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Supply chain risk-sharing contracts from a buyers' perspective: content and experiences

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Abstract: Incentive alignment, and risk and gain sharing, are argued to be key factors for the successful implementation of Supply Chain Management (SCM). Incentive-related issues can be improved by contract-based, information-based and trust-based solutions. The focus of this article is on contract mechanisms used in the context of high demand volatility, supply allocation and outsourced supply chains. Two case illustrations from a high-tech industry (Agilent and Hewlett Packard) describe recently implemented risk-sharing contracts, as well as experiences and issues regarding their implementation from a buyers' perspective. Although the work of implementing these more formal contracts is demanding, buyers are pleased with the results and the buyers also report pleased suppliers. In the cases, the main barrier to implementing risk-sharing contracts seems to be the shift in mindset and culture needed internally, especially among purchasers.

Keywords: supply chain risk sharing; incentive alignment; contracts; agency theory; information; trust.

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Biographical notes: Dr. Andreas Norrman is an Associate Professor in Supply Chain Structure and Organisation, and the Head of the Department of Industrial Management and Logistics at Lund University (Sweden). He is on the board of the Swedish National Excellence Competence Centre in Logistics, Next Generation of Innovative Logistics (NGIL). Dr. Norrman is also affiliated with the Center of Excellence in Supply Chain Management (CESCM) at Louvain School of Management at Université Catholique de Louvain (Belgium) and the Turku School of Economics (Finland). He teaches graduate courses in industrial purchasing, logistics and supply chain management. Dr. Norrman has published in journals such as the *European Journal of Purchasing and Supply Management*, *International Journal of Physical Distribution and Logistics Management*, *International Journal of Logistics Management* and *International Journal of Production Economics*. He is currently interested in researching incentive alignment in supply chains, and the relationship between supply chain design/business models and business law.

1 Introduction

When changing structures, processes or capacity within supply chains, an issue is that the changes and investments must often be made in other positions and organisational units than the benefits will turn up later. Hence changes and investments to improve supply chain performance will not always be made, as the person taking the risk might not reap the benefits. Risk and gain sharing are hence argued by many authors to be key factors for successful implementation of Supply Chain Management (SCM) (*e.g.*, Cooper and Ellram, 1993; Cooper *et al.*, 1997; Motwani *et al.*, 1998; Mentzer *et al.*, 2001; Lee, 2004). Incentives must be aligned in the supply chain (*e.g.*, Lee, 2004; Narayanan and Raman, 2004) to reach the full effect of different interorganisational SCM concepts, and improve supply chain coordination (Fugate *et al.*, 2006) and collaboration (Simatupang and Ramaswami, 2005a). However much this is emphasised, it seems to be little developed in practice (*e.g.*, Narayanan and Raman, 2004).

Incentives could be made visible and formalised by being put into well-structured contracts. Whether contracts are positive or negative for a relationship is debated (see, *e.g.*, Poppo and Zenger, 2002).

The purpose of this study is to extend the knowledge of how risk and gain sharing (or incentive alignment) in supply chains could currently be applied in practice. This is done by describing context, content and implementation experiences from a buyers' perspective in two illustrations (Agilent and Hewlett-Packard (HP)) from an explorative case study. The context is risk sources related to uncertainty in demand and supply, *e.g.*, investments in supply chain capacity and inventory that could improve supply chain performance. Although the paper will be explorative and descriptive in nature, the empirical insights will finally be reflected on from a theoretical perspective mainly anchored to agency theory. Stock (1997) points to agency theory as one with great potential to be used in the field of SCM for defining and understanding inter- and intrafirm organisational relationships.

Next, the methodology is discussed, followed by a theoretical framework, consisting of three areas (risk sharing, incentive alignment and contracts in supply chains; agency theory; contracts versus relational governance). Then, two cases are summarised before being discussed empirically and theoretically. The paper ends with concluding comments.

2 Method

Since only limited empirical research on supply chain risk and gain-sharing mechanisms has been found, an explorative approach to generating tentative patterns and illustrations was chosen. A case study approach was employed, as in an early stage of an emerging topic this is appropriately used to establish the field (Eisenhardt, 1989b), and it is preferred in examining contemporary events (Yin, 1994). The study was characterised by a systems approach (Arbnor and Bjerke, 1997; see *e.g.*, Gammelgaard, 2004 for discussion on its use in supply chain management-oriented research). To gain insights from a number of buying companies that have recent experience of implementing structured risk-sharing mechanisms with suppliers, a multiple case study was chosen. The companies should meet three criteria: having a volatile demand, facing the risk of allocations of supplied material and having an 'outsourced supply chain'. (The last

criterion was mainly operationalised as if they were using contract manufacturers). The reasons for those criteria were that they should face an external uncertainty that had an impact on the whole supply chain (insecure demand and supply), and that this uncertainty was quite high (volatile demand) and hence challenging. Finally we looked for companies in a supply chain where we could believe that companies had different business models and goals, but also where interorganisational interfaces could be complex and not only linear (*i.e.*, an outsourced supply chain where there might be a direct relationships between OEM and a second-tier supplier in parallel with the 'linear' relationship OEM – contract manufacturer – second-tier-supplier). Industries that have those characteristics include different high-tech industries. The companies were also selected on the basis of their willingness to share a potentially interesting experience. Five companies were explored, but to keep this article short, only two (Agilent and HP) are described and used as illustrations. These two were selected as they have similarities, especially in the risk-sharing mechanism used, but also differences, *e.g.*, in context (size and industry position). A case study protocol/interview guide was developed both to cover certain constructs from the theoretical framework, and to explore the companies' more practical experiences and lessons learned from the implementation. For all cases the main respondent was met face to face at least once. To increase construct validity (Yin, 1994), information also came from workshop presentations complemented with written material, tape-recorded semistructured phone interviews, e-mails and information collected from the web (mainly in 2004). Further, the case descriptions were sent to the respondents and confirmed (2006). In both cases representatives from the companies other than the interviewees read, suggested minor changes to and confirmed the descriptions. As the companies show both similarities and differences in general characteristics, it is possible to do analysis with pattern matching as well as explanation building (Yin, 1994). This study is mainly explorative, taking the buyer perspective, hence external validity concerning the whole relationship could be discussed. The ambition is not to propose normative generalisations, but to contribute through cases illustrating a fairly unexplored research area.

3 Frame of reference

Three perspectives of risk sharing and contracts are briefly summarised: incentive alignment and risk sharing and how they are discussed within SCM research; the main ideas within agency theory; and finally, contracts as a positive or negative way to govern relationships.

3.1 Incentive alignment and supply chain risk sharing

Despite the fundamental vision of SCM that companies should focus on the 'supply chain as a whole', one problem with risk and gain sharing in supply chains is that companies might prioritise their own interests instead of the whole supply chain's, unless induced to adopt this holistic view (Agrell *et al.*, 2004). A lack of aligned incentives is one of the factors creating supply chain discontent (Simatupang and Ramaswami, 2005b). Narayanan and Raman (2004), studying more than 50 supply chains, confirm this by finding that companies did not act in ways that maximised the network's profit.

