms among them on operational cost performance in model 1. We test the three-way interaction term (i.e., supplier partnership* specific investments* environmental uncertainty) in Model 2.

The results in model 1 indicate that supplier partnership, specific investments, environmental uncertainty, and the interaction term of specific investments with supplier partnership are significant in predicting operational cost performance ($b$ = 0.64; $p$ < 0.01; $b$ = -0.39; $p$ < 0.01; $b$ = -0.21; $p$ < 0.05; $b$ = 0.31; $p$ < 0.05 respectively). However, we find that the interaction term of supplier partnership with environmental uncertainty and the interaction term of specific investments with environmental uncertainty are insignificant in predicting

operational cost performance ($b$ = 0.03 and $b$ = -0.18, respectively). The goodness-of-fit test in model 2 yields $\chi^2_{(32,\, N = 175)}$ = 47.36, $\chi^2/df$ = 1.48, non-normed fit index (NNFI) = 0.91, comparative fit index (CFI) = 0.97, and root mean squared error of approximation (RMSEA) = 0.05. With an increase in eight degrees of freedoms, $\Delta\chi^2$ is 5.29 and insignificant at $p$ = 0.01 ($\Delta\chi^2 \geq 20.09$). $\Delta R^2$ = 0.02 is also insignificant. Although the three-way interaction term in model 2 is positive, it is not statistically significant ($b$ = 0.03), which agrees with our expectation. Therefore, Hypothesis 4 is supported.

## 5. Discussion and Conclusions

Drawing on TCE, we use SEM fed with data from 175 electronics manufacturers in Hong Kong to analyze the relationships between supplier partnership and operational cost performance, and test whether this relationship will be moderated by specific investments, environmental uncertainty, and their interaction terms jointly and separately. The SEM results show that (1) supplier partnership is positively and significantly related to operational cost performance, and (2) specific investments is a moderator while environmental uncertainty and the three-way interaction among supplier partnership, environmental uncertainty, and specific investments are not. Our study extends the OM literature and provides compelling empirical evidence that the degree of specific investments moderate the alignment of governance structure while environmental uncertainty does not. In Hong Kong's electronics industry, it is costly to develop tailor-made operating processes. Specific investments in effort, human, and dedicated finance resources make existing assets more productive.

Specific investments bring about partner cooperation and commitment irrespective of environmental uncertainty. With the support of information sharing, partners are better prepared to overcome unforeseen, exogenous disturbance, and behavioural uncertainty. Specific investments enhance the relational ties between the partners regardless of

environmental uncertainty, which is neglected in the traditional TCE literature (Blomqvist et al. 2002). This finding agrees with prior studies (e.g., Wei et al. 2012). Song et al. (2005:262) even found that if the whole industry faces rapid technological changes, the importance of close relationships with other supply chain members will decrease. Hierarchy or joint ventures (JV) should be more appropriate than supplier partnership in highly uncertain environments. Incidentally, Blomqvist et al. (2002:9) remarked that "The JV can deploy resources from each participant in order to respond to changing conditions; thus, the way the JV uses resources and the joint capabilities to be developed will not be static. This is difficult for competitors to imitate in a timely fashion" and 'The recent trend towards partnerships may actually be only a reaction against too centralized (integrated) and too planned hierarchies, which cannot cope with radical uncertainty when facing turbulent time".

### 5.1. Theoretical Implications

Our findings bear three theoretical implications. First, the traditional TCE literature that proposes that different modes of governance mechanism (i.e., market, hybrid, and hierarchy) can be equally effective in lowering costs, provided that they are aligned with the situations of the transactions is supported. Specifically, supplier partnership could be superior to the other two forms of governance (i.e., market and hierarchy) by enhancing the operational cost performance of firms in different environments when substantial specific investments have been made.

Second, specific investments have a negative impact on operational cost performance. This finding is also consistent with traditional TCE because Williamson (1991) has argued that specific investments increase transaction costs of all forms of governance. Overall, this finding ascertains the validity of traditional TCE's predictions that supplier partnership is used to safeguard supplier specific investments and such investments play a negative role .

Third, environmental uncertainly does not have a significant impact on the effectiveness

of supplier partnership in enhancing operational cost performance. The detailed reviews of TCE-related empirical studies conducted by David and Han (2004), and Rindfleisch and Heide (1997) consistently pointed out that the predictability of traditional TCE about the role of environmental uncertainty in firms' choices of governance mechanisms is not convincing. Nevertheless, the result should be interpreted with caution. Different sources or measures of environmental uncertainty may have varying effects on the efficacy of different governance mechanisms in lowering transaction costs (Sutcliffe and Zaheer, 1998).

## 5.2. Managerial Implications

Our findings also bear two practical implications. First, specific investments should be minimized in supplier relationships. Firms should focus on those practices that induce no or a low level of specific investments. After dealing with suppliers for a long period of time smoothly and specific investments are inevitable, supplier partnership should be adopted and is found effective. It can not only alleviate the negative effects of specific investments on cost performance, but also safeguard against opportunism so that the specific investments can be recouped (c.f. Crosby, 1978). Joint surplus can be created through melting by complementary skills in the R&D context (Blomqvist et al., 2002).

