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From the Editors

The special importance of theory building and practice in the field of chains and networks has already been identified by many researchers and industry leaders, because of the increased complexity of the (global) network economy and increased attention to consumer interests in high quality (and safe) products and sustainable production methods. Although many initiatives for supply chain and network development exist today, a platform for knowledge building and dissemination is still missing. The Journal on Chain and Network Science aims to bring together interdisciplinary knowledge of academia and businesses around the world to build this international platform.

It is therefore with great pleasure that the Editorial Board presents the first issue of the Journal on Chain and Network Science. We want to invite you to support this initiative by submitting high standard papers, by taking a subscription and/or by persuading others to do so, or by simply being an enthusiastic reader. We hope to hear from you soon!

In the first article of this issue the editors will set the base-line for a discussion on the contents and scope of chain and network theory and its applications. We hope this will be the start of a lively exchange of thoughts and experiences between chain and network theorists of different disciplines and different nations.

The editors

Prof.dr. S.W.F. (Onno) Omta

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Chain and network science: A research framework

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Abstract

In this first article of the Journal on Chain and Network Science the base-line is set for a discussion on contents and scope of chain and network theory. Chain and network research is clustered into four main 'streams': Network theory, social capital theory, supply chain management and business economics and organizational theory. Furthermore a research agenda is formulated. The article ends with management implications of the different contributions to this first issue.

1. Perspectives on chain and network science

The fast development of technology, combined with increased global competition and more stringent customer demands put strong pressures on companies to improve the quality of their products and processes. Competition involves not only on price, but also a wide variety of product and service attributes. The pressure to do more with less inexorably forces companies to focus on few, unique, hard to imitate and distinctive core competencies, while establishing co-operations in fields in which they do not possess distinctive competencies. For instance, over 50% of Du Pont's new agricultural product leads stem from university

laboratories (MacLachlan, 1995). As Gambardella (1992) concludes: *'To be part of a network, and to be able to effectively exploit the information that circulates in the network, has become even more valuable than being able to generate new knowledge autonomously.'* The capability of building and maintaining inter-organisational network relationships is increasingly viewed as key to sustained competitive advantage.

Figure 1 clearly shows that related industrial networks are increasingly converging. The boundaries of the computer industry overlap with telecommunications, office equipment, entertainment and consumer electronics. Increasing interdependence of previously separate industries produces new competitors, but also new possibilities for alliances and acquisitions. Managers may find that control

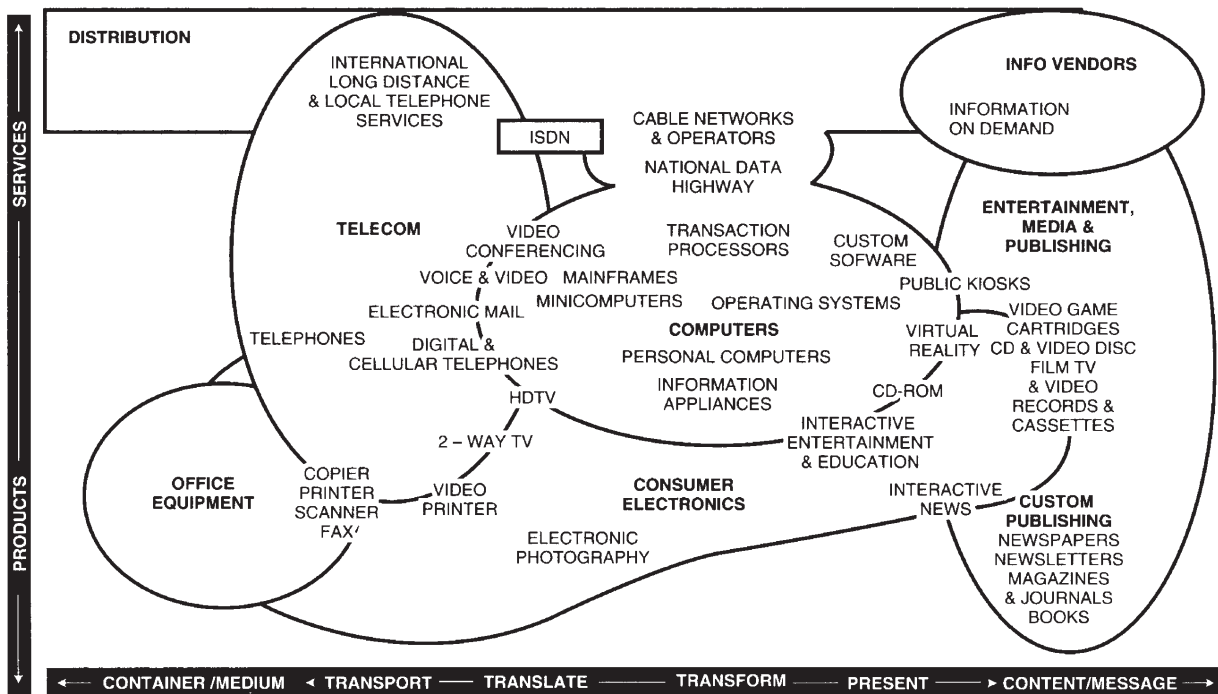


Figure 1: Integration of related industrial networks (Ford and Saren 2001).

should be shared. As Ford and Saren (2001) cite: *'Today the watchword is not divide and conquer but co-operate-to-compete'*. In this emerging competitive environment, the ultimate success of the single business will depend on the management's ability to integrate the company's intricate network of business relationships with outside companies. Several authors refer to such networks as virtual corporations, in which a number of firms create flexible linkages to attain common or complementary objectives (e.g., Davidow and Malone 1992, Campbell 1996, Upton and McAfee 1996, Yoshino and Srinivasa Rangan 1995).

The Journal of Chain and Network Science (JCNS) aims to become the expertise platform for academia and business in this exiting field of research by focusing on the development and validation of strategies, methods and techniques for the improvement of the efficacy of business networks. The concepts addressed in JCNS embrace, among others, chain and network organization and optimisation, partnership management, network dynamics, E-commerce, quality, tracking and tracing and sustainable development. JCNS contributions are based on empirical research, well-considered observations of inter-organisational management experience, as well as conceptual contributions to the field of chain and network science. JCNS intends to provide a specific platform for theoretical contributions. The theoretical domain includes new insights from management and organization, sociology, economy, operations research and logistics, and engineering. Each discipline has a different view and method of dealing with inter-organisational relationships. JCNS expects to be truly international. The contributions will reflect the views of scientists and practitioners from all over the world, and will present research results from chains and networks in quite different cultural contexts. In this first issue articles are included that present research findings from South and North America, Canada, the EU, and New Zealand.

2. Theoretical domain

Chains and networks are the obvious objects of study in the JCNS. Networks are looked upon as the total of actors within one industry and/or between related industries, which can potentially work together to add value to customers. Actors can be distinguished, either at the micro-level, where the actor is a person, for instance the individual producer, an entrepreneur etc., or at meso-level, where actors are aggregations of individuals working together for a common goal, e.g. firms, research institutes, and government agencies. Chains are considered to be composed of the actors in these networks which vertically work together to add value to customers. A chain is defined as the processes linking supplier

and user companies, from the initial raw materials to the ultimate consumption of the finished product.

The concept of the supply network, introduced by Harland (1999, see figure 2), tries to integrate the network and supply chain approach. She looks upon the individual firm as a nexus with its own unique network of upstream and downstream partners. She cites Benetton and Toyota as the best examples of 'hubs', facilitating and coordinating the flow of information in large supply networks, and connecting upstream with downstream demand. A supply chain can be considered to be a special form of a supply network, in which the inter-organisational relationships between the upstream and downstream partners with the focal firm are of a dyadic form. Supply networks differ in shape, reflected in the breadth and length of the network. The breadth of the network reflects the number of suppliers and customers. The length of the network reflects the number of echelons until the end-user. In general, the breadth of the supply network is now narrowed, because of the transition to a limited number of 'preferred suppliers'.

So far, chains and networks have been studied from a wide range of theoretical perspectives, for instance systems thinking, cybernetics, resource dependency approach, transaction cost economics, agency theory and game theory. In order to reach some clarity, we have clustered network research into four main 'streams'. The reader should keep in mind that the overview given below is certainly not exhaustive, but merely gives an impression of the richness of approaches to inter-organisational co-operation.

Network theory

One of the main contributions of the Industrial Marketing and Purchasing Group (IMP) on network research is the actor, resource, and activity model (Håkansson 1982, 1992). The necessity for organizations to exchange resources is an important explaining factor for inter-organisational relationships in this approach. Activities of actors occur in the form of chains of activities (R&D, marketing, design, sales, administration etc. combined to value chains, Porter 1985), constituting buyer-seller relationships and industrial networks as these are linked to other actors in the network. In the network theory, forms of collaboration are not only based on economic motivations; power and trust are key concepts in this approach (Uzzi, 1997). Actors are believed to act on the basis of their functional role in the network, while goal orientation, interests, rules and power relations determine this role (Nooteboom, 1996; Omta and Van Rossum, 1999). Kamann (1998) states that, based on the resource-dependence perspective, one can easily argue that neither buyers nor suppliers are completely free to select and change counterparts. The degree of dependency of an

actor on its counterparts is contingent upon the criticality of the resources supplied (Chatterji, 1996), Power balances play a significant role, and game theory can be helpful in describing the individual actor's dilemma. The actors in these networks will search for alliances, because of the concentration on the 'distinctive capabilities'. Some of these relationships will be based on trust and loyalty, while others will be based on opportunism. A key factor is the innovative process that takes place over time in which actors are able to adjust and interweave transaction chains, accommodate routines that were strange before, transfer activities to other actors and build up common recipes, standards and cognitive maps. In the course of this process the network becomes either sustainable, growth and learning, or it stagnates, or even collapses. The great number of strategic issues that can be addressed within the network approach demonstrates its broad scope. Thorelli (1986) gives a few examples: positioning of the firm and its product, marketing channels and franchising, patent and trademark licensing, turnkey contracts and 'systems' selling, barter and reciprocal trading, make-lease-or-buy decisions, split versus unified sourcing, cartels, and interlocking directorates.

Social capital theory

Recently, social capital theory has become an important new branch within the network approach. The social capital argument assumes that the behaviour and expectations of

actors are constrained by the degree to which the relationship between the actors is embedded in the network structure. Consequently, one may distinguish between a situation in which the network structure is closely knit (the relationships are then redundant, i.e. actor A has relationships with actors B and C, and B and C also have a relationship) and a situation in which non-redundant relationships prevail. Coleman (1988) describes this phenomenon as the degree of 'closure' of the network. In a similar vein, Granovetter (1985) speaks about strong versus weak ties in a network. Burt (1997) formulates it slightly differently as the occurrence of 'structural holes' in the network. Network-relations may enhance the 'social capital' of a company, by making it feasible to get easier access to information, technical know-how and financial support. But, at the same time, these relationships may lead to 'social liability', e.g. by reducing the possibilities to relate to companies outside the network, risking spill-over, and high co-ordination costs of the network-relations. Leenders and Gabbay (1999) provide an extensive overview of the social capital research to date.

Supply chain management

Supply chain management aims at the integration of business planning and balancing supply and demand across the entire supply chain. It tries to bring suppliers and customers together in one concurrent business process. It spans the entire chain from initial source to the ultimate

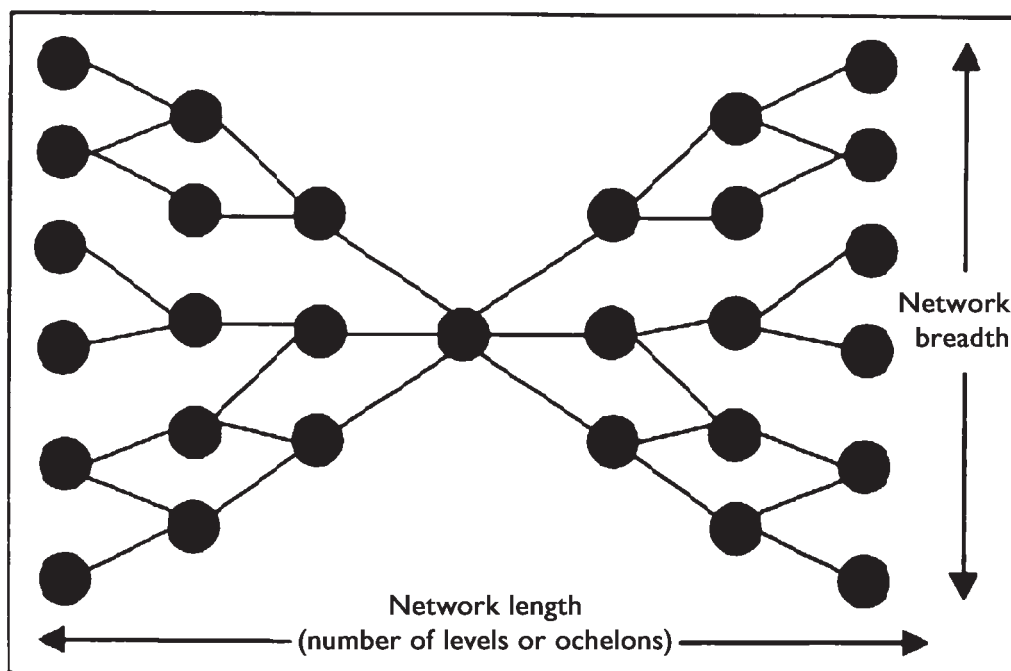


Figure 2: A supply network, a focal firm with its network of upstream and downstream partners (Harland 2000).

consumer (Schorr, 1998; Handfield and Nichols, 1999; Croom et al., 2000; Tan 2001). Advanced ICT (e.g. E-commerce) systems are increasingly becoming the backbone of these integrated supply chains. Supply chain management research is well supported by modelling and modelling tools. For example, mathematical models to support decision making for chain multi-echelon replenishment environments are described by Silver et al. (1998). Berry and Towill (1992), and Towill (1996) stress the importance of dynamic modelling in supply chain analysis and design. Handfield and Nichols (1999) deal with dynamic choice problems incorporating optimal control theory. Typical features of supply chain management are (Cooper et al. 1997, Lambert and Cooper 2000) as follows:

- It evolves through several stages of increasing intra- and inter-organisational integration and coordination.
- It potentially involves many independent organizations, thus, managing intra- and inter-organisational relationships is of essential importance.
- It includes the bi-directional flow of products (materials and services) and information, and the associated managerial and operational activities.
- It seeks to fulfil the goals of providing high customer value with an appropriate use of resources, and building competitive chain advantages.

Business economics and organizational theory

Early work on supply chain management identified logistics benefits of reduced lead times and costs through integrating the internal chain, and through make-or-buy decisions that determine which activities will be vertically integrated and which will be produced through transactions with other firms. The new institutional theory of transaction cost economics (Williamson, 1975, 1985) and agency theory (Eisenhardt, 1989b) provide the rationale for the make-or-buy decisions. These theories are concerned with the governance relationships of organizational co-operation, integrating views from business economics and organizational theory. In TCE the transactions between companies are the units of analysis. The three major characteristics of transactions are frequency of the transaction, uncertainty in the transaction, and asset specificity of the transaction. Agency theory is directed at the ubiquitous agency relationship, in which one party (the principal) delegates work to another (the agent), who performs that work. It focuses on risk assessment and the contractual arrangements between organizations, under conditions of bounded rationality and opportunism. A major point of attention is the trade-off between the cost of measuring behaviour and the cost of measuring outcome and transferring risk to the agent.

3. The research agenda

According to Lambert and Cooper (2000), business managers are increasingly aware of the emerging paradigm of inter-network competition. Executives are striving to interpret the company's chain and network structure. To assist them, there is a clear need for building theory and developing tools and methods for successful CNS practice. Below an overview is given of the relevant research questions, inspired by Lambert and Cooper:

- What are the operational definitions of the key business processes and what are the relationships among these processes? How do you obtain buy-in from the functional areas in order to implement a process approach within the firm? Beyond internal integration, how should inter-organisational change management be implemented?
- How should chains and networks be mapped? What processes should be used to map the best chain and network structure given the desired outputs?
- What are the methods that should be used to determine the value proposition at the consumer level? How should the various firms in chains and networks share the costs and the benefits?
- What metrics should be used to evaluate the performance of chains and networks and inter-enterprise relationships?
- What are the critical success factors and barriers in linking a firm to specific companies in chains and (industrial) networks?
- How should the firm decide which internal processes to link with these companies? What decision criteria determine whose internal business processes prevail across all or part of chains and networks?
- What determines the type and level of integration that should be applied to each process-link?
- What are the policy scenarios for a company concerning the diffusion and adoption of innovations?
- How does coalition formation take place in industrial networks?
- How can companies join forces in product and process development?

4. Research methods

The research presented in JCNS is conceptual or quantitative in nature. It includes descriptive research on chain and network structures and the determination of (institutional, technological etc.) performance factors, modelling with respect to chain and network behaviour, as well as testing the research outcomes on the basis of longitudinal data, including network information (e.g. of strategic alliances). Frequently used research methods include questionnaire surveys (using multivariate statistical methods), simulations

and case observations. Emphasis is put on the quantification of chain results and empirical testing of model outcomes. Although case studies are generally supposed to provide only limited general knowledge, if carefully designed (e.g. following Eisenhardt 1989a, and Yin 1994), they possess significant descriptive, explorative and even explanatory power. The articles of Lazzarini *et al.* and Lefebvre *et al.* in this Journal are fine examples of conceptual contributions, elucidated by a number of carefully chosen case studies. The study of Lindgreen shows the strength of the case study, being its high resolution. In his contribution, the six dimensions of relationship quality are analyzed in great detail. The contribution of Van Heck shows the advantages of the simulation technique, by comparing the effectiveness of competitive auction systems for E-business. The contribution of Cabral and Traill is a fine example of the explanatory power of a large-scale survey. The statistical power of their study is high, even small differences in the study population are traced.

5. Management implications

JCNS intends to be a virtual platform in which chain and network scientists meet with business managers to exchange the latest ideas and concepts. Therefore an overview of the managerial implications of the different contributions in the first issue is given below.

In the second article of this issue, *Integrating supply chain and network analyses: The study of netchains*, Lazzarini *et al.* try to conceptually integrate the formerly separate research areas of chain and network science. They stress that where the supply chain literature emphasizes the active role of management in inter-organisational collaboration to co-ordinate the flow of products, information and decisions in supply chains, the network analysis literature tends to portray inter-organisational collaboration as more autonomous and emergent. It advocates managers develop network ties between firms, and at the same time pursue enough flexibility to position their firms to benefit from new information and knowledge in the network. From the point of view of netchain analysis, both types of business policy recommendations are valid depending on the type of inter-organisational interdependence they are addressing. The authors posit that source of value and co-ordination mechanisms correspond to particular and distinct types of interdependencies: pooled, sequential, and reciprocal. The authors therefore argue that it is crucial that management should first carefully analyze the (types of) interdependencies for the formulation of an inter-organisational strategy.

In the third article of this issue, *An E-commerce transition model for supply chain management*, Lefebvre *et al.* provide a

powerful management tool for traditional “brick-and-mortar” companies to adapt their procurement, sales and chain management processes to the digital economy, in order to become “brick-and-click” companies. They present a conceptual framework of E-commerce that helps companies understand the requirements needed to move forward towards the seamless integration of intra- and inter-organisational processes using a five-wave transition model, which is illustrated through a technology function matrix identifying different functional processes and their evolution over the waves. This five-wave transitional model can accompany key decision-makers through progressive steps that correspond to different B-2-B E-commerce needs and specifications.

In the fourth article of this issue, *Determinants of a firm's likelihood to innovate and intensity of innovations in the Brazilian food industry*, Cabral and Traill show the vital importance of external alliances in innovation. Their findings confirm that the number of a firm's external alliances, along with its investment in external technology and R&D, and firm size are the significant variables in determining a firm's likelihood to innovate. Whereas external alliances, along with firm size and market orientation are related to the intensity of innovation. They conclude that firms might be more effective with a strategy that boosts linkages with other firms, universities and research agencies. Their results suggest that public policy should focus on the stimulation of development and diffusion of pervasive technologies, either directly, e.g. through the financing of research institutions, or indirectly, e.g. through the elimination of institutional barriers, such as the customs barriers to import technology.

In the fifth article of this issue, *In search of relationship quality, customer retention and shareholder value: Findings from an exploratory, qualitative multiple case study*, Lindgreen warns against the current over-emphasis on the importance of CRM (customer relationship management) in management literature. He argues that these computer-based systems can never replace real interest in customers. He concludes that companies should nourish the quality of the network of relationships with their own employees, their suppliers and customers. But he also warns against over-embeddedness of the network, when the relationships become so tight that it becomes difficult to distinguish between business relationships and friendships.

The last article of this issue, *Innovative Electronic Auctions in Supply and Demand Chains: Empirical Research in the Flower Industry*, is a fine example of the possibilities of experimental economic research. According to Van Heck, the Internet gradually evolved to a powerful and reliable infrastructure for E-business. Important savings are made as a result of reducing transaction costs, and improving the search-and-find capabilities for all parties concerned. At the moment

there are many web-based auctions, but the place to study efficient auction systems is not the World Wide Web, but rather the flower auctions in Holland. This is illustrated by presenting the results of a cross-case analysis of ICT initiatives in the Dutch flower auctions. It results in a useful guide to evaluate and explain the successes and failures of ICT-based auctions in new markets.

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Integrating supply chain and network analyses: The study of netchains

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Abstract

This paper introduces the concept of netchain analysis. A netchain is a set of networks comprised of horizontal ties between firms within a particular industry or group, which are sequentially arranged based on vertical ties between firms in different layers. Netchain analysis interprets supply chain and network perspectives on inter-organisational collaboration with particular emphasis on the value creating and coordination mechanism sources. We posit that sources of value and coordination mechanisms correspond to particular and distinct types of interdependencies: pooled, sequential, and reciprocal. It is further argued that the recognition and accounting of these simultaneous interdependencies is crucial for a more advanced understanding of complex inter-organisational relations. The paper concludes with an analysis of a set of netchain configuration examples, including buyer-supplier relationships, information technology induced inter-organization collaborations, and the introduction of the “macrohierarchy” organization structure.

Key words: network, supply chain, value chain, interdependence, cooperative strategy

1. Introduction

Supply chain and network analyses have been treated as two distinct strands in the literature on inter-organisational collaboration. Supply chains are defined as a set of sequential, vertically organized transactions representing successive stages of value creation. The literature on supply chain analysis (SCA) suggests vertical interdependencies require a systemic understanding of resource allocation and information flow between firms engaged in sequential stages of production (Christopher, 1998; Simchi-Levi *et al.*, 2000). Value chain analysis (Porter, 1985), an approach describing a set of sequential activities creating value within firms, has been more recently extended to activities between firms (Barney, 1997).

