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An empirical investigation of antecedents to information exchange in supply chains

Martin Müller*, Sonja Gaudig*

Abstract:

In this investigation, following the principal-agent theory, possibilities to reduce existing information asymmetries are being derived and their effects on the information exchange are being examined. Results of an empirical investigation based on a structural equation model confirm that monitoring measures and frequent meetings positively influence the exchange of information while explicit contracts rather have negative effects. Premiums and specific investments, however, seem to play insignificant roles. Measures, such as building a reputation mechanism, will probably prove to be effective only in the long run.

Keywords: information exchange, supply chain management, empirical study

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1 Introduction

Fawcett/Magnan (2001) aptly sum it up by stating: “information is the ‘life blood’ of effective supply chain management”. *Large (2005)* equally comes to the conclusion that “open, friendly and extensive communication” with the supplier encourages successful supplier relationship management.

Against this background, it is surprising that information exchange in SCM has so many shortcomings, as shown by various studies (*Frohlich/Westbrook, 2001, Kempainen/Vepsalainen 2003, Spekmann/Kamauff/Myhr 1998, Cachon/Fisher 2000*). One study e.g., which explicitly deals with SCM and considers inherent peculiarities, was conducted by *Windischer/Grote (2003)* within 136 companies. Regarding point-of-sale data, only about 10 to 20 percent of the companies share this information with their main suppliers. Overall, the exchange of information must be considered very unsatisfactory. In most cases, numerous competing interests and information asymmetries within the supply chain are being made responsible.

Worth noting is also that the “Bullwhip Effect” (*Forrester 1978, Lee et al., 1997*), though long since known and easily avoidable by correctly passing on all order information, is still fairly common (*Müller 1995*).

Despite increasing attention being paid to SCM, relevant publications refer only occasionally to measures which might help to improve information exchange (*Li et al., 2006*) and to avoid existing information asymmetries and diverging interests (*Feldmann/Müller 2003*). Especially the principal-agent approach, though, might prove helpful when realizing measures to avoid information asymmetries within SCM. So far, however, these measures and their possible relevance for SCM have not been investigated yet. The following comments are meant to help reduce this research deficit.

- Therefore, this paper aims, by means of an empirical investigation to answer the question how measures to avoid information asymmetries affect the intensity of information exchange within SCM, in order to realize a better exchange of information. To this end and to answer this question, measures suggested by the principal-agent theory will be dealt with.

In this context, the research studies by Fawcett et al. (2009, 2008, 2007) should be stressed, which deal with the factors that might support or inhibit information exchanges in supply chains. Starting from a behavioural science perspective, Fawcett et al. work with the variables ‘connectivity’, ‘willingness’ and ‘information-sharing capability’. Factors like transaction costs, social dilemmas and opportunistic behaviour do play important roles in these research studies but the argumentation is not built on the principal-agent theory, an approach this paper takes.

Subsequent to this introduction, an explanation of the theoretical foundations of the principal-agent theory will be given, and measures to reduce information asymmetries will be derived.

On the basis of the previously defined theoretical model, hypotheses regarding assumed correlations between these measures and information exchange are being derived. Subsequently, the data collection method as well as the base data used in this study are being described. Finally, the method to analyze the results of this study are being presented. To this end, methods in structural equation models, especially the PLS method, are being discussed in more detail.

On this basis, results as well as consequences for SCM will be discussed. The study concludes by considering the limitations of this investigation and by suggesting future research areas.

2 Theoretical frame of reference

Previous publications show that the principal-agent theory was repeatedly used as a theoretical basis for the foundation of organizational questions regarding buyer-vendor relationships (Müller, 2005).

„In fact, the agent and principal are merely two (ore more) individuals (or organizations) in some sort of explicit or implicit contractual relationship” (Arrow, 1986)
The principal-agent approach therefore focuses on the contract and its role in transactional relationships between a client (principal) and a contractor (agent). By delegating decisions to the agent, the principal tries to benefit from the agent’s information and specific knowledge. The latter has, as far as his or her knowledge, skills and experience are concerned, an informational advantage over the principal. Thus, the principal-agent

approach is based on an asymmetrical distribution of information: the principal lacks access to adequate information on the agent's behaviour as the agent's intentions and activities are hidden. The principal cannot know for sure whether the agent's performance has influenced the result or whether external environmental influences have to be made responsible. Especially in complex and unsafe situations it is barely possible to reliably attribute the agent's actual performance.

The principal-agent theory helps to explain the problem of existing information asymmetries in supply chain relationships and to derive suitable measures to reduce such asymmetries. A supply chain with different value-added levels can be interpreted as a sequence of bilateral client- contractor relationships, as shown in Figure 1, in which the information exchange between companies is limited by an asymmetrical distribution of information between the client and the contractor. According to the theory, the agent has an informational advantage over the principal since the agent denies the principal full access to important information and e.g. his or her cost situation.

Figure 1

Insert Figure 1

The principal-agent theory here distinguishes between three different forms of information asymmetries: 'hidden characteristics', 'hidden action' and 'hidden intention'. Each form of these information asymmetries is characterized by a specific informational advantage the agent has over the principal. In this context, 'adverse selection', the phenomenon described by Akerlof (1970), should be mentioned which is caused by existing information asymmetries between buyers and sellers.

The principal-agent theory recommends specific measures in order to reduce such information asymmetries.

- In 'hidden characteristic situations', when the principal cannot find out whether the agent will be able to meet his or her obligations, the principal-agent theory suggests signalling activities in the form of reputation building and specific investments (Arrow 1986).
- In 'hidden action situations', the principal lacks the expertise necessary for a satisfactory evaluation of the agent's efforts. Instead, he or she can only observe the results of the agent's actions. In order to create incentives for the agent to behave according to the principal's expectations, the principal-agent theory rec-

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ommends suitable incentives and control mechanisms as e.g. monetary incentives, frequent meetings or monitoring activities (Holmström 1979).

- In ‘hidden intention situations’, however, the principal lacks information on the agent’s motives and intentions. Therefore, he or she cannot determine whether a better result could have been obtained had the contractor reached a different decision. In this case, the principal-agent theory suggests explicit contracts, sanctions and, when faced with particularly difficult problems, the vertical integration (Klein/Crawford/Alchian 1978).

These measures suggested by the principal-agent theory in order to reduce existing information asymmetries form the basis for further investigations on how to improve information exchange.

There are numerous definitions of the term *information exchange* explaining its different dimensions. Following these definitions, different options exist when conceptualizing information exchange. One of the most common definitions, which will also be used in this paper, is to consider information exchange as transfer activity between principal and agent. Existing definitions considering information exchange as transfer activity, stress the significance of anticipation during the exchange of information (Doucette, 1997), others refer to reciprocity (Roloff, 1981). Furthermore, the informational value (Heide/Miner, 1992) as well as the scope and efficiency are characteristics of the transfer (Anderson/Narus, 1990). In order to examine this multi-faceted transfer activity of information exchange, it is necessary to consider the above-mentioned elements.