Consequently, supply chains performed poorly. They argue, “A supply chain stays tight only if every company on it has reasons to pull in the same direction.” To induce supply chain partners to behave in ways that are best for everybody, monetary incentives have to be created or modified, *e.g.*, the risks, costs and rewards of doing business should be distributed fairly across the network. But managers find it tedious and time-consuming to define roles, responsibilities and accountability for businesses they do not manage directly. Misaligned incentives often cause excess inventory, stock-outs, incorrect forecasts, inadequate sales efforts and even poor customer service (Narayanan and Raman, 2004).

Narayanan and Raman (2004), presumably inspired by agency theory, find three reasons as to why incentive-related issues arise in supply chains:

- 1 When companies cannot observe other firms’ actions, they find it hard to persuade those firms to do their best for the supply chain (often called *hidden actions*).
- 2 It is difficult to align interests when one company has information or knowledge that others in the supply chain do not. (often called *hidden information* or *asymmetric information*).
- 3 *Incentive schemes* are often *badly designed*.

They argue that these issues should be tackled by a stepwise approach. Firstly, executives must acknowledge that the problem of misaligned incentives exists; secondly, they must pinpoint and diagnose the cause. Finally, incentives can be aligned or redesigned to obtain the right motivation and behaviour. Many managers do not understand the operational details of other firms sufficiently to realise what impact incentives could have. Three types of solutions to redesign incentives are recommended: *contract based* (changing contracts to reward partners for acting in the supply chain’s best interest), *information based* (to gather or share information that was previously hidden) and *trust based* (to use intermediaries or personal relationships to develop trust with supply chain partners). Lee (2004) outlines three similar methods: first, to exchange information and knowledge freely with vendors and customers; next, to lay down roles, tasks and responsibilities clearly for suppliers and customers; and finally, to equitably share the risk, costs and gains of improvement initiatives. Also, the antidotes for supply chain discontent recommended by Simatupang and Ramaswami *et al.* (2005b) are in line: mutual objectives, appropriate measures, information sharing, decision synchronisation, incentive alignment and streamlined processes.

Narayanan and Raman (2004) argue that companies should explore contract-based solutions before they turn to other approaches, because contracts are quick and easy to implement.

The literature regarding supply chain risk management could be divided into two major streams of research:

- 1 conceptual exploratory research trying to grasp and structure management issues related to supply chain risks, *e.g.*, focused on processes for risk assessment
- 2 modelling research using mathematical models to optimise or understand the consequences of a clearly defined risk-sharing instrument.

Most articles are found in the modelling literature and concentrate on theoretical analysis of contract-oriented mechanisms (see *e.g.*, Tsay *et al.*, 1998; Cachon, 2002; Liu, 2005). Tsay *et al.* (1998) classify the supply chain modelling literature focused on contracts into eight streams based on different contract clauses, such as pricing, minimum purchase commitments, quantity flexibility or lead times. The area still contributes with much interesting research findings (*e.g.*, Chen *et al.*, 2006; Jin and Wu, 2007; Wang and Liu, 2007) but still the context of the modelling analysis is often rather narrow, with simplifications such as a two-stage supply chain, and a single product, buyer and supplier. Already Tsay *et al.* (1998) believed that the design of contracts, and understanding how they affect supply chain behaviour and performance, was an important field of research but the scope of issues that the literature has addressed so far has been too limited. They call for research that extends the scope to production systems of greater structural complexity, including, *e.g.*, multilayered and branching supply networks in which each party might have contracts with several others. Agrell *et al.* (2004) is one example that follows this. They develop a three-tiered model to analyse incentive conflicts and coordinating contracts with the telecommunications industry as the context.

Another industrial context is provided by Cachon and Lariviere (2001), who describe a successful example of revenue sharing: instead of buying the copies, the home video provider Blockbuster agreed to give the movie studios a share of the rental fees in return for a much lower upfront price on the videotapes. This new contract mechanism resulted in better profits for both parties, as well as happier end consumers: incentives were created for Blockbuster to have more tapes in stock and hence higher availability and customer service.

3.2 Agency theory

Jensen and Meckling (1976) define the agency relationship as the “contract under which one or more persons (the *principal(s)*) engage another person (the *agent*) to perform some service on their behalf which involves delegating some decision-making authority to the agent”. Agency theory uses the metaphor of a *contract* (or more generally a *mechanism*) as the unit of analysis, and to describe and define the agency relationship. The principal and the agent are engaged in cooperative behaviour, but have potentially differing *objectives* and *risk attitudes*. The principal wants to determine what reward he/she should offer the agent to ensure that:

- the agent accepts the task
- the agent performs the task in a satisfactory way.

The optimal choice of type and parameters for the contract above depends on the *information* and *uncertainty structure* of the problem, the risk attitudes of the actors, the alignment of objectives between parties and the cost of monitoring and enforcement. Some underlying assumptions in agency theory are a potential for *opportunism*, *self-interest* and *asymmetric information*, meaning that the agent has hidden or private knowledge about, for example, his/her capability or exerted effort that the principal cannot see.

Two main categories of problems are discussed that can occur in agency relationships:

1 *The agency problems* that arise when:

- the two parties involved have different goals
- when it is difficult or expensive for the principal to monitor and verify the agent's action.

Such problems are closely linked to information asymmetry. Some subproblems are *moral hazard*, *adverse selection* and *signalling*. A *signalling problem* occurs, for example, if the agent has some private information that he/she would like to convey to the principal by some observable action (cf. Salani, 1997). One example is a supplier providing a high-quality product, offering generous warranties or return policies.

2 *The risk-sharing problem* arises when the principal and the agent have different attitudes towards risk. The problem here is that the principal and the agent may prefer different actions because of their different risk preferences (Eisenhardt, 1989a).

Other examples of agency models in operations management research are Corbett and Tang (1998), Zenios and Plambeck (2000), Corbett and Karmarkar (2001) and Iyer *et al.* (2005).