Second, environmental uncertainty is relatively less important than specific investments in affecting the supplier partnership - operational cost performance relationship. Nonetheless, managers have to be aware that environmental uncertainty is a complicated construct, which could have different sources (Sutcliffe and Zaheer, 1998) and multiple dimensions (Balakrishnan and Wernerfelt, 1986). Therefore, rather than ignore the impact of environmental uncertainty completely, managers of Hong Kong electronics manufacturing firms should carefully examine the sources and the dimensions of their respective environments and consider whether changes in their environments would result in adaptation problems as suggested by TCE and, in turn, whether supplier partnership is suitable in

alleviating those problems.

*Limitations and Further Research*

While the findings of this study are representative of Hong Kong's electronics industry, the conclusions are not readily generalized to other national contexts such as Japan or the U.S.A. Another limitation is that we examine only a particular period in which the supplier partnership – cost performance relationship is in effect. A longitudinal study of the relationship may provide more insights on how the relationship progresses and its impact on non-financial firm performance. In addition, more items should be operationalized to manifest specific investments in more detail in future studies. Finally, rigorous statistical analyses should be used to increase the accuracy of the findings.

**References**

Aguinis, H., Boik, R.J., Pierce, C.A., 2001. A generalized solution for approximating the power to detect effects of categorical moderator variables using multiple regression. Organizational Research Methods 4, 292-323.

Aiken, L.S., West, S.G., 1991. Multiple Regression: Testing and Interpreting Interactions. Sage, Newbury Park, CA.

Anderson, E., Jap, S.D., 2005. The dark side of close relationships. Sloan Management Review 46 (3), 75-82.

Anderson, J.C., Gerbing, D.W., 1988. Structural equation modeling in practice: a review and recommended two-step approach. Psychological Bulletin 103, 411-423.

Arend, R.J., 2006. SME-supplier alliance activity in manufacturing: Contingent benefits and perceptions. Strategic Management Journal 27 (8), 741–763.

Armstrong, J. S., Overton, T. S., 1977. Estimating nonresponse bias in mail surveys. Journal of Marketing Research 14, 396-402.

Artz, K.W., Brush, T.H., 2000. Asset specificity, uncertainty and relational norms: An examination of coordination costs in collaborative strategic alliances. Journal of Economic Behavior and Organization 41 (4), 337–362.

Bagozzi, R.P., Baumgartner, H., Yi, Y., 1992. State versus action orientation and the theory of reasoned action: An application to coupon usage. Journal of Consumer Research 18, 505-518.

Balakrishnan, S., Wernerfelt, B., 1986. Technical change, competition and vertical integration. Strategic Management Journal 7 (5), 347-359.

Barney, J.B., 1999. How a firm's capabilities affect boundary decisions. Sloan Management Review Spring, 137-145.

Baron, R.M., Kenny, D.A., 1986. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. Journal of

Personality and Social Psychology 51 (6), 1173-1182.

Beekman A.V., Robinson, R.N., 2004. Supplier partnerships and the small, high-growth firm: Selecting for success. Journal of Small Business Management 42 (1), 59–77.

Blomqvist, K., Kylaheiko, K., Virolainen, V.M., 2002. Filling a gap in tradition transaction cost economics: Towards transaction benefit-based analysis. International Journal of Production Economics 79 (1), 1-14.

Bohrnstedt, G.W., Marwell, G., 1978. The reliability of products of two random variables. In K.F. Schuessier (Ed.). Sociological Methodology: 254-273. San Francisco. Jossey-Bass.

Burnes, B., New, S., 1997. Collaboration in customer-supplier relationships: Strategy, operations and the function of rhetoric. International Journal of Purchasing and Materials Management 33 (4), 10-17.

Cannon, J.P., Homburg, C., 2001. Buyer-supplier relationships and customer firm costs. Journal of Marketing 65, 29-43.

Carr, A.S., Smeltzer, L. R., 1999. The relationship among purchasing benchmarking, strategic purchasing, firm performance, and firm size. The Journal of Supply Chain Management 36 (3), 51-60.

Chau, P.Y.K., 1997. Reexamining a model for evaluating information center success using a structural equation modelling approach. Decision Sciences 28 (2), 309-334.

Chen, I.J., Paulraj, A., Lado, A.A., 2004. Strategic purchasing, supply management, and firm performance. Journal of Operations Management 22 (5), 505-523.

Choi, T.Y., Eboch, K., 1998. The TQM paradox: Relations among TQM practices, plant performance, and customer satisfaction. Journal of Operations Management 17 (1), 59-75.

Coase, R.H., 1960. The problem of social cost. Journal of Law and Economics 3 (1), 1-44.

Cortina, J.M., Chen, G., Dunlap, W.P., 2001. Testing interaction effects in LISREL: Examination and illustration of available procedures. Organizational Research Methods 4 (4), 324-360.

Crosby, P.B., 1978. Quality is Free: The Art of making Quality Certain. McGraw-Hill Inc., US.

David, R.J., Han, S.K., 2004. A systematic assessment of the empirical support for transaction cost economics. Strategic Management Journal 25 (1), 39-58.

Donaldson, L., 2001. The Contingency Theory of Organizations (Saga, Thousand Oaks, CA).