The measurements used were developed in accordance with Chen/Paulraj (2004) and Lusch/Brown (1996). They gather to what extent information can be made available by the main supplier in a timely and proactive manner and if even critical information are being exchanged and finally if this exchange is reciprocal. The focus has been put on information regarding products or costs in particular since especially the latter must be seen as a crucial factor for the exchange process within SCM (Huang/Lau/Mak, 2003).

Below, hypotheses are now being derived for the measures as described in the above model in order to avoid information asymmetries in supply chain management (reputation, premiums, specific investments, frequent meetings, monitoring, explicit contracts) (see Figure Model).

Reputation

Reputation represents an instrument in order to avoid behavioural insecurities and with which information on the other party's reliability and goodwill is made available. Pre-conditions for a functioning reputation mechanism are the communication of experiences with agents, the direct or indirect diffusion of these experiences by third parties to other agents as well as the reaction to such experiences by terminating the business relationship with opportunistic agents (*Büschken, 2002*). At the same time, reputation involves assessing the character, the skills, the reliability or other traits of the business partner which might be significant for the exchange relationship (*Jones/Hesterly/Borgatti, 1997*). *Dyer (1996)* provides a measurement value for determining the reputation degree with regard to fairness and reliability attributed to the car manufacturer from the supplier's view. *Gierl (2004)* provides measurement values for determining the degree of investments which the buyer has made in his/her reputation of maintaining fair relationships with suppliers. There are, however, no measurements which determine to what extent buyers establish reputation mechanisms in order to spread information on the supplier's reliability and goodwill. Therefore, following the definition of a reputation mechanism, new measurement values have been established.

These measurements gather to what extent a functioning reputation mechanism regarding communication, diffusion and reaction has been established, from the buyer's point of view, in the relationship with a main supplier.

Reputation-building behaviour is seen as strategically important in situations where partners lack full access to information sources, e.g. when parties are not equally informed on parameters such as implementations or strategies. In particular, situations are being considered in which one party has access to specific information but the other party has not. Reputation mechanisms enable the informed party to make credible information accessible to the uninformed party. Meanwhile, the reputation mechanism can also be used as a screening-strategy by the uninformed party in order to better assess the other partner's behaviour (*Müller, 2005*). Trust-building measures, like building a reputation mechanism, reduce opportunist tendencies, as was shown by *Gierl (2004)*.

H01: An increased chance that the main supplier's reputation might be damaged by the communication and distribution of bad experiences with regard to his or her information policy results in a better exchange of information.

Specific investments

According to the theory, specific investments equally offer mechanisms regarding behaviour-based control (*investment*). Specific investments are investments made within exchange relationships which, outside of the relationship, are of little or no value. As a consequence, the investor will suffer considerable losses if the exchange relationship is dissolved. Here specific investments in physical goods, production facilities, tools or qualifications can be concerned (*Buvik, 2002*). This definition of specific investments was also used by *Kwon (2004)*. The indicators for this paper were developed in accordance with *Kwon's (2004)* measurements. Measurements include to what extent specific investments, at the buyer's request, are being made in information systems, processes and the buyer's employees by the main supplier.

If the agent was forced by the principal to make a specific investment, dissolving the exchange relationship would result in considerable losses for the agent, e.g. the decrease in value of equipment and furnishings, qualifications that cannot be used again or incoming payments, previously stimulated by investments, that won't be received in the future. This should be avoided if possible as these losses on the part of the agent do influence his behaviour in the exchange relationship (*Stump/Heide, 1996*).

This instrument might also be used in a supply chain relationship. The buyer for example, might force the main supplier to make a specific investment by threatening to otherwise dissolve the relationship. In doing so, the buyer seeks closer ties with the main supplier, which results in an extensive harmonization of objectives and interests. Previous publications have proved the positive correlation between specific investments being made and building close ties with the partner (*John/Weitz 1989; Joshi/Stump, 1999*). In this case, the main supplier might be more enticed to give the buyer access to information by which improvements in performance and cost reductions can be achieved, as these factors are of interest to the main supplier.

Equally, *Fawcett et al. (2009, 2007)* assume that IuK-systems have a positive effect on the information exchange in supply chains. "When a firm installs the technology needed to make information regarding customer and supplier needs, capacities, and capabilities readily available to decision makers, the company is more likely to appropriately align its strategy and structure with the environment, resulting in above average performance." (*Fawcett et al. 2009*). On the other hand, *Joshi/Stump (1999)* refer to a negative correlation between specific investments being made and the building of long-term relationships.

H02: More specific investments in IuK-systems, processes and resources on the main suppliers' request result in a better exchange of information.

Premiums

Premiums are, according to the theory, another possibility of behaviour-based control. Premiums can be described as financial incentives constituting a subjective value or advantage for the recipient. Financial incentives can be offered by means of behaviour-based or output-based premiums (Britton/Ball, 1999). Output-based premiums are granted by the principal for services being rendered by the agent going beyond customary practices within the specific sector or market (Murry/Heide, 1998). By contrast, behaviour-based premiums are paid to reward the agent when he behaves in a certain, previously specified way, e.g. incentive payments to reward the agent's suggestions for improving such factors as the principal's cost or performance management. The indicators used in this paper gather to what extent behaviour-based or output-based premiums are being paid by the buyer to control the information exchange with his main supplier. The impact of performance-related premiums was analyzed in Murry/Heide's (1998) publication. They come to the conclusion that performance-related premiums as incentive mechanisms of the manufacturer have a positive impact on the retailer's behaviour. The principal might also have the option to grant incentive payments to reward certain suggestions for improvement on the part of the agents, e.g. suggestions for improving the cost or performance management. Wathne/Heide (2000) argue that using incentives to harmonize the different parties' interests can only be successful if expectations involved are sufficiently monitored, e.g. when incentives are combined with control. Furthermore, performance-related premiums depend on two additional conditions, i.e. the agent can successfully influence the factors affecting remuneration and the agent recognizes the connection between his behaviour and the remuneration to be received.

H03: More monetary incentives we grant for the quick and extensive transmission of cost and product data result in more information being exchanged.

Frequent meetings

Frequent *meetings* serve the purpose of regular communication and of information exchange between principal and agent. Actors are thus enabled to get to know each other. If the information exchange is considered positively, the foundation will be laid for a trusting relationship (Müller, 2005).

Frequent meetings are meant to improve the cooperation between principal and agent in buyer-vendor relationships. Following the collaboration concept, it is important to establish the parties' common goals as well as to coordinate the actions in order to achieve mutual performance improvements. Measurements therefore gather to what extent regular meetings between buyer and main supplier take place for determining objectives, assigning tasks and improving performances with regard to information transfer.

Frequent meetings in order to build trustful relationships are another possibility to exert behaviour-based control. Since more frequent cultivation of communication relationships may indicate and promote special trust-building (*Large, 2005*).