3.3 *Contracts and relational governance*

Governance of interorganisational relationships or exchanges involves more than formal contracts. Contrary to the research reported above, other researchers, *e.g.*, with a background in sociology, argue that formal contracts are costly and bad substitutes for relational governance, and that contracts might even signal distrust and encourage opportunistic behaviour (*e.g.*, Ghoshal and Moran, 1996; Macaulay, 1963). Different social processes that promote norms such as flexibility, solidarity and information exchange are important. Through these, relational governance may also function to mitigate the exchange hazards targeted by formal contracts – hazards associated, for example, with exchange-specific asset investments, difficult performance measurements and uncertainty (Poppo and Zenger, 2002). Research in economics and sociology has generally viewed relational governance and formal contracts as substitutes for each other (*e.g.*, Larson, 1992; Gulati, 1995; Dyer and Singh, 1998; Macaulay, 1963). Macaulay (1963) argues that contracts may have undesirable consequences, *e.g.*, that detailed negotiated contracts can get in the way of creating good exchange relationships. Ghoshal and Moran (1996) find that the use of rational contracts signals that partners are neither trusted nor reliable to behave appropriately without such controls. Dyer and Singh (1998) argue that informal self-enforcing agreements that rely on trust and reputation 'often supplant' the formal control characteristic of formal contracts. In particular, trust reduces the transaction costs by "replacing contracts with handshakes" (Adler, 2001). Within supply chain and industrial network research in the last decades, topics like collaboration, relations and information sharing have been high on the agenda and trust has been a more discussed construct than formal contract. In the supply chain field, Christy and Grout (1994) and Skjoett-Larsen (1999) distinguish between situations where the supply chain

partners seek safeguards via contracts or openness and trust, concluding that building up openness and trust is the most suitable protection against opportunism when both process and product specificity are high. When only product specificity is high, the buyer seeks safeguards through contracts, while when process specificity is high, the supplier will use contracts to safeguard itself.

Poppo and Zenger (2002), however, argue that contract and relational governance function complementarily. Rather than hindering or substituting for relational governance, well-specified contracts might actually promote more cooperative, long-term, trusting exchange relationships. Well-specified contracts narrow the domain and severity of risk to which an exchange is exposed, and thereby encourage cooperation and trust. In addition, well-crafted contracts promote longevity in exchanges by increasing penalties that accompany severing an exchange relationship. Customised contracts narrow the domain around which parties can be opportunistic. Despite compelling arguments for viewing relational governance and contractual complexity as substitutes, the logic for viewing them as complements appears equally compelling. In settings where hazards are severe, the combination of formal and informal safeguards may deliver greater exchange performance than either governance choice in isolation. Formal contracts help ensure that the early, more vulnerable stages of exchange are successful. Seshardi and Mishra (2004) also argue that contracts and relationships are complementary, and that contracts provide an evolving governance structure within which relationships themselves evolve. Das and Teng (1998) argue that both trust and control are needed to build confidence in partnerships, and Taylor and Plambeck (2007) exemplify how informal agreements (relational contracts) can be modelled.

4 Illustrations: implemented risk-sharing mechanisms

4.1 Agilent

4.1.1 Company and context

Agilent is a global high-tech company that delivers capital equipment to different growth markets, especially high-tech industries such as semiconductor manufacturers. The company is among the top three in its market with a net revenue of over \$6 billion (2003), and has its origin and major customer base in the USA. More than half of the revenue is generated outside the USA in over 110 countries. Some units of Agilent have a supply chain that is almost fully outsourced, and where contract manufacturers put together the entire system for them while final integration and testing are done in-house. Second-tier suppliers provide circuit boards, cables, *etc.*

Two major uncertainties that Agilent faces are volatile demand and the risk of allocation of their supplies. The volatile business can be seen in their net revenue, which for 2000 and 2001, for example, was 50%–80% higher than for 2002 and 2003. In addition to volatile business, a high percentage of their revenue is generated from sales with a seasonal pattern. A large part of Agilent's costs are fixed, which means that variability in revenue, due to business cycles, could disproportionately affect their results. While being profitable in 1999–2001, the company lost considerable amounts in 2002 and 2003. In terms of uncertain supply, allocation is very common regarding Application-Specific Integrated Circuits (ASICs) and semiconductor products: when the industry tightens up, everyone starts clambering for various types of semiconductors.

That Agilent sometimes has suffered allocation problems and had to buy on the spot market was one of the big reasons for Agilent to implement structured contractual mechanisms for risk sharing.

4.1.2 Example of supply chain risk-sharing mechanism

Agilent had previously tried to reduce uncertainty by improving forecasts and sharing real-time data, but now finds greater potential in trying to prepare for uncertainty. This includes working with 'range forecasting' and using structured contractual mechanisms to better coordinate with suppliers and secure different supply options. In the summer of 2002 Agilent started to implement such contract mechanisms for sharing risk and securing cost-effective levels of supply availability and responsiveness (flexibility). The results expected from the programme were – together with contract manufacturers and strategic suppliers:

- to develop common sets of definitions, tools and processes to consistently seize, cost and implement flexibility levels
- to develop common methods and processes.

The main thrust of the contract (Figure 1) is that Agilent first develops an internal range forecast, and not merely a point forecast, of expected demand. Then Agilent tries to get the supplier to guarantee supply and availability, especially for demand at the high end of the range forecast, as well as lead times and prices. Suppliers will secure clearer planning information, a price tied to flexibility and a purchase commitment. The commitment is a liability from Agilent specifying minimum purchase. Another ingredient is to be explicit about who is liable for what, as liability was previously not very well defined.

Figure 1 Agilent's connection between range forecast and contract constructs (see online version for colours)