Ellram, L.M., Edis, O.R.V., 1996. A case study of successful partnering implementation. International Journal of Purchasing and Materials Management 32 (Fall), 20-28.

Ellram, L.M., Tate, W.L., Billington, C., 2008. Offshore outsourcing of professional services: A transaction cost economics perspective. Journal of Operations Management 26, 148-163.

Fornell, C., Larcker, D.F., 1981. Evaluating structural equation models with unobservable variables and measurement errors. Journal of Marketing Research 18 (1), 39-50.

Forza, C., 2002. Survey research in operations management: A process-based perspective. International Journal of Operations and Production Management, 22 (2), 152-194.

Frazier, P.A., Tix, A.P., Barron, K.E., 2004. Testing moderator and mediator effects in counseling psychology, Journal of Counseling Psychology 51 (1), 115-134.

Fynes, B., de Búrca, S., Mangan, J., 2008. The effect of relationship characteristics on relationship quality and performance. International Journal of Production Economics 111 (1), 56-69.

Ganesan, S., 1994. Determinants of long-term orientation in buyer-seller relationships. Journal of Marketing 58, 1-19.

Grando, A., Belvedere, V., 2006. District's manufacturing performances: A comparison among large, small-to-medium-sized and district enterprises. International Journal of Production Economics 104 (1), 85-99.

Hair, J.F., Black, B., Babin, B., Anderson, R., Tatham, R., 2006. Multivariate Data Analysis (Upper Saddle River, NJ: Prentice Hall).

Han, J.Q., Trienekens, J.H., Omta, S.W.F., 2011. Relationship and quality management in the Chinese pork supply chain. International Journal of Production Economics 134 (2), 312-321.

Heide, J.B., John, G., 1988. The role of dependence balancing in safeguarding transaction specific assets in conventional channel. Journal of Marketing 52, 20-35.

Hong Kong Trade Development Council, 2012, Electronics industry in Hong Kong, assessed on 21 July, 2012, available at http://www.hktdc.com/info/mi/a/hkip/en/1X00401Z/1/Hong-Kong-Industry-Profiles/Electronics-Industry-In-Hong-Kong.htm

Ireland, R.D., Hitt, M.A., Vaidyanath, D., 2002. Alliance management as a source of competitive advantage. Journal of Management 28 (3), 413-446.

Jambulingam, T., Kathuria, R., Doucette, W., 2005. Entrepreneurial orientation as a basis for classification within a service industry: the case of retail pharmacy industry. Journal of Operations Management 23 (1), 23-42.

Jöreskog, K.G., Sörbom, D., 2001. LISREL 8.5: Structural Equation Modeling, Chicago: Scientific Software International, Inc.

Joshi, A.W., Stump, R.L., 1999. The contingent effect of specific asset investments on joint action in manufacturer-supplier relationships: An empirical test of the moderating role of reciprocal asset investments, uncertainty, and trust. Journal of Academy of Marketing Science 27 (3), 291-305.

Kathuria, R., 2000. Competitive priorities and managerial performance: A taxonomy of small manufacturers. Journal of Operations Management 18 (6), 627-641.

Kerlinger, F., 1986. Foundations of Behavioral Research. New York: Holt, Rinehart Winston.

Kline, R.B., 1998. Principles and Practice of Structural Equation Modeling. N.Y.: Guildford Press.

Klein, S., Frazier, G.L., Roth, V.J., 1990. A transaction cost analysis model of channel

integration in international markets. Journal of Marketing Research 27 (May), 196-208.

Koh, S.C.L., Saad, S.M., 2006. Managing uncertainty in ERP-controlled manufacturing environments in SMEs. International Journal of Production Economics 101 (1), 109-127.

Krause, D.R., Handfield, R.B., Beverly, B. ., 2007. The relationships between supplier development, commitment, social capital accumulation and performance improvement. Journal of Operations Management 25 (2), 528-545.

Krause, D.R., Scannell, T.V., Calantone, R., 2000. A structural analysis of the effectiveness of buying firm's strategies to improve supplier performance. Decision Sciences 31 (1), 33-55.

Lamming, R., 1986. For better or for worse: technical change and buyer-supplier relationships. International Journal of Operations and Production Management 6 (5), 20-29.

Li, S., Ragu-Nathan, B., Ragu-Nathan, T.S., Rao, S.S., 2006. The impact of supply chain management practices on competitive advantage and organizational performance. Omega - The International Journal of Management Science 34 (2), 107-124.

Li, W., Humphreys, P.K., Yeung, A.C.L., Cheng, T.C.E., 2007. The impact of specific supplier development efforts on buyer competitive advantage: An empirical model. International Journal of Production Economics 106 (1), 230-247.

Loehlin, J.C., 1998. Latent Variable Models, third ed. Lawrence Erlbaum, Hillsdale, New Jersey.

Mathieu, J.E., Tannenbaum, S.I., Salas, E., 1992. Influences of individual and situational characteristics on measures of training effectiveness. Academy of Management Journal 35 (4), 828-847.

McCutcheon, D., Stuart, F.I., 2000. Issues in the choice of supplier alliance partners. Journal of Operations Management 18 (3), 279-301.