Equally, *Poppo/Zenger (2002)* argue that by maintaining communication relationships, the parties are enabled to obtain information on each other's behaviour. Thus, they can better decide whom to trust or rather not to trust. *Large (2004)* comes to the same conclusion. According to him, communication quantity has the biggest impact on the quality of the relationship and concludes that buyers who frequently communicate with suppliers can most certainly expect good performances and services from them.

H04: More frequent meetings and talks with our main suppliers on tasks, performance improvement and objectives result in a better exchange of information.

Monitoring

Another possibility of behaviour-based control is *monitoring*. According to *Noordewier/John/Nevin (1990)*, monitoring means a certain number of supervising actions by which the buyer makes sure that the services stipulated in the exchange contract are being rendered by the seller. These actions, however, are not specified further in this publication. Following *Grover/Malhotra (2003)*, monitoring is a concept of different types of control mechanisms. They here refer to the publication of *Stump/Heide (1996)*. *Stump/Heide (1996)* see monitoring as a number of measures to control various output factors such as product quality, delivery terms, price adequacy as well as completion of an order. *Stank/Crum/Arango (1999)* equally understand monitoring as consideration of different performance factors. In addition to that, behaviour-based control mechanisms may also be considered during monitoring (*Stump/Heide, 1996*). The use of multi-functional teams is mentioned as one option to observe the other party's behaviour. Measurements in this paper concentrate on performance and behaviour-related mechanisms in order to supervise the exchange of information regarding products and costs with the main supplier.

The possibility to use monitoring as a control measure depends on the fact whether there is any evidence that obligations have not been met (Wathne/Heide, 2000; Lal, 1990). In this case, information asymmetries can be corrected by means of control mechanisms, thus ensuring better transparency thanks to the information made available. Other authors (McGee 2004, Fawcett et al. 2009) agree that monitoring has a positive effect on information exchange. "For example barcodes, RFID, data warehouses, and data mining technologies allow a firm to continuously monitor customer behavior and detect environmental trends; making it possible to respond quickly to changing competitive rules" (Fawcett et al. 2009, McGee, 2004).

More control options result in increased harmonization of interests. Some publications, however, come to the conclusion that monitoring rather increases the dangers of opportunism as the use of monitoring mechanisms might signalize distrust (Murry/Heide, 1998; John, 1984). In this context, they refer to the importance of adequate relationships. Though, a positive association is here implied.

H05: More supervision of the documentation and transmission of product and cost information results in more information being exchanged.

Explicit contracts

Explicit *contracts* offer ways to control agents in buyer-vendor relationships based on their behaviour. Explanations on methods for inter-organizational control via explicit contracts can first be found in Heide's (1994) publication. He identifies role specification, planning, process adaptation, control mechanisms, incentives as well as sanctions as possible control mechanisms of explicit contracts. Thus, explicit contracts specify the performance to be achieved as well as necessary controlling elements. These elements are to be itemized in advance so that misunderstandings as far as contractual stipulations are concerned can be avoided. In this paper, measurements regarding explicit contracts gather in particular to what extent the transfer of information on products and costs is being described in contracts.

One possibility to reduce existing behavioural insecurities as well as diverging objectives between main supplier and buyer in a supply chain relationship is, according to the principal-agent theory, the conclusion of a contract.

It is here imperative to draw up the contract in such a way that the main supplier's behaviour can be controlled by adequate incentives in the buyer's interests and by appropriate sanctions, so that non-conformity will not make sense for the main supplier. Se-

curity mechanisms, available e.g. with vertical integration, can also be realized when drawing up explicit contracts. Thus, contracts contain hierarchical controlling elements, as e.g. explicit information on roles and responsibilities to be assumed, specified methods with regard to monitoring and sanctions for non-compliance as well as results and performances to be achieved (*Poppo/Zenger, 2002*).

Here, however, previous research has shown that regulating information exchange can be problematic as it might prove difficult to exactly determine in advance which information is required in the future. Even if information exchange is to be controlled by explicit contracts, partners still might have enough room to maneuver (*Hamel/Doz/Prahalad, 1989*). Explicit contracts specifying the partners' anticipated reactions or possible sanctions could also be seen as violation of the decision-making autonomy, which might encourage opportunistic behaviour (*Cavusgil/Deligonul/Zhang, 2004*). Therefore, the following negative association is being implied.

H06: More detailed specifications on control, incentive and sanction mechanisms in contracts result in less information being exchanged.

3 Data collection via online survey

The questionnaire was sent to 1200 members of the Confederation of Logistics (Bundesvereinigung für Logistik (BVL)). For conducting the online survey, a period of about 6 weeks was determined. This response period was chosen to give survey participants enough time to fill in the questionnaire. In order to improve the rate of return, follow-ups were carried out after about 2 and 4 weeks. Altogether, 166 questionnaires were filled in and sent back, representing a rate of return of 13.8 percent. As the questionnaire was thus filled in by means of an online tool (*Grant/Teller/Teller, 2005*), information that participants had left out when answering the questions could be excluded. Otherwise, participants would not have been able to continue to work on the questionnaires. In doing so, all 166 questionnaires could be included in the analysis, i.e. no questionnaire had to be left out due to missing information. The sample size, due to the analysis method (*Götz/Liehr-Gobbers, 2004*) chosen and the questions to be examined, can thus be considered sufficient.

With regard to company sizes, the sample shows the following distribution: small and medium-sized enterprises with a turnover of up to 50 Mio. Euro represent a proportion of 49 percent compared to large companies with 46 percent. About 5 percent did not

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2 include any information on their annual turnover. This suggests that both in small and
3 medium-sized enterprises and in large companies information exchange in buyer-seller
4 relationships is considered and dealt with similarly.
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7 An exact comparison with the population, however, was not possible as sector informa-
8 tion was available for some addressees only. When analyzing the sample with regard to
9 the duration of business relations with the relevant main supplier, it becomes clear that
10 more than 58 percent of these relations have lasted more than 10 years. Another 15 per-
11 cent of business relations have lasted more than 8 years. Therefore, mostly close or
12 long-term business relations are considered in this investigation. In order to generalize
13 the findings based on the empirical study, it is necessary to ensure that these findings,
14 with regard to the population, are representative. To verify whether distortions occurred
15 due to contact persons not participating in this survey, a so-called non-response test was
16 being performed. On the basis of the return date, the sample was then being divided in
17 three equal portions and the first one, i.e. the companies that replied early, was com-
18 pared with the last portion, the companies that replied late. This test was based on Arm-
19 strong/Overten's suggestion (1977, p. 397) that companies that reply last are similar to
20 companies which reply not at all. The comparison by means of the t-test and with a sig-
21 nificance level of only one percent showed significant differences in average values just
22 for one of the 32 measured, Likert-scaled indicators. The value measured in this investi-
23 gation roughly corresponds to the significance level of the tests and thus to the error
24 contribution which could be expected. It can therefore be assumed that altogether non-
25 response bias does not occur. The sample can thus be considered representative.
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27 By checking the respondents' eligibility by means of their personal details it was exam-
28 ined whether a possible informant bias might have occurred. About 81 percent of the
29 sample are purchasing managers and heads of logistics as well as supply chain manag-
30 ers and executives. They represent the relevant target group. Besides, most of the re-
31 spondents have occupied their positions for a long time so that they can be expected to
32 have the necessary know-how to answer the questions.
33