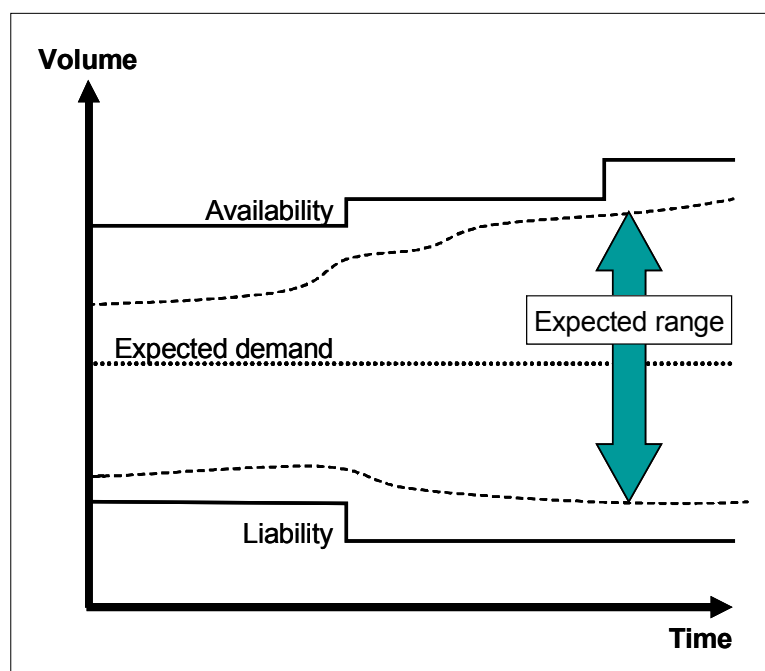
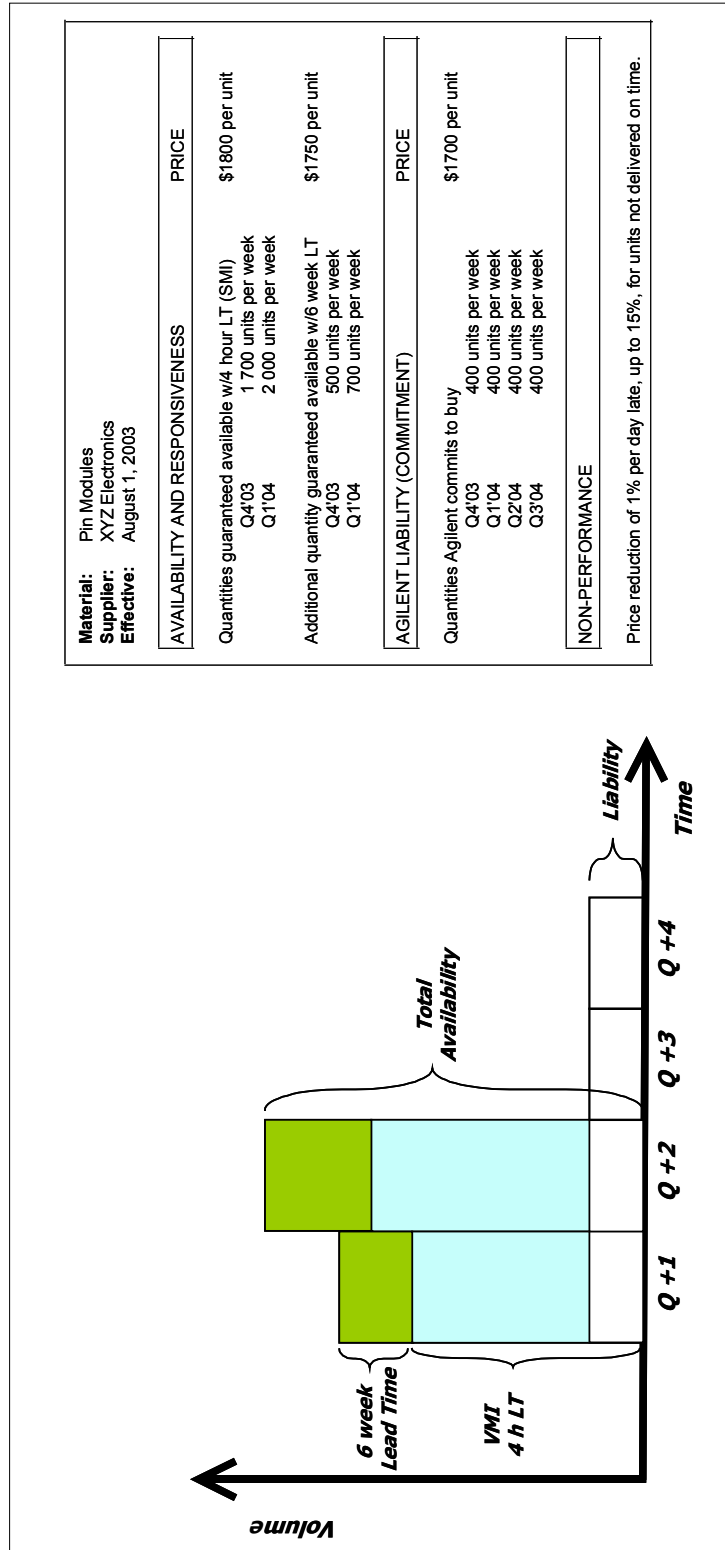


Figure 2 Illustration of Agilent's contract mechanisms (see online version for colours)

This type of contract provides an opportunity to differentiate between more or less unexpected scenarios within the contract (Figure 2). The levels of different contract parameters could also differ over time – in Figure 2, levels are set for the four coming quarters, and they all differ. Regarding volumes and lead times, a standard short lead time could be agreed on (*e.g.*, based on the Vendor Managed Inventory set-up) for the ‘standard’ demand, while additional demand must be called off with longer lead time. For both these categories, the price per unit might differ. In addition, a minimum purchase commitment is part of the agreement. This liability, the minimum purchase commitment, often has a longer time horizon than the other parts of the contract, but promises are for lower quantity. The duration of commitment differs, *e.g.*, specific quantities are defined for a short lead time (VMI), and a long lead time (flexibility) for quarters 1 and 2, while the minimum purchase commitment is given for the next four quarters. Typically the length of a minimum purchase commitment is six to nine months, but agreed upon three months in advance, which makes it a three- to twelve-month commitment. The purchase commitment is a major change in how Agilent was doing business.

In addition to volume/capacity, lead time, price and liabilities, penalties are part of the contract (Figure 2). Those different dimensions create many different supply options. All in all, this type of agreement gives information and incentives that prepare the suppliers for a range of potential demand scenarios. Agilent does not find this type of commitment a problem, unless the product is close to the ‘End of Life’.

As part of the concept, the prices for different flexibility levels (lead time and volume) could differ. Increased availability and flexibility normally drive the suppliers to increase inventory of raw material, *etc.*, and they would like these costs to be compensated by higher prices. Prices are also dependent on Agilent’s liability: with no commitment, the supplier takes all the risk of supply obsolescence and inventory holding. On the other hand, if Agilent accepts all liability directly for all material put into the supply chain, then the supplier takes a limited risk and could tend to give a lower unit price. In reality, the prices for the different options are often set equal due to difficulties in implementing different values in the ERP system.

The range forecasts are typically not shared, but Agilent shares the maximum availability and the purchase commitment, and sometimes the expected run rate. This information, which is not intended to be used for planning, gives signals for pricing. Normally there will be an interrelation between the ratio of availability to liability and prices. The lower the ratio (which often is between 3–5 to 1), the better the price the buyer could get, as the uncertainty for the supplier decreases. Some suppliers are willing to take higher ratios, and Agilent will try to keep the minimum purchase commitments low, typically because that assures that Agilent does not have to take on inventory in case of a downturn. Upturns and downturns are fairly large in their magnitudes, so it helps Agilent to have low levels of minimum purchase commitment and high levels of availability – even if that means that the purchase commitment has to stretch out for a fairly long period.

The contract’s quantities, prices and commitments are updated every quarter, but the overall format and structure will apply for a long time. The current focus has been on Agilent’s supply side, but the next step is to implement it downstream. Agilent is looking to try to develop the concept on their sell-side and offer ‘real options’ to customers.

4.1.3 Experiences from implementation

From June 2002 until June 2004, more than 100 risk-sharing agreements (or extensions) were structured with many different companies, typically with the contract manufacturers putting together the large assemblies. But there were also cases with both small and large second-tier suppliers. The materials could be, for example, boards, assemblies of boards, or boxes with boards in them, but also special parts designed by Agilent such as specific power supplies, ASICs or cables. These customised products are not purchased directly from the supplier but are built for Agilent and assembled by the contract manufacturers. Agilent has felt for many years that the relationship with those suppliers should be maintained, and that Agilent to some extent should control the supply chain. Hence the contract is between the subsupplier and Agilent, while the contract manufacturers call off the material they need from this contract. When selecting suppliers to start with, Agilent tried to locate the parties with the highest value and/or longest lead times.