Merschmann, U., Thonemann, U.W., 2011, Supply chain flexibility, uncertainty and firm performance: An empirical analysis of German manufacturing firms, International Journal

of Production Economics 130, 43-53.

Mezgár, I., Kovács, G.L., Paganelli, P., 2000. Co-operative production planning for small- and medium-sized enterprises. International Journal of Production Economics 64 (1-3), 37-48.

Monczka, R.M., Petersen, K.J., Handfield, R.B., Ragatz, G.L., 1998. Success factors in strategic supplier alliances: The buying company perspective. Decision Sciences 29 (3), 553-577.

Narasimhan, R., Jayaram, J., 1998. Causal linkages in supply chain management: an exploratory study of North American manufacturing firms. Decision Sciences 29 (3), 579-605.

Nunnally, J.C., Bernstein, I.H., 1994, Psychometric Theory (McGraw Hill, New York).

Panayides, P.M., Lun, V.Y.H., 2009. The impact of trust on innovativeness and supply chain performance. International Journal of Production Economics 122 (1), 35-46.

Ping, R.A., 1995. A parsimonious estimating technique for interaction and quadratic latent variables. Journal of Marketing Research 32, 336-347.

Pedhazur, E.J., 1982. Multiple Regression in Behavioral Research: Explanation and Prediction. New York: Holt, Rinehart & Winston.

Prahinski, C., Benton, W.C., 2004. Supplier evaluations: communication strategies to improve supplier performance. Journal of Operations Management 22 (1), 39-62.

Reines-Eudy, R., 2000. Using structural equation modeling to test for differential reliability and validity: an empirical demonstration. Structural Equation Modeling 7 (1), 124-141.

Rindfleisch, A., Heide, J. B., 1997. Transaction cost analysis: Past, present, and future applications. Journal of Marketing 61 (October), 30-54.

Robb, D.J., Xie, B., Arthanari, T., 2008. Supply chain and operations practice and performance in Chinese furniture manufacturing. International Journal of Production Economics 112 (2), 683-699.

Sanchez, A.M., Perez, M.P., 2005. Supply chain flexibility and firm performance.

International Journal of Operations and Production Management 25 (7), 681-700.

Sharma, S., Durand, R.M., Gur-Arie, O., 1981. Identification and analysis of moderator variables. Journal of Marketing Research 18, 291-300.

Shin, H., Collier, D.A., Wilson, D.D., 2000. Supply management orientation and supplier/buyer performance. Journal of Operations Management 18, 317-333.

Skinner, W., 1969. Manufacturing – missing link in corporate strategy. Harvard Business Review, May-June, 136-145.

Song, M., Droge, C., Hanvanich, S., and Calantone, R., 2005, Marketing and technology resource complementarity: An analysis of their interaction effect in two environmental contexts, Strategic Management Journal, 26, 259-276.

Stuart, F.I., 1997. Supplier alliance success and failure: A longitudinal dyadic perspective. International Journal of Operations and Production Management 17 (6), 539-557.

Sutcliffe, K.M., Zaheer, A., 1998. Uncertainty in the transaction environment: An empirical test. Strategic Management Journal 19 (1), 1-23.

The Hong Kong Electronic Industries Association Limited, 1999. Annual Directory of Hong Kong Electronics Industry (The Hong Kong Electronic Industries Association Limited).

Veloso, F.M., Benner, M.J., 2007. ISO 9000 Practices and financial performance: A technology coherence perspective. Journal of Operations Management 26 (5), 611-629.

Vickery, S., Calantone, R., Droge, C., 1999. Supply chain flexibility: An empirical study. The Journal of Supply Chain Management 35 (3), 16-24.

Wang, L.W., Yeung, H.Y., Zhang, M., 2011, The impact of trust and contract on innovation performance: The moderating role of environmental uncertainty. International Journal of Production Economics, 134 (1), 114-122.

Ward, P.T., Duray, R., 2000. Manufacturing strategy in context: environment, competitive strategy and manufacturing strategy. Journal of Operations Management 18 (2), 123-138.

Wei, H.L., Wong, C.W.Y., Lai, K.H., 2012. Linking inter-organizational trust with logistics

information integration and partner cooperation under environmental uncertainty. International Journal of Production Economics, In Press.

Williamson, O.E., 1975. Markets and Hierarchies (The Free Press, New York).

Williamson, O.E., 1985. The Economic Institute of Capitalism: Firms, Markets, Relational Contracting (The Free Press, New York).

Williamson, O.E., 1991. Comparative economic organization: The analysis of discrete structural alternatives. Administrative Science Quarterly 36 (2), 269-96.

Wong, C.Y., Boon-itt, S., Wong, C.W.Y., 2011. The contingency effects of environmental uncertainty on the relationship between supply chain integration and operational performance. Journal of Operations Management 29, 604-615.

Wong, C.W.Y., Lai, K.H., Ngai, E.W.T., 2009. The role of supplier operational adaptation on the performance of IT-enabled transport logistics under environmental uncertainty. International Journal of Production Economics, 122 (1), 47-55.

Wu, Z., Choi, T.Y., 2005. Supplier–supplier relationships in the buyer–supplier triad: Building theories from eight case studies. Journal of Operations Management 24 (1), 27-52.