34 For these reasons, the occurrence of a possible informant bias can thus be excluded.
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36 To exclude accidental and systematic measurement mistakes, the validity of the measur-
37 ing instrument (Anderson/Gerbing, 1991) was being verified both during development
38 and subsequently by means of the results. The validity measures like the psa-index and
39 the csv-index showed that indicator allocation to the constructs as well as their content-
40 related relevance is unambiguous. In order to determine the error terms during meas-
41 urements, the two-product model (Diamantopoulos/Winkelhofer, 2001) was being ap-
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plied. The result shows a high external validity. For these reasons, the occurrence of a common-method bias can be excluded.

4 Model development and data analysis

As constructs cannot be measured directly, however, an operationalization of these latent constructs via indicators might be required. For measurements of latent constructs, linear structural equation modeling has been used in this paper.

4.1 Measurement model

By means of the measurement model, the constructs are assigned appropriate indicators. In principle, two different modeling approaches can here be used. In the formative case, indicators present defining features of the underlying construct. Accordingly, the value of the construct will change as soon as the expression of at least one indicator changes within the formative measurement model. Contrary to that, the construct in reflective measurement models causes the indicators' expressions, i.e. indicators represent the underlying construct. While indicators can be freely chosen when specifying the reflective measurement model, the specification of formative constructs must be as detailed as possible. The decision whether indicators are to be specified reflectively or formatively is based on content-related considerations. In this case, formative indicators are concerned as the indicators are about defining features which, as the sum of single measures or elements, reflect the relevant measures or the construct respectively (*Jarvis et al., 2003*). The measurement model is therefore being specified by means of formative indicators.

Based on a thorough analysis of relevant literature, first a written definition of constructs was developed (*Diamantopoulos/Winkelhofer, 2001*). Such a procedure compels the researcher to draw up a definition of the constructs that is as extensive, clear and comprehensible for third parties as possible. This is essential since, in the formative case, the construct is defined by the entirety of its indicators and therefore all facets are also represented by indicators. Subsequently, formative indicators were generated on the basis of the definitions developed. In those cases where appropriate indicators could already be found in the literature, these indicators were used and adapted to the context to be examined. In the other cases, they were derived from the definition previously developed. For all facets of the construct must be covered by indicators in order to obtain

content-related congruence between definition and operationalization (*Bollen/Lennox, 1991*). At last, these indicators were tested within the framework of a preliminary analysis.

4.2 Evaluation of the measurement model

The measurement model comprises 24 indicators, and one statement each was formulated for each indicator. By means of 7-point scales, the degree of approval was measured. An overview of the indicators on which this paper is based can be found in appendix 2. For verifying the quality of the measurement model, quality criteria discussed by *Götz/Liehr-Gobbers (2004)* were used for the verification of formative measurement models.

For verifying the quality of the measurement model on the basis of empirical results, indicators first have to be examined with regard to multicollinearity. Analyzing the correlation matrix of the indicators did not provide any evidence of it. A calculation of the Variance Inflation Factor (VIP) for most of the indicators, however, showed a degree of multicollinearity which, with a value of 12, was too high, possibly leading to a distortion of parameter values. To solve this problem, correlation structures between indicators of the relevant construct were taken into account when calculating the weights of the indicators. This is made possible by mode A of the partial least squares method (PLS) being used as analysis method in this paper. Since in mode A weights represent covariances between latent constructs and indicators. Following the logic of formative measurement models, measurement quality is evaluated by means of these indicator weights and their respective significances (*Nunnally/Bernstein, 1994*). Results of the measurement evaluation are illustrated in appendix 3. Values mentioned by *Chin (1998)* were used as boundary values. Predominantly, the criteria reach good values. Except for two indicators, the criteria are met with regard to all the other indicators. Eliminating formative indicators in the case of decreased quality is regarded critically in the literature. When the hypothesis test instead of the optimization of statistical quality measures is being emphasized, an adaptation of the model with formative indicators is not advised (*Hinkel, 2001*). In this case, formative indicators were therefore not eliminated. Equally, the Stone-Geisser test shows communality- Q^2 values of constructs above zero, which suggests a sufficient predictive relevance of the measurement model.

4.3 Evaluation of the structural model

The analysis of the full model (see appendix 1) was carried out by using the partial least squares method (PLS). As with the PLS method no special conditions are to be met when distributing the data, only non-parametrical tests can be used. For evaluating the quality of the structural model, the following criteria are mentioned in the literature: the coefficient of determination, the path coefficient, the effect size and the Stone-Geisser test (Götz/Liehr-Gobbers, 2004). When analyzing the structural model, which illustrates the correlations between measures and information exchange, it becomes evident that some path coefficients with a value > 0.1 refer to a correlation between single measures and the exchange of information (Seltin/Keeves, 1994). Equally, effect size calculations indicate that the measures exert strong to substantial influence on information exchange. This investigation is based on one-sided significance tests as the hypotheses established and to be verified are directional, i.e. with regard to measures, an effective direction towards the information exchange can be assumed. At the same time, the coefficient of determination of the endogenous latent variable ‘information exchange’ has an average to substantial value with $R^2 = 0.486$ (Chin, 1998). Equally, the Stone-Geisser test carried out shows, with $Q^2 = 0.2634 > 0$, adequate prognostic relevance of the structural model (Chin, 1998). Overall, the structural model can therefore be considered adequate with regard to quality so that valid statements can be made on the basis of this model.

4.4 Parameter estimation

The calculation of parameters to estimate possible correlations is being done on the basis of the PLS estimation algorithm by Wold (1985). Finally, estimation values are assessed by means of significance tests which can be performed with approximate t-statistics generated by resampling techniques. Resampling is a computer-based statistical method for the specific analysis of data. For want of appropriate distribution assumptions with the PLS-method, statements on the significance level can only be made on the basis of additional resampling plans like bootstrapping and jackknifing. Calculation results are illustrated in figure 2.

Figure 2:

Insert figure 2

With regard to the measures 'reputation mechanism', 'specific investments' and 'premiums', according to the hypothesis H01, H02 and H03, a positive association with information exchange was assumed. The path coefficient of the measure 'premiums', with a value of -0.023, the coefficient of the measure 'specific investments', with a value of -0.053 and also the coefficient of the measure 'reputation mechanism', with a value of 0.008, refer to a missing association with regard to information exchange (Seltin/Keeves, 1994). With a value of $t = 0.2233$, a value of $t = 0.4675$ and a value of $t = 0.0838$, these ones can be considered negligible. Thus, these hypotheses remain without results.