Agilent's respondent thinks that the implementation of structured contracts tends to be easier with smaller suppliers, as it is easier to get their higher managers to look at the concepts, be interested in new ideas and ponder how they can meet their customers' needs. Agilent is certainly also a more important customer for smaller suppliers than for bigger ones. Suppliers chosen could be more equipment/technology based or those more centred on manpower. There are situations when suppliers might have to make major investments as a result of a rapid increase in Agilent's market. Hence Agilent is trying to figure out what the capacity limits are and whether the supplier can work extra shifts, or if others can increase capacity without heavy investments.

The key benefit for Agilent has been the flexibility the contracts establish (measured for example, as the ratio of availability to commitment). Agilent gives the supplier better visibility of their requirements and their best estimation of the possible ranges the business will go through. Agilent is also explicit about commitments. Agilent has improved its ability to predict supply chain performance and assess the impact of different risk sources (availability/shortage risk, liabilities/inventory risk, material cost/price risk). Firefighting has decreased, creating a smaller, less reactive workload in volatile demand situations (proactive quarterly contracting leading to reduced daily firefighting, less need for *ad hoc* 'fire-drills'). Employee morale has improved (less firefighting, more win-win engagements with suppliers, less finger pointing). The supplier relationships have, according to Agilent, been more constructive (clear expectations/boundaries, less second guessing, better trust, more win-win engagements). Inventory management has improved, especially ramp-down/end-of-life inventory exposure management. Finally, Agilent has enhanced its capability to give reliable sell-side offerings, where it can tailor supply solutions offered to customers supported by matching buy-side contracts. But the approach results in more complex contracts to manage than before, and much more analysis to do before closing the contracts. Although there are more costs in developing those kinds of contracts and doing business this way, even the suppliers are reported by Agilent to be happy:

"We are extremely pleased with the performance of the structured agreements. We would not have been able to support the recent ramp without the upside requirements you presented in the structured agreements." (Supplier A)

"Structured agreement is a good program and we would like to extend it to other boards. We have found that it is more difficult to do pricing, but it's worth it." (Supplier B)

“This is the smoothest contract we have going. It’s predictable and we’re willing to commit per the terms.” (Supplier C)

A key learning point Agilent stresses is that this approach is not about implementing a software tool but introducing a change of mindset. Enabling tools, such as software for contracts comparison, are necessary but not sufficient. Instead it should be recognised that cross-functional change is required. Hence, change leadership fundamentals are important, especially strong programme governance and general management support. Agilent started its work on one unit, and experienced that one should focus deployment initially on the smallest unit, where cross-functional processes can be integrated. Savings come in the form of lower total cost, including lower inventory costs, fewer write-offs, less lost revenue and lower material costs. However, many very significant savings are difficult, if not impossible, to project or quantify.

Implementation problems have occurred. One problem was to try to make suppliers understand the volatility of Agilent’s business. The minimum purchase commitment in the contracts has definitely made it easier to achieve the needed flexibility. Agilent typically seizes the purchase commitment with a magnitude and duration so they eventually burn out all the unique material. In the case of obsolescence, Agilent also allows the minimum purchase commitment to be converted to dollars. If the components are not going to be used, Agilent converts the commitment to money and will not ask that they be shipped.

It was found more difficult to implement with the second tier, *e.g.*, due to the relationship between the second-tier supplier and the first-tier supplier. As Agilent is taking the liability, the second tier desires to focus on Agilent and not as much on the first-tier supplier getting the material. One main barrier for implementing risk-sharing mechanisms was that it required different decision-making capabilities within Agilent. *Range forecasts*, as an example, was a new terminology and a new way of thinking that sometimes slowed down the whole process. Furthermore, the new process is more proactive, and managers are thinking at least a quarter in advance, making commitments for up to one year. Previously, Agilent was also making commitments, but not as visibly: perhaps it was easier to make those commitments when no one really saw them. One implementation barrier is the need to ‘bring some potentially dirty laundry out into the open’ and get managers used to making some of the decisions a bit differently. Agilent also finds it a challenge to keep contracts coordinated, as contracts are ultimately based on negotiations. Different people and companies will be motivated differently, and the final contracts will hence display some differences. Therefore, Agilent is trying to standardise at least the contract format. Other barriers and challenges were, in some examples, to convince suppliers to provide all the different ranges and to change the way suppliers plan. Agilent’s approach to overcoming these barriers was trying to be very open and explaining exactly what was going to drive what within their supply chain. Agilent created models of supply chains in the attempt to show suppliers exactly how they were going to plan differently, and explained that Agilent was doing this with all strategic suppliers.

In the area of introducing explicit liabilities into contracts, once that became established things became easier. In the past, Agilent’s liability was more or less all material in the supply chain driven by whatever forecast happened to be available, or whatever forecast the contract manufacturer or supplier was planning on. There was no consistent forecasting process – just the capability to track all that was impossible – so

what Agilent had to do was ask the suppliers what Agilent was liable for. One of the key benefits is that Agilent can now see what liability is created, instead of relying on the suppliers and their planning ability to define it.

4.2 Hewlett Packard

4.2.1 Company and context

The Hewlett Packard Company (HP) is a global high-tech company active in a number of businesses related to information technology and services. The company has its origin in the USA, but has customers and operations all over the world. HP belongs to the top three in their different markets with a net revenue of over \$70 billion (2003). The supply chain is, to a large degree, outsourced (and has been so for a long time). Demand is found to be highly volatile, as well as supply-side prices. Although HP has a large purchasing power, they see themselves as vulnerable on the supply side and facing the risk of supply allocation. When HP started this approach, there was, for example, a lack of flash memories. In 2000, HP started to address risk and uncertainty management, with the idea to apply financial risk management techniques in the procurement area and to change their mindset on risk sharing. Instead of pushing risk to the suppliers, HP should move to sharing risk with the logic that risks in the supply chain should be managed where it drives the least cost. The focus is on uncertainties in demand, supply and price. A Procurement Risk Management (PRM) group was established, which reports to a Vice President in procurement. HP decided to tackle three types of risks:

- 1 *demand and mix uncertainty*, leading to the cost of flexibility, wasted capacity, channel inventory
- 2 *supply uncertainty*, leading to excess and obsolescence cost of shortages, and lost revenue
- 3 *material cost uncertainty*, leading to purchase part variance, margin surprises and lost deals.