Yang, J, Wong, C.W.Y., Lai, K.H., Ntoko, A.N., 2009. The antecedents of dyadic quality performance and its effect on buyer–supplier relationship improvement. International Journal of Production Economics 120 (1), 243-251.

Young-Ybarra, C., Wiersema, M., 1999. Strategic flexibility in information technology alliances: The influence of transaction cost economics and social exchange theory. Organization Science 10 (4), 439-459.

Yeung, A.C.L., Cheng, T.C.E., Lai, K.H., 2006. An operational and institutional perspective of total quality management. Production and Operations Management 15 (1), 156-170.

Yeung, K., Zhou, H.G., Yeung, A.C.L., Cheng, T.C.E., 2012. The impact of third-party logistics providers' capabilities on exporters' performance. International Journal of Production Economics 135 (2), 741-753.

Zhou, K.Z., Poppo, L., Yang, Z., 2008. Relational ties or customized contracts? An examination of alternative governance choice in China. Journal of International Business Studies 39, 526-534.

Table 1. Sample profile.

| Company characteristics | Frequency ($n$ = 175) | Percentage |
|---|---|---|
| *Number of employees* | | |
| 1 – 50 | 35 | 20.0 |
| 51 –200 | 25 | 14.3 |
| 201 – 500 | 28 | 16.0 |
| 501 – 1,000 | 35 | 20.0 |
| 1,001 – 2,000 | 20 | 11.4 |
| 2,001 – 5,000 | 23 | 13.2 |
| 5,001 – 10,000 | 3 | 1.7 |
| Over 10,000 | 6 | 3.4 |
| *Gross annual sales (HK$ Million)* | | |
| | 9 | 5.1 |
| Less than 3 | 17 | 9.7 |
| 3 – 10 | 36 | 20.6 |
| 11 – 50 | 32 | 18.3 |
| 51 – 100 | 42 | 24.0 |
| 101 – 300 | 14 | 8.0 |
| 301 – 600 | 8 | 4.6 |
| 601 – 1,000 | 17 | 9.7 |
| Over 1,000 | | |
| *Kind of products producing:* | | |
| *1. End-products for end-users* | | |
| *2. Components for end-product manufacturers* | | |
| *3. Components for other component manufacturers* | | |
| 1 only | 98 | 56.0 |
| 1 and 2 | 5 | 2.9 |
| 2 only | 57 | 32.5 |
| 2 and 3 | 3 | 1.7 |
| 3 only | 12 | 6.9 |

Table 2. Results of measurement validation.

| Scale name | Variable name | CITC | Factor loading | Scale statistics |
|---|---|---|---|---|
| Supplier Partnership | INFO | 0.60 | 0.71 | Cronbach's alpha: 0.74<br>Largest eigenvalue (variance explained): 2.03 (68%)<br>Second largest eigenvalue (variance explained): 0.56 (19%) |
| | COMMIT | 0.64 | 0.80 | |
| | COOP | 0.55 | 0.64 | |
| Cost Performance | CP1 | 0.64 | 0.73 | Cronbach's alpha: 0.81<br>Largest eigenvalue (variance explained): 2.16 (72%)<br>Second largest eigenvalue (variance explained): 0.48 (16%) |
| | CP2 | 0.63 | 0.74 | |
| | CP3 | 0.70 | 0.82 | |
| Specific Investment | SI1 | 0.78 | 0.84 | Cronbach's alpha: 0.89<br>Largest eigenvalue (variance explained): 2.48 (83%)<br>Second largest eigenvalue (variance explained): 0.29 (10%) |
| | SI2 | 0.82 | 0.89 | |
| | SI3 | 0.78 | 0.85 | |
| Environmental Uncertainty | EU1 | 0.69 | 0.80 | Cronbach's alpha: 0.82<br>Largest eigenvalue (variance explained): 2.20 (73%)<br>Second largest eigenvalue (variance explained): 0.42 (14%) |
| | EU2 | 0.66 | 0.75 | |
| | EU3 | 0.67 | 0.77 | |

Table 3. Exploratory factor analysis of the constructs.

| Factor loading | | | | |
|---|---|---|---|---|
| Item* | Supplier Partnership | Cost Performance | Specific Investment | Environmental Uncertainty |
| INFO | 0.815 | 0.147 | -0.023 | 0.057 |
| COMMIT | 0.817 | 0.265 | 0.028 | 0.012 |
| COOP | 0.766 | 0.071 | -0.207 | 0.129 |
| CP1 | 0.139 | 0.834 | -0.103 | 0.020 |
| CP2 | 0.238 | 0.757 | -0.219 | -0.004 |
| CP3 | 0.129 | 0.844 | -0.179 | -0.103 |
| SI1 | -0.111 | -0.135 | 0.883 | -0.016 |
| SI2 | -0.103 | -0.109 | 0.916 | 0.029 |
| SI3 | 0.011 | -0.260 | 0.862 | -0.030 |
| EU1 | 0.072 | -0.066 | -0.116 | 0.862 |
| EU2 | -0.010 | 0.103 | -0.051 | 0.863 |
| EU3 | 0.143 | -0.126 | 0.172 | 0.834 |

*: See Appendix for the survey questions of the measurement items.