Network analysis (NA), in turn, provides numerous tools to map the structure of inter-organisational relationships or “ties” based on the recognition that network structure constrains and at the same time is shaped by firms’ actions (Granovetter, 1973; Burt, 1992; Nohria, 1992; Wasserman and Faust, 1994). Unlike SCA, NA is not particularly concerned with vertically organized ties, but rather with horizontal relationships between firms belonging to a particular industry or group (Powell, 1990).

Even though both SCA and NA stress the importance of interdependencies between multiple firms and how inter-organisational relationships can be a source of competitive advantage (Dyer and Singh, 1998), the integration of their core concepts and analytical tools is still to be done². Yet, it has been recognized that NA could benefit from a careful assessment of distinct types of ties (Nohria, 1992), whereas SCA could benefit from a network-based perspective of interfirm relations (Aitken, 1998; Stuart *et al.*, 1998).

This paper attempts to fill this void in the literature by introducing the concept of *netchain* - a set of networks comprised of horizontal ties between firms within a particular industry or group, such that these networks (or *layers*) are sequentially arranged based on the vertical ties between firms in different layers (Figure 1). Netchain analysis explicitly differentiates between horizontal (transactions in the same layer) and vertical ties (transactions between layers), mapping how agents in each layer are related to each other and to agents in other layers.

For example, it is becoming increasingly important to evaluate not only how suppliers transact with a given buyer, but also how they interact between themselves to promote knowledge exchange (Stuart *et al.*, 1998; Dyer and Nobeoka, 2000). SCA is not well equipped to discuss relations among

¹ We thank the helpful comments by two anonymous referees. All remaining errors and omissions are our own.

² Some authors apply NA in contexts involving supply chains (Uzzi, 1997; Burt, 1992; Dyer and Nobeoka, 2000; Swaminathan *et al.*, 2000), but the comparative and simultaneous assessment of vertical and horizontal relationships is not their main goal.

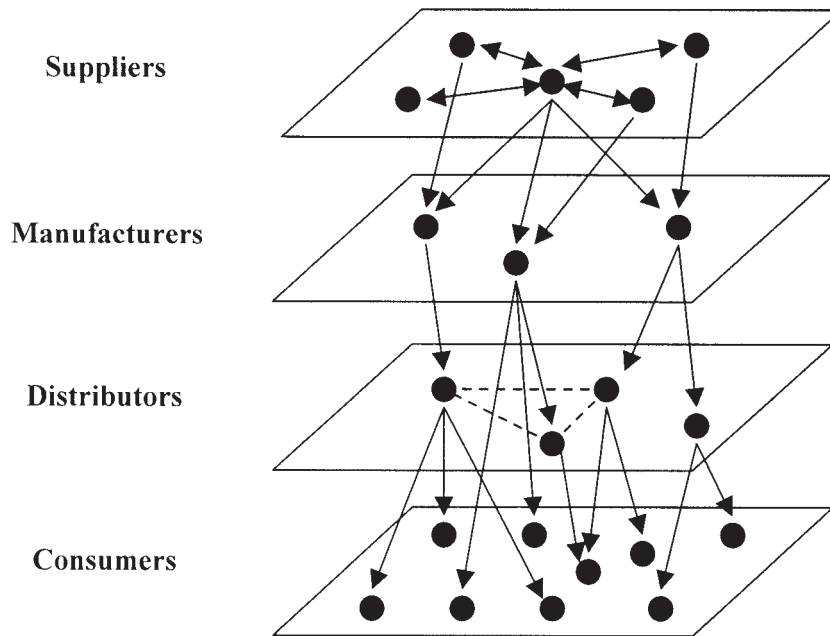


Figure 1. An example of a generic netchain.

suppliers because it focuses on elements related to vertical transactions, such as logistics management or the design of contractual arrangements between buyers and suppliers. On the other hand, even though NA provides elements to evaluate social attachments and knowledge transfer between firms, it is not particularly concerned with vertical ties. A combination of both perspectives may generate an enhanced general framework to assess inter-organisational collaboration.

More generally, we posit that such analytical integration is necessary because SCA and NA have focused on distinct types of *interdependencies* involved in inter-organisational collaboration. But if SCA and NA focus on particular types of interdependencies, what happens when *several* types of interdependence occur in a given inter-organisational setting? Stabell and Fjeldstad (1998) propose a framework considering organizational responses to distinct types of interdependence, but the authors treat chains and networks as *alternative* models. The same is true for Norman and Ramirez's (1993) distinction between value chain and value constellation, which resembles a network. The netchain approach, in contrast, is intended to *integrate* SCA and NA by recognizing that complex inter-organisational settings embody several types of interdependencies, which are associated with distinct *sources of value* - that is, strategic variables yielding economic rents - and *coordination mechanisms* involved in inter-organisational collaboration.

In order to discuss these issues in detail, the paper is organized as follows. In the next section, the main sources of value in inter-organisational relationships analysed by SCA and NA scholars are reviewed. In the third section, these sources of value are related to particular types of interdependencies and coordination mechanisms. The assessment of interdependencies is employed as an integrative element in netchain analysis because it avoids confining the study of inter-organisational collaboration to particular sources of value or coordination mechanisms. Subsequently, examples of netchain configurations are presented illustrating specific applications of netchain analysis. The netchain configurations section includes buyer-supplier relationships, inter-organisational collaboration supported by information technology, and macrohierarchies, which are defined as patterns of ownership between organizations arranged in layers. Concluding remarks and suggestions for future research follow.

2. Sources of value emanating from supply chain and network analyses

In this section we identify the main contributions of supply chain analysis (SCA) and network analysis (NA) as they suggest alternative *sources of value* in the study of inter-firm collaboration. Sources of value are strategic variables yielding economic rents. They can be either associated with cost reduction, rent creation, or rent capture. The identification

of these sources of value is crucial in assessing the contributions of SCA and NA and how both approaches can be integrated in a single analytical framework.

Sources of value in supply chain analysis (SCA)

SCA is a broadly defined field focusing on successive stages of value creation and capture in a vertically organized set of firms. Three core sources of value in SCA are identified: optimisation of production and operations, reduction of transaction costs, and appropriation of property rights.

Optimisation of production and operations

The concept of supply chain management has its roots in the 1960s concept of logistics management - a planning tool that seeks to develop a system-wide, integrated view of the firm. Subsequently, supply chain management extends the concept of logistics management to external integration of the firm. The supply chain is conceived as "a series of linked suppliers and customers" (Handfield and Nichols Jr., 1999, p. 2). It encompasses all activities associated with the flow and transportation of goods from the raw materials stage through the end user plus the concomitant information and financial flows. Supply chain management refers to the coordination and alignment of materials, financial, and information flows for all activities and processes involved in a supply chain (Simchi-Levi *et al.*, 2000). Assuming the supply chain is managed as a single entity, supply chain optimisation models specify how chain performance is maximized by the optimal choice of a set of several production-related explanatory variables, such as number of stages in the supply chain, inventory levels, product differentiation, among others. Therefore, supply chain management models focus on the optimisation of production and operations as a key source of value. Supply chain performance includes quantitative cost-based and technical efficiency measures and qualitative indicators of customer responsiveness and satisfaction (Beamon, 1998).

Reduction of transaction costs

In addition to production optimisation, several scholars stress the importance of considering the optimisation of transactions based on Coase's (1937) insight that there are positive costs of using the market system, which later became known as transaction costs. These costs include *ex ante* search costs, bargaining and contracting costs, plus monitoring and enforcement costs, which occur in a post-contractual stage. Three distinct approaches in the literature analyse economic organization in a situation of positive transaction costs: agency theory, transaction cost economics, and measurement. In the *agency* literature, transaction costs emerge due to divergent interests and informational

asymmetries between the parties to a contract (Jensen and Meckling, 1976). The design of incentive contracts can align the objectives of principals and agents and mitigate opportunistic behaviour, thereby increasing transactional efficiency (Sappington, 1991).

The second approach, *transaction cost economics* (TCE), is associated with Williamson's (1985) work. In contrast to agency theory, TCE emphasizes contract incompleteness, which hinders the possibility of crafting optimal incentive contracts. However, similar to agency theory, TCE considers the hazards of opportunistic behaviour, particularly when relationship-specific investments are involved (Klein *et al.*, 1978). The major proposition of TCE is the presence of specific investments shifts organization away from markets to "hybrids" or, in the limit, vertical integration to mitigate potential hold-up problems (Williamson, 1985). Therefore, supply chain organization is a source of value when transactions are governed by efficient structures, from markets to hierarchies, aligned with attributes of the transactions along the chain (Zylbersztajn, 1996).

The third approach, *measurement*, focuses on the difficulty of measuring performance or product attributes in a transaction as a major explanatory variable determining governance choice (Barzel, 1982). When the performance or attributes of goods being transacted are imperfectly measured, pay-for-performance or pay-for-quality is problematic (Holmstrom and Milgrom, 1994). As a result, agents need to craft appropriate governance mechanisms to monitor and enforce contractual arrangements. Efforts to promote "traceability" of food products in supply chains in order to signal and guarantee certain product attributes to consumers, such as safety and origin, is an example.

Value capture in weak appropriability regimes

According to Teece (1986), innovators are not always able to capture the rents from innovation. Competitors or agents located in downstream or upstream stages in the supply chain may benefit from innovation when *appropriability regimes* are weak or they possess *complementary assets*. Weak appropriability occurs when technology is either easy to imitate or patent systems are not strongly enforced. Complementary assets, in turn, occur when new technology adoption depends on assets owned by other firms. If competitive advantage is shaped by the firm's ability to capture value from its resources (Teece *et al.*, 1997; Teece, 1998), then the implications for supply chain management are evident: allocate investments through the chain in order to capture the gains from innovation, focusing on complementary assets. For example, biotechnology firms acquired complementary assets downstream in the agricultural chain (*i.e.*, seed companies) to capture the value generated by knowledge-based assets through genetically

modified seeds sold to farmers as those assets can be easily replicated by simply growing the seeds (Kalaitzandonakes and Bjornson, 1997).

Sources of value in network analysis (NA)

NA is a broad field commonly associated with sociology, but economists and strategy scholars have recently analysed network-based industries and have applied network concepts to explain economic organization and performance. Three core sources of value are emphasized in NA: social structure, learning, and network externalities.

Social structure

Social network approaches share a common emphasis on the role of social structure - *i.e.*, interpersonal relationships and individual positions occupied by agents in a network - influencing individual or collective behaviour and performance. Granovetter (1985) uses the term *embeddedness* to explain how social relations affect the economic behaviour of agents and the institutional arrangements supporting transactions. The literature on social capital focuses on the role of "resources accruing to an individual or group by virtue of their location in the network of their more or less durable social relations" (Adler and Kwon, 1999, p. 4).

Different strands in social NA have assumed, however, divergent perspectives regarding the *type* of social relationship (or tie) and social structure that is more conducive to cooperative behaviour and superior performance. Some authors argue that *dense networks* with agents extensively connected with each other (Coleman, 1990) and *strong ties* defined as repeated, affective, relational exchanges (Nelson, 1989; Krackhardt, 1992) facilitate the emergence of trust, create social norms, and promote cooperation as a consequence. Dense networks can also create conditions for the emergence of intra-industry coalitions of firms that negotiate better terms of trade with firms in other industries or reduce competition within their own industry (Pfeffer and Nowak, 1976; Galaskiewicz, 1985; Lane and Bachmann, 1996). Cartels, trade associations, and cooperatives are examples of this phenomenon.

Other authors emphasize that sparse networks with several *non-redundant* contacts connected by *structural holes*³ (Burt, 1992) and *weak ties* defined by occasional, market-like exchanges (Granovetter, 1973) generate new information and diversity crucial to trigger innovation and create opportunities for network participants. This is important

because strong ties and dense networks may induce "lock in" to idiosyncratic resources, which may be less valuable in the future due to technological or institutional ruptures (Grabher, 1993; Uzzi, 1997; Afuah, 2000). McEvily and Zaheer (1999) find a positive effect of structural holes on firm performance: firms that have non-redundant contacts outperform competing firms.

Learning

There are two fundamental types of learning processes with distinct consequences in terms of value creation. When autonomous agents or groups develop knowledge "locally" and specialize themselves in particular knowledge fields, learning tends to favour knowledge *diversity*. In this case, autonomous agents develop particular skills and "encapsulate" them in their interaction with other agents (Demsetz, 1988; Zenger and Poppo, 1999). Within a network perspective, knowledge diversity is beneficial because it generates positive externalities to multiple agents through knowledge spillovers, which enhance opportunities for innovation (Feldman and Audretsch, 1998; Kogut, 2000). Another type of learning involves systemic, joint efforts to create and refine a certain body of knowledge. This type of learning tends to induce knowledge *co-specialization*, *i.e.*, skills that are dedicated to the agents participating in a given exchange (Zenger and Poppo, 1999). Co-specialization enables value creation through the combination of individual capabilities and the development of specific routines (Nelson and Winter, 1982; Kogut and Zander, 1992). However, co-specialization entails costs since it tends to reduce the range of new, valuable opportunities that can be exploited by agents and also their capacity to interpret external knowledge (Leonard-Barton, 1995). Rowley *et al.* (2000) offer a connection between learning and social structure and suggest that knowledge diversity is best served by weak ties, which tend to be conduits of new information, whereas co-specialization is facilitated by the existence of strong ties, which promote cooperation.

Network externalities

This source of value is extensively discussed in the literature on *economic* networks. Network externalities occur if the benefits to adopt some type of technology or contract increase with the expected number of adopters, thus inducing increasing returns to adoption (Arthur, 1989). Katz and Shapiro (1985) distinguish between direct and indirect network externalities. The direct type occurs when,

³ For instance, if an agent A is connected to a network of agents N_A and B is connected to another network N_B in such a way that agents in N_A and N_B are not connected to each other, a tie between A and B would be non-redundant. This tie would span a structural hole between networks N_A and N_B . If, however, many agents in N_A and N_B have direct ties with each other, a tie between A and B would be redundant because they would be already connected with each other indirectly through their ties with agents in N_A and N_B .

for example, an agent adopting a trading technology, such as electronic commerce, increases the benefit for other agents to adopt that technology due to increased arbitrage opportunities or decreased trading costs (Domowitz, 1995; Economides, 1996). The indirect type occurs when there are complementarities among several technologies or exchange modes. Consider for example the benefits of purchasing a computer, which strongly depends on the supply of complementary products such as software shared by many users. In the presence of network externalities, there are benefits to promote interfirm coordination in order to capture the value generated as a result of network growth and avoid "lock in" to inferior technologies (Farrell and Saloner, 1985; Arthur, 1989) or contractual standards (Kahan and Klausner, 1997) that compete simultaneously over time.

3. Conceptualising netchains

In this section, it is argued that SCA and NA can be successfully integrated by identifying an underlying variable that explains why these approaches emphasize different facets of inter-organisational relationships. This variable is the nature of *interdependence* between two firms or agents, since transactions arranged as chains (emphasizing vertical ties) or networks (emphasizing horizontal ties) tend to differ with regard to the type of interdependence they generate (Stabell and Fjeldstad, 1998). Thompson's (1967) seminal categorization of organizational interdependencies is employed to contrast SCA and NA.⁴ The objective is not to refine Thompson's framework, but rather use it as a tool in analysing distinct types of inter-organisational interdependencies emanating from SCA and NA. Thompson (1967) identifies three types of interdependence: pooled, sequential, and reciprocal. *Pooled* interdependence,

the simplest type, occurs when each individual in a group makes a discrete, well-defined contribution to a given task. *Sequential* interdependence refers to serially structured tasks, when the activities of a firm or agent precede those of another. Finally, *reciprocal* interdependence - the most complex - involves simultaneous, ongoing relationships between parties in which each agent's input is dependent on the others' output and *vice-versa* (Figure 2).⁵

We posit that SCA has focused on sequential interdependencies, whereas NA has primarily dealt with either pooled or reciprocal interdependencies. In this section, this claim is supported in two ways. First, it is shown that the sources of value emphasized by SCA and NA correspond to distinct types of interdependencies. In addition, we discuss the coordination mechanisms commonly proposed by SCA and NA, which are associated with distinct interdependencies. This section concludes showing how netchain analysis can successfully integrate SCA and NA with a simultaneous assessment of all types of interdependencies.

How distinct sources of value correspond to particular types of interdependence

In the following discussion, the types of interdependence proposed by Thompson (1967) are outlined and related to the main sources of value emphasized by SCA and NA scholars.

Pooled interdependence

In this case, interdependence involves discrete or autonomous contributions by loosely coupled agents (Astley and Zajac, 1991). Pooled interdependence is more akin to *independence* because the relationship between agents is sparse and indirect (Van de Ven *et al.*, 1976). Involving more or less anonymous agents, pooled interdependence

⁴ Even though Thompson focuses on interdependencies within firms, other authors apply his framework in the context of inter-organisational collaboration (Borys and Jemison, 1989; Gulati and Singh, 1998).

⁵ Van de Ven *et al.* (1976) propose a fourth type of interdependence: team work. The nature of interdependence is similar to the reciprocal case, but the authors characterize team interdependence as involving simultaneous actions. Reciprocal interdependence may involve a temporal lapse in the feedback process. But since we are not particularly concerned with temporal issues, teamwork is considered as a special case of reciprocal interdependence.

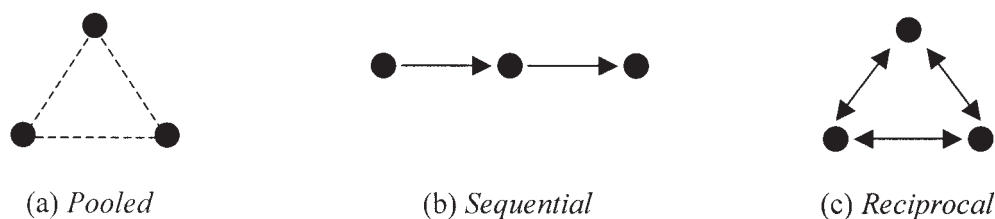


Figure 2. Representation of types of interdependence.

has clearly a flavour of weak social ties and structural holes as “arbitrage” opportunities - *e.g.*, job opportunities in a large network - are magnified. Additionally, due to its emphasis on autonomous and loosely coupled agents, pooled interdependence supports a situation of knowledge diversity, where specialized agents exchange knowledge directly or indirectly through products or services that embody such knowledge (Weick, 1976). Finally, since the connection between agents is sparse, it tends to be mediated by some underlying technology or organizational mode possibly with increasing returns to adoption. Thus, pooled interdependencies are likely to be associated with network externalities: the value of the network increases with its expected size (Stabell and Fjeldstad, 1998).

As discussed in the following section, Internet-based procurement mechanisms known as business-to-business (B2B) exchanges enable the connection between autonomous agents, thus creating pooled interdependencies between them. Some organizations - such as the chemical company Buckman and the World Bank - are stimulating knowledge sharing between their “internal specialists” located in different countries to solve practical problems. The underlying interdependence is pooled because those specialists interact infrequently and contribute with knowledge resulting from local, specialized experiences.

Sequential interdependence

This kind of interdependence involves direct relationships between agents ordered in a serial fashion: one agent’s input is another agent’s output. It is straightforward to note that this describes precisely a supply chain. The sources of value associated with buyer-supplier relationships usually stem from managing sequential interdependencies (Borys and Jemison, 1989). Inventory management, logistics, and the like attempt to optimise sequential production processes and operations, while efficient governance mechanisms attempt to reduce transaction costs and appropriate property rights in downstream or upstream stages in the chain, *i.e.*, optimise sequential transactions.

The organization of transportation services is an evident example of sequential interdependence. Consider the international flow of cargo, correspondence and packages with sequential transactions from the origin to the destination, involving domestic trucking, domestic freight forwarding, international air transport, foreign freight forwarding, and forward trucking (Wada and Nickerson, 1998). The output of one stage (*e.g.*, a parcel coming from another country through air transport) is clearly the input of another stage (*e.g.*, freight forwarding). The value created from managing these transactions originates not only from logistics optimisation, but also from reductions in transaction costs, which are critical in the presence of local

(*e.g.*, an unusual destiny) and temporal specificities (*e.g.*, customer requirement for fast delivery). In addition, the common practice of tracking parcels and cargo to inform clients about the exact position of those units in their route at a given moment attempts to solve measurement problems making use of information technology.

Reciprocal interdependence

Reciprocity in this kind of interdependence means that one agent’s input is another agent’s output *and vice-versa*. Consequently, agents are mutually dependent on the choices and actions made by each other. In this context, one should expect recurring, deep, intertwined relationships between agents, which suggests a situation of strong social ties and dense networks. Agents in this case are likely to be tightly coupled: the knowledge of one agent strongly depends on the knowledge of another, *i.e.*, there is knowledge co-specialization.

A strategic alliance in which parties seek “to broaden or deepen their skills or to develop new skills jointly” is an example of inter-organisational collaboration involving reciprocal interdependence (Gulati and Singh, 1998, p. 797). In addition, groups characterized by shared culture, identity, and norms, such as regional clusters of small firms and close-knit groups, create reciprocal interdependencies through the development of dense networks. Japanese supplier networks, which are discussed in the next section, are also an example of inter-organisational relations showing reciprocal interdependencies.

Pooled and reciprocal interdependencies involve sources of value that are commonly dealt with in NA. And since serially ordered ties describe a chain organization, it is not surprising that SCA focuses on sources of value associated with sequential interdependencies. It is important to notice that the sources of value that are related to each type of interdependence are *main* sources of value. It is possible that, for example, strong social ties and dense networks facilitate cooperation and decrease transaction costs as a result (Ouchi, 1980). But transaction cost minimization is not the *unique* reason for those relationships since they can involve value creation - for example, joint knowledge development - and other outcomes that transcend the simple desire to reduce transaction costs (Zajac and Olsen, 1993; Dyer, 1997).

How interdependencies correspond to distinct coordination mechanisms

Another way to demonstrate that NA and SCA focus on distinct types of interdependencies is to review the main *coordination* mechanisms proposed or implied by each approach. Thompson (1967) suggests that each type of

interdependence should be handled with particular coordination modes. These coordination modes include standardization, plan, and mutual adjustment.

Standardization

According to Thompson (1967), pooled interdependencies are well managed by standardized rules and shared mechanisms to orchestrate transactions. The economic approach to networks argues that compatibility between products and components, usually achieved through a standardized technological platform, is a key element to capture network externalities. Thus, firms may coordinate product design to generate increasing returns to adoption (Farrell and Saloner, 1985; Katz and Shapiro, 1985). Another example of coordination through standardization is a financial exchange, where contracts and negotiation rules are standardized in such a way to allow trade at low cost and therefore attract many anonymous agents (Telser and Higginbotham, 1977; Domowitz, 1995; Economides, 1996). In section 4, it is shown how the Internet enables the emergence of standardized codes that support information transfer between firms and pooled interdependencies. Also, firms encouraging knowledge sharing between internal specialists depend on standardized mechanisms through the Internet to form discussion groups and retrieve information from sparsely connected individuals.