As to the measures 'monitoring' and 'frequent meetings', also a positive association according to the hypotheses H04 and H05 between these measures and information exchange was assumed. The path coefficient of the measure 'monitoring' shows a value of (0.437, $p < 0.01$) and the coefficient of the measure 'frequent meetings' a value of (0.509, $p < 0.01$) therefore indicates a strong, positive and significant association regarding information exchange. These hypotheses can therefore not be rejected. Proportional to the other measures, the measure 'monitoring', with an effect size of $f^2 = 0.12$, exerts a weak to moderate influence on information exchange and the measure 'frequent meetings', with an effect of $f^2 = 0.21$, exerts a moderate to strong influence on information exchange.

With respect to the measure 'explicit contract', a negative association according to hypothesis H06 between this measure and information exchange was assumed. The path coefficient of the measure 'explicit contract' shows a value of (-0.188, $p < 0.10$) and therefore indicates a weak, negative association with regard to the information exchange. The relevant hypothesis can therefore not be rejected. The negative influence of the measure 'explicit contract' on the information exchange proportional to the other measures and with an effect size of $f^2 = 0.02$ has to be considered weak.

5 Discussion of results and implications for theory and practice

The summary of the hypothesis test produces mixed results. While one half of the hypotheses could not be rejected and thus the assumptions made could be supported, the

other half of the hypotheses remain without results and thus make the interpretation and discussion of findings difficult.

Reputation

With respect to the measure ‘reputation mechanism’, the result is unclear. At first, reputation does not seem to be a significant measure either. Further investigations, however, i.e. when only relationships with main suppliers of more than 10 years are considered, suggest a possible correlation between reputation mechanism and information exchange. This could be explained by the fact that this measure proves to be effective only in the long run. A possible cause for this might be the period of time that it takes to build a reputation mechanism.

When looking at single measures, it seems that this assumption can be confirmed since the single measure “response to a known misdemeanour of the main supplier” contributes the most to information exchange variance. By contrast, the two other measures which ensure the communication and diffusion of the main supplier’s unfair behaviour, contribute to a far lesser degree to information exchange variance.

In the long run, buyers should supposedly diffuse and also communicate the experiences gained with their main supplier, i.e. build a reputation mechanism. By doing so, trust-building mechanisms can be enhanced and the main supplier’s opportunistic behaviour might be prevented by also communicating bad experiences made with him or her. Jonsson/Zineldin (2003) for instance were able to prove that reputation positively influences the supply chain performance. Here, reputation was seen as one of the key factors (cf. Jonsson/Zineldin 2003, p. 236). A party’s good reputation builds trust in another party and is thus the foundation for the formation of a close and long-term relationship. According to Ploetner/Ehret (2006, p. 8) who have looked at trust-building measures within SCM, however, this is a long drawn-out process. Therefore, building a reputation mechanism must probably be seen as a long-term measure to promote information exchange whose full potential unfolds only in the future.

Specific investments

Equally, as far as specific investments are concerned, the result remains unclear. Basic data prove that companies for the most part refrain from using this measure. Specific investments as well might hardly be relevant for information exchange within SCM.

On closer examination of the single measures, information exchange is affected most profoundly by the main supplier's adaptation of the information processes, while the other measures do influence information exchange only slightly or not at all.

A possible explanation might be found in *Joshi/Stump's* (1999) publication. *Joshi/Stump* (1999) establish a negative association between specific investments and long-term relationships, often found within SCM and units examined here. They interpret this result in such a way that using specific investments is likely to promote opportunistic behaviour in long-term relationships.

They also point out that this result according to the 'transaction cost theory' is quite astonishing and not explainable (cf. Joshi/Stump 1999, p. 344). However, the authors try to explain this result by referring to the 'relational exchange theory'. By means of this theory they come to the conclusion that there are situations in which the negative effect of specific investments is more important than the positive effect of dependence, i.e. the value of continuing relationships are no longer important for the investing party (cf. Joshi/Stump 1999, p. 346). Thus, the parties behave contrary to the transaction cost theory.

Another publication that deals with specific investments within SCM, refers to specific risks with regard to investment decision-making. In this study, investment decision-making from the suppliers' view was being examined, namely in supply chain networks dominated by buyers (cf. Ojala/Hallikas 2006). With regard to specific investments, they identified lack of trust, insufficient information transfer on the buyer's part as well as existing power asymmetries as potential risk factors. The authors stress the fact that investment decision-making within SCM is a complex and high-risk problem when it comes to decision-making. They note, however, that the necessity of a close cooperation, as within SCM, progressively increases the pressure on suppliers to make specific investments. They argue that the willingness to make specific investments within SCM is closely linked to the following factors: open information exchange, mutual dependence and a trusting atmosphere. Therefore, specific investments do not seem to have any effects on information exchange. The exchange of information is rather a prerequisite for the willingness to make specific investments.

Premiums

As to the measure 'premiums', there is no clear result. Basic data show that a high percentage of companies do not use premiums. This could be explained by the fact that premiums might not be truly relevant for information exchange within SCM.

The indicator that measures to what extent contractual stipulations with the main supplier do exist with regard to financial remunerations also suggests that premiums by means of monetary incentives are not truly significant. This single measure does not contribute to explaining the variance of the information exchange and does therefore not influence it.

This might be due to the fact that business partners' socialization, promoted on a long-term basis, to expect financial remunerations for providing certain information, does not seem to make sense and would involve unsustainable costs.

Radhakrishnan/Srinidhi (2005), who have examined the effects of a resource-based remuneration system to improve information exchange in a value-added chain, also come to this conclusion. The authors of this paper tried to identify under which monetary conditions the retailer is ready to disclose the informational advantage he or she has over the manufacturer regarding market information. They found that the retailer's readiness to pass on his or her knowledge depends not only on the quantity of information but also on the result he or she might be able to realize when the market information is not shared with the manufacturer. In order to be able to use the additional information, however, the manufacturer will incur costs which usually exceed the benefits he or she might gain from the additional information. Thus, premiums do not seem to be suitable measures to encourage information exchange. Alternatively, rather than promoting monetary remunerations in terms of extrinsic motivation the participants' intrinsic motivation should be encouraged instead. By doing so, they will recognize the importance of information exchange when it comes to a more efficient and effective completion of their tasks.

Frequent meetings

As expected, frequent meetings exert a positive influence on information exchange. On closer examination of the single measures it becomes clear that meetings which help to improve cooperation exert a positive influence on information exchange. Results found in previous papers, especially with regard to inter-organizational communication, could thus be confirmed. Large (2006, p. 1023; 2004, p. 439) also found that communication quantity is truly relevant for successful supplier management performance provided that the relationship is based on a good and solid foundation. Besides, Wallenburg's findings (2004, p. 249) equally confirm that relationship intensity can positively influence communication and information intensity. These results show that frequent

meetings are of great importance for close and long-term relationships as found within SCM.