Table 4. Correlations of the indicators.

| Items | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Unit cost | 1 | .525** | .623** | -.001 | .069 | -.088 | .246** | .307** | .219** | -.277** | -.199** | -.268** |
| 2. | WIP inventory | .525** | 1 | .600** | .020 | .045 | -.099 | .271** | .382** | .282** | -.275** | -.301** | -.396** |
| 3. | Cost defects | .623** | .600** | 1 | -.113 | .005 | -.177* | .265** | .276** | .202** | -.280** | -.295** | -.342** |
| 4. | Resources allocated | -.001 | .020 | -.113 | 1 | .612** | .615** | .150* | .003 | .162* | -.108 | -.096 | -.050 |
| 5. | Tailored to meet | .069 | .045 | .005 | .612** | 1 | .578** | .026 | .084 | .155* | -.061 | -.022 | -.109 |
| 6. | Training & evaluate | -.088 | -.099 | -.177* | .615** | .578** | 1 | .137 | .104 | .126 | .121 | .169* | .114 |
| 7. | INFO | .246** | .271** | .265** | .150* | .026 | .137 | 1 | .576** | .451** | -.162* | -.126 | -.044 |
| 8. | COMMIT | .307** | .382** | .276** | .003 | .084 | .104 | .576** | 1 | .518** | -.091 | -.093 | -.101 |
| 9. | COOP | .219** | .282** | .202** | .162* | .155* | .126 | .451** | .518** | 1 | -.242** | -.247** | -.159* |
| 10. | Change plan | -.277** | -.275** | -.280** | -.108 | -.061 | .121 | -.162* | -.091 | -.242** | 1 | .754** | .706** |
| 11. | Cannot predict | -.199** | -.301** | -.295** | -.096 | -.022 | .169* | -.126 | -.093 | -.247** | .754** | 1 | .757** |
| 12. | Winning is tough | -.268** | -.396** | -.342** | -.050 | -.109 | .114 | -.044 | -.101 | -.159* | .706** | .757** | 1 |

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 5. Discriminant validity: Chi-square differences between constrained and unconstrained models.

| | SP | CP | SI |
|---|---|---|---|
| Supplier Partnership (SP) | | | |
| Cost Performance (CP) | 105.12 | | |
| Specific Investments (SI) | 139.50 | 146.08 | |
| Environmental Uncertainty (EU) | 122.69 | 197.92 | 171.77 |

All chi-square differences are different at the 0.05 level.

Table 6. Estimations of the measurement model parameters.

| Scale name | Effect indicator | Path coefficient estimate (*t*-value) |
|---|---|---|
| Supplier Partnership | INFO | 0.71 (9.35) |
| | COMMIT | 0.80 (10.67) |
| | COOP | 0.64 (8.40) |
| Cost Performance | CP1 | 0.73 (10.21) |
| | CP2 | 0.74 (10.42) |
| | CP3 | 0.82 (11.76) |
| Specific Investments | SI1 | 0.84 (13.16) |
| | SI2 | 0.89 (14.32) |
| | SI3 | 0.85 (13.40) |
| Environmental Uncertainty | EU1 | 0.80 (11.03) |
| | EU2 | 0.75 (10.44) |
| | EU3 | 0.77 (10.78) |

Table 7. Fit measures of three models for Hypotheses 1 and 2.

| Goodness of Fit Measures | Criteria | Model 1 | Model 2 | Model 3 |
|---|---|---|---|---|
| *Absolute Fit Measure* | - | | | |
| Chi-square ($\chi^2$) of Estimated Model | - | 7.31 | 15.80 | 32.46 |
| Degree of Freedom (*df*) | - | 8 | 12 | 16 |
| Chi-square/Degree of Freedom ($\chi^2/df$) | [1, 3] | 1.00 | 1.32 | 2.03 |
| Root mean squared error of approximation (RMSEA) | ≤ 0.08 | 0.0 | 0.04 | 0.076 |
| *Comparative Fit Measures* | | | | |
| Non-normed Fit Index (NNFI) | ≥ 0.90 | 1.00 | 0.98 | 0.92 |
| Comparative Fit Index (CFI) | ≥ 0.90 | 1.00 | 0.99 | 0.96 |

Table 8. Summary of statistical tests of the hypotheses 1 and 2 in Figure 1.

| | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| Paths in the structural model | Point estimate (*t*-value) | Point estimate (*t*-value) | Point estimate (*t*-value) |
| Supplier partnership $\rightarrow$ Operational Cost performance | 0.49 (5.07***) | 0.42 (4.58***) | 0.48 (4.77***) |
| Specific Investments $\rightarrow$ Operational Cost performance | - | -0.35 (-4.38***) | -0.39 (-4.77***) |
| Supplier partnership* Specific Investments $\rightarrow$ Operational Cost performance | - | - | 0.16 (1.89*) |
| Chi-square ($\chi^2$) | 7.31 | 15.80 | 32.46 |
| Degree of Freedom (*df*) | 8 | 12 | 16 |
| $R^2$ | 0.24 | 0.37 | 0.42 |

***: significant at $p < 0.01$ level.

**: significant at $p < 0.05$ level.

*: significant at $p < 0.10$ level.