Plan

Sequential interdependencies require coordination by a plan, involving "the establishment of schedules for the interdependent units by which their actions may then be governed" (Thompson, 1967, p. 56). This type of coordination denotes discretionary actions by a coordinating agent, who plans the flow of products and information, and promotes adaptation to changing internal or external conditions.⁶ Indeed, the literature on supply chain *management* has called for managerial discretion in order to optimise production processes and operations (Beamon, 1998), or align efficient governance mechanisms to sequential transactions (Zylbersztajn and Farina, 1999). For instance, the management of courier services requires a central planner, such as Federal Express and DHL, who not only defines schedules, routes and transport modes, but also contractual arrangements to coordinate sequential transportation stages from the sender to the recipient (Wada and Nickerson, 1998).

Mutual adjustment

Thompson (1967) claims that reciprocal interdependencies require the transmission of new information through mutual feedback processes, which he calls "mutual adjustment." Instead of a central planner, mutual adjustment implies joint problem solving and decision making. As a result, personal or group-based coordination mechanisms become necessary (Van de Ven *et al.*, 1976). Perhaps not surprisingly, social network scholars commonly discuss this type of coordination. As Powell (1990, p. 303) remarks, "in network modes of resource allocation, transactions occur neither through discrete exchanges nor by administrative fiat, but through networks of individuals engaged in reciprocal, preferential, mutually supportive actions." According to social network scholars, the formation of inter-organisational relations tends to be *emergent* rather than premeditated, where feedback from past transactions in the network is a crucial element. Past transactions are likely to reveal information about performance and partners' conduct (Gulati and Gargiulo, 1999), foster learning (Powell *et al.*, 1996), and reinforce social norms and informal sanctioning mechanisms (Granovetter, 1985).

In sum, SCA focuses on coordination mechanisms involving some sort of plan or discretionary managerial action, which according to Thompson (1967) corresponds to sequential interdependence. NA, in turn, emphasizes either standardization or mutual adjustments, which are appropriate coordination mechanisms to deal with pooled and reciprocal interdependencies respectively.

Netchain analysis: Assessing all types of interdependencies

Figure 3 summarizes the preceding discussion and presents the sources of value and coordination mechanisms corresponding to each type of interdependence, showing that NA focuses on pooled and reciprocal interdependencies, whereas SCA emphasizes sequential interdependencies. We propose that one way to integrate SCA and NA is to consider *simultaneously* all types of interdependencies that occur in a given inter-organisational setting.

This simultaneous assessment is the core of netchain analysis. Instead of focusing on certain sources of value and/or coordination mechanisms *given* a certain type of interdependence, the netchain approach begins by recognizing the relevant interdependencies involved in inter-organisational collaboration. The concept of netchain

⁶ Victor and Blackburn (1987) refine Thompson's model by considering conflicts of interest created by interdependencies. When these conflicts are high, they argue a "chain of command" will emerge. Note, however, that these conflicts tend to be critical in the case of sequential interdependencies because one party's input is an output of the other: conflicts over prices, for example, tend to be acute. Thus, the prediction is the same: coordination by plan (command) will emerge in the case of sequential interdependencies.

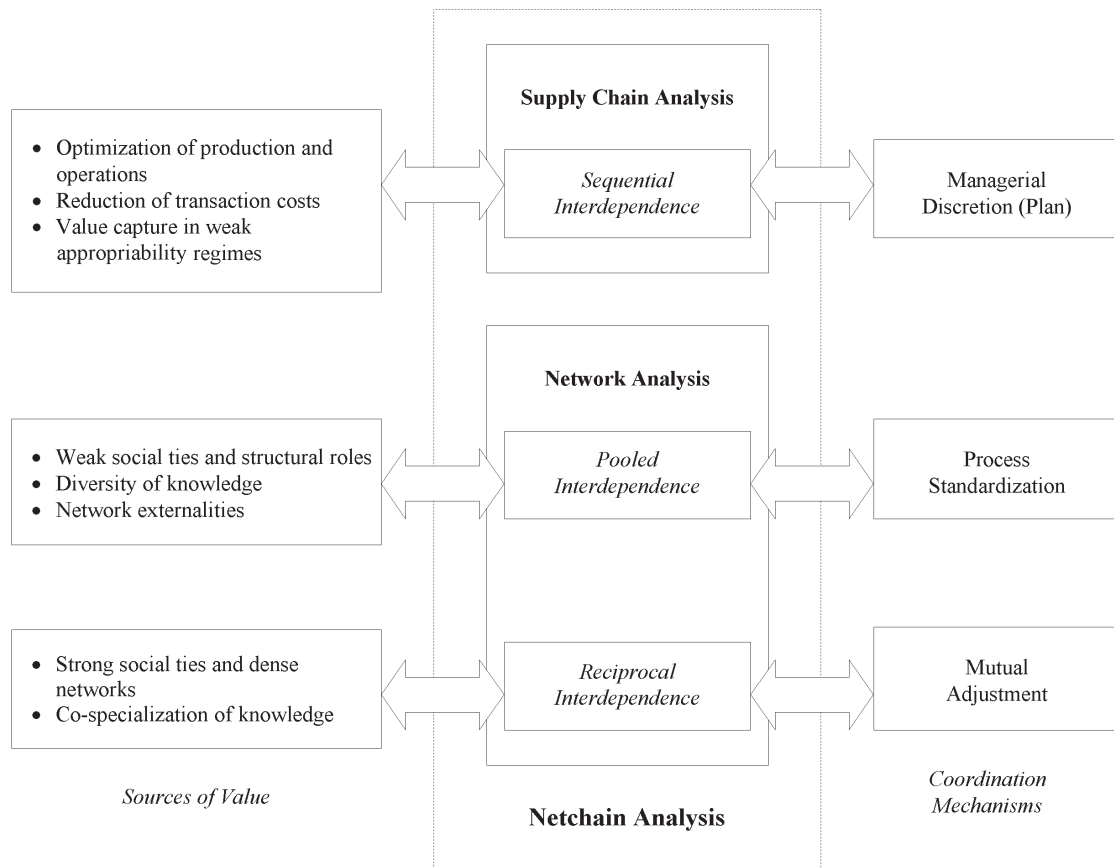


Figure 3. An overview of netchain analysis.

integrates SCA and NA precisely because it allows for a simultaneous account of all types of interdependencies, in addition to the sources of value and coordination mechanisms associated with them. If, for example, we confine ourselves to the analysis of sequential (vertical) transactions, several sources of value and coordination mechanisms associated with pooled or reciprocal interdependencies are likely to be neglected. In other words, netchain analysis does not take interfirm interdependence as given, but rather includes it as a key variable in the model. In the next section, netchain analysis is applied to specific empirical cases. Before proceeding, two important remarks are in order. First, it was previously mentioned that SCA and NA focus on vertical and horizontal transactions respectively. Even though the graphical representation of a netchain proposes a combined assessment of horizontal and vertical ties, the crucial aspect to qualify a given tie in a netchain is the nature of interdependence between agents. For example, vertical transactions typically exhibit sequential interdependencies (Pennings, 1981), but they can also

embody reciprocal elements such as strong social attachments and knowledge co-specialization. At first glance, this may appear to be inconsistent with the fact that vertical ties exhibit sequential interdependence. Yet Thompson (1967, p.55) proposes a hierarchical relationship between interdependencies by arguing, "all organizations have pooled interdependencies; more complicated organizations have sequential as well as pooled; and the most complex have reciprocal, sequential, and pooled."

Second, netchain analysis abstracts from issues regarding firm boundaries. Gulati and Singh (1998) offer a theory to explain the choice between equity and non-equity strategic alliances based on Thompson's notion of interdependence. We believe, however, that interdependencies do not fully determine firm boundaries. For example, reciprocal interdependencies can be carried out internally by the firm or externally through alliances or social mechanisms. Paraphrasing Jensen and Meckling's (1976) conceptualisation of the firm as a nexus of contracts,⁷ which avoids the analytical demarcation of firm boundaries, a

⁷ Zylbersztajn and Farina (1999) use the same term to characterize chain organization.

netchain is conceptualised as a *nexus of interdependencies*. In other words, the netchain approach analyses the nature of interdependencies involved in a given setting, taking firm boundaries as exogenous. The study of endogenous firm boundaries within a netchain would be an important extension of this work.

4. Some netchain configurations

In this section, the concepts developed in the previous section are applied to the analysis of particular cases involving distinct netchain configurations. These cases serve to demonstrate the applicability of the concept, not to support specific theoretical claims, and indicate necessary steps toward the future use and refinement of netchain analysis.

Buyer-supplier relationships

Traditional approaches to the management of buyer-supplier relationships have focused on the design and maintenance of vertical, serially ordered relations between a buyer and its suppliers individually. The analysis of “tiered” supplier structures is an example, where attention is paid to the choice of certain top-tier suppliers who supply critical resources to the buyer and are responsible for product and service flow from lower-tier suppliers (Asanuma, 1989). This view, however, focuses solely on sequential interdependencies between buyers and suppliers. Some authors challenge this view and suggest network-based interactions between suppliers are equally important (Stuart *et al.*, 1998).

Japanese manufacturing is a classic example of horizontal relations, where suppliers are organized through associations (*kyoryokukai*) aimed at promoting knowledge exchange and socialization (Nishiguchi, 1994; Dyer and Nobeoka, 2000). Contrary to common sense, Japanese supplier associations emerged due to a governmental initiative to promote cooperation, even though in some cases - such as in Toyota's association - they were reinforced by private initiatives (Nishiguchi, 1994). Supplier associations have also been replicated in other countries, such as in Toyota's plants in the U.S. (Holmstrom and Roberts, 1998; Dyer and Nobeoka, 2000) and Australia (Langfield-Smith and Greenwood, 1998).

However, network-based relations between suppliers are not only restricted to supplier associations. Dyer and Nobeoka's (2000) empirical analysis of Toyota's supplier networks in both Japan and the U.S. show that practices other than associations are used to foster exchange of knowledge and socialization between suppliers. Consulting and problem-solving teams are organized by Toyota in order

to pursue quality- and productivity-enhancing solutions to several production problems. A key element is the existence of voluntary learning teams (*jishuken*), involving groups of suppliers exchanging knowledge between them in a more practical manner. These teams are heavily valued by suppliers as a way to promote improvements in production processes, cut costs, or create new solutions based on sharing individual experiences.

As a common attribute of Toyota's supplier networks, Dyer and Nobeoka (2000, p. 350) remark that they are “highly interconnected, strong-ties network [with] multiple pathways among members effectively eliminating most structural holes.” Thus, one crucial source of value in this model refers to dense relationships with strong ties. Additionally, the authors point out suppliers in these networks “have developed reciprocal obligations for sharing knowledge with other members in the network” (p. 363), thus suggesting knowledge co-specialization. One natural question in this context is how to avoid the shortcomings of dense networks, strong ties and knowledge co-specialization, such as a lower potential to innovate and interpret external knowledge. Dyer and Nobeoka (2000, p. 365) note that in this model “there is the risk that the diversity of knowledge that resides in the network will diminish over time.” Toyota has responded to this risk by employing several tactics such as changing the composition of learning groups from time to time and searching for “best practices” in other contexts through committees organized by supplier associations.

Thus, supply chains with supplier networks involve typically two types of interdependencies: one sequential, between assemblers and their suppliers, associated with vertical ties; and another reciprocal, among suppliers, associated with horizontal ties. This basic netchain configuration is depicted in Figure 4: single arrows represent sequential interdependencies, while double arrows represent reciprocal interdependencies. Sequential interdependencies are managed by discretionary, planned actions by a central firm, such as Toyota. Reciprocal interdependencies, in turn, are coordinated through mutual adjustments - in Toyota's case, through feedback from each other's experience in the

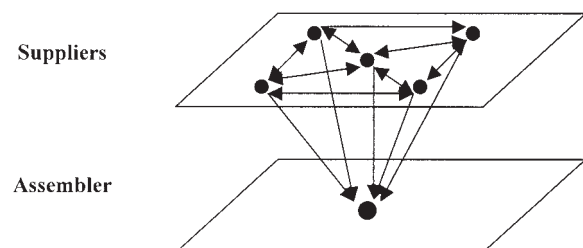


Figure 4. Buyer-supplier relationships.

supplier network. Even though Toyota coordinates to some degree the formation and maintenance of these supplier practices, voluntary learning teams are considered to be more effective in knowledge sharing. Instead of relying on knowledge imposed by a given buyer, this new model of buyer-supplier relationships emphasizes systemic learning and collective decisions within supplier networks (Stuart *et al.*, 1998).

Notice that traditional SCA, focusing on vertical ties embodying sequential interdependencies, is unable to assess the sources of value that emanate from reciprocal interdependencies between suppliers, such as strong social ties and knowledge co-specialization. On the other hand, NA tends to neglect the importance and distinctive nature of vertical ties given the sequential interdependencies they generate. The netchain approach allows for a more complete picture of this inter-organisational setting, considering simultaneously the existence of sequential and reciprocal interdependencies, which are associated with distinct sources of value and coordination mechanisms.

IT-enabled inter-organisational collaboration

To understand how information technology (IT) supports inter-organisational collaboration in the context of a netchain, two IT innovations that induced distinct types of interdependence are contrasted in this section: closed electronic data interchange (EDI) systems, and Internet-based procurement.

EDI involves computer-to-computer exchange of information between buyers and suppliers (Holland *et al.*, 1992; Marcussen, 1996). *Early* (or *closed*) EDI systems, which gained momentum especially in the 1990s, are associated with specifically negotiated codes and a proprietary, or closed, electronic architecture to transfer information. According to Holland *et al.* (1992, p. 544), early EDI systems are "used to encourage close trading relationships with a smaller number of suppliers." Within this perspective, early EDI systems involve investments by both parties in private computer connections and training, implying a closed architecture of connection and agreements specifying information transfer codes (Brousseau, 1994; Dearing, 1995). Many authors document two main advantages of early EDI systems: a potential reduction of transaction costs, including procurement and monitoring expenses (Brousseau, 1994; Dearing, 1995) and the optimisation of production through

information sharing (Holland *et al.*, 1992), shortened lead times (Dearing, 1995; Niederman, 1998), inventory reduction and increased product quality (Kekre and Mukhopadhyay, 1992). These sources of value are strongly associated with sequential interdependencies. Additionally, private communication systems are commonly implemented by a *systems initiator* (*e.g.*, a buyer), "who deploys a proprietary [system] to expand the scope of hierarchical control" to a particular firm (*e.g.*, a supplier), "which exercises the choice between accepting or rejecting" the new system (Zaheer and Venkatraman, 1994, p. 551). This has clearly a flavour of plan-based coordination.⁸

In contrast, the Internet allows for standardized transacting procedures shared by many agents and an open architecture of connection, the World Wide Web (Kambil *et al.*, 1999; Croom, 2000). Internet procurement has emerged with the help of "orchestrated" markets called business-to-business (B2B) exchanges. B2B exchanges create an electronic marketplace with low-cost entry and standardized transactional procedures - *e.g.*, the display of buyer's specifications, bidding procedures, market clearing, safeguarding, and so on. Interdependencies are pooled because the bidding process is impersonal and carried out by autonomous suppliers. As such, network externalities constitute the main source of value associated with Internet-based procurement. Namely, the benefits of this governance mechanism increase with the number of suppliers adhering to the same standard because an alternative supplier that can closely match buyer's specifications will likely participate in the bidding process (Lazzarini and Nickerson, 2000). This is the case in B2B exchanges involving price negotiation instead of "catalogs" with posted prices, since in the first case Internet procurement reduces transaction costs and increases competition in the procurement process (Kaplan and Sawhney, 2000).

A remarkable example of a B2B exchange is FreeMarkets Online, which has generated approximate savings of 15 percent in the procurement costs of its clients mainly due to lower acquisition prices (Rangan, 1998). Glen Meakem, one of the firm's co-founders, points out that his company "introduces buyers to aggressive, world-class suppliers that they may not have known about before" (Rangan, 1998, p. 10). As another example, the British retailer Safeway reduced the cost of connecting its web of suppliers through the Internet to "only a few thousand dollars against several million for EDI. [Thus,] the supermarket can easily increase

⁸ It is also possible that the strong attachment between firms brought by early EDI systems also induced reciprocal interdependencies in the long run. As Zaheer and Venkatraman (1994, p. 554) hypothesize, "trust is enhanced through greater use of communication between [the parties] under conditions of dedicated electronic interfacing." Also, the presence of trust increases the willingness of the parties to invest in expensive, non-redeployable electronic connections. For simplicity, the focus is placed on the sequential nature of interdependencies emphasized by early EDI systems.

the number of its suppliers, giving it more choice and better prices" (The Economist, 1999, p. 17). This suggests that the advent of Internet-based procurement is creating pooled interdependencies between a large number of loosely coupled agents, where standardization of connection and transacting procedures is the key coordination mechanism enabling low cost supplier participation.

Netchain configurations representing these contrasting IT-enabled inter-organisational structures are presented in figure 5. The structure of early EDI-based procurement is presented in figure 5a, depicting idiosyncratic, sequential transactions between a buyer and a supplier. The structure of Internet-based procurement is depicted in figure 5b, with two basic differences from the former case. First, there is a new layer occupied by an "infomediary," such as a B2B exchange, which aggregates many buyers and many suppliers with an open architecture of connection and standardized transacting procedures (Hagel III and Singer, 1999). Second, this infomediary induces horizontal, pooled interdependencies among buyers and among suppliers - depicted in figure 5b as dashed lines - using standardization as a coordination mechanism.⁹ The netchain approach provides a more complete framework to contrast these two

IT-based models because it recognizes the distinct types of interdependencies involved in each case, which lead to distinct sources of value and coordination mechanisms.

Macrohierarchies

Macrohierarchies are hierarchies involving organizations - instead of agents within organizations - that jointly coordinate some of their activities through multiple layers of ownership. One particular example of macrohierarchy is discussed: farmer cooperatives organized in a multi-layered fashion, which is known as the *federated* structure.

In a federated agricultural cooperative, patrons are members of a local cooperative, which in turn is a member of a regional cooperative.¹⁰ Regional cooperatives themselves may also decide to form an inter-regional cooperative.¹¹ As a result, a federated cooperative is structured by means of sequential layers of ownership (Figure 6). In addition, cooperatives are characterized by restricted residual claims, *i.e.*, they are owned and controlled by patrons (Fama and Jensen, 1983). Consequently, the vertical ties between subsequent layers of a federated cooperative structure entail both a transaction and an ownership relationship.

⁹The single arrows denoting sequential interdependencies in Figure 5b refer to the flow of orders, not necessarily the physical flow of products. Indeed, many B2B exchanges do not get involved in storage or physical handling of products; they go directly from a particular supplier to a particular buyer.

¹⁰A patron is defined as any person who transact with a firm. For example, a farmer in an agricultural cooperative, a depositor in a savings and loan mutual association, a borrower in a credit cooperative, or a buyer in a consumer cooperative.

¹¹ Contrasting to this federated or multi-layered structure, patrons are direct members of a regional cooperative in a centralized structure.

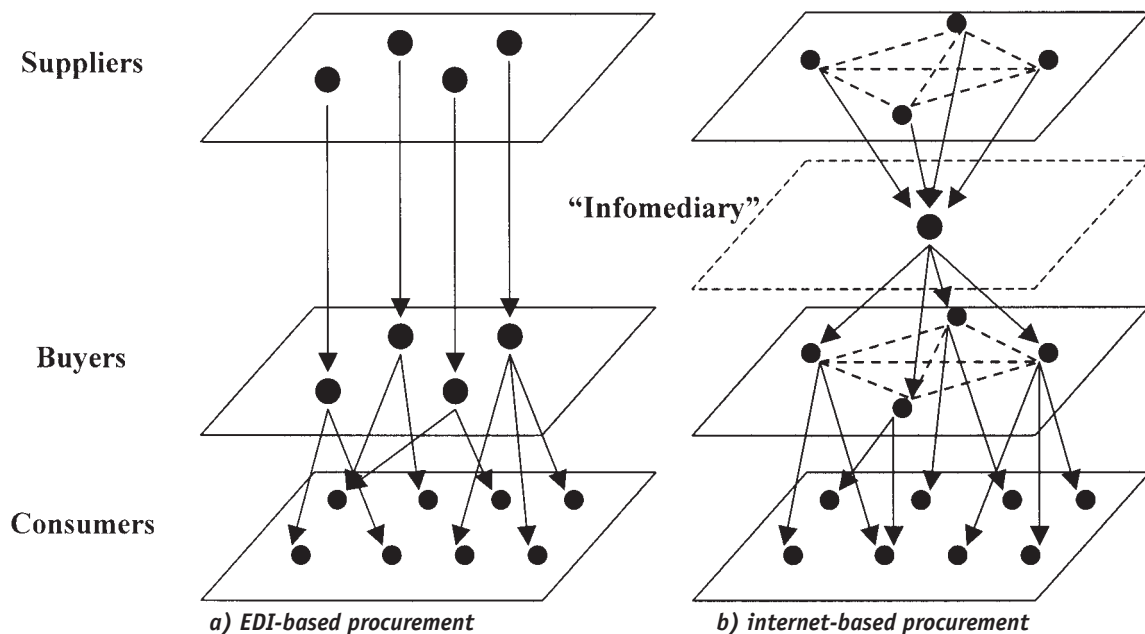


Figure 5. inter-organisational collaboration induced by information technology.

The assignment of ownership in a cooperative to its patrons is often explained as a transaction cost minimization strategy, which is a source of value associated with sequential interdependencies. When farmers own - and, therefore, control - an agricultural cooperative they avoid potential hold-up situations arising from location and temporal asset specificity. For example, by forming a cooperative, dairy farmers can invest in equipment for storage and processing, thereby avoiding downstream pressures to reduce prices given the perishable nature of their product. Additionally, market contracting is costly when the firm has better information than its patrons (or vice-versa). In case a firm knows more about the quality of the product it sells, it has an incentive to deliver a lower-quality product than originally promised. In this case, customer ownership reduces the firm's incentive to exploit its information advantage. Hansmann (1996) explains the formation of consumer and agricultural supply cooperatives on the basis of measurement problems of this sort.

Notice that there are multiple sequential interdependencies in many farmer cooperatives, since in one occasion farmers sell their output to the cooperative (e.g., milk), while in other occasions they acquire production inputs from the cooperative (e.g., seeds and fertilizers). These interdependencies are not properly classified as reciprocal because these transactions are not necessarily carried out together, except in some cases where the cooperative "bundles" services (e.g., product acquisition and technical support) and products (e.g., farm inputs). As discussed previously, the contractual hazards created by these sequential transactions determine ownership by farmers, which then acquire rights to control (or "plan") the allocation of resources through successive stages of the supply chain.

In addition to these sequential interdependencies, federated cooperative structures are also characterized by pooled and/or reciprocal interdependencies among members (or cooperatives) within the same horizontal layer. For example, individual members within the same layer keep their decision-making autonomy, but pool their financial and productive resources to create a higher-level structure to develop related businesses, therefore characterizing a pooled interdependence. This higher-level structure defines common, standardized rules to commercialise products, purchase inputs, transfer information, and divide the residual claims among members.