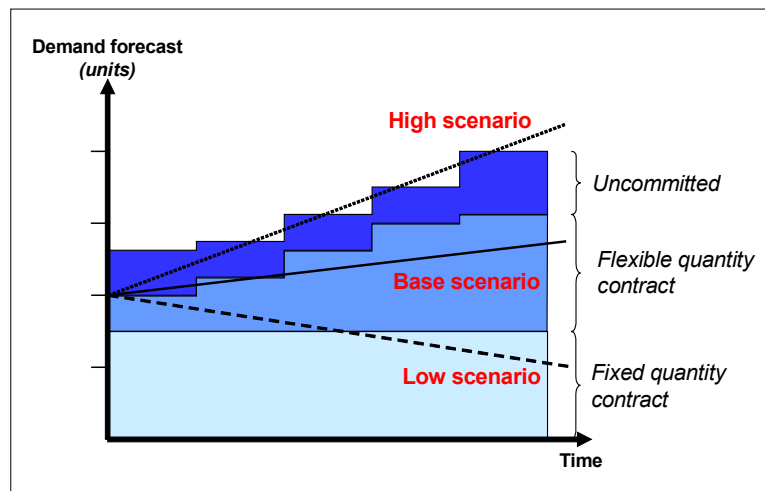
4.2.2 Example of supply chain risk-sharing mechanism

Previously, some of HP's different businesses have had problems with accurate forecasting. The forecasts the suppliers received had significant uncertainty and the suppliers started to second-guess. Ultimately, HP did not get the needed parts. The new approach includes a new way of linking forecasts to different kinds of contract mechanisms, in order to better share risks and uncertainties. It includes trying to measure the uncertainty by using forecast scenarios for the demand, availability and price of components. Now HP first tries to develop scenarios to measure risks and to structure supplier agreements by using a forecast that is divided into three scenarios: a low scenario, a base scenario and a high scenario (Figure 3).

These three ranges are then related to different types of contract mechanisms. The low scenario relates to a fixed quantity contract at the bottom. The idea is to commit to a fixed quantity (but the price could be flexible due to the market). Similar to many others in the industry, HP has previously used the practice to commit a 'market share' of their demand and never to commit volume. HP is now increasingly committing real volumes, and these contracts with a binding commitment on both sides is a big step. Sometimes HP

is committing the volume three months ahead, sometimes more. To commit the volume is seen as a huge change within HP. The base scenario is related to a flexible quantity contract, while the high scenario relates to an uncommitted part which is more or less bought on the spot market. HP realises that to buy something on the spot market could of course lead to a higher price – but also that these high volumes on the other hand are already ‘good news’.

Figure 3 HP’s connection between range forecast and contract mechanisms (see online version for colours)



In terms of information sharing, the new range forecast with different scenarios is not sent to suppliers, but rather the traditional point forecast. In the other direction, HP gets information about capacity and capacity investments and has a good understanding of suppliers' investment plans.

Usually the length of a contract is either one or two years, and very seldom three years. The parameters, such as prices, are updated meanwhile and the frequency of those renegotiations depends on the market practices and the volatility. Updates could be quarterly, monthly or twice a month (with no case fits all). The difference with the new type of contract is that one portion of the contracts is the run rate (flexible quantity), and one portion is a fixed volume. That is a significant difference in comparison to previous contracts. Three terms are structured in the contracts:

- 1 quantity (*e.g.*, fixed quantity; min and/or max quantity; fixed and flexible percentage)
- 2 pricing terms (*e.g.*, market based with specified discounts; fixed price; price caps and floors)
- 3 cash-flow terms (*e.g.*, buyer penalties; loans; upfront payments; royalties).

How the terms, and their different parameters, are set differs between relations. It is all seen as a toolbox, or framework, that could be used in negotiations. Different suppliers are sensitive about different things, and so are the purchasers. For example, there is no norm for in which tile (10% of the forecast or something else) the fixed order quantity

should end up. That specific issue is really dependent on the quality of the forecast: there have been cases of 50%, 60% and even 70% of the forecasted volume that has been committed. The length of a commitment also depends on the contract, the market and what advantage HP thinks it can get from it. Normally the length of a commitment is between two months and one year. The different terms and parameters are interrelated, so the percentage and the length of commitment have a definite impact on, for example, the price HP gets.

HP is primarily working with risk-sharing contracts with large component suppliers, and not with contract manufacturers or Electronic Manufacturing Service (EMS) providers. HP wants to control its strategic components (risky, high dollar or high technology) itself, and for this different set-ups are used. HP could, for example, first buy the components from the suppliers and then resell them to the EMS. Finally, the EMS will resell the whole assembled unit to HP. By this approach, HP has a chance to mask prices when appropriate and the contract manufacturers are not familiar with their new contracts with suppliers. So far, however, HP has seen more value in committing volumes to component suppliers, and the experience is that component manufacturers prefer dealing with them directly instead of the EMS.

Other types of risk sharing, like direct investments in machines, fixtures, capacity options, and mixed ownership of inventory, could be used, but are very rare and normally not used.

4.2.3 Experiences from implementation

By mid-2005 HP had implemented more than 100 risk-sharing contracts, and stated an impact of more than \$200 million in savings over five years. After working with this type of contract once or twice, the suppliers realised its value for them. After some time, according to HP's respondent, the suppliers 'just loved it' and the suppliers said, "Come to us with fixed quantity commitments and we are ready to make commitments for these volumes."

The first 3,5 years of the implementation was about learning and improving by learning, developing tools and creating awareness. The PRM group did this by running as many pilots as possible. The first two years, HP focused on the 'low scenarios'. The market was 'soft' those years, with lower demand than supply. Hence HP could start with a focus on price risk the first two years. In year 1 they started with one commodity and in year 2 they worked with three commodities. When the market started to move towards higher risk for allocation, the focus was shifted. Demand and supply risk were added the third year, and HP now worked with 14 commodities. In terms of internal rollout, it was spread over different Business Units and started with people who ready to try. Today HP is going for where the biggest returns and quick wins are. The real challenge, HP points out, is the implementation, and especially the change of mindset that has to be made internally. The biggest barrier has been skill sets, combined with metrics.

After the first years' learning and development, PRM's focus was on trying to drive the new mindset and culture, and to transmit their skills. It was important to align internal measures and incentives to the new approach, so PRM had to adjust metrics and business processes in parallel. As people behave in line with their metrics, those must be changed. While procurement normally focuses on unit costs, this was not found right in this context. Hidden costs are normally not measured, but some examples of what could be measured instead were 'What is the cost of shortages per commodity?' 'What is the cost

of bad volume forecasting?' The underlying question is that if cost impacts are not measured, how could investments to avoid impact be justified? Another cost that is hard to measure is flexibility, which is not for free. The respondent, however, thinks that a purchase commitment on the other hand gives a lower price.