Table 9. Summary of statistical tests of the hypothesis 3 in Figure 2.

| | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| Paths in the structural model | Point estimate (*t*-value) | Point estimate (*t*-value) | Point estimate (*t*-value) |
| Supplier partnership $\rightarrow$ Operational Cost performance | 0.49 (5.07***) | 0.52 (5.20***) | 0.52 (5.20***) |
| Environmental Uncertainty $\rightarrow$ Operational Cost performance | - | -0.13 (-1.82*) | -0.13 (-1.82*) |
| Supplier partnership* Environmental Uncertainty $\rightarrow$ Operational Cost performance | - | - | 0.003 (0.04) |
| Chi-square ($\chi$2) | 7.31 | 13.92 | 15.23 |
| Degree of Freedom (df) | 8 | 12 | 16 |
| $R^2$ | 0.24 | 0.26 | 0.26 |

***: significant at $p < 0.01$ level.

**: significant at $p < 0.05$ level.

*: significant at $p < 0.10$ level.

Table 10. Summary of statistical tests of the hypothesis 4 in Figure 3.

| | Model 1 | Model 2 |
|---|---|---|
| Paths in the structural model | Point estimate (*t*-value) | Point estimate (*t*-value) |
| Supplier partnership → Operational Cost performance | 0.64 (3.85***) | 0.64 (3.81***) |
| Specific Investments → Operational Cost performance | -0.39 (-4.19***) | -0.39 (-4.09***) |
| Environmental Uncertainty → Operational Cost performance | -0.21 (-2.14**) | -0.21 (-2.08**) |
| Supplier partnership* Specific Investments → Operational Cost performance | 0.31 (2.00**) | 0.31 (2.00**) |
| Supplier partnership* Environmental Uncertainty → Operational Cost performance | 0.03 (0.32) | 0.03 (0.35) |
| Specific Investments* Environmental Uncertainty → Operational Cost performance | -0.18 (-1.20) | -0.19 (-1.19) |
| Supplier partnership* Specific Investments* Environmental Uncertainty → Operational Cost performance | - | 0.03 (0.29) |
| Chi-square ($\chi 2$) | 42.07 | 47.36 |
| Degree of Freedom (df) | 28 | 32 |
| $R^2$ | 0.39 | 0.41 |

***: significant at $p < 0.01$ level. **: significant at $p < 0.05$ level.

*: significant at $p < 0.10$ level.

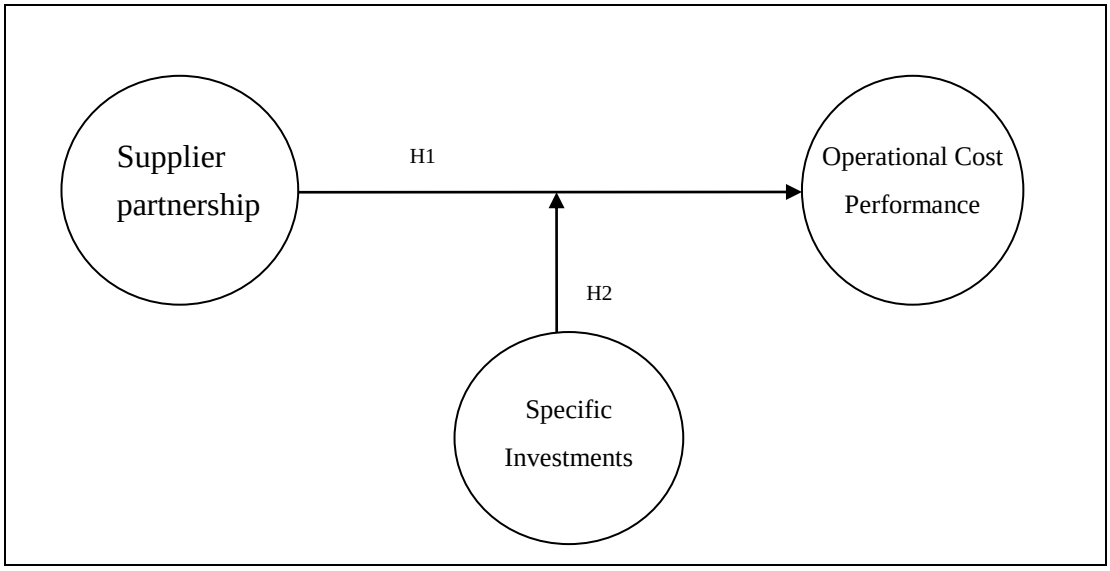


Figure 1. The main and interaction effects of specific investments.