Additionally, Bonus (1986) refers to the local cooperative as a "social group" with an "esprit de corps." The formation of reciprocal interdependencies among farmers in local cooperatives is explained as a consequence of intimate personal knowledge and strong social ties, a distinguishing characteristic of rural communities. In those circumstances, members are likely to employ joint decision making and problem solving to coordinate their activities - i.e., mutual adjustments. As a result, the transactional and ownership components of the vertical ties are embedded in a network of personal relationships among members. These social attachments may foster the emergence of trust, which tends to neutralize potential internal conflicts and opportunistic behaviour. In other words, reciprocal interdependencies may positively affect vertical transactions between layers. According to Staatz (1987), some cooperatives have an identifiable base of member-patrons who are more inclined to reveal strategic, proprietary information to their cooperative (and vice-versa). Farmers can also be members of more than one local cooperative - such as in the case of farmer *F* in figure 6 - which tends to facilitate the joint

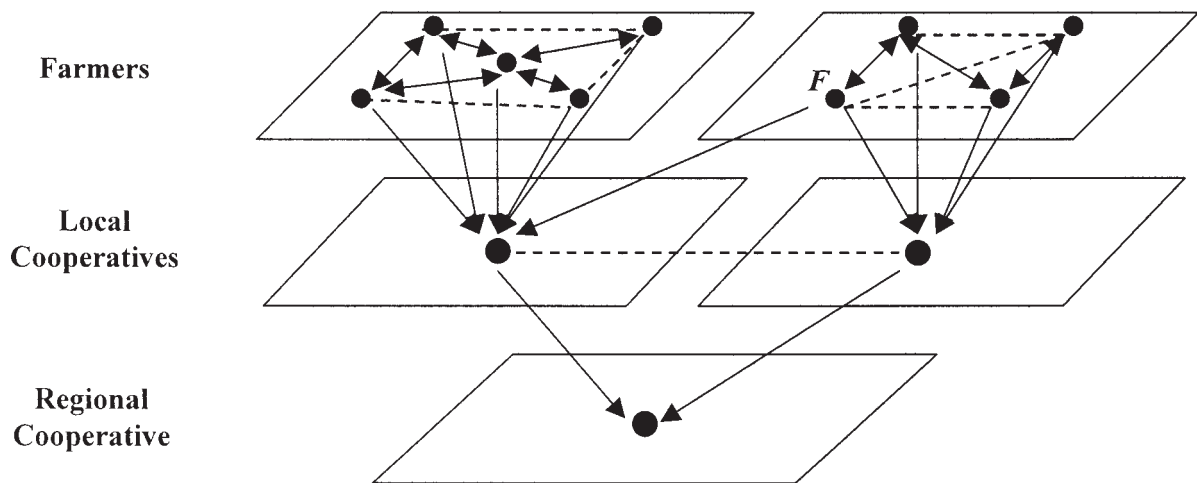


Figure 6. An example of macrohierarchy – The federated cooperative structure.

coordination of local cooperatives belonging to a higher-level (regional) cooperative.

Therefore, the analysis of vertical patterns of ownership between organizations should also consider the nature of the interdependencies involving firms within the same layer, which tend to be either pooled or reciprocal. Layers that are more in the base of the hierarchical structure are more likely to present a higher proportion of reciprocal interdependencies due to social interactions among individual members. Nevertheless, the concept of macrohierarchy based on the netchain framework helps to accomplish the simultaneous assessment of these interdependencies and how they influence the nature of ownership ties.

5. Conclusions

SCA and NA are important, yet analytically disconnected approaches to study inter-organisational collaboration because they focus on different types of interdependencies. Netchain analysis attempts to integrate SCA and NA by considering simultaneously all types of inter-organisational interdependencies, which correspond to distinct sources of value and coordination mechanisms. This is important for both positive and normative reasons.

In a positive sense, the simultaneous account of distinct interdependencies is crucial to the analysis of complex inter-organisational relations, instead of assuming that the world is arranged either vertically or horizontally. If only one particular type of interdependence is focused, crucial elements involving other types of interdependence are likely to be missed, which may be responsible for a substantial part of the rent creation in the system. *Therefore, the netchain perspective posits that the assessment of interdependencies in a given inter-organisational setting is the first analytical step.*

In a normative sense, the netchain approach can reconcile the somewhat diverging ways of how SCA and NA inform business policy. The literature on supply chain management emphasizes the role of managerial discretion to coordinate the flow of products, information and decisions in supply chains. Thus, according to SCA, managers are well advised to actively coordinate the chain within which their firms are located to minimize transaction costs, optimise production flows, or capture value along the chain. inter-

organisational collaboration in the NA literature, however, tends to be portrayed as more autonomous and emergent. Following this perspective, managers should develop social ties where activities are mutually adjusted instead of planned and at the same time pursue flexibility to position their firms in valuable networks to benefit from new information and knowledge diversity.

From the point of view of netchain analysis, all business policy recommendations are valid depending on the type of inter-organisational interdependence they are addressing. Therefore, it is clear that normative decisions should first involve considerations about interdependencies. As Levinthal and Warglien (1999, p. 343) put it, the performance of complex systems should be enhanced through "a shift from designing on the basis of a given set of interdependencies to designing by manipulating the set of interdependencies." For instance, the first crucial decision faced by an entrepreneur who wants to invest in a distribution system is not contract negotiation, logistics design and other coordinating activities. The entrepreneur must first define the type of interdependence that the distribution system will embody: he or she can either connect several suppliers and customers through a B2B exchange or manage the flow of specialty products from a restricted set of suppliers to a restricted set of buyers. For this reason, *the netchain perspective also insists that the design of interdependencies is the first step in the formulation of inter-organisational strategies.*

Several lines of future research can expand and improve the framework proposed herein. It would be useful to develop quantitative measures for the assessment of a firm's position in a netchain and distinguish between the different types of interdependencies involved in the system. The vast literature on social NA can contribute to the development of those measures¹². Another possible line of research could involve an endogenous demarcation of firm boundaries in a netchain. In other words, in how many layers should a firm be present (the vertical scope of the firm), and what should be the extent of its participation in each layer (the horizontal scope)? A dynamic analysis of the evolution of netchains, in particular with regard to possible changes in the interdependencies between agents when they transact over time, is also needed. In addition, it is important to include the role of "chain service providers," such as financial

¹² Blockmodeling is a tool in social NA that allows for the aggregation of agents into sectors; the network of sectors is analyzed instead of the network of agents. Some authors have used this technique to model vertical relationships (Madhavan et al., 1998). However, much intra- and inter-layer information is not captured by this analysis. As Wasserman and Faust (1994) remark, a blockmodel is "a model, or a hypothesis about a multi-relational network. It presents general features of the network, such as the ties between positions, rather than information about individual actors" (p. 395, emphasis in the original). In contrast, the netchain approach attempts to model specifically how each agent in a layer is related to agents in other layers.

organizations and logistics firms, which are not *direct* participants in a netchain but contribute in the process of value creation by interacting with several layers.¹³

Finally, netchain analysis could simultaneously assess more than one netchain at a time in order to evaluate competition between alternative netchains. In many industries, firms are developing competing networks (Gomes-Casseres, 1994) that are actually *competing netchains*. For instance, several airlines are forming alliances to expand bookings on international markets, share computer reservation systems, explore marketing practices such as frequent flyer programs, and in some cases develop joint procurement operations. It is clear these alliances should not only be defined in terms of the (horizontal) ties between airlines, but also in terms of their ties with agents on upstream (aerospace manufacturers, input suppliers) and downstream layers (travel agencies, web sites and customers). The relative performance of competing netchains depends crucially on how their underlying interdependencies deliver superior sources of value, and how firms employ appropriate coordination mechanism to cope with those interdependencies.

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E-Commerce Transition Model for Supply Chain Management

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Abstract

The creation of Internet-based companies is changing the way business is being carried out and increasing the pressure on traditional firms, which now need to adapt to the new challenges brought about by the so-called digital economy. Successful electronic commerce activities depend on the partners involved in the product or service being delivered. Firms able to communicate with their partners electronically for procurement, sales, or supply chain management have become what many call clicks-and-mortar companies.

An empirically based technological model that helps organizations understand the requirements of moving towards the seamless integration of intra- and inter- organizational processes is proposed. This five-wave transitional model accompanies key decision-makers through progressive steps that correspond to different business-to-business e-commerce needs and specifications. As organizations move along these technological waves, we can witness the gradual opening-up of new opportunities for carrying out business. This paper presents the model, its requirements and its technological and organizational underpinnings. The model is illustrated with examples from organizations in a major industrial sector.

Key word: electronic commerce, supply chain, technological requirements

1. Introduction

At the dawn of this new millennium, we are finally starting to witness the exponential growth of electronic commerce (e-commerce) that most specialists have been forecasting for the last few years. It is clear that the diffusion of electronic commerce will persist, and indeed accelerate, in the years to come. Five of the largest North American research firms have provided forecasts of the projected growth of Business-to-Business e-commerce (see appendix 1). As for the definition of "electronic commerce", there are several and they differ considerably. The OECD tackled the issue in its e-commerce work program initiative (OECD 1999) and came up with the following: *"Electronic commerce refers generally to commercial transactions, involving both organizations and individuals, that are based upon the processing and transmission of digitised data, including text, sound and visual images and that are carried out over open networks or closed networks that have a gateway onto an open network"* (OECD 1997).

Elsewhere, the Japanese Ministry of International Trade and Industry (MITI), which has been a strong promoter of supply chain integration, defines electronic commerce as *"the conducting of commercial transactions (the exchange of merchandise, services, information, and/or money between suppliers and receivers for the commercial transfer of goods between economic actors) through electronic mediation using Internet technology"* (MITI and Electronics Policy Division 1999).

Clearly, electronic commerce facilitates the exchange of information by developing stronger buyer-supplier relationships. Suppliers are no longer seen as potential competitors but as partners (PricewaterhouseCoopers 1999). Bakos and Brynjolfsson (1993) discuss the value-adding partnerships that have emerged with the new information technologies. These collaborations favour outsourcing to a smaller number of faithful suppliers. Indeed, Collins and Bechler conclude in their study that the outsourcing of manufacturing has become a competitive imperative and is now a strategic choice for most organizations (Collins and Bechler 2000). Furthermore, despite the increasing need for an integrated and flexible supply chain where the focus has shifted from push (forecast-driven) management to pull (demand-driven) management, long-term partnerships between manufacturers and suppliers have been more beneficial than arm's-length relationships in terms of quality, time to market, and product development (Collins and Bechler 2000; Groves and Valsamakis 1998; Handfield et al. 1999; Heikkilä and Vollmann 1999; HIDC 1998). The label Supply Chain Management (SCM) is currently being used to designate these activities: *"It integrates planning and balances supply and demand across the entire supply chain — it ties suppliers and customers together in one concurrent business process that focuses on the ultimate customer"* (Schorr 1998).

Cox et al. (2000) have analysed different types of buyer-supplier relationships and are convinced that a buyer with a dominant position can and should exploit its situation to benefit the overall relationship (i.e. improve quality and

reduce costs). These relationships are being promoted through the creation of major electronic platforms (or marketplaces) where large organizations are joining forces to increase their buying power. Four of the world's biggest defence and aerospace firms (Boeing, Raytheon, Lockheed Martin and BAE Systems) have pooled their resources and merged with Commerce One to form a Web-based marketplace for aerospace parts and services. The platform brings together 37,000 suppliers and a significant number of airlines in order to process \$71 billion in annual procurement expenditures. The automobile industry has been moving in a similar direction, with the likes of Ford, General Motors and DaimlerChrysler creating, in May 2000, a marketplace known as Covisint, along with new members Renault, Nissan and Toyota. This platform is expected to handle more than \$750 billion in transactions annually. This paper will look at some of the new business-to-business electronic commerce functionalities (transaction processes) that seem to be emerging between manufacturers and suppliers, with a special focus on the technologies required to support these e-commerce applications.

2. Electronic commerce transaction processes

Most of the business-to-business electronic commerce platforms that have emerged in the last year, or even months, in various industrial sectors have focused on catalogues,

auctions and bidding systems. Most of these marketplaces plan on developing sophisticated technical and graphical exchange tools but very few have been able to market them effectively yet. The automobile and aeronautic platforms, along with more company-specific platforms such as GE's TPN system, are still dealing with basic transactional services. Others such as E-vis have developed collaborative design and engineering platforms that meet the needs of innovative firms in a niche market. These more advanced platforms will evolve in the years to come such that SMEs, which often have an important role in designing a product (up to 70% of a car or a plane), will have to learn to use these technologies and, most importantly, deal with them securely in order to transfer confidential and often very strategic information.

A comparative study conducted by the MITI in Japan and Andersen Consulting in the U.S. has identified the major B-to-B electronic commerce transaction processes carried out by organizations engaged in electronic commerce (MITI and Electronics Policy Division 1999). These e-commerce functionalities, shown in figure 1, will intensify in the years to come. Most of the electronic commerce functionalities singled out by the MITI study are procurement-oriented. Other reports and papers in procurement and electronic commerce identify similar activities (Industry Directions 2000; Smeltzer and Siferd 1998). This obviously raises some very fundamental questions with respect to e-commerce functionalities and their supporting technologies.

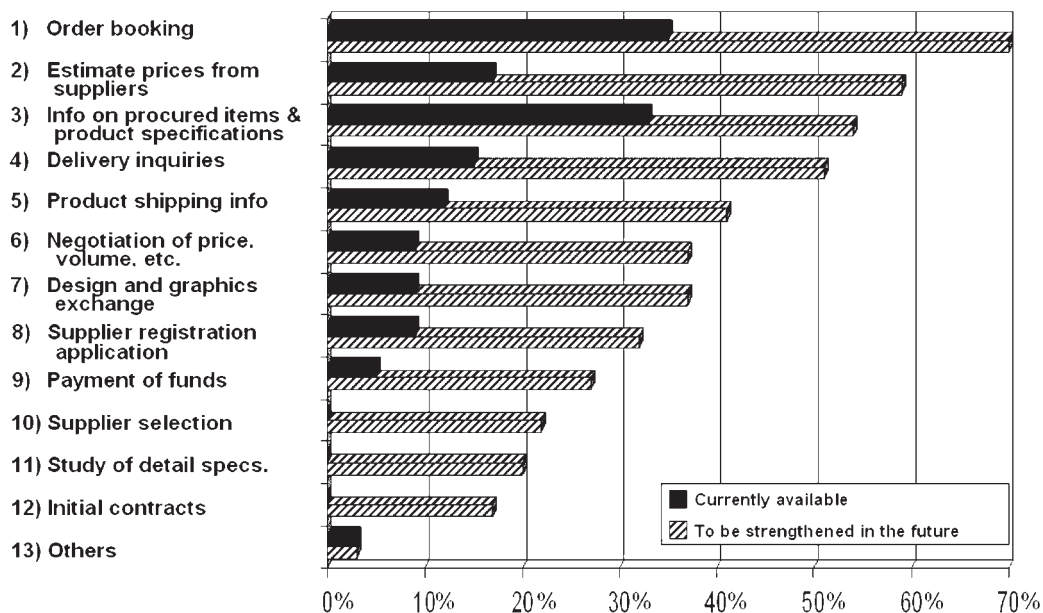


Figure 1. E-commerce functionalities.

Source: MITI and Andersen Consulting, *Size of Market Study for Electronic Commerce*, March 1999.

3. Research questions and methodology

The organizations that will benefit from these initiatives are those that understand the needs and requirements of carrying out electronic commerce activities and how this will ultimately change the way business is conducted. In this paper, we will try to answer the following questions:

1. Are electronic commerce transaction processes cross-functional within the organization? If so, which functions of a company (sales, marketing, manufacturing, design, etc.) are the most affected by organizational and technological changes?
2. What technologies are required to optimise the flow and management of information that supports e-commerce functionalities within and between organizations?

Research design

In order to answer these questions, we have combined three different methodological strategies that are briefly outlined below.

Case studies

First we have chosen a specific research design called "multiple-case embedded design" (Yin 1999). Several case studies seem highly preferable to one case study; based on the wide variety of SMEs, it appears highly improbable that SMEs may be subsumed under one unique revelatory case. Embedded case studies by definition involve more than one unit of analysis: different units of analysis appear more appropriate to thoroughly analyse the complex transition. Four widely differing SMEs were retained. The only common characteristic pertains to the fact that they are all from the electric/electronic industry and act as subcontractors for the same major client, a large public utility company.

The first SME operates in a traditional sector and specializes in high quality steel forgings. In-house melting, forging, heat-treating, machining, testing and inspection facilities provide the flexibility to produce a highly diversified range of forged products. It has over 50 years of forging experience and an excellent reputation, amongst the leaders in the open die forging industry.

The second SME is an affiliate of a large group of transformer companies. It provides transformers to all national and international standards and its product range includes liquid filled transformers for distribution, generator step-up, medium and large power substation, autotransformers, furnace, grounding, shunt and series reactors, and phase angle regulation.

The third SME is a high-tech company and a leading developer and manufacturer of precision monitoring and control devices for the electricity industry. It offers three types of products:

condition-monitoring apparatus with expert system software for predictive maintenance of circuit breakers, point-on-wave command synchronizer for the activation of a circuit breaker at the optimum moment of the voltage cycle, and a portable automated system that eliminates the difficulty and tedium from capacitor-bank testing.

The fourth SME acts as a rather small job shop with 40 employees. Its main activities are precision machining, metal roll manufacturing and welded component manufacturing. It relies on strong engineering and manufacturing competencies to offer customized services to clients in different industries.

A rigorous protocol is essential for multiple-case design; in particular, field procedures, interview guides and specifications for the case study report were carefully established. Several different sources of evidence were used: written internal reports, data obtained from articles, and additional information gained from focused interviews with key managerial personnel within each firm. The in-depth interviews in particular proved to be very a rich and valuable source of data. The analysis of data across multiple sites includes within-case and cross-case analysis, with the former being a prerequisite for the latter. In this section, we will present only the results of our cross-case analysis, which was performed using Glaser and Strauss's constant comparative method: this is particularly effective at discovering emerging patterns across cases (Miles and Huberman 1994). Frequent visits to these companies enabled us to identify the individuals (operators, technicians, buyers, etc.) who were most able to address very specific questions and to validate the answered questionnaires and the information collected during interviews. All of this was conducted over a three-year period, which allowed us to witness the gradual change, from the creation of web sites, to the implementation of ERPs (Enterprise Resource Planning), to the creation of electronic marketplaces. These in-depth case studies were determinant in understanding the evolving nature of technological requirements associated with the changing functionalities and applications of e-commerce.

Simulations

Second, simulations were conducted at ePoly in the Virtual Enterprise Laboratory of ePoly, which specializes in the development and simulation of advanced e-commerce applications. Its sophisticated technological infrastructure can integrate large software applications such as ERPs (SAP R/3) to VPDMs (Nexprise) and other e-commerce and software tools (Entrust Technologies, Profitkey RRM, Impress OIS, etc.). Deeper insights were therefore gained when simulating supply chain environments and product life cycle analysis platforms.

Technological scanning

Third, constant monitoring activities were performed. Tracking of international norms and standards, along with the identification and analysis of e-commerce best practices were key activities in this process. A thorough literature review as well as constant interactions with our technology and research partners proved to be very useful inputs for this study (Lefebvre et al., 2001).

These three different methodological strategies led us to formulate a wave model, which is illustrated in figure 5.

Validation of the transaction model

The model was first developed to describe the evolution in technologies that would enable an organization to formulate an e-commerce business plan. In order to validate our work, we then presented the model to different organizations in various industries (including the SMEs that participated in the case studies). In most cases, the natural reaction of management teams was to position their company along the waves while trying to benchmark themselves, taking into account the current state of advancement of their respective technologies within their industries. One important aspect for management to capture was the variation in technological advancement for the different organizational functions of their company. A large manufacturing company is a good example of this: the technology exploited for design purposes is state-of-the-art and easily configurable to communicate with suppliers. Yet the manufacturing system is ancient and difficult to manage in a supply chain environment. This has incited us to focus our efforts on the most e-commerce-influenced functions of an organization, which are identified in section 4. To fully grasp the implications of technologies in these functions, we then illustrated a technological wave/function matrix with the most current e-commerce transaction processes identified by the MITI/Andersen Consulting study (see section 2). Displayed in section 6, the matrix presents electronic transaction processes related to different organizational functions and technological waves, which can provide management with a tool to reflect on their e-commerce-related activities.

4. Value chain activities

Background

In the 1990s, with the advent of technologies such as ERPs, a great deal of activity was concentrated on cross-functional applications within an organization. But ERP vendors like

SAP and Oracle are now focusing on inter-organisational activities such as supply chain management or advanced planning and optimisation. Business-to-business e-commerce will allow organizations to gradually share information with their suppliers and their customers. The question then becomes, where should companies start and how should they organize themselves?

The literature describing the key functions of an organization that does business electronically is scarce. A Japanese Investigating Committee Report produced by the MITI and the Japan Electronic Commerce/CALS Organization (JECALS) has classified business segments into three categories of activities (MITI CALS 1999). According to the study, the vast majority of e-commerce business operations fall under marketing and sales, design and manufacturing, or procurement. Our research has led us to believe that e-commerce transaction processes will be mostly product-oriented. A great deal of the efforts now being conducted by major electronic suppliers like Dell or automobile manufacturers like Volvo, BMW and DaimlerChrysler are aimed at supporting integrated product life cycles from design right up to recycling. This requires the gathering of a lot of information on all parts and components of a product throughout its useful life. The information gathering is made possible by the use of product life cycle databases, which support the electronic collaboration between product integrators, suppliers and customers. Birou et al. (1998) singled out three functional areas to demonstrate cross-functional integration using the product life cycle approach, namely logistics, operations and purchasing.

The integration of suppliers requires major changes to product development processes that may force several key functions within an organization to adjust their processes. Handfield et al. (1999) suggest that, although the design and engineering phases account for a minor fraction of total product costs, it is in those phases that 80% of the total cost of the product is determined. It is also important to mention that purchased materials often account for over 50% of the cost of goods sold, reaching as high as 80% in some industries (Anderson and Katz 1998; Handfield et al. 1999). Consequently, procurement plays a crucial role in product and process development, which includes identifying the right technologies and suppliers, and also leveraging opportunities by taking the leadership of cross-functional teams (McGinnis and Mele Vallopra 1999). For example, global strategic suppliers for the Boeing 777 project¹ were integrated in the design process from the beginning, which resulted in the rapid development of the aircraft (Anderson and Katz 1998).

¹ The Boeing 777 was entirely designed electronically, linking a supplier base located in Europe, North America, Australia and Asia.