For the first phase, the key success factors were to have a clear focus; to have the right individual involvement; to have the right balance between development, training, consulting; to really sell it internally and to have the right people for this (HP admitted they initially had "the best analytical guys, not the best sales guys"); and finally to have patience. The result in different business units was mostly related to their willingness to change their current way of doing business. The best strategy is to find an open-minded person to work with. In the current phase, which is more of a rollout, three things were stressed as important to handle: people, business processes/IT and metrics. Now the approach is to select one unit internally and try to change its way of doing business, then 'copy' it to others. In general, new skills are needed, but first new metrics. HP is trying to get balanced cost metrics, not only focusing on unit cost as before, and hence they have added metrics such as shortage cost, 'cash-to-cash', material cost accuracy and inventory deployment cost. In terms of extending the approach, it was in HP's plan to extend it to more tiers. The idea was to start to train ten companies further upstream.

5 Empirical analysis and discussion

5.1 *Effects of implementing risk-sharing contracts*

The buying companies in the study highlighted many positive effects. The structured risk-sharing contracts were seen as a key to secure capacity and flexibility in volatile industries with allocation situations. By making explicit purchase commitment, Agilent and HP experienced that they were treated better in allocation situations. Further, the size and length of commitment seemed to affect the price level. Normally the price got better with a larger commitment. One price risk of long-term contracts, however, was that a market changes into a 'seller's market', which could result in higher prices. (But, once the price level is set, the actual price is sometimes renegotiated frequently to keep a stable relation to the market price.) According to the companies studied, the suppliers also expressed satisfaction with the new type of contracts. For the suppliers, requirements were made more explicit, and expected demand was easier to understand. The fact that different parties' liabilities and commitments were made more explicit and visible was also important per se. Within the buying firm, the liabilities created could be seen better, which improves decision making (although making decisions gets harder when you understand what risks you are taking). To make explicit purchase commitment to suppliers, created, *e.g.*, a need for an internal plan to handle obsolescence which was previously often handled more *ad hoc*. As processes are defined to improve the predecision analysis, and the set-up with purchase commitments is made to reduce the risk of allocations, it all creates smaller and less reactive workloads in allocation situations. Finally, a positive effect on the buy side of the structured risk-sharing contracts was that they improved the opportunity to offer risk sharing on the sell side. One reason for this is that the impact on supply of different demand scenarios can be calculated: if you offer this kind of flexibility in contracts to the customers, it will result in the necessary commitments and costs related to supply in the following subsections.

5.2 Experienced challenges and barriers of risk-sharing contracts

Although giving interesting effects, aligning incentives in supply chains by risk-sharing contracts was not an easy task. It affected both internal and interorganisational processes, as well as changing the commercial interface between companies. (It could, of course, also have a legal aspect, which is not covered here.) The main challenge seemed to be internal to the buying company, and more precisely to handle people and change management. Suppliers might first be surprised and suspicious (if used to a competitive relationship), but then positive. One reason for internal barriers was that taking more explicit and proactive decisions on commitments demanded more proactive decision making, and maybe also new competences. Previously 'hidden commitments' had initially to be illuminated, and hence a 'cleaning-up process' starts that might lead to scrapping obsolete material, a cost that someone has to take. The 'demand side' in companies is often hesitant to pay for a flexibility they previously had asked (and will ask) for due to their inaccurate forecasting.

All in all, there was an increased workload with analysis and negotiations for all involved parties. One example was the need to develop cost models for the supply chain that could describe what would happen in different scenarios and the impact on different players (and make sure the model is right over time). Another example, very much stressed by HP, was the need to develop new metrics for the purchasers, for example, as the old metrics are not aligned to this way of doing business.

5.3 Experienced success factors for implementing risk-sharing contracts

Both Agilent and HP found a success factor in their making purchase commitments, *i.e.*, sharing the risk and gains. It was also important that there was trust and a good relation. In addition, openness, visibility and clarity, such as the use of open calculations/cost models for supply chain impacts, are important. If the market suddenly changes, for example, from a neutral or allocation market to one with excess supply, it is suggested to avoid a change of behaviour back to the old competitive approach. That would reduce trust and limit the opportunities to later go back to risk sharing. Furthermore, it is recommended that the suppliers chosen should not be too dependent on the buying firm.

It was also important to have a good forecasting process, as the forecast is the platform for setting up realistic capacity requirements and commitment levels. Agilent and HP both had moved from point forecasting to range forecasting. However, before Agilent's focus was on the forecast and information sharing; now it is on the structured contract. It also seemed necessary to change the leadership and develop a good capability to sell the ideas internally. Last, but definitely not least, among the success factors was to develop new metrics and new skill sets.

6 Theoretical discussion

6.1 Using contracts to align supply chain incentives

From a theoretical point of view, the studied companies have acknowledged the problem of misaligned incentives, diagnosed the cause and redesigned the contracts (compare Narayanan and Raman, 2004). The cases illustrate situations where companies move

towards more contract-based solutions to redesign incentives (see Cachon and Lariviere, 2001). Although information-based and trust-based solutions still seem important, the focus in these cases is on the new type of contract and the signals it provides internally and externally. The cases are characterised by uncertainties of volatile demand and risks for supply allocation. Uncertain supply can of course be handled by increased capacity and flexibility, linking to specific investment or assets (a risk that the buyer normally tries to force upon the supplier). To use the agency theory, the companies in the supply chain could be viewed as *principal* (the studied company) and *agents* (the suppliers) with different *objectives*, *information* and *risk attitudes*. Hence the agency problems, *e.g.*, the signalling problem and the risk-sharing problem, could be observed.

6.2 Using contracts to structure and improve relationships

The *contracts* in the cases are more complex than the previous ones used in the relationships, and they contain a mix of mechanisms (*minimum purchase commitments*, *quantity flexibility*, *pricing*, *lead times*, *etc.*) applied in different ranges. However, the result seems to be better structured relationships, and there are more explicit interfaces between the companies when it is clearer who takes different risks, and where and how risks are shared. It has been important to create clear commitment and liabilities, *e.g.*, by clearly defined flexibility and upper capacity ranges by the suppliers and minimum purchase commitment by the buyers. The minimum purchase commitment means that the buyer, upfront, takes more of the demand risk than previously. (In the long term the buyer might decrease total liability, as the total value of obsolete inventory might be reduced due to a better-aligned supply chain.) Furthermore, different prices could be applied for different volume ranges and flexibilities – meaning that, for example, the flexibility gets a price. All in all, the *pretransaction costs increase* as they take more time to develop, more analysis has to be made and new competences are needed. But buyers as well as suppliers seemed willing, in the cases studied, to take on this extra work as it resulted in better contracts later. Further, this heavier process of establishing the contract seems not to have a negative impact on *trust* and on the *relation*; on the contrary, it seems to enable the parties to better understand each other and the impact of different mechanisms on the whole supply chain. *Roles, tasks and responsibilities become clearer*, both in the interface between companies and internally (see Lee, 2004). These cases indicate that well-specified risk-sharing contracts could help the *development of cooperative, long-term and trusting relationships*, and that well-specified contracts *reduce the uncertain area* for the parties. The more formalised contracts seem to drive more information sharing, both through implicit signals and explicit information. This implies (compare, *e.g.*, Poppo and Zenger, 2002) that contract and relational governance need not always be substitutes but that they can be *complementary* – one promotes the other. Trust is argued by these cases to be needed for developing this kind of risk-sharing mechanism. The process of developing the structured and well-crafted contracts and mechanisms, as well as the use of them as a government structure, is also seen to increase trust in the relations.