Purchasers are therefore advised to regularly contact and personally meet with their main suppliers and to strengthen this relationship. Here, frequent meetings and the quality of information exchanged are important factors. Intensive communication leads to better informed parties, which again creates a trusting atmosphere and a close and long-term relationship.

Monitoring

As expected, monitoring measures exert a positive effect on information exchange. Thus, previous results on possibilities to implement monitoring measures could be confirmed (*Murry/Heide, 1998; John, 1984*). Both *Murry/Heide (1998)* and *John (1984)* came to the conclusion that monitoring should only be applied within trusted relationships. In their publications, they draw the conclusion that, in fact, monitoring poses a risk when pursuing common goals. Within trusted relationships, this risk can considerably be reduced. In simple terms, the result could be summarized within the following thesis: monitoring in long-term relationships encourages the pursuit of shared information exchange. In accordance with indicator weights, the verification of documents and reports as well as the supervision of the communication with the main supplier play important roles. The assignment of process teams, however, seems to have less significance for the improvement of information transfer.

Equally, other publications refer to the fact that monitoring measures are frequently drawn on by the industry (*Shutt, 1995*). It has to be taken into consideration, however, that monitoring measures involve certain costs. Besides, monitoring measures seem to exert weaker effects on information exchange than the measure 'frequent meetings' does. Therefore, when using monitoring measures, it has to be made sure that costs are carefully weighed against the potential benefits of information exchange.

Explicit contracts

Explicit contracts negatively influence information exchange within SCM and should thus be avoided if possible.

Previous investigations suggested a negative influence on opportunistic behaviour (*Cavusgil/Deligonul/Zhang, 2004*), a fact that this investigation supports. Consequently, it

can be concluded that explicit contractual stipulations regarding information exchange within SCM are probably rather inappropriate.

This is particularly relevant if the information need repeatedly changes and if there is a comprehensive information network, a condition typical for relations within SCM.

Another indication is the strong indicator weighting (CONTRACT1), measuring the regulations on scope and frequency of product and cost information to be exchanged with the main supplier. Here, especially explicit stipulations might be concerned, limiting the necessary flexibility during the exchange of information (cf. Anderson et al. 2001). Especially those sectors that are subject to constant changes with regard to product or cost information are advised to refrain from such explicit contracts. In fact, other mechanisms come into play here as explicit contracts might also inhibit the adaptation to changing market conditions (cf. Brown/Cobb/Lusch 2006). In this way, contractual stipulations might have negative consequences for a party and as a result will probably trigger opportunistic behaviour on its part.

Next to explicit contracts, relational contracts become increasingly important in relevant literature. These contracts are based on implicit agreements that in particular comprise common values, norms, expectations and beliefs. By means of these relational contracts, it is possible to establish the roles and expectations of the parties, while, at the same time, the parties' flexibility and autonomy is not undermined (cf. Brown/Cobb/Lusch 2006). In their paper Brown/Cobb/Lusch (2006) have looked at the effects of explicit and relational contracts within SCM and come to the conclusion that explicit contracts have legalizing roles in trade relationships but do not exactly help to improve relations. In fact, the authors find that by means of relational contracts differing role perceptions can be resolved.

In summary, it can be ascertained that the measures to promote information exchange seem to supplement each other and can therefore not be substituted. Other publications support this assumption. *Murry/Heide (1998)* find for example that premiums functioning as incentives apparently cannot be compensated by personal relationships. Equally, *Poppo/Zenger (2002)* indicate that formal control mechanisms in fact complement those mechanisms that help to promote personal relationships.

The implications and consequences for practitioners can be summarized as follows:

- A reputation mechanism is, in the long run, of significance for information exchange within SCM. Building reputation should thus be seen as a long-term investment.
- Specific investments must be seen as rather inappropriate when it comes to encouraging information exchange within SCM. In fact, a functioning information exchange is a prerequisite for specific investments to be beneficial.
- Premiums do not significantly influence information exchange within SCM and should thus be avoided.
- Frequent meetings can encourage information exchange considerably within SCM and should thus be used extensively.
- Monitoring measures are an essential instrument when it comes to encouraging information exchange within SCM. Costs of these measures, however, should be taken into consideration.
- Explicit contracts do have a negative effect on information exchange within SCM and should thus be avoided if possible.

6 Limitations of this paper and suggestions for further research

Methodically, this investigation shows that, by considering the effects of measures on information exchange in an overall model, valid results can be produced. By combining the measures in a full model, it is possible to better evaluate potential interdependencies as well as the effects of the measures as far as their intensity on the information exchange is concerned. It was thus possible to make statements on the effect of each measure proportional to the other measures. In accordance to the coefficient of determination, which indicates the explained variance of the information exchange, it can be ascertained, however, that measures examined here only account for about 50 percent of the variance. It is therefore possible that other factors that, so far, have not been taken into consideration, influence information exchange as well. Neither premiums nor specific investments make a noteworthy impact on information exchange. This, at first glance, also applies to the reputation mechanism. As far as these measures are concerned, the principal-agent theory does not necessarily help to illustrate information exchange. This implies that the principal-agent theory, in some areas, meets its limits.

The principal-agent theory only allows for a partial consideration of possible measures, i.e. from the purchaser's view. Consequently, those measures that, from the main supplier's perspective, might improve the exchange of information have not been considered. For this reason, relevant measures should also be examined from this perspective. In this paper, the authors looked at bilateral relationships between the buyer and the main supplier. In order to give the complexity of supply chains more attention, however, future research should also include the implementation of measures to promote information exchange for the entire supply chain. Besides, institutional framework conditions might be able to influence the application of measures that are not taken into consideration within the principal-agent theory. Institutional framework conditions include e.g. cultural norms as well as laws and regulations that may limit a company's room to manoeuvre. These framework conditions might e.g. influence the way certain measures are being applied. Furthermore, future research should include another differentiation on the subject 'information exchange' in order to determine whether the implementation of relevant measures leads to differences in quality or quantity during the exchange of information. A model was developed in order to explain the information exchange within SCM. The validation, however, was limited to German companies only. Therefore, further research on the verification and application of the model within an international context would be helpful. Results show that trust-building measures and interactions associated with them like e.g. frequent meetings between participants are of particular importance for the information exchange within SCM. As, however, direct interactions between participants are no longer considered in the principal-agent theory, in this regard this theory reaches its limits. Further observations with regard to the interaction behaviour in participants and thus on information exchange therefore should be based on behaviour-based theories instead.