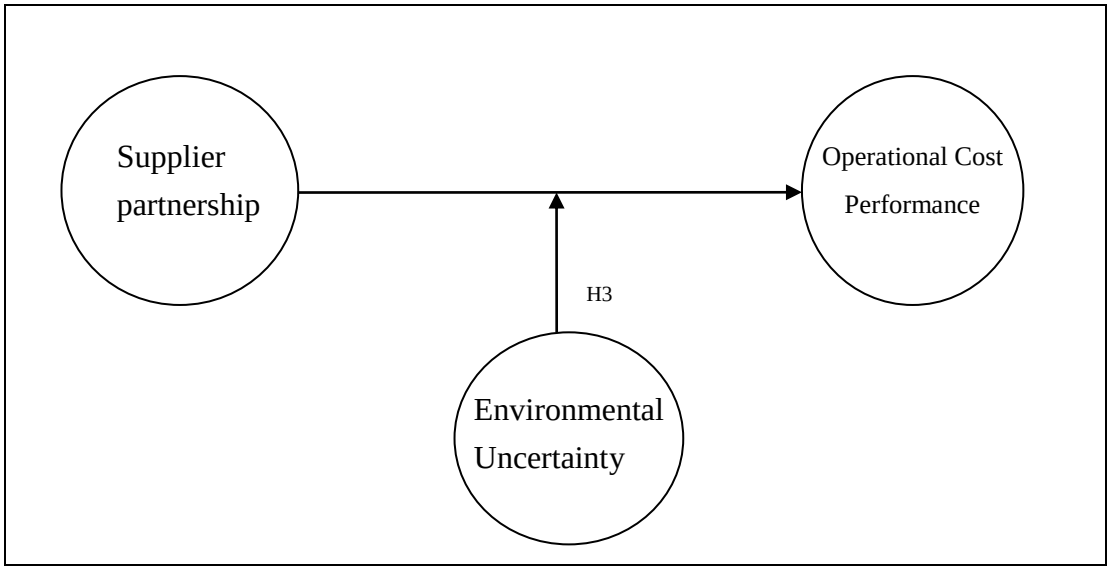


Figure 2. The interaction effect of environmental uncertainty.

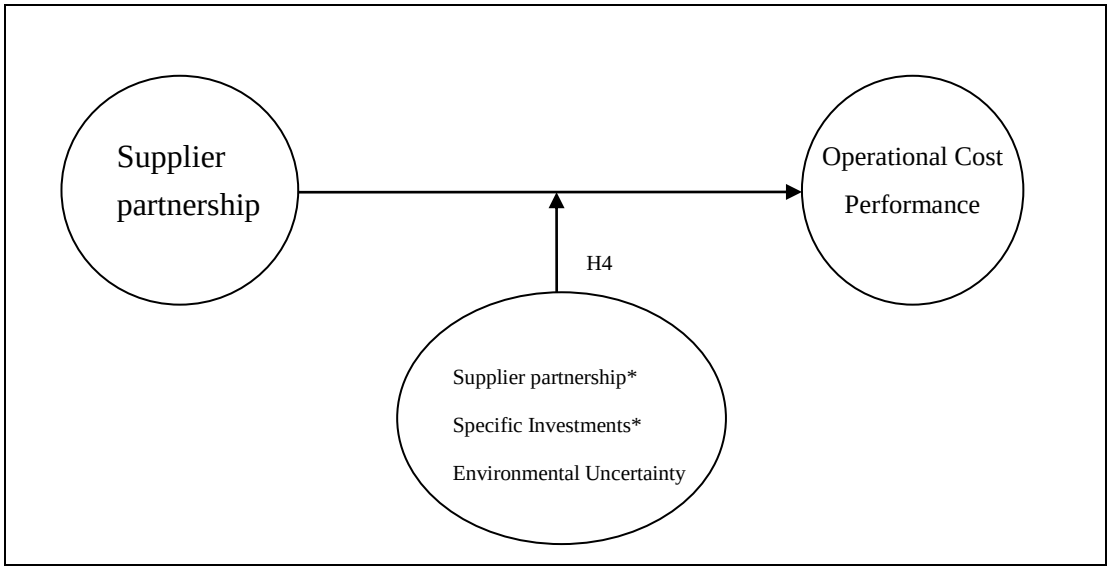


Figure 3. The three-way interaction effect on the supplier partnership – operational cost performance relationship.

Appendix A. Survey questions and descriptive statistics.

| Survey question | Mean | S.D. |
|---|---|---|
| Please answer the following questions with one supplier in mind. This should be the supplier that is the most crucial to the performance of your company at present and in the long run.<br>[1 = strongly disagree, 7 = strongly agree] | | |
| EU1. Our company must often change our marketing plan quickly. | 2.94 | 1.79 |
| EU2. Our company cannot predict the actions of our competitors. | 2.71 | 1.69 |
| EU3. Winning in the market place is a tough battle. | 2.91 | 1.88 |
| SI1. Resources (e.g., finance, personnel, etc.) allocated to dealing with this supplier would be wasted if we decide to deal with a new supplier. | 4.82 | 1.28 |
| SI2. Our operating process has been tailored to meet the requirements for dealing with this supplier. | 4.71 | 1.28 |
| SI3. Training and evaluating this supplier have involved substantial commitment of time and money. | 5.30 | 1.28 |
| Please rate your manufacturing plant's operational cost performance in the following areas.<br>[1 = strongly dissatisfied, 7 = strongly satisfied] | | |
| CP1. Cost per unit produced | 5.15 | 1.00 |
| CP2. Work-in-process inventory | 4.99 | 1.08 |
| CP3. Costs associated with defects, reworks or returned products | 5.09 | 1.12 |