6.3 Using contracts to improve internal and supply chain information

Asymmetric and hidden information are also issues in these supply chains. To establish better internal information, the buyers have changed their forecasting process and are now working with range forecasting, which provides better internal information. However, the explicit information to suppliers is still not the whole range forecast but a 'point'. But by getting the upper capacity and the purchase commitment (and by the ratio between those), the suppliers get important *signals* about the buyers' expected upper and lower forecasted demand, and the ratio indicates how well the buyer believes in his/her forecast (a higher ratio or spread could indicate a lower confidence in the forecast). The minimum purchase commitment can also be seen as a signal of an intention to work long term together – the longer commitment over time of course provides an indication of this. Also, whether commitment is expressed as a percentage of volume or a fixed volume signals how much of the demand uncertainty risk the buyer really assumes. (Normally in agency theory, the supplier (agent) is the one signalling, but here we also found signals from the buyer (principal). Internally, the fact that commitment must be taken has forced the internal decision process to be improved. When the 'sales side' in companies has to understand and pay for the costs accruing from inaccurate forecasting and unnecessary flexibility, wiser decisions could be the result.

Although information sharing improves, there are still examples of hidden information and distrust. The interface between buyer and EMS is one where, for example, HP was trying to keep EMSs at a longer information distance than many of their second-tier suppliers.

6.4 Understanding contract's and trust's interrelation to develop supply chain management

To summarise, the agency theory's focus on the contract as a construct to handle and relate other constructs and assumptions such as principal, agent, external uncertainty, self-interest and alignment of goals, different risk attitudes, opportunism and asymmetric information (the last two related to trust and information sharing) seems to be one useful approach to understand supply chain risk sharing. The interrelation between contract, information and trust/opportunism seems interesting and not simple. In this explorative study, the new contract mechanisms on one hand seem to have led to improved explicit and implicit information sharing, *e.g.*, by clearly signalling commitment, as well as improved relations. On the other hand, trust, openness and visibility are reported as success factors for implementing the contracts. It seems valuable to improve the understanding of the interrelation between contracts and trust in the supply chain context.

7 Concluding discussion

Supply chain risk and gain sharing is a research area that has received more attention lately. In the illustrations reported on here, contracts have been more structured, explicit and detailed to drive improved supply chain performance. This paper contributes to the field of SCM and procurement by focusing on the role of contract mechanisms as a

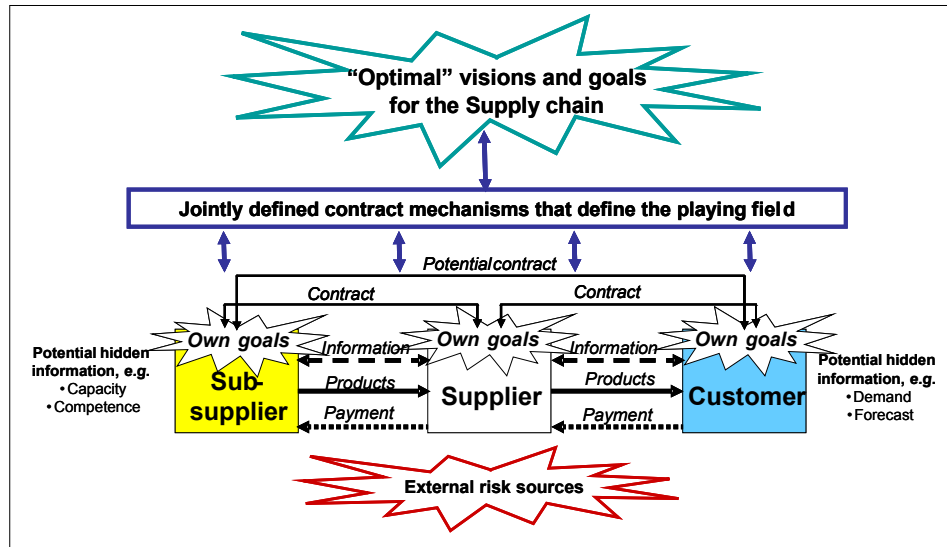
vehicle for risk and gain sharing, by illustrating it with two explorative case studies from an industry with challenging uncertainties. The content of the contract mechanism, as well as experiences from implementation (such as benefits, issues and success factors), were described and discussed using an incentive alignment and agency theory framework. It provides some realistic assumptions regarding commercial supply chains such as information asymmetry, differing objectives and opportunism that should not be neglected although many might hope for the context to be different. These summarised experiences from practical implementation complement the previous, more stylistic findings from modelling-oriented research.

The case illustrations report positive experiences as well as issues related to risk-sharing contracts implemented in a challenging supply chain context. Through these contract mechanisms, the companies seem to have better developed a “tight supply chain pulling in the same direction” (Narayanan and Raman, 2004). Contracts, sometimes argued to be negative for relationships or to have their main value for lawyers in court, could also be seen as a vehicle to signal information and commitment. As illustrated in the cases, to give a volume commitment could be a way of signalling confidence in one’s own forecast as well as to a long-term relationship. This might increase trust and improve the relation, maybe resulting in the supplier giving guaranteed supply in allocation situations as well as lower unit prices. In the cases’ context, the experience was that these mechanisms worked well in handling uncertain demand and supply. In addition, the process of defining and implementing the structured contract might strengthen the trust in the relation, as a lot of issues have to be discussed proactively and explicitly. In this study, internal barriers have been stressed as important issues to handle. Risk- and gain-sharing mechanisms imply a new culture for purchasers previously used only to pushing risk onto suppliers. To get a new culture in place, measurements and internal incentives must be aligned with the new approach.

Observed in this study, but not much discussed and hence an issue for future research, is that many supply chains are not linear concerning contracts: there could be multiple formalised relations between and over tiers, making it very complex. Another issue is to incorporate a business cycle perspective in the contract. The power situation between buyer and seller could shift during a business cycle depending on the demand/supply situation. If a joint SCM vision of long-term synergies exists, it might make little sense to leverage on each other’s weak position in negotiations compared to finding incentives and risk- and gain-sharing mechanisms that could make the supply chain benefit over a longer time horizon.

If contract mechanisms would be an important part of proactive relational governance in supply chains, the issue would be for strategic partners to jointly define contract mechanisms that establish the ‘playing field’ for the company-specific contracts (Figure 4). This ‘playing field’ would then be the link between the supply chain vision and joint goals, and the specific contracts against which each company has to optimise its business. Whether this approach is purely academic, or could bring value in real supply chains, is an issue for further research.

Figure 4 Contract framework as link between supply chain vision and company contract (see online version for colours)



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