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Figure 1:

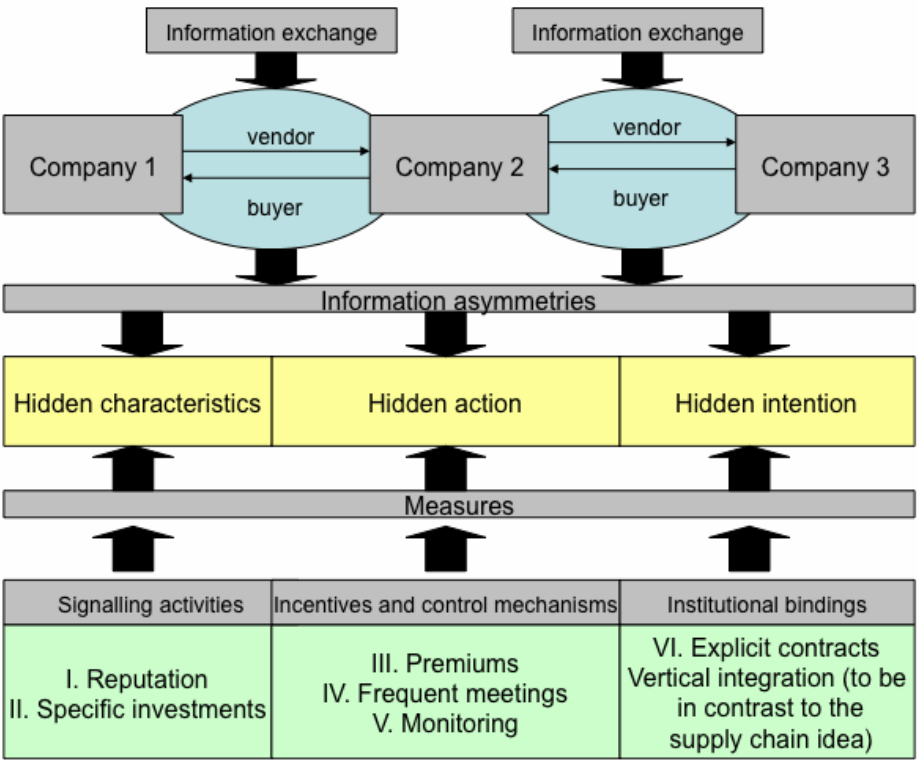
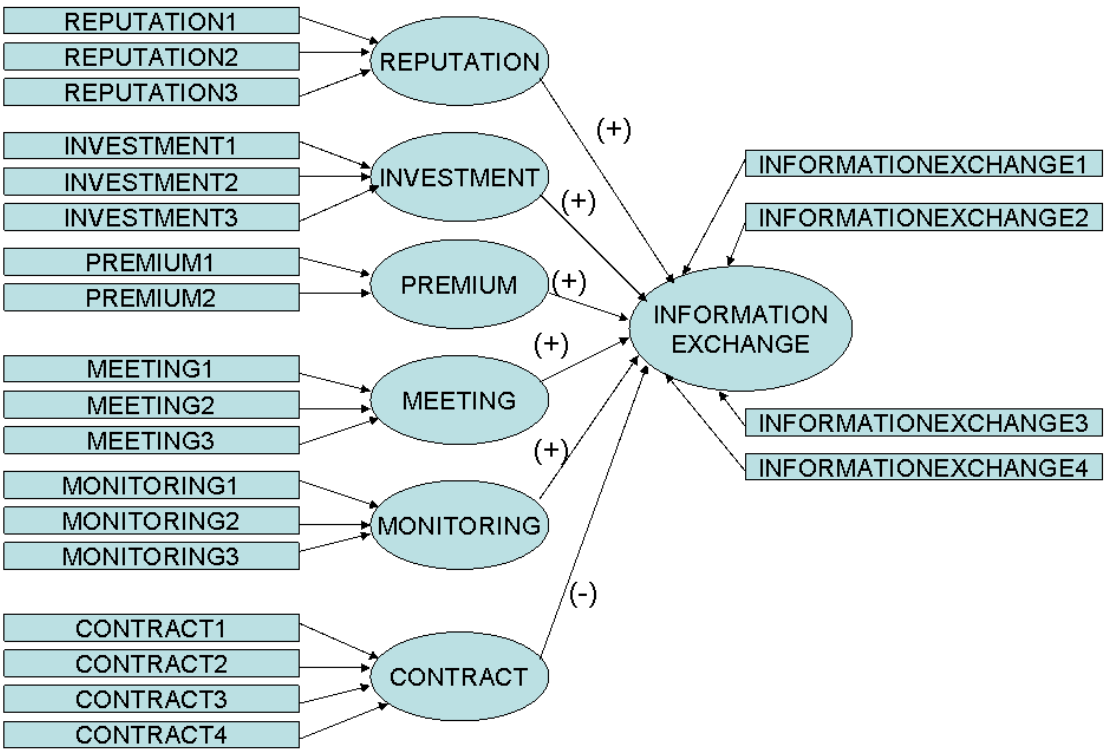


Figure 2:

Independent variables	Path coefficients	Significance Levels (t-statistic)	Effect size (f ²)
Reputation	0,008	0,0838 n.s.	n.c.
Specific investments	- 0,053	0,4675 n.s.	n.c.
Premiums	- 0,023	0,2233 n.s.	n.c.
Frequently meetings	0,509	4,0866 ***	0,21
Monitoring	0,437	3,4211 ***	0,12
Explicit contract	- 0,188	1,3179 *	0,02
Dependent variable	Coefficient of determination (R²)	Stone Geisser Test (Q²)	_____
Information exchange	0,486	0,293	-----

(Significance level: * $p \leq 0.10$; ** $p \leq 0.05$; *** $p \leq 0.01$)