Procurement has evolved from a reactionary and operational function to a more strategic and proactive one. It has been prompted by cross-functional objectives and highly collaborative environments (Segev *et al.*, 2000). Efficient, secure and quick transactional exchanges, along with new planning and forecasting tools and methodologies, have allowed a shift from current tasks to more strategic and value-added activities (Cassivi *et al.* 2000). As shown in figure 2, procurement activities and competencies, which are now mostly related to transactional buying, will gradually shift to sourcing strategy and analysis, supplier development and new product and process development (Laseter 1998), all of which are much more strategic in nature and which hold important potential benefits for organizations.

Empirical evidence

According to our analysis, electronic commerce will mainly transform the engineering and design, sales and distribution, and procurement functions. The sales and procurement transaction processes are closely linked while distribution,²

which has been identified by specialists as the most important outsourced activity, will require a large amount of information exchange (figure 3). The implementation of design and engineering transaction processes will lead to the second boom in e-commerce.

In the automobile industry, the initial focus will be on procurement and then supply chain planning; it will finally move towards collaborative design and shorter market time cycles (Cooke 2000). Electronic commerce will eventually modify manufacturing functionalities. At present, a majority of shop floors are not computerized. Companies are not ready to share manufacturing data and only the critical information required by procurement is processed electronically. Developments in modular production should greatly enhance the transition to electronic commerce (Van Hoeck and Weken 1998).

5. Assessment of e-commerce technologies

Background

The concepts of electronic commerce and supply chain management are increasingly appealing to most organizations. Reductions in inventory, product development time, time to market, procurement workforce, and the like, have encouraged large companies to adopt advanced technologies in order to achieve the potential savings. Some complex e-commerce transaction processes require the combination of several technologies that must evolve progressively in an integrated environment. Our case studies in the electric/electronic industry led us to develop a technological model that helps large and small companies. The five-wave model accompanies an organization through the different phases of technological integration required to support increasingly complex e-commerce applications. The GartnerGroup (2000) has drawn up a list of technology enablers for supply chain management (Table 1). It sorted

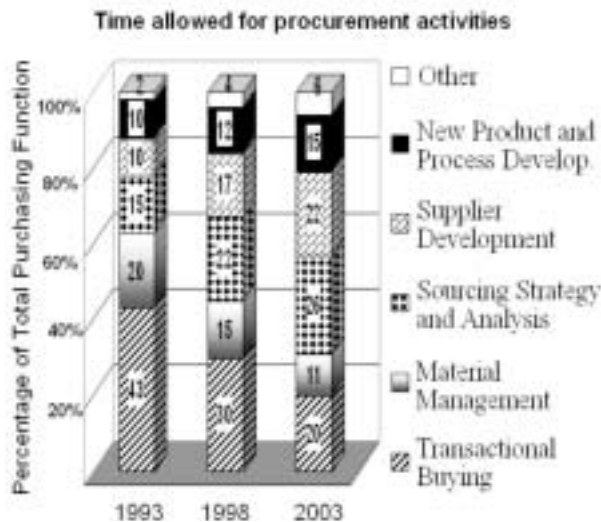


Figure 2. Evolution of procurement.
Source: Adapted from Laseter, T.M., *Balanced Sourcing*, 1998.

² This definition of distribution includes external transportation activities.



Figure3. The key functions of the value chain presently affected by e-commerce.

Table 1. Technology enablers.

Concept	Issues	Technology enablers
Intra-enterprise	Enterprise functions require information beyond transaction-oriented data.	ERP, data collection tools, data warehouses, data mining and service control point groupware.
Inter-enterprise	Suppliers' and customers' needs to be successful.	Extranets, schedule sharing, customer and supplier self-service applications.
Extended enterprise	Trading partners' abilities and capabilities.	Supply chain monitoring system, CPFR, EDI, POS data, extranets, opportunity management systems.

Source: GartnerGroup, 1999.

these technologies into three distinct classes: Intra-, Inter- and Extended Enterprise. Langenwalter (2000) has also classified supply chain relationships into five stages that show the probable evolution of supply chain integration in relation to its potential effectiveness (Figure 4). Even though technology is not the focus, the development of a supply chain is well presented. At the highest level of effectiveness, a fully integrated supply chain involving technology sharing generates flexible, seamless processes.

5.2 Empirical evidence

The proposed five-wave transition model (Figure 5) goes beyond classifying supply chain management or electronic

commerce concepts, like the two previous examples. It identifies different business-to-business e-commerce needs and specifications and assists firms in detecting their technological and organizational requirements. The highest wave is one where the organization focuses on products, is at ease with international norms and standards, and feels secure dealing electronically with suppliers and clients. We will describe each wave, illustrating some of the related technological and organizational issues.

The **first wave** consists of the integration of the different internal systems within the organization with various electronic communication tools (Internet, EDI, VPN, etc.). The systems concerned usually relate to simple administrative functions such as invoicing but may also correspond to more complex information exchanges as is the case with production planning activities. These systems support the connection of commercial transactions (sales, procurement, etc.) through simple electronic links. There are numerous examples of activities realized in this first wave. They range from the use of the Internet to regularly inform suppliers or clients of the most recent production plans generated by an MRP system to bidding on a request for quote (RFQ) received electronically through private or public bidding platforms (e.g. www.tpn.com).

The adoption of computerized management systems to coordinate activities within an organization characterizes the **second wave**. Two technological scenarios are usually favoured by organizations:

- 1) Integration of independent management systems to form a "best-of-breed" solution.
- 2) Total or partial adoption of various modules of an ERP tool that can be complemented with specialized applications.

As examples of the second wave, we can mention the adoption of ERP systems in order to manage internal activities right up to the integration of an advanced planning system (APS) into an MRP system to optimise production planning.

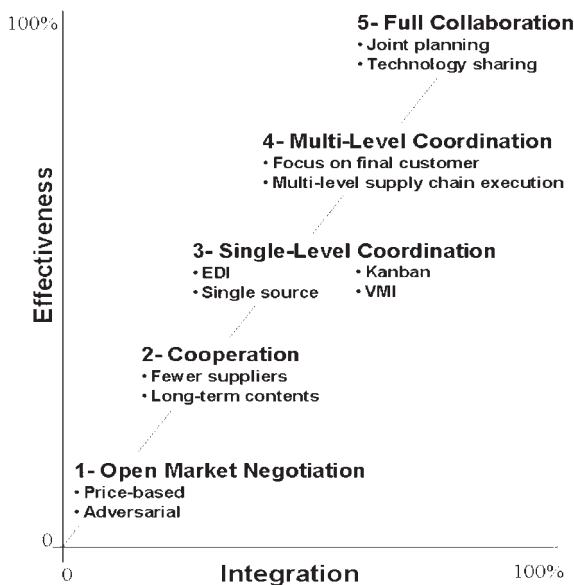


Figure 4. Supply chain relationships.

Source: Langenwalter, G., *Enterprise Resources Planning and Beyond*, 2000.

The **third wave** focuses on automating the capture of information generated during operations (production, warehousing, distribution) and integrating it into the company's management system (ERP, for example). In this operations-oriented stage, a manufacturing company may integrate its shop floor activities (CNC machines, etc.) with its ERP using a manufacturing execution system (MES). The term collaboration has been widely used in e-commerce and supply chain descriptions. It forms the focal point of the **fourth wave**, which we refer to as Product/Service Value Chain Integration. It centres on the collaboration between various organizations from the same sector to develop products and services through processes or supply chain activities in a virtual mode. At this stage, the customer is also integrated into the value chain, thus facilitating product or service customisation. Examples range from a consortium of organizations using CPFR (collaborative planning, forecasting and replenishment) technology to monitor their supply chain activities to the simultaneous and collaborative design of a virtual prototype (product and manufacturing processes) by a prime contractor and a few strategic suppliers. The **fifth wave** emphasizes the product life cycle support strategy based on the integration of multi-sector B-to-B

platforms. As mentioned previously, it embodies the notion of a virtual enterprise where access to a larger number of subcontractors is facilitated by communication technologies based on specific protocols (e.g. XML, STEP) and where supplier certification (e.g. ISO 14040) becomes a barrier to entry for the supply base. The product life cycle optimisation wave allows a temporary, ad hoc consortium of independent enterprises to pool their respective competencies in order to create a product or support a product line. Very few fifth-wave projects have yet been undertaken; one example is the development of a system that optimises the environmental impact during the design, manufacturing, utilization and recycling phases of a product. This is now being simulated in firms such as BMW.

One important aspect of the model is the possibility to evolve through the waves. The decision for an organization to move on to another wave is often triggered by events, which we will refer to as transitional milestones. Proactive and innovative firms will have a strategic plan with clear transitional milestones to guide them through the process. But most of the time, organizations are confronted by unexpected or undesired milestones that force them to adopt

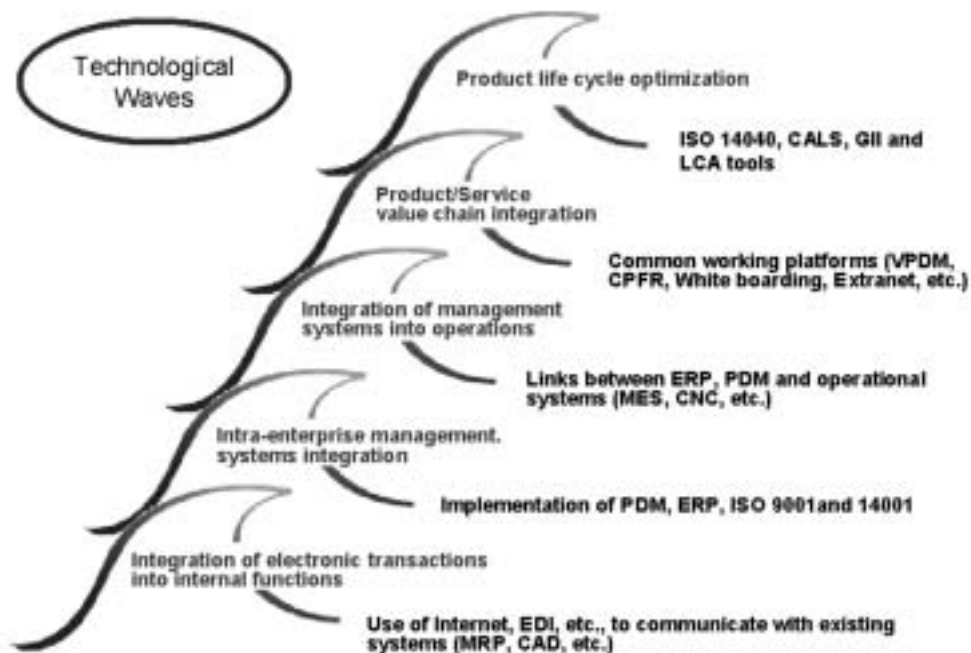


Figure 5. The technological wave transition model.

- | | | |
|----------------------------------|--|---|
| CAD: Computer-Aided Design | CALS: Continuous Acquisition and Lifecycle Support | CNC: Computerized Numerical Control |
| EDI: Electronic Data Interchange | ERP: Enterprise Resource Planning | GII: Global Information Infrastructure |
| LCA: Life Cycle Assessment | MES: Manufacturing Execution System | MRP: Material Resource Planning |
| PDM: Product Data Manager | VPDM: Virtual Product Development Manager | CPFR: Collaborative Planning, Forecasting and Replenishment |

Table 2. Possible transitional milestones from the 1st to the 2nd wave.

Type	Transitional milestone
Market	Emerging opportunities in e-commerce such as new products or services
Organizational	Mergers or acquisitions of 2nd- wave organizations
Political-economic	Multi-country or international financial reporting
Sectorial	Sectorial or industry pressures
Technological	Evolution of web-based ERP functionalities

new technologies very rapidly, without having time to prepare adequately. We have identified five types of transitional milestones (market, organizational, political-economic, sectorial and technological) that can influence the technological plan of an organization. Examples of transitional milestones that have prompted some organizations to jump from the first wave (simple electronic communications) to the second (ERP) are shown in table 2.

6. The transaction processes

The wave model implicitly assumes that technologies will affect certain organizational functions and activities. Bridging these two dimensions forms a conceptual framework in which electronic commerce strategies can be developed. Evidently, these strategies are often revealed through

transaction processes, which are crucial to the flow of information within and between organizations.

To illustrate this context, we aligned the five technological waves horizontally and the selected functions vertically in the matrix shown in figure 6. In order to demonstrate the value of the matrix, we integrated the e-commerce transaction processes identified in the MITI study described in section 2. Three of the twelve transaction processes were selected to demonstrate the model. These three processes are very different and yet complementary with respect to the organizational function concerned and the technology required.

The following illustrates how each transaction stands in the matrix and shows its potential evolution as we move through the different waves.

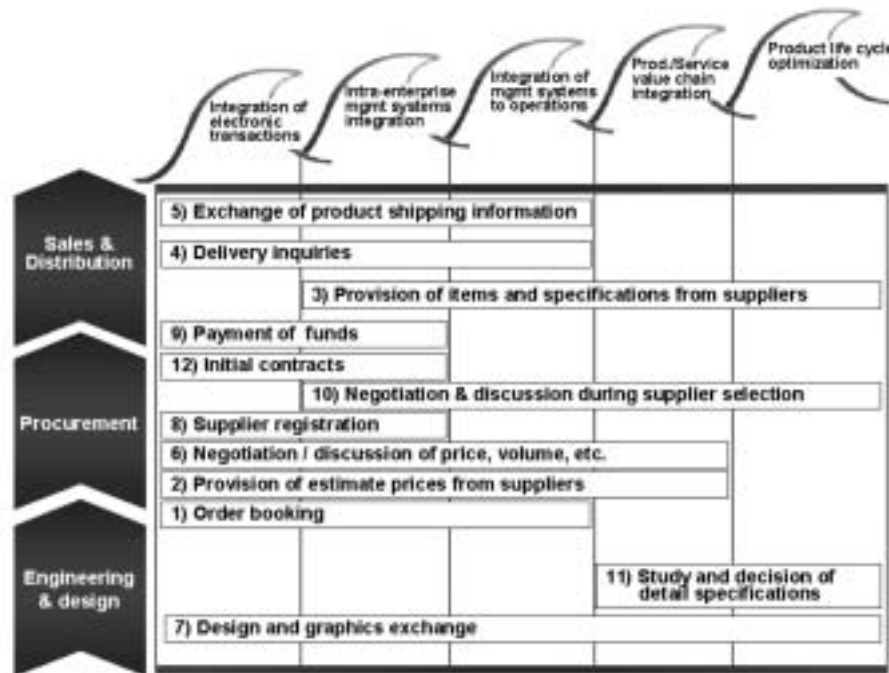


Figure 6. Technology / function matrix.

Provision of estimate prices from suppliers

This transaction involves purchasers. It occurs very frequently in supply chains and covers four technological waves since the methods used by the procurement department to purchase a product/service differ in complexity. A brief description of this transaction across different technological scenarios follows:

- 1st wave: Obtaining a price (and CAD file) through the Internet.
- 2nd wave: Being able to easily obtain information on a product or service (bid history, last price paid, etc.) and to compare it those of competitors.
- 3rd wave: "Make or buy" decisions requiring faster feedback from the shop floor and/or distribution centre.
- 4th wave: Collaborating on product development in order to get quicker, more accurate prices on, for example, custom-made products and special demands.

Delivery inquiries

This transaction involves the sales and distribution workforce. It can be carried out automatically through various systems:

- 1st wave: Exploiting electronic communications such as e-mail to minimize costs and errors when compared to fax or telephone communications.
- 2nd wave: Processing inquiries by accessing information systems (e.g. ERP) without any human intervention from the seller/manufacturer (through the use of specific APIs).
- 3rd wave: Allowing the transmission of critical information to key customers and suppliers by:
 - (i) Linking a Global Positioning System (GPS) to an information system to trace a fleet of trucks.
 - (ii) Monitoring the manufacturing activities of an organization with the help of an inventory control system on the shop floor.

Study and decision of detail specifications

This transaction involves the design and engineering departments. It entails precise details that are very frequently listed on a CAD file or other types of electronic blueprints. To be effective, this activity must be executed in a real-time collaborative environment:

- 4th wave: Developing products on common platforms (e.g. VPDm) through the collaboration of engineers and design specialists (from various organizations).

- 5th wave: Understanding the product life cycle by involving the different stakeholders (designer, manufacturer, recycler, distributor, etc.) that may influence the development of a product.

7. Conclusion and future research

This research project started in the early days of electronic commerce in 1997, when e-commerce transaction processes were mainly exploited by large organizations. Although the project is very broad in that it touches upon the study of numerous functions in firms in a specific sector of industrial activity known to be relatively advanced in e-commerce applications, our objectives have been to understand the global e-commerce picture, to identify the emerging technologies and to create a conceptual framework using a technological transition model. The wave model was further illustrated through a technology function matrix identifying different functional processes and their evolution over the waves.

In the future, we hope to expand the model to other organizational functions and e-commerce functionalities as they become more diffused in organizational settings. Technologies will most certainly evolve over time, offering new opportunities but also requiring new organizational capabilities and skills. Monitoring these changes will become a constant challenge for researchers and organizations.

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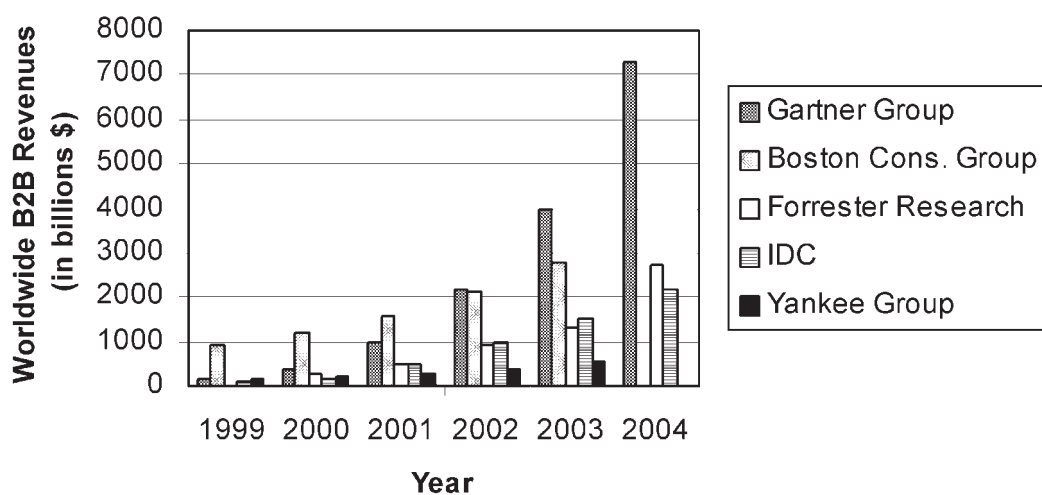
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Appendix 1: Projected growth in B-to-B e-commerce



Source: Gartner Group (January 2000), Boston Consulting Group (December 1999), Forrester Research (February 2000), International Data Corporation (April 2000) and Yankee Group (March 1999).

Determinants of a firm's likelihood to innovate and intensity of innovation in the Brazilian food industry

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Abstract

This paper defines the relative role of firms' characteristics on both their likelihood to innovate and the intensity of innovation (innovative outputs). Using Christensen's (1995; 1996) and Teece's (1986) proposals for analysing assets (resources and capabilities) and inter-asset linkages in order to produce and commercially exploit technological innovation, a conceptual framework is defined suitable to identify the variables affecting the probability of a firm to innovate and those affecting a greater count of innovations, once the firm has decided to innovate.

Thus, a "double-hurdle" approach involving censored and truncated models was applied. The findings confirm that firms innovative assets investment in external technology, investment in R&D, and external alliances, alongside firm size are the significant variables in determining firms' likelihood to innovate, whereas external alliances, firm size and market orientation are related to intensity to innovate in the Brazilian Food Industry.

Key words: food industry, economics of innovation, Brazil, innovative assets, complementary assets

1. Introduction

This paper aims to define the relative role of firms' characteristics on both their likelihood to innovate and the intensity of innovation (innovative outputs). Specifically, this refers to the identification of which innovative and complementary assets, when combined in a multivariate framework, are firstly statistically significant in distinguishing innovating from non-innovating firms in the Brazilian Food Industry (BFI), and secondly in distinguishing more from less innovating firms.

2. Innovative and complementary assets and technological innovation in the food industry

Christensen's (1995; 1996) and Teece's (1986) proposals for analysing assets (resources and capabilities) and inter-asset linkages in order to produce and commercially exploit technological innovation define the conceptual framework depicted in figure 1: both innovative and complementary assets, and their interplay are recognized as major determinants of technological innovation.

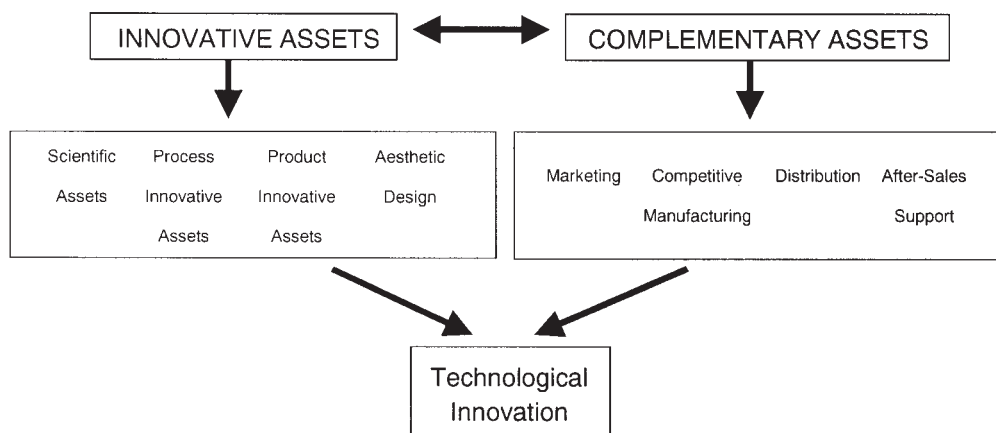


Figure 1.

In his framework, Christensen (1995; p.730) points 'to the importance of having access to relevant innovative assets in order to secure the very production of technological innovation'. The basic point of this approach is that technological innovation requires not only the application of R&D effort, but also (and sometimes excluding R&D) the application of different types of innovative assets for innovation development. Christensen (1996; p.197) claims that R&D is a limited concept to indicate the full spectrum of innovative assets needed for technological innovation. In general, the R&D concept within firms is restricted to 'what goes on in the R&D or engineering department of the firm' and, 'in its narrow statistical meaning, grossly underestimates or even neglects important parts of technological development efforts' (p.196).