Appendix 1:
Full model



Appendix 2:**Table 2: Indicators of the measurement model**

Constructs	Indicator identification	Indicator text	Indicator code
Explicit Contract	Contractual arrangements(cf. Bu-vik/Haugland 2003, p. 32, cf. Lusch/Brown 1996, p. 35)	The contract with our main supplier stipulates to what extent and at which intervals product or cost information has to be exchanged.	CONTRACT1 (formative)
	Contractual sanctioning mechanisms (cf. Cavusgil/ Deligonul/Zhang 2004, p. 17)	The contract with our main supplier clearly stipulates what consequences will result from late or incomplete provision of product or cost information agreed upon.	CONTRACT2 (formative)
	Contractual incentive mechanisms (cf. Heide 1994, p. 75; cf. Shirley/Xu 1998, p. 370)	The contract with our main supplier clearly stipulates which financial remuneration is to be paid for the timely and complete provision of product or cost information agreed upon.	CONTRACT3 (formative)
	Contractual control mechanisms (cf. Heide 1994, p. 75; cf. Shirley/Xu 1998, p. 370)	The contract with our main supplier clearly specifies which mechanisms can be used to supervise the flow of information.	CONTRACT4 (formative)
	Existent contractual regulations (cf. Bu-vik/Haugland 2003, p. 32)	Contractual stipulations specify the communication and information-based operations between our company and our main supplier.	CONTRACT0 (reflective)
Monitoring	Information-based output control (cf. Noordevier/John/ Nevin 1990, p. 92)	Our company records in writing whether the main supplier provides reports, lists or similar with the relevant cost or product information in a timely and complete manner.	MONITOR1 (formative)
	Communication-based output control (cf. Noordevier/ John/Nevin 1990, p. 92)	Our company supervises whether product and cost information to be provided by the main supplier is being communicated to our employees.	MONITOR2 (formative)
	Behaviour-based control (cf. Ittner et al. 1999, p. 266)	Our company uses process teams or other mechanisms to observe the flow of information between us and our main supplier.	MONITOR3 (formative)
	Existent control (in accordance withStump/Heide 1996)	Our company has protocols or similar concerning the communication and information-based operations with our main supplier.	MONITOR0 (reflective)
Premiums	Behaviour-based premiums (in accordance with Britton/Ball 1999, p. 134 et seq., Murry/Heide 1998, p. 60)	For the main supplier's suggestions leading to the improvement of our cost or performance management, monetary incentives are being granted.	PREMIUM1 (formative)
	Output-based premiums (in accordance with Murry/Heide 1998, p. 60, Britton/Ball 1999, p. 134 et seq.)	For the main supplier's improved performance in terms of a more transparent presentation of or a faster provision with cost or product information, monetary incentives are being granted	PREMIUM2 (formative)
	Monetary incentive mechanisms (in accordance with Murry/Heide 1998, p. 60, Britton/ Ball 1999, p. 134 et seq.)	We grant our main supplier monetary incentive to remunerate him for the good communication and execution of information-based operations.	PREMIUM0 (reflective)

Specific Investments	Investment in physical assets (cf. Kwon 2004, s. appendix)	At our request, our main supplier has made significant investments in specific communication and information systems within our business relationship.	INVESTMENT1 (formative)
	Investments in structural assets (cf. Kwon 2004, s. appendix)	At our request, our main supplier has adapted his information processes to our requirements.	INVESTMENT2 (formative)
	Investment in human resources (cf. Kwon 2004, s. appendix)	At our request, our main supplier has made considerable investments in the qualification of our employees with regard to communication.	INVESTMENT3 (formative)
	Existent specific investments (cf. Joshi/Stump 1999, p. 351)	Thanks to our main supplier's investments, our company has special equipment or qualifications concerning information-based operations and communication with our main supplier.	INVESTMENT0 (reflective)
Frequent Meetings	Exchange on objectives (in accordance with the collaboration concept, cf. Friese 1998, p. 62)	Regular meetings with our main supplier are being organized to determine common goals.	MEETING1 (formative)
	Exchange on process improvements (cf. Chen/Paulraj 2004, p. 141)	We regularly discuss possibilities to improve processes with our main supplier.	MEETING2 (formative)
	Exchange on the determination of responsibilities (in accordance with the collaboration concept, cf. Friese 1998, p. 62)	We regularly meet with our main supplier to determine tasks and responsibilities.	MEETING3 (formative)
	Existent regular meetings (cf. Chen/ Paulraj 2004, p. 141)	Regular meetings are being scheduled with our main supplier.	MEETING0 (reflective)
Reputation mechanism	Communication (cf. Büschken 2002, p. 6)	We communicate any unfair behaviour of our main supplier to third parties.	REPUTATION1 (formative)
	Diffusion (cf. Büschken 2002, p. 6)	Third parties will spread information in our sector concerning any unfair behaviour that we might have experienced with our main supplier.	REPUTATION2 (formative)
	Reaction (cf. Büschken 2002, p. 6.)	Business connections with other companies in our sector help to directly communicate any unfair behaviour of our main supplier to a large number of people, which will result in our main supplier's loss of reputation.	REPUTATION3 (formative)
	Functioning reputation mechanism (cf. Jones/Hesterly/ Borgatti 1997, p. 926)	If we have had experiences with our main supplier, his reputation will be damaged.	REPUTATION0 (reflective)
Information Exchange	Efficiency (cf. Chen/ Paulraj 2004, p. 141)	Exchange of product or cost information with our main supplier is timely.	INFORMATION EXCHANGE1 (formative)
	Reciprocity (cf. Chen/Paulraj 2004, p. 141; Lusch/Brown 1996, p. 35)	We inform one another of events or changes regarding products or costs that concern the other party.	INFORMATION EXCHANGE2 (formative)
	Anticipation (cf. Lusch/Brown 1996, p. 35)	Our main supplier, without request, supplies information on costs or products that might be relevant for us.	INFORMATION EXCHANGE3 (formative)
	Information value (cf. Chen/Paulraj 2004, p. 141)	We share even sensitive information with our main supplier.	INFORMATION EXCHANGE4 (formative)

	Existent information exchange (cf. Brown/Cobb/Lusch 2006, p. 170)	Communication with our main supplier is open and prompt.	INFORMATION EXCHANGE0 (reflective)
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For Peer Review Only

Appendix 3:
Parameter estimations of the measurement model

Indicator	P _{sa} - Index	C _{sv} - Index	VIP (max)	Weights	t-statistic	Two- product- model	t-statistic	Communi- nality-Q ²
CONTRACT1	1	1	12.798	0.422	3.453***	0.744	17.476***	0.657
CONTRACT2	0.9	0.8		0.371	3.982***			
CONTRACT3	0.8	0.6		0.099	0.572 n.s.			
CONTRACT4	1	1		0.291	2.859***			
MONITOR1	0.9	0.8	12.798	0.602	6.708***	0.650	9.854***	0.670
MONITOR2	0.9	0.8		0.311	4.620***			
MONITOR3	0.7	0.4		0.274	3.230***			
PREMIUM1	1	1	12.683	0.795	1.493*	0.656	4.501***	0.898
PREMIUM2	1	1		0.235	0.456 n.s.			
INVESTMENT1	1	1	12.808	0.292	1.544*	0.826	15.073***	0.757
INVESTMENT2	0.7	0.5		0.436	2.139**			
INVESTMENT3	1	1		0.375	2.520***			
MEETING1	0.8	0.6	12.807	0.403	12.70***	0.862	23.104***	0.843
MEETING2	0.8	0.6		0.352	16.67***			
MEETING3	0.9	0.8		0.332	12.40***			
REPUTATION1	1	1	9.919	0.313	2.682***	0.605	8.482***	0.889
REPUTATION2	1	1		0.344	4.382***			
REPUTATION3	1	1		0.406	2.973***			
INFORMATION EXCHANGE1	0.6	0.4	12.464	0.411	11.838***	0.771	14.519***	0.293 (Redun- dancy- Q ²)
				0.293	6.215***			
INFORMATION EXCHANGE2	0.7	0.5		0.268	4.506***			
				0.292	6.735***			
INFORMATION EXCHANGE3	0.7	0.5						
INFORMATION EXCHANGE4	1	1						

(Significance level: * p ≤ 0.10; ** p ≤ 0.05; *** p ≤ 0.01)