Hence, the innovative assets, contemplated in this approach, encompass the resources and capabilities 'required for producing new or improved technologies and ultimately new products and processes' (Christensen, 1996; p.197). They are divided into four generic groups: scientific research assets, process innovative assets, product innovative application assets and aesthetic design assets. They were defined by Christensen (1996; p.198) as below:

- a. Scientific research assets (corresponding to the R in R&D) involve both basic research of a pre-competitive nature and applied or industrial research that provide direct inputs into process development and new product application.
- b. Process innovative assets both comprise resources and capabilities for "hardware" process innovation, and the more "systemic" capacity involved in developing the production system, the inbound and outbound logistics, quality control, and plant layout.
- c. Product innovative application assets are the resources and capabilities required for product development (apart from the possibly scientific research and aesthetic design): product engineering, instrumentation and software development.
- d. Aesthetic design assets are mostly thought of as a part of the marketing attributes of the product, but aesthetic design is also a distinct part of, or has a close physical relationship to, the product which makes it a bridge between technical and functional features of the product and marketing attributes.

These categories of innovative assets represent a more comprehensive model for understanding the multi-dimensional base of the innovative process within firms. Whereas in some firms this process is more concentrated on formalized research, in others diverse forms of internal learning or aesthetic design are dominant. However, most firms, generally, deploy more than one category of innovative

asset. Christensen (1995; 1996) borrowed from transaction cost economics the analysis of inter-asset specificity to characterize the degree to which innovative activities based on one asset depend on other asset(s). The degree of inter-asset specificity is low if the innovative activity relates exclusively to one asset. It is high if there is connection of two or more assets as, for instance, when product innovation demands major alteration in the production process and/or previously activated R&D. In this paper, three categories of innovative assets are analysed: 1) investment in R&D, 2) external alliances aiming to develop innovation, and 3) investment in technologies externally developed.

Given the relatively low industrial level of R&D expenditures in relation to sales ratio, compared to other industries, R&D is generally not considered as a very important asset to innovations in the food industry. However, the emergence of new "technological paradigms" for food processing has stimulated food firms to carry out in-house R&D and/or contract out R&D from independent firms, thus increasing R&D expenditures and technological capabilities. Moreover, in general terms, Cohen and Levinthal (1989) claimed a dual role for R&D, *i.e.*, it is not only important to innovate but it also improves the firms' capacity to assimilate and exploit new knowledge. Although, not very important in the case of capital embodied innovations, R&D is essential in the cases of 'disembodied innovations that require more complementary internal effort, and more pre-existing expertise in an area' (Cohen and Levinthal, p.594). Hence, since innovative activity, in any form, demands firms' competence, R&D activity plays a very important role in helping to build up the necessary competence to develop, assimilate and adapt technologies.

Consequently, theory does not provide unambiguous prior expectations about the role of R&D in a firm's innovative outputs in the food industry. However, whereas previous empirical works have found a strong relationship between R&D expenditures and innovative output for industries in general, in the food industry this has not been the case (*e.g.*, Connor *et al.*, 1985). In turn, given the proposals that R&D effort increases a firm's innovative competence, it is predicted that a significant relationship exists between R&D expenditures and a firm's innovative intensity. Furthermore, since a huge part of food firms' R&D expenditure is allocated to contracted out R&D activity, a significant relationship between external alliances, that aim to develop innovation and innovative outputs, is predicted.

In terms of level of investment in technologies externally developed has been suggested (*e.g.*, Connor *et al.*, 1985; Galizzi and Venturini, 1996) that especially process innovations originating from outside the food industry explain the technical efficiency and the high level of productivity growth observed in the food industry.

Thus, the following hypotheses related to the relationship between innovative assets and innovative outputs are formulated:

- Hypothesis 1. Given the predominance of both capital embodied and incremental innovations in the BFI, R&D expenditure is not a strong predictor of a firm's likelihood to innovate.
- Hypothesis 2. Given that R&D activity increases a firm's capacity to innovate, R&D expenditure is predicted as strongly related to a firm's innovative intensity.
- Hypothesis 3. Given the high level of outsourced R&D in the food industry, external alliances aiming to develop innovation are a strong predictor of innovative outputs in food firms.
- Hypothesis 4. The level of investment in technologies externally developed will be statistically significant in the likelihood to innovate and in the intensity of innovations in the food industry.

Christensen's framework is concerned with innovative assets required to produce a technological innovation. However, the innovative activity is only completed when the innovation is successfully commercialised. To achieve this, innovating firms also need complementary assets that support the innovative activity and secure to them the benefits of innovation (Teece, 1986). These complementary assets are related with functional areas of firms such as marketing, competitive manufacturing, distribution and after-sales support. They can be matched internally or contracted out, typically downstream in the chain.

Thus, studies have tried to define the relative role of selected supporting assets on innovative outputs. Related variables include firms' marketing orientation and functions in the chain and product chains of firms (levels of vertical integration and horizontal diversification, respectively)¹. In terms of marketing orientation, the indicators selected include advertising and exports influence on innovations². Advertising is considered a very important marketing activity supporting innovation in the food industry, mainly in the case of product innovation. In addition, Galizzi and Venturini (1996; p.142) found that its importance also depends on the customer targeted. The importance of exports to innovations is also relative, depending upon, among other things, the size and growth potential of firms' domestic market. In the case of the overall Brazilian manufacturing industry, Braga and Wilmore (1991; p.429) found that

exports positively influence technological efforts. However, the authors stressed that the result might vary from one industry to another.

With regards to vertical integration, in general it is expected that a higher level of integration favours a higher level of innovative output. However, this relationship is mediated by a series of other characteristics, such as degree of innovative inter-asset specificity, kind of innovation (autonomous or systemic³), and level of technology appropriability. The proposals are that vertical integration is more feasible when there is high inter-asset specificity, predominant systemic innovations, and low levels of appropriability. In turn, considering the prevalent aspects of innovations in the food industry, such as incremental, process, and new only to the innovating firm (imitation), one can consider them as autonomous and presenting weak appropriability. On the other hand, one can deduce that while autonomous innovations favour decentralization, weak appropriability favours integration. Thus, one cannot provide unambiguous prior expectations about the direction of the relationship between innovative output and vertical integration. However, as the general level of inter-asset specificity in the industry is low, the relationship between vertical integration and innovative output should be weak. In turn, reasons are given (*e.g.*, Teece, 1996; p.203) to suggest that the innovative performance might also be impacted by the scope of firms. However, it is also posited (*e.g.*, Nelson, 1959) that the horizontal diversification effect on innovative output should be more significant when associated to "basic" research. This clearly is not the case in the food industry. From the propositions above, the following hypotheses are formulated related to the relationship between complementary assets and innovative outputs:

- Hypothesis 5. Given the predominance of process innovations in the food industry, advertising level is not a strong predictor of a firm's likelihood to innovate.
- Hypothesis 6. Given that the intensity of innovations is associated with a larger proportion of product innovations, advertising level is expected to be significantly associated with a firm's innovative intensity.
- Hypothesis 7. Given the size and growth potential of the Brazilian food market, exports are not significantly related to a firm's innovative outputs (likelihood and intensity).
- Hypothesis 8. Higher levels of vertical integration and horizontal diversification are not significantly associated with a firm's likelihood and intensity to innovate.

¹ Based on these two dimensions (functions or stages in the chain and product chains or production activities) Bijman et al. (1997; p.408) present a typology of food processing firms.

² It is recognised that this is a limited number of indicators to measure the construct. Kohli et al. (1993), for instance, propose a measure of market orientation (MARKOR) comprised of thirty-two indicators (scale items).

³ See Teece (1998; p.268) about these two kinds of innovations.

Now the effect of complementary variables will be considered. The objective is to evaluate the effect of complementary assets on innovations, controlling their influences through other conventionally considered determinants of innovative activity. They are firm size and age.

In terms of firm size, it has been one of the most tested explanatory variables in studies about the determinants of innovation. Both theoretical reasoning and empirical results for its relationship with innovation did not reveal conclusive results. The latter has shown that this undefined result is due to the fact that the relationship of size with innovation depends on the empirical context, industry or sector. There are conditions and industries where the innovative efficiency is a prerogative of smaller firms and other conditions and industries where the efficiency in innovation prevails for larger firms. In the case of the food industry the majority of empirical studies has confirmed the hypothesis that larger firms are more innovative, as in the studies of Galizzi and Venturini (1996; p.144) and Huiban and Boushina (1998). The latter authors found that firm size is the strongest determinant of the probability to innovate in the French food industry. They also found that in this industry 'the best situation for innovation seems to be a large firm located in a not highly concentrated market' (p.396). In the case of the Brazilian industry, as a whole, Braga and Wilmore (1991; p.429) also found that size is significantly related to technological efforts although presenting rather low estimated coefficients.

Finally, with regards to firm age it is suggested that accumulated learning favours innovative output. The hypotheses which are correspondent to complementary variables are formulated below.

- Hypothesis 9. Large firms in the food industry are more likely to innovate and to present a greater innovative intensity.
- Hypothesis 10. Older firms present higher likelihood and intensity to innovate.

3. The data set, method, analytical model and results

The empirical basis for achieving the paper's objective is a data set assembled from a survey focusing upon innovative activity in the BFI. This survey was designed to assemble a broad description of the firms' organizational characteristics and innovative activity in the BFI.

The survey measured innovation through a direct proxy, which has been considered as providing a more reliable account of the innovative intensity, within firms and across industries, than the use of R&D and patents⁴. In achieving this, innovation was defined as the first commercial transaction of an idea involving a new or improved product or process of production (Galizzi and Venturini, 1996; p.7). Hence, technological innovation involves shifts in the process of production (process innovation) or the improvement or creation of a new consumer or capital good (product innovation). In some studies, "first" has been qualified as either new to the world or new to the country at issue (e.g., Pavitt, 1984; p.344), while in other studies new has been qualified as new for the world, country or firm (e.g., Cesaratto and Mangano, 1993; p.115; Christensen *et al.*, 1996; p.8; Myers and Marquis, 1969; p.3). The survey followed these trends measuring innovation in the "broad" sense of new to the world, country or firm⁵. Accordingly, the direct indicator chosen to use in the survey was 'innovation count', that means the number of technological innovations generated and/or acquired by a surveyed firm in a previously defined period of time. Researchers have identified these innovations, among others, by asking the firms' managers to list the innovations implemented in their firms, or posing the same question to technical experts and firm insiders regarding the innovations implemented in some line of business. The survey mixed the two approaches: first, firms were asked to list their innovations in the research period; second, the list was submitted to the analysis of a group of food technology experts (three), from EMBRAPA - Brazilian Agricultural Research Company. This committee assessed not only whether the indicated innovation really should be considered a technological innovation, but also assessed the responses about the qualitative characteristics of the

⁴ Patel and Pavitt (1995) and Santarelli and Piergiorganni (1996) present an extensive list of shortcomings and drawbacks of innovation indicators. Cabral (1999) summarizes the main shortcomings of patents and R&D.

⁵ This broad sense was applied based on the premise that technological innovations, at world level in the food industry, are not a very common event. In addition, as Rosegger (1996; p.172) states, 'a product or process hardly ever remains unchanged as it is diffused; therefore, "firsts" abound even after an original innovation has occurred, and many of these turn out to be at least as significant, technically and economically, as the basic innovator's contribution'. In turn, Kline and Rosenberg (1986; p.283) suggest that '...most important innovations go through rather drastic changes over their lifetimes - changes that may, and often do, totally transform their economic significance'. Finally, one important reason for this choice was to follow other international studies and compare these results. Thus, this work is considering the processes of innovation and imitation in Schumpeterian terms.

innovations in terms of complexity, type, and newness (*e.g.*, radical or incremental, product or process). The main result achieved was the homogenisation of the qualitative responses.

In order to carry out the survey, the food processing industry was defined based on the official industrial classification approved by the Brazilian Government⁶. In this classification, the food industry is one of the twenty-one two-digit industry groups that comprise the country's manufacturing industry and it is distinguished by nine food sectors (three-digit level). From this definition, the list of firms in the food industry was taken as the basis for sample selection. Hence, 38,916 firms⁷ in the food industry constituted the initial population to base the sample selection. As some questions were considered as very new to firms and demanding a very organized internal file system, the smallest ones (lesser than five employees) were excluded from this population basis. Thus, the definitive population basis was composed of 19,045 firms or 48.9% of the industry's total, but corresponding to 92.4% of the employment, 96.2% of the payroll, 97.9% of the output and 97.6% of the value-added⁸.

From the population basis, a relatively large stratified random sample of 1,000 firms was selected. The stratification was undertaken by economic activity (food three-digit manufacturing line of business), firm size (number of employees) and geographical region of Brazil. These firms were asked to fill out a questionnaire (Appendix 1) about their organizational characteristics and also their innovative, strategic and managerial activities, during the three year period of 1994 to 1996. This period of three years was defined due to yearly fluctuations in industries' and firms' innovative activities and to take into account the fact that technological innovations may not be a very steady event at the firm level. Actually, the longer the period the better the information, especially for longitudinal studies. The three year period began in 1994 as this was the starting point of a large restructuring of the Brazilian economy.

248 firms responded to the questionnaire (24.8%). From these, 167 (67.4%) indicates that they had not introduced innovations in the period, 77 firms (31.0%) that they had introduced 233 innovations, four firms (1.6%) have not

responded to this question. Six firms were excluded from this research, three because they did not correspond to the definition given of food processing firms (two are exclusively in catering and one is exclusively in the wholesaler sector) and three because they did not respond to the letter asking for complementary and clarifying information. From the 233 innovations, the committee of experts excluded 95 because they were considered as not conforming to the definition of technological innovation. They referred to organizational innovations or to adaptive changes in manufacturing (minor change in the production process or simple replacement of old equipment), or to simple product variations (changes of shape, label and/or packaging design). Thus, of the 242 firms, 66 innovating firms, and 138 innovations were included in the following analysis. The distribution of these figures by food sector, at three-digit level, is presented in table 1.

The analytical model should be suitable to identify the variables affecting the probability of a firm to innovate and those affecting a greater count of innovations, once the firm has decided to innovate. A model used to account for this double information has been the Tobit regression model. But, as there is no reason to expect that the same variables affect both decisions (as in the theoretical propositions above), the use of two analytical models or the application of the "double-hurdle" approach has been usually suggested (*e.g.*, Burton *et al.*, 1994; Goetz, 1995; Wakelin, 1998). The first should be a censored model where the dependent variable, likelihood to innovate, is defined as the probability of the i th firm deciding to innovate (coded as: $LI_i = 1$ if the i th food firm innovated; or $LI_i = 0$ if the i th firm did not innovate). The second should be a truncated model, where the dependent variable, intensity of innovative output, is observed only if it takes a value greater than zero. It is coded as $PI_i > 0$, with PI_i standing for firm's number of innovations. With regards to innovative assets, the indicators include⁹: R&D expenditure (*redmo*), measured as a proportion of a firm's turnover according to one of the seven classes given in the survey questionnaire, which is the usual measure of R&D intensity. External alliances (*altot*) measured through number of agreements, with private companies and public agencies and universities, to develop technological

⁶ FIBGE - Brazilian Institute of Geography and Statistics: Resolucao do Presidente N° R.PR. 054/94. This classification is very similar to NACE, English SIC and USA 1992 Standard Industrial Classification Manual.

⁷ From 43,034 establishments. This small difference confirms that most food processing firms develop production activities in just one place. (see also Connor and Schiek, 1997; p.65).

⁸ Source: FIBGE - Censo Industrial 1985. Actually, these shares refer to establishments with more than five employees, due to the lack of this information by firms. In addition, it is noted that the choice of this year (1985) was due to the fact that it represented the last quinquenal (every fifth year) industrial census by FIBGE. From this year on, the FIBGE passed to publish an annual industrial research with the information aggregated at a greater level.

⁹ For further information on the survey questions and indicators measurement, see the questionnaire in Cabral (1999).

Table 1. Food sectors and innovativeness.

Sector	Surveyed Firms		Innovating Firms			Innovations		
	(Count)	(%OTFS)	(Count)	(%OTIF)	(Index)	(Count)	(%OTIF)	(Index)
Meat and Fish	32	13.2	8	12.1	.92	18	13.1	.99
Fruits and Vegetables	19	7.9	7	10.6	1.34	22	15.9	2.01
Fat and Oils	10	4.1	2	3.0	.73	2	1.5	.36
Dairy	27	11.2	6	9.1	.81	10	7.2	.64
Grains and Animal Feed	53	21.9	9	13.7	.63	16	11.6	.53
Sugar	13	5.4	5	7.6	1.41	18	13.1	2.43
Coffee	9	3.7	2	3.0	.81	5	3.6	.97
Miscellaneous-Cocoa-Bakery	57	23.5	20	30.3	1.29	34	24.6	1.05
Others	22	9.1	7	10.6	1.16	13	9.4	1.03
Total	242	100	66	100	-	138	100	-

OTFS = Share of total firms surveyed; OTIF = Share of total innovating firms; OTI = Share of total innovations; Index=OTIF/OTFS or OTI/OTFS. The index greater than one means that the sector presents a performance in terms of innovating firms or innovations above the overall industry's mean.

Source: Survey

innovations that each firm carried out during the research period. Technological innovation activities (*tecmo*), excepting R&D expenditures, measured by proportion of a firm's turnover, also from the seven classes in the questionnaire, allocated to acquisition of technology externally developed. The indicators of complementary assets include: Advertising (*advmo*) measured by the ratio of advertising expenditure over turnover (seven points). Exports (*expmo*) measured by the scores (also seven points) each firm gave to proportion of turnover generated through exports. Vertical integration (*proto*) measured by the number of production and distribution stages (food chain) in which each firm participates. Finally, horizontal diversification (*atota*) measured by the number of food segments (four-digit SIC level) in which each firm produces and commercialises.

The complementary variables, as above, include size and age. In terms of size, the majority of studies have used firms' total employment full-time equivalent. However, some studies (e.g., Scherer, 1965) prefer to use annual sales (*turmo*) because the theoretical propositions about the positive influence of size on innovative output are mainly based on the availability of financial resources and cash-flow. Hence, and considering that the variables are positively but not perfectly correlated, size will be measured, at the start, by employment (*empme*). Alternatively, a second equation will be run, with *turmo* replacing *empme*. In addition, many related studies have shown that innovative output increases with large sized-firm, but only until a particular threshold. Thus, they have concluded that there is non-linearity in the

relationship. Hence, a quadratic specification for the size variables (*empme*² and *turmo*²) shall be included in the models to test for possible non-linearity. Finally, age (*fiold*) will be measured by number of years since the firm's establishment until the survey year 1997.

The functional econometric form for the first model, therefore, is:

$$Lli = f(\text{redmo}, \text{altot}, \text{tecmo}, \text{advmo}, \text{expmo}, \text{proto}, \text{atota}, \text{empme}, \text{fiold})$$

As above, the dependent variable is of the binary type, taking the values of zero or unity, with the former being predominant. The specification should take the form of a censored model, of which the Logit regression model is one of the well-established procedures.

The functional econometric form for the second model just changes the dependent variable to PIi. It can be written as:

$$PIi = f(\text{redmo}, \text{altot}, \text{tecmo}, \text{advmo}, \text{expmo}, \text{proto}, \text{atota}, \text{empme}, \text{fiold})$$

The results of the parameter estimates for firms' likelihood to innovate and firms' intensity of innovation, in the two models (logit and truncated) are presented in table 2. As expected, given the high correlation coefficient between them, the variables *empme* and *turmo* presented similar significance and direction of the relationships, with a slightly higher predictive significance for the model with *empme*. Thus, only the results with this variable will be reported here, a discussion of which will follow below.

Table 2. Parameter estimates for innovative likelihood and intensity.

Explanatory Variables	Logit Model		Truncated Model					
	Equation 1		Equation 2		Equation 3		Equation 4	
Redmo	0.47	(0.24)**	0.47	(0.24)**	-0.14	(0.26)	-0.20	(0.20)
Altot	0.38	(0.17)**	0.39	(0.18)**	0.32	(0.17)*	0.36	(0.13)***
Tecmo	1.10	(0.26)***	1.10	(0.26)***	-0.23	(0.27)	-0.84	(0.20)
Advmo	0.2710	(0.18)	0.27	(0.18)	0.44	(0.18)**	0.32	(0.13)**
Expmo	-0.20	(0.22)	-0.21	(0.22)	0.10	(0.23)	-0.16	(0.18)
Proto	0.25	(0.25)	0.25	(0.25)	-0.29	(0.32)	-0.27	(0.24)
Atota	-0.26	(0.18)	-0.26	(0.18)	-0.22	(0.28)	-0.28	(0.21)
Empme	0.0019	(0.0007)**	0.002	(0.0007)***	0.00012	(0.00007)*	0.0009	(0.00018)***
Empme ²			-0.00000005				-0.000000024	
			(0.00000003)*				(0.00000006)***	
Field	-0.01	(0.01)	-0.01	(0.01)	0.50	(0.11)	-0.34	(0.86)
Constant	-4.32	(0.84)***	-4.32	(0.84)***	1.36	(1.30)	1.93	(0.93)**
Chi Square	91.32***		91.48***					
Sigma					1.61	(0.25)***	1.28	(0.17)***
Nagelkerke R ²	0.51		0.51					
Number of Observations	202		202		62		62	

Standard errors in parentheses. *, **, *** Significant at 10%, 5% and 1%, respectively.

Table 2 shows that, overall, both models present a set of statistically significant coefficients, in terms of chi-square distribution for logit and sigma for truncated models. The results confirm most of the hypotheses previously formulated, and in particular, that there are important differences between the likelihood to innovate and the intensity of the innovative process, in food firms. The differences will be reported and discussed below, starting with the first model.

The estimated logit model correctly predicts 81% of the possible outcomes (innovate/no-innovate). The individual influence of explanatory variables follows. The first equation confirms that the incremental nature and predominant external sources of innovations make the investment in technologies externally developed the most significant variable, in a multivariate framework, of the food firms' probability to innovate. Another reason for that is the existence of "redundant technologies" for the industry (see Cabral, 1999). Redundant technology, according to Padberg and Westgren (1979) means that the state of the art in food science and technology offers relevant opportunities for technological innovation in the food industry. In other words, the stock of available technology presents a "surplus" compared with technology in use in the industry. Investment

in technologies externally developed, thus, increases by more than three times the odds that a firm innovates¹⁰.

The first equation also confirms the hypothesis that a firm's likelihood to innovate is also related to size. Although this hypothesis was confirmed with high statistical significance ($p < 0.05$), the estimated coefficient is rather small.

The R&D expenditures variable presents a highly significant and relatively expressive coefficient. It is significant at less than 5% and increases by more than one and a half times the odds that a firm innovates. In addition, the variable regarding a firm's external alliances to carry out innovative activities is also statistically significant. These results suggest the rejection of the hypothesis that R&D is not a strong predictor for innovation and to accept the hypothesis about the importance of alliances. Thus, they confirm the proposals of an increasing role of outsourced R&D activities in the innovative process of food firms. In addition, this suggests that although not exclusively dependent on R&D, the innovative activity of food firms may be enhanced with R&D competence.

With regards to the remaining variables in the first equation, all results, except age, confirm the research hypotheses. The level of advertising and the level of functions in the chain (*proto*) present positive coefficients although not statistically

¹⁰ The antilog of 1.10 is 3.01.

significant. Similarly in terms of significance, but in the opposite direction, the levels of exports (*expmo*), of product chains (*atota*) and age (*fiold*) present a negative sign. These results add evidence for the theoretical suggestions that food firms' likelihood to innovate is not significantly determined by complementary assets, in terms of market orientation, vertical integration and horizontal diversification. Despite the changes in demand, Brazilian food firms continue to be predominantly manufacturing oriented.

In turn, the second equation of the logit model included the quadratic term of the size variable (*empme*²). As hypothesized, this term presents a negative and significant ($\rho < 0.1$) coefficient. Thus, this confirms that the influence of size is not linear, suggesting that the likelihood to innovate increases with firm size up to a threshold level and then declines, confirming a "U" inverted relationship.

As above, the truncated model is included in the analysis to identify the variables affecting a greater count of innovations once the firm has decided to innovate. The basic premise was that there is no reason to expect that the influences of the variables on the likelihood to innovate and on the innovation intensity are similar. The existence of differences was confirmed by the results. From the logit model, (the first equation), just the variables regarding firms size and alliances present again, in the truncated model (equation three), positive and significant coefficients. In addition, the variable advertising expenditures, as hypothesized, attains statistical significance. This result suggests that firm size, external alliances to undertake research, and market orientation (*expmo* changes sign from negative to positive, although not significant) increase the intensity of innovations of firms in the food industry.

Finally, the fourth equation reinforces the result that the influence of size on innovative activities is not linear, since the coefficient of *empme* squared is negative and statistically significant. This provides additional evidence that there is no appreciable effect of scale on innovative activity (see Klevorick *et al.*, 1995; p.786).

4. Discussion

The findings show that investment in technology externally developed is a very significant variable related to firms' likelihood to innovate in the BFI, confirming Connor *et al.* (1985) proposal and Gallizzi and Venturini (1996) findings. Three main aspects explain this influence: the incremental nature and the predominance of capital embodied innovations in the industry and the existence of "redundant" technology. Hence, this is in accordance with the characterization of food firms as "supplier-dominated" in innovative terms. However, this factor is not significant in

explaining the intensity of innovations in these firms. In this case, there is much at work to increase the innovative efficiency, such as market orientation and external alliances to develop technology.

The findings also suggest that a firm's R&D effort is related to the firm's likelihood to innovate, but not to the intensity of innovation. This result is rather surprisingly given previous proposals that whilst a firm can innovate without engaging in R&D, it will increase its competence to innovate when carrying out R&D (*e.g.*, Cohen and Levinthal, 1989; Connor *et al.*, 1985).

In turn, firm size was confirmed also as a very important determinant of both a firm's likelihood and intensity to innovate. However, in both relationships, the influence of firm size increases up to a threshold and then declines, suggesting an inverted "U" shaped relationship. Similar to the influence of size, the level of outsourced R&D increases not only the likelihood but also the intensity to innovate. This result means that although small, the link of food firms with private and state institutions of research and development has been very effective in spurring food firms into innovative activity.

With regard to complementary assets, the association was confirmed between market orientation, expressed by one single indicator, advertising expenditures (*advmo*), with the intensity to innovate. This was expected due to the fact that advertising is related to product innovation, which in turn is related to a higher level of innovative output. The other complementary assets indicators, product chains (horizontal diversification), functions in the chain (vertical integration), exports (*expmo*) and age (*fiold*) were not significantly related with either likelihood or intensity. Thus, one possible deductive statement from these results is that specialization in product and in stages of production, and the predominance of domestic market targeting impose more pressure on firms in the BFI to innovate.

5. Concluding remarks

These different variables influencing the probability and intensity of the innovative activity of firms in the BFI, in different ways confirm that firms' resources and capabilities might correctly be imputed as the main factors at work in defining the innovative possibilities of any firm in the food industry. In other words, from the incentives and constraints posited by the "context", firms' behaviour further constrains and enhances its innovative trajectory.

This result requires that to define the most useful technology strategy, firms need to identify their technological possibilities and constraints, and boost innovative and complementary assets (resources and capabilities). The best innovative strategy for these firms should be to allocate

financial resources aiming to update equipment, to learn how to use them effectively, and to strengthen links with upstream suppliers. In addition, considering that the factors investment in external technology, R&D effort, size, and market orientation explain among one and a half and three times the likelihood or intensity of a food firm to innovate, food firms will be more innovative-effective with a strategy to boost their R&D efforts and linkages with other firms and/or universities and/or agencies of research, with a view on "inducement mechanisms" arising from technology and market opportunities.

In turn, the result suggests that public policies aiming to spur the innovativeness in the BFI might focus initially on stimulating the development and diffusion of pervasive technologies by the food industry upstream suppliers. Complementary policies should incite food manufacturer firms to allocate resources and to develop absorptive capacity aiming to adopt and adapt technologies - "artefacts" and "knowledge" (embodied and disembodied) - from suppliers, private or public, and competitors. The policies may be direct, through, for instance, financing of food research and subsidies for technology acquisitions, and indirect, through elimination of institutional barriers to innovation, such as custom barriers to import technology. In addition, the result also indicate that encourage firms' linkages for developing innovative projects, firms' achievement of a minimum scale (size), and firms' increase in market orientation, should lead to a higher innovativeness (absolute and relative) in the industry.

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Appendix 1:

This is a shortened version of the questionnaire used in the research

A. This part refers to organisational characteristics of your firm

Firm (Identification Code):

Q1. Which food sector, according to FIBGE's three-digit classification, represents your firm's principal activity? (Please tick the appropriate box):

- | | | |
|-------|------------------------------------|--------------------------|
| I. | Meat and Fish Processing | <input type="checkbox"/> |
| II. | Fruits and Vegetables Processing | <input type="checkbox"/> |
| III. | Fat and Oils | <input type="checkbox"/> |
| IV. | Dairy | <input type="checkbox"/> |
| V. | Grains and Animal Feed Processing | <input type="checkbox"/> |
| VI. | Sugar | <input type="checkbox"/> |
| VII. | Coffee | <input type="checkbox"/> |
| VIII. | Miscellaneous-Confectionery-Bakery | <input type="checkbox"/> |
| IX. | Others | <input type="checkbox"/> |

Q2. In which segments of the food industry does your firm develop production activities, according to FIBGE's four-digit classification of the industry? (Please rate the productive activities of your firm in order of importance in terms of volume of production, whereby 1. represents main activity; 2 the secondary activity; 3. the third most important activity; and so on until the least important activity, or O for not applicable):

- | | | |
|--------|---|--------------------------|
| I. | Beef and Pork Slaughtering and Processing | <input type="checkbox"/> |
| II. | Poultry Dressing and Processing | <input type="checkbox"/> |
| III. | Prepared meats: Sausages | <input type="checkbox"/> |
| IV. | Fish Processing | <input type="checkbox"/> |
| V. | Fruit Processing, Canning, and Freezing | <input type="checkbox"/> |
| VI. | Vegetable Processing, Canning, and Freezing | <input type="checkbox"/> |
| VII. | Fruit and Vegetable Juices | <input type="checkbox"/> |
| VIII. | Oils | <input type="checkbox"/> |
| IX. | Refined Oils | <input type="checkbox"/> |
| X. | Vegetable and Animal fats | <input type="checkbox"/> |
| XI. | Fluid Milk | <input type="checkbox"/> |
| XII. | Cheese and Other Milk Products | <input type="checkbox"/> |
| XIII. | Ice Cream | <input type="checkbox"/> |
| XIV. | Rice Milling | <input type="checkbox"/> |
| XV. | Wheat Milling | <input type="checkbox"/> |
| XVI. | Manioc Processing and Flour Production | <input type="checkbox"/> |
| XVII. | Corn Milling and Flour Production | <input type="checkbox"/> |
| XVIII. | Corn Oil | <input type="checkbox"/> |
| XIX. | Animal Feeds | <input type="checkbox"/> |
| XX. | Other Grains Processing | <input type="checkbox"/> |
| XXI. | Raw and Cane Sugar Milling | <input type="checkbox"/> |
| XXII. | Sugar Refining | <input type="checkbox"/> |
| XXIII. | Coffee Milling and Roasting | <input type="checkbox"/> |
| XXIV. | Instant Coffee Production | <input type="checkbox"/> |
| XXV. | Bakery Products | <input type="checkbox"/> |

- XXVI. Biscuits
- XXVII. Chocolate and Confectionery
- XXVIII. Pastas
- XXIX. Sauces and Condiments
- XXX. Diet Products, Children's Foods, and Cans
- XXXI. Others (Please specify)

Q3. Which stages of the food value-added chain is your firm involved in? (Please tick the appropriate box):

- I. Production of Raw Materials (Agricultural Sector)
- II. Primary Processing (Undifferentiated Products, most of them for Intermediate Demand, e.g., Sugar)
- III. Secondary Processing (Differentiated Products, most of them for Final Demand, e.g., Chocolate, Pastas)
- IV. Wholesaling
- V. Retailing
- VI. Catering and Restaurant management
- VII. Other (Please specify)

Q4. What was your firm's turnover (gross sales), in thousands of "Reais", in 1994 to 1996? (Please tick the appropriate box):

	1994	1995	1996
Less than 1,000 (One Million)			
1,000 TO 5,000			
5,000 TO 10,000			
10,000 TO 50,000			
50,000 TO 100,000			
More than 100,000 (One Hundred Million)			

Q5. What percentage of the turnover (gross sales) was related to exports? (Please tick the appropriate box):

	1994	1995	1996
None (0%)			
Less than 10%			
10% to 20%			
20% to 30%			
30% to 40%			
40% to 50%			
More than 50%			

Q6. What percentage of turnover (gross sales) was spent on advertising? (Please tick the appropriate box):

	1994	1995	1996
None (0%)			
Less than 1%			
1% to 2%			
2% to 3%			
3% to 4%			
4% to 5%			
More than 5%			

Q7. What percentage of the turnover (gross sales) was spent on R&D (basic, applied and development)? (Please tick the appropriate box):

	1994	1995	1996
None (0%)			
Less than 0.5%			
0.5 to 1%			
1% to 1.5%			
1.5% to 2%			
2% to 2.5%			
More than 2.5%			

Q8. What percentage of the turnover (gross sales) was spent on other technological innovation activities, such as acquisitions of patents and royalties, technology adaptation, etc.? (Please tick the appropriate box):

	1994	1995	1996
None (0%)			
Less than 1%			
1% to 5%			
5% to 10%			
10% to 15%			
15% to 20%			
More than 20%			

Q9. Does your firm have a formal R&D department? (If yes, in what year was it established?):

YEAR:

Q10. What was the employment position of your firm in 1994 to 1996? (Indicate the average number of employees in full-time equivalent per year in the chart below):

	1994	1995	1996
Total number of personnel (Full-time employees)			
Personnel in R&D			
Ph.D. Researchers			
M.Sc. Researchers			
B.S. Researchers			
Technicians and auxiliary personnel			

Q11. To what extent has your firm developed the managerial functions below? (Please indicate on a three-point scale, in which 1 represents insignificant, not relevant, or informal, 2 represents an intermediary position, and 3 represents very significant, relevant, or formalised):

	1	2	3
Does your firm have a policy regarding technological innovation?			
Does your firm engage in long-term strategic planning?			
Does your firm conduct marketing research?			

Q12. What external agreements for undertaking R&D did your firm sign in the period from 1994 to 1996? (Please specify the number in the space provided):

- Number of agreements with other private firms or independent laboratories to carry out R&D.
- Number of agreements with universities or other non-profit research institutions to carry out R&D.
- Number of R&D firms or independent laboratories of which your firm has majority ownership (main shareholder).
- Number of R&D firms or independent laboratories of which your firm has minority ownership (main shareholder).

B. This part refers to the characteristics of your firm’s innovations

Q13. Did your firm produce and/or adopt technological innovations in the period from 1994 to 1996? (Circle the appropriate answer and follow the instructions).

- I. No. (Complete the questionnaire through question 18, and then return the questionnaire in the enclosed envelope)
- II. Yes. (Complete questions 19-27, and then return the questionnaire in the enclosed envelope)

Q14. If your answer was YES to question 13, what innovations were implemented by your firm in the period 1994 to 1996? (Write in the spaces below the name and the year of each innovation. Please use the additional sheets enclosed if the firm generated/adopted more than ten innovations):

- I. Innovation 1 _____ Year: _____
- II. Innovation 2 _____ Year: _____
- III. Innovation 3 _____ Year: _____
- IV. Innovation 4 _____ Year: _____
- V. Innovation 5 _____ Year: _____
- VI. Innovation 6 _____ Year: _____
- VII. Innovation 7 _____ Year: _____
- VIII. Innovation 8 _____ Year: _____
- IX. Innovation 9 _____ Year: _____
- X. Innovation 10 _____ Year: _____

Q15. What were the major characteristics of each innovation? (Tick the appropriate answer in the chart below):

Characteristics	Innovations									
	1	2	3	4	5	6	7	8	9	10
The innovation was developed										
I. Internally (produced by firm)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
II. Externally (purchased/received)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Was the innovation patented?										
I. No	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
II. Yes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Was the innovation developed in collaboration with external institutions?										
I. No	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
II. Yes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

	1	2	3	4	5	6	7	8	9	10
Which institutions participated in the development of the innovation?										
I. Customer	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
II. Private industry	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
III. Government agencies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
IV. Universities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
V. Other (please specify)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

The novelty of the innovation was										
I. Radical (major)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
II. Incremental (minor)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

What type was the innovation?										
I. Product innovation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
II. Process innovation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
III. Combined (product and process)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

How new was the innovation?										
I. New for the industry as a whole	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
II. New for the industry in Brazil	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
III. New only to the firm	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Q16. In what department of the firm was the innovation developed? (Indicate the locus for each innovation in the chart below):

	1	2	3	4	5	6	7	8	9	10
R&D Department	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Design department	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Production department	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Marketing department	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other (please specify)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Q17. What factors played the determinant role in the development/adoption of each innovation, *i.e.*, what was/were the main motive (or motives) to innovate? (Please indicate the extent of influence of each factor on each innovation, using a seven-point scale, in which 1 represents insignificant or no relevant influence, and 7 represents very significant or very relevant influence):

Innovation 1	Extent of INFLUENCE						
	1	2	3	4	5	6	7
Customer's direct request	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
New technological development (1)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
New scientific development (2)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Customer need (3)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
To strengthen market position (4)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- (1) The generation of the innovation was based on private or public technological knowledge.
- (2) The generation of the innovation was based on private or public scientific knowledge.
- (3) As perceived by the firm through formal or informal marketing research or another communication channel.
- (4) To respond to a competitor's action.

IMPORTANT: IF YOUR FIRM ADOPTED OR GENERATED MORE THAN TEN INNOVATIONS IN THE PERIOD 1994 TO 1996, PLEASE USE THE ADDITIONAL SHEET ENCLOSED AND PHOTOCOPIES IF NECESSARY. ONCE AGAIN, THANK YOU VERY MUCH FOR YOUR COLLABORATION.

Please indicate in the space below:

Your position in the firm: _____

Your name: _____

Your telephone number: _____

Is there anything else you would like to tell us about the innovation process in your firm? If so, please use the space below for this purpose.

In search of relationship quality, customer retention and shareholder value: Findings from an exploratory, qualitative multiple case study

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Abstract

This article reports on the findings from an exploratory, qualitative first part of a research that (1) theorises that successful creation of shareholder value in relationship marketing and management requires relationship quality, which translates into customer retention, and that (2) models relationship quality and customer retention as key mediating variables in the creation of shareholder value. A multiple case study involving companies (in exporter-importer dyads) in the Danish-British dairy sector, the Danish-British bacon sector and the New Zealand-British wine sector explored the key constructs of relationship quality; specifically, the cases examined whether or not the dimensions of relationship quality that Roberts (1998) and Roberts *et al.* (2000) have suggested are an appropriate framework. These dimensions are as follows: trust in credibility, trust in benevolence, commitment, conflict, satisfaction and social bonding. The evidence of the findings suggests that it does make sense to employ relationship quality as a concept in relationship marketing and management, and that the six dimensions are an appropriate framework for doing so. The managerial implications of the research findings are examined. The article concludes that there is a positive relationship between all of the antecedents of relationship quality (except for conflict), and that there is a positive relationship between customer retention and all of the consequences of customer retention (except for customer costs), and it proposes to test this idea in a confirmative, quantitative second part (using LISREL) in the context of the New Zealand-British wine sector.

Key words: customer retention, relationship management, relationship marketing, relationship quality, shareholder value

1. Introduction

It has been argued that agribusiness and the food industry traditionally have embraced *transaction marketing* (the 4Ps: product, price, promotion and place) and *supply chain management* (Barkema 1992; Barry *et al.* 1992; Kalfass 1993; Sporleder 1992). Over the past two decades, however, the terms *relationship marketing* and *relationship management* have emerged as alternative frameworks for thinking about marketing and management behaviour, postulating that a key task is to secure sustainable competitive advantage through relationships, networks and interactions because competing firms cannot easily duplicate these (Brodie *et al.*, 1997; Buttle 1996; Christopher *et al.*, 1991; Grönroos 2000; Gummesson 1999).

There are several sectors where relationship marketing and management are advanced, including the bank, hotel and

hospital sectors. But agribusiness and the food industry represent an interesting opportunity for gaining possible insights into how firms are *beginning* to seek to employ constructs from relationship marketing and management: At the end of the 1990s, agribusiness and the food industry thus started to turn to relationship marketing and management (Behner *et al.*, 1995; Hughes 1994; Srivastava *et al.*, 1998; Tansey *et al.*, 1995). For example, eight major consumer trends are driving the European food industry to become part of horizontal and vertical relationships. Agribusiness and the food industry also constitute a possible opportunity for achieving knowledge of how firms in one sector have learned from the experiences of firms in other sectors.

Despite the fact that relationship marketing and management were first introduced in the early 1980s (Berry 1983), there is still a lot of debate about what is meant by

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these terms. It has been noted that they mean different things to different authors (Brodie *et al.*, 1997; Cooper *et al.*, 1997; Eiriz *et al.*, 1999; Harker, 1999; Lindgreen *et al.*, 1999). Indeed, Collins (1999) suggests that the language in the literature has imposed tunnel vision and that *marketing* should be banished from our relationship vocabulary and replaced with *management*, and Carlell and Mägi (1999) even contend that there is a lack of clarity of what is understood by the key term *relationship*. As a result, there is still little consistent story of how relationship marketing and management fit into the greater marketing landscape. The biggest challenge to the theoretical development of relationship marketing and management has perhaps been the lack of empirical investigations that aim at describing and exploring particular aspects of relationship marketing and management programmes implemented in real-life settings (Buttle *et al.*, 2000; Collins, 1999; Lindgreen, 2001; Snehota *et al.*, 1998).

Relationships

Fundamental to relationship marketing and management is *relationships* (Gummesson, 1999; Holmlund, 1997; Page *et al.*, 1998; Roberts *et al.*, 2000). The emphasis in most business models used to be on sick relationships instead of healthy relationships (Young *et al.*, 1989): Two cases in point are the industrial marketing and marketing channels literature that have focused on power, conflict and control (O'Neal, 1989; Rosenbloom, 1991; Stern *et al.*, 1992). With the concept of supply chain management, a more harmonious view of relationships was introduced; and, at the present time, authors argue that the confrontational model of buyer-seller relationships needs to be replaced with a more co-operative one (Davies, 1996; Lehmann, 1997; Lewin *et al.*, 1997).

Relationship quality

Buttle *et al.* (2000) write that *relationship quality* should be of considerable corporate interest because of its possible commercial payoffs. They refer to Eriksson and Vaghult (1999) who suggest that there is a positive effect of relationship satisfaction on customer retention and purchase levels (see also Frisou, 1995); and to Hopkinson (2000) who observes that relationship quality results in a number of benefits for both the buyer and seller, including protection of the customer base and reduced propensity to switch. In a conceptual model of the dynamics of relationship quality that Storbacka *et al.* (1994) developed, service quality translates into customer satisfaction that again translates into first relationship strength, then relationship longevity and finally customer relationship profitability, as referred

to by Buttle *et al.* (2000). See also Fornell (1992), Goderis (1998) and Reichheld (1996) who argue that customer satisfaction translates into higher customer retention; and Bolton *et al.* (1991) and Scheuing (1995) who find that customer satisfaction results in increased shareholder value. As a final example, Zeithaml *et al.*, (1996) propose a nomological network in which relationship quality and service quality positively affect behavioural intentions that are said to lead to behavioural outcomes and increased customer lifetime value.

2. Research issue

Gummesson (1997, 1998) nevertheless notes that the measuring of returns on relationships is still in its infancy. In order to proceed, then, what is relationship quality? Buttle *et al.* (2000, p. 2) acknowledge:

“Despite this potential ... there is relatively little attention paid to the issue of relationship quality”.

Roberts *et al.* (2000, p. 3) argue:

“Though several papers ... have measured the relationship quality between manufacturers and resellers and between salespersons and customers ... there is no tested scale by which service firms can begin to measure the quality of their relationship with customers and thus evaluate the success of their relational programs. Furthermore, it has not been empirically demonstrated whether the quality of the intangible aspects of a relationship adds any additional explanatory power over the commonly used service quality scale (SERVQUAL) in explaining behavioural intentions”.

A number of models attempt to provide insight into the characteristics of strong buyer-seller relationships (Anderson *et al.* 1990; Mohr *et al.* 1994; Morgan *et al.* 1994). In a review of these models, Fontenot *et al.* (1997) identify ten constructs that are included to characterise a buyer-seller relationship: co-operation, interdependence, commitment, trust, opportunistic behaviour, communication, conflict, power, shared values and relationship outcome. Seeking to conceptualise relationship quality, Holmlund (1996, 1997) argues that relationship quality is influenced by the quality of the core product/service (technical dimension), the quality of the interpersonal relationships (social dimension) and the financial costs and benefits attached to the relationship (economic dimension).

More recently, Roberts (1998) and Roberts *et al.* (2000) review the dimensions on relationship quality that have been proposed in the literature and find that most of the

studies have not examined the measure of relationship quality systematically and that different authors have proposed different dimensions. They themselves employ Bagozzi's (1984) framework in order to define relationship quality: attributional definition, structural definition and dispositional definition. The structural definition tells how relationship quality is linked to other related concepts, such as service quality (Crosby *et al.* 1990) and perceived service quality (Parasuraman *et al.*, 1988). The dispositional definition describes the action tendencies or consequences of relationship quality, such as enhanced co-operation, on-

going communication, decreased price sensitivity and increased word-of-mouth (McKenna 1995; Morgan *et al.* 1994; Reichheld 1996). The attributional definition is the most interesting one for the purposes of this article. Roberts *et al.* include six dimensions of relationship quality: trust in credibility, trust in benevolence, commitment, conflict, satisfaction and social bonding. Drawing upon the existing literature (such as in marketing and psychology), they proceed to define each of the dimensions (see table 1) - sometimes using existing definitions (Roberts 1998; Roberts *et al.* 2000).

Table 1. Dimensions of relationship quality - and their background and definition.

Dimension	Background and definition
Trust in credibility	It has been argued that trust is a multi-dimensional construct and that two key dimensions are trust in credibility and trust in benevolence (Anderson <i>et al.</i> , 1990; Ganesan, 1994; Kumar <i>et al.</i> , 1995). Roberts (1998, p. 44) defines trust in credibility as follows. "Trust in a firm's credibility is based on the extent to which the customer believes that the firm's word can be relied upon, that they are sincere, and that they will perform their role effectively and reliably."
Trust in benevolence	Trust in benevolence is, according to Roberts (1998, p. 44), as follows. "Trust in a firm's benevolence is the customer's perception of the extent to which the firm is concerned for the welfare of the customer. This includes having intentions and motives beneficial to the customer when new conditions arise for which a commitment was not made, and avoiding acting in a way that will result in negative outcomes for the customer."
Commitment	It has been said that commitment is an important indicator of relationship quality (Moorman <i>et al.</i> 1992; Morgan <i>et al.</i> 1994). In the organisational literature, commitment may be affective commitment, continuance commitment or normative commitment (Meyer <i>et al.</i> 1993). Roberts <i>et al.</i> (2000, p. 9) argue that affective commitment is the important part of commitment when it comes to business relationships. "[Commitment] may be either affective commitment (attachment to firm), continuance commitment (perceived cost of leaving an organization), or normative commitment (perceived obligation to stay with an organization). ... [Only] affective commitment influences the degree to which the consumer <i>wants</i> to maintain a relationship with the firm."
Conflict	It has been contended that conflict is a negative indicator of relationship quality with greater negative affect leading to greater perceived risk and lower levels of relationship quality (Chaudhuri, 1998; Raven <i>et al.</i> , 1970). Roberts (1998, p. 51) found that conflict is made up of affective conflict and manifest conflict. "Conflict is the tension between two or more social entities that arises from the incompatibility of actual and desired responses. Affective conflict is defined as hostility, frustration and anger towards a partner. This can develop into manifest conflict, which involves behavioural responses, such as open expression of disagreement or overt attempts to block the other's goal attainment."
Satisfaction	It has been noted that satisfaction provides an evaluation of the quality of all past interactions with the service provider, and shapes expectations about the quality of future interactions (Crosby <i>et al.</i> 1990; Storbacka <i>et al.</i> 1994). Based upon that, Roberts <i>et al.</i> (2000) find that Storbacka <i>et al.</i> (1994, p. 25) offer the best definition. "Customer satisfaction is the customers' cognitive and affective evaluation based on their personal experience across all service episodes within the relationship."
Social bonding	It has been stated that social bonding is an important indicator of relationship quality (Barnes, 1997; Berry, 1995; Czepiel, 1990; Parasuraman <i>et al.</i> , 1991; Wilson, 1995). Roberts (1998, p. 56) defines social bonding as follows. "Social bonds are present to the degree that the consumer is recognised by and enjoys interacting with their service provider. Higher levels of social bonding will resemble friendship."

Source: The table draws upon Roberts (1998) and Roberts *et al.* (2000) and Storbacka *et al.* (1994).

But does it really make sense to employ relationship quality as a concept in relationship marketing and management? Are the six dimensions, presented by Roberts (1998) and Roberts *et al.* (2000) as indicators of relationship quality, really appropriate indicators?

As mentioned earlier, there have been very few empirical studies on what constitutes relationship quality - with Holmlund (1996, 1997) and Roberts (1998) and Roberts *et al.* (2000) as notable exceptions - and the literature review which was carried out did not identify any such studies within the agribusiness and the food industry context. There is, therefore, an evident need to develop more knowledge on both relationship quality and the relationship between relationship quality, customer retention and shareholder value. This first part of a larger research was undertaken in order to gain a better understanding of what constitutes relationship quality.

3. Research methodology

Case study method

The research falls naturally into two parts: an *exploratory, qualitative first part* and a *confirmative, quantitative second part*. Only the first part is reported on here. Deductive theory building was difficult because there is no consensus as to what constitutes relationship quality, which is both a contemporary and pre-paradigmatic phenomenon. As a result, it should be investigated within its real-life context. The case study method, which takes a holistic perspective on real-life phenomena with all of their potentially rich and meaningful characteristics intact, facilitates the exploration of complex concepts. Uniquely, the method avoids the need to pre-select the context type variables to be included in the investigation; instead, important contextual variables impinging on the behaviour of interest is observed over time (Creswell 1994; Eisenhardt 1989; Yin 1994). This means that the case study method offered the researcher the opportunity to investigate whether the six dimensions suggested by Roberts (1998) and Roberts *et al.* (2000) are an appropriate framework for describing relationship quality, or whether other dimensions should be included as indicators.

Contextual setting

The *British food and beverage market* was believed to be an interesting context. Britain imports food and beverage products from sectors where it does not have an inherent competitive disadvantage. The reason has been said to be more associated with strong relationships between the foreign exporter and the British importer than with efficiency

of production (Shaw, 1994; Wilson *et al.*, 1997; Woolven, 1996). Denmark and New Zealand have traditionally been among the major producers and exporters of products for the British consumer (Shaw, 1994; Tansey *et al.*, 1995; Woolven, 1996). The *Danish-British dairy sector*, the *Danish-British bacon sector* and the *New Zealand-British wine sector* were chosen specifically as appropriate contexts.

Which cases should then be included? It is important to appreciate that the case study method does not depend on numbers for epistemological justification. Cases should instead be added until theoretical saturation is reached (Eisenhardt 1989). In meetings with trade organisations (i.e., The Danish Bacon and Meat Council; The Danish Dairy Board; The Danish Institute of Agricultural and Fisheries Economics; The Wine Institute of New Zealand), the sample of cases was determined (see table 2).

Most studies on buyer-seller relationships have collected data from a single party in the dyad but such data is often misleading as only one side of the story is examined (Anderson, 1994; Iacobucci *et al.*, 1996). This is why this research focused on the *exporter-importer dyad* in order to correlate perceptions from both the exporter and the importer and to investigate the convergence of the two parties' views (see Table 2). At times, a dyadic approach was not possible, however. For example, confidentiality - combined with a fragile business relationship between the two entities - was a problem in the case of Corbans Wine. In other cases, the British importer did not wish to participate in the research because of time pressure. Geographical proximity (Gummesson 1991) was yet another problem. The research consists of 24 cases in all, i.e. it is a multiple case study.

Theory development from case study data

To induct theory from the case studies, the eight-step procedure proposed by Eisenhardt (1989) was followed. The most important steps are explained below. The overall research problems were first identified to avoid loss of focus:

Does it make sense to employ relationship quality as a concept in relationship marketing and management?

If so, are the six dimensions proposed by Roberts (1998) and Roberts *et al.* (2000) appropriate indicators of relationship quality?

With potentially important indicators of relationship quality specified and with the cases selected, an interview protocol was crafted. Although the case study orientation is generally toward multiple sources of evidence (Yin 1994) in order to refine otherwise fallible observations (Creswell, 1994;

Table 2. Sampling of cases and dyads for the Danish-British dairy sector, the Danish-British bacon sector and the New Zealand-British wine sector.

Sector	Case(s) ^a	Dyad(s) ^b
The Danish-British	The research included <i>MD Foods</i> . More than 90 per cent of all Danish milk is processed at MD Foods that is the only Danish dairy company with a significant export to Britain. After merging with Arla to form Arla Foods, MD Foods is now the largest dairy company in all Europe. The research also included the <i>Danish Dairy Board</i> as a 'background case study'.	
The Danish-British bacon sector	The research included two of the four meat-processing plants in Denmark: <i>Danish Crown</i> and <i>Vestjyske Slagterier</i> . (Of the remaining plants, Steff-Houlberg is oriented strongly toward the Danish market and TiCan has only recently installed its own marketing and distribution activities). The research also included <i>Tulip International</i> (that distributes all bacon products from Danish Crown) and <i>ESS-Food</i> (that distributes some 20 per cent of all Danish pork and pig meat products). The research also included the <i>Danish Bacon and Meat Council</i> and the <i>Danish Institute of Agricultural and Fisheries Economics</i> as 'background case studies'.	<i>Vestjyske Slagterier - Roach Foods</i> <i>Tulip International - Tesco</i> <i>ESS-Food - Bearfields</i>
The New Zealand-British wine sector	The criteria for the vineyards to be included in the research were as follows. They should be of different sizes; it should not be too difficult to get to a particular vineyard; and the vineyards should export to Britain. Five small-sized vineyards (<i>Goldwater Estate</i> , <i>Kumeu River Wines</i> , <i>Te Mata Estate Winery</i> , <i>Trinity Hill</i> and <i>Waiheke Vineyards</i>), two medium-sized vineyards (<i>Babich Wines</i> , <i>Hunter's Wines</i>) and two large-sized vineyards (<i>Corbans Wines</i> and <i>Villa Maria Estate</i>) were included in the research. The research also included the <i>Wine Institute of New Zealand</i> as a 'background case study'.	<i>Kumeu River Wines - Boxford Wine</i> <i>Trinity Hill - Laurent-Perrier</i> <i>Babich Wines - Percy Fox</i>

^aThe 18 cases (on the exporter side), which form part of the research, are italic; ^bThe six cases (on the importer side), which form part of the research, are underlined. There are thus 24 cases in all.

Erlandson *et al.*, 1993; Lincoln *et al.*, 1985), the *in-depth interview* has widely been regarded as the single most important source of evidence when the aim is to understand complex phenomena and processes (Creswell 1994; Easton 1995; Glaser *et al.* 1967; Lincoln *et al.* 1985; Miles *et al.* 1994; Patton 1990). But the research also involved the collection and analysis of existing market intelligence; the analysis of archival data, such as annual company reports, business documents and customer records; and site observations. All of these multiple sources of evidence allowed for *triangulation* of the case study data, which Yin has likened to "the development of converging lines of

inquiry" (Yin 1994: 92). In other words, the findings of a case study are likely to be more accurate if they are based upon many sources of information. Findings were evaluated through the common measures of *validity* and *reliability* issues (see table 3).

The analysis of interview data was carried out in two stages: within-case analysis involving write-ups for each case and cross-case analysis involving searches for cross-case patterns. With regard to *within-case analysis*, each individual case was analysed in a four-stage interactive process that was developed by Miles and Huberman (1994). At the stage of data reduction, the volume of data was condensed. This

Table 3. Design tests and case study tactics that were employed in the research.

Design test	Theoretical explanation of the construct	Case study tactics
Construct validity	Construct validity is to ensure that correct operational measures have been established for the concepts that are being studied.	Multiple sources of evidence Chain of evidence Interview respondents reviewing draft of case study report
Internal validity	Internal validity is to make sure that a causal relationship - i.e., certain conditions lead to other conditions - has been established. Internal validity is a concern for explanatory or causal case studies but not for exploratory or descriptive case studies, which do not attempt to make causal statements.	Pattern matching Rival explanation as patterns Explanation building Time series analysis
External validity	External validity is to prove that the domain to which a case study's findings belong can be generalised.	Specification of the population of interest Replication logic in multiple case studies
Reliability	Reliability involves demonstrating that the findings from a case study can be repeated if the case study procedures are followed.	Interview protocol Clearly conceptualised constructs Multiple indicators Execution of pilot tests Case study data base

Source: The table draws upon Yin (1994) with regards to the theoretical explanation of the constructs. All of the tactics mentioned in the table were employed during the research in order to triangulate the case study data.

also happened in the middle stages of the research through coding and memoing (see below) as well as in the activities of finding themes, clusters and patterns. In the later stages of the research, data reduction occurred when ideas were conceptualised and explained. In order not to reduce data so much that significant information is lost, the research was not stripped from its context (Punch 1998), as evidenced by the many text units (see below). In terms of coding, the researcher put labels against pieces of the data (Glaser 1978; Miles *et al.* 1994; Punch 1998). That is, the coding consisted of summarising the data by pulling together themes and identifying patterns. The approach was to employ a pre-specified coding scheme (Lindgreen 2001) that drew heavily on the six dimensions of relationship quality but also on other constructs that have been suggested as important in relationship marketing and management. In terms of memoing, the researcher sought new patterns and a higher level of pattern coding.

With regard to *cross-case analysis*, one method was to look for inter-group differences in the indicators of relationship quality. Another one was to list similarities and differences between sets of cases. Yet a third method was to divide the data by source and then to establish whether the sources resulted in the same pattern.

4. Exploratory findings

The quality of the relationship between the exporter and the importer was found to be key, as evidenced in the following text units:

"I would like to say that when we talk about relationships, the way that we work is very much about relationships."
Marketing director, ESS-Food.

"You need a relationship with customers, suppliers, staff, management - it goes right through the whole business."
Marketing director, Bearfields.

"I don't think that our marketing is particularly sophisticated or clever ... The key feature of ours is that we are in networks ... I would switch on the network [when trying to locate a new distributor]. We have found that we virtually don't have to move outside of the networks that we are in."
General manager (Name of vineyard withheld for confidentiality reasons).

Overall, the research found strong empirical evidence that relationship quality is made up of the six constructs that Roberts (1998) and Roberts *et al.* (2000) propose. Although the case study may take a variety of forms (Yin 1994), the

Table 4. Research findings and text evidence supporting these findings.

Indicator	The Danish-British dairy sector	The Danish-British bacon sector	The New Zealand-British wine sector
Trust in credibility	<p>"Tesco [one of the largest food retailers in Britain] has agreed with MD Foods that instead of having five suppliers of milk it will cut down its supplier base to only two suppliers. Indeed, Tesco is seriously considering whether or not letting MD Foods being the sole supplier." <i>Marketing director, MD Foods</i></p>	<p>"Our firm participates at trade shows around the world. The cost ... is very high ... but you have to do it because if you suddenly do not participate then [people may think] that we can no longer afford it." <i>Marketing director, ESS-Food</i></p> <p>"I can tell you that Vestjyske Slagterier's credibility with Tesco has increased 100 per cent from their last visit. Tesco visited Vestjyske Slagterier a couple of years ago and the response to these welfare initiatives from them then had been very negative." <i>Marketing director, Rouch Foods</i></p>	<p>"I have a reasonably high profile within the industry because of my long-term involvement, particularly in New Zealand ... so that does give us some advantage in trying to build a new brand. I know all the press people very well right around the world. It is relatively easy for me to get a hearing from anybody. I know all the people in the trade and it is easy for me to open doors. Whereas a new company starting with no person with profile in there is very difficult." <i>General manager, Trinity Hill</i></p>
Trust in benevolence	<p>"The goal for MD Foods is not to increase the market share of its butter products but rather to increase the value of the whole category of butter products at Tesco. MD Foods achieves this goal together with Tesco." <i>Marketing director, MD Foods</i></p>	<p>"We, the trader, take the risk. ... The supplier knows that he is guaranteed payment [from us] and that if the customer who buys the goods go out of business then that is the trader's problem." <i>Marketing director, ESS-Food</i></p> <p>"[People] ... probably trust Tesco more than they would trust the Church of England or certainly more than they would trust the government." <i>Marketing director, Tulip International</i></p>	<p>"She [Margaret Harvey, Fine Wines of New Zealand] has a very good reputation amongst the trade as standing for, representing and knowing something about the quality of New Zealand wines and she has the personal reputation and integrity so she is not going to sell anybody a pup or oversell." <i>Marketing manager, Waiheke Vineyards</i></p> <p>"We have one specific brand manager who looks after Babich specifically in the UK but when their export or marketing man comes over here, they will spend time with my sales team, so they are working with the sales team here seeing customers and promoting their wine." <i>Sales representative, Percy Fox</i></p> <p>"I think that it is important for the producer that its distributor should be able to put his wines into the right client base in the UK. I think in many ways we are able to do that because we have a track record of dealing with the top wine merchants in the UK, which is where Kumeu River needs to be placed. We have always been able to place it in the right outlets." <i>General manager, Boxford Wine</i></p>

Table 4. Research findings and text evidence supporting these findings (continued).

Indicator	The Danish-British dairy sector	The Danish-British bacon sector	The New Zealand-British wine sector
Commitment	<p>"The borders between the producer and the retailer become blurred ... In the near future, a team of MD Foods employees will be working together with a team of Tesco employees; they will do this at the headquarters of Tesco." <i>Marketing director, MD Foods</i></p>	<p>"They [Tulip International] have to deliver the basics, which is competitive pricing, good service level, quality product within specification. They are the main things in terms of what you expect as a minimum. And then you expect clients to work with you and together to take profit out of the supply chain, to share information together on the supply chain." <i>Key account manager, Tesco</i></p>	<p>"[Are] we supplying them with the appropriate strategies and objectives, quality of wine, pricing, support? You have to look at it on both sides. It is never just the fault of the distributor." <i>Export manager, Corbans Wines</i></p>
Conflict	<p>"Although MD Foods and the retailers together agree prices on the products there are certain purchasers ... who do backtracking ... who want to squeeze the price." <i>Marketing director, MD Foods</i></p>	<p>"To customers who had shown little loyalty, Vestjyske Slagterier said that it did not feel obliged to do something extra for these customers. Of course, Vestjyske Slagterier did what was possible but it did not ship additional products. ... [The industrial action] has been a major problem for these customers. That is always the case: you are very vulnerable if you have only one product." <i>Marketing director, Vestjyske Slagterier</i></p>	<p>"And even when the business relationship is under some stress, it is extremely important that both companies are able to deal with that pressure of stress without the relationship becoming negative. I must say that with this particular brand partner, we have had a high degree of stress and pressure in the relationships and there has been very few points this year where it has spilled over into negativity." <i>Export manager, Corbans Wines</i></p>
Satisfaction	<p>"Preferred suppliers and customers ... are looking for the total service offering or the total experience." <i>Marketing director, MD Foods</i></p>	<p>"It is important to have a good relationship to a customer because he is prone to accept a faulty delivery. That is not the case with the customer who only buys once in a while." <i>Marketing director, ESS-Food</i></p>	<p>"We actually give each other a shake up now and again ... Yes, we are very good friends." <i>Marketing manager, Waiheke Vineyards</i></p>
	<p>"Preferred suppliers and customers ... are looking for the total service offering or the total experience." <i>Marketing director, MD Foods</i></p>	<p>"What is a relationship? It is very much about service. That is, we can make life easier for a customer in Britain; we can offer him a product so he does not need to call a lot of people; we can supply a product that meets his production requirements or his specifications." <i>Marketing director, ESS-Food</i></p>	<p>"Kumeu are the only New Zealand winery that we work with, although this was not always the case. ... I am not interested in representing other wineries." <i>General manager, Boxford Wine</i></p>
	<p>"I need up-to-date information ... It is all about information. The more information I have got, the more I know what to do with the market." <i>Marketing director, Bearfields</i></p>		

Table 4. Research findings and text evidence supporting these findings (continued).

Indicator	The Danish-British dairy sector	The Danish-British bacon sector	The New Zealand-British wine sector
Social bonding	<p>"[Social bonding] is an attempt of saying: we spend a lot of time together, and it is much better spending that time with people you like. If you get along well in private with people [with whom you work] it is much easier to get things through, to land the order." <i>Marketing director, MD Foods</i></p>	<p>"With a close relationship to the customer we have - perhaps not the exclusivity - but definitely access to the customer." <i>Marketing director, ESS-Food</i></p> <p>"It is very, very important that the personal relationships are up and working." <i>Marketing director, Vestjyske Slagterier</i></p>	<p>"We have stayed with them and they come and stay with us here and over a ten-year period I think we have got a very good relationship with the family as a whole. Obviously, it helps in business if you are friends as well as colleagues and I think we probably are." <i>General manager, Boxford Wine</i></p> <p>"It is person to person." <i>Marketing manager, Waitheke Vineyards</i></p>

essential characteristic is that the report contains explicit presentations of the key evidence that were used to draw the conclusions. This, however, makes the case study reporting discursive and readers find the lengthy description of results exhausting. Therefore, a number of text units supporting the research findings have been collected in Table 4 so that in the following only a few examples are given to show the appropriateness of the six dimensions of relationship quality.

Trust in credibility and trust in benevolence

The two constructs of trust in credibility and trust in benevolence were found to be important in exporter-importer dyads. An importer thus places much trust in a vineyard's credibility if the vineyard produces wines of consistently high quality and/or if the people working with the vineyard have in-depth knowledge of the wine sector and a prominent position within the wine community:

"I think it [trust in credibility] depends on the quality of the wine, and in our case we are New Zealand's most highly awarded wine company and that has given us credibility amongst all of our distributors." *Export manager, Villa Maria Estate.*

"I think [that] anybody who has met the family [Brajkovich] understands the respect with which they are regarded within the New Zealand wine trade. It would be impossible not to trust them. Their late father was highly regarded and respected within the New Zealand wine trade ... and the rest of the family is held in similar regard." *General manager, Boxford Wine.*

An importer can improve his credibility by choosing to represent only the best wines and/or to go the extra mile for the exporter when identifying the best outlet for the wines:

"It is important that the product be distributed throughout the best wine merchants ... We could, if we wanted to, actually sell all the wine through just two outlets but I do not think that [this] is the long-term benefit of Kumeu River." *General manager, Boxford Wine*

Frequent and forthright communication between the parties was found to foster trust in benevolence, as echoed in the following text unit:

"I think that a customer appreciates a flow of information. You must be able to supply information about what is happening in the market ... If you cannot do this the

customer will be very unhappy and probably leave you." *Marketing director, ESS-Food*

Social bonding

The social bonding that was mentioned is a key element. For example, the general manager of a New Zealand vineyard argued that his network has been the single most important factor in the success of the vineyard, as evidenced in the last of the above three statements. The general manager first served his apprenticeship with Firm A before buying Firm B, a chain of specialist wine shops in London. At the same time, because he attended night school, he became part of a network consisting of similar young people who later went on to senior positions in the wine trade. The value of the network has been evident:

"Because I knew everybody in the English wine trade, it was not a matter of me finding someone to sell it. I was just dealing with friends. When I walked in they did not just say: 'oh, New Zealand wine, forget it.'" *General manager (Name of vineyard withheld for confidentiality reasons).*

The manager of the vineyard does not move outside the network so when the vineyard wants to develop a new wine market (in a new country) it will ask its current importers to signal to their colleagues in the new wine market that the vineyard is available for distribution. A formal interview and evaluation process will then take place during which the vineyard will confer with the existing importers:

"We have found that we virtually do not have to move outside of the networks that we are in. That is fine because you know where all your money is going and whether you are going to get paid or not and how your goods are going to be sold and presented and all the things that are important. It is the easiest way to do it when you are a small player based in New Zealand." *General manager (Name of vineyard withheld for confidentiality reasons).*

With regard to the British wine market, the vineyard decided to let Firm C distribute its wines, partly because this firm is widely known within the British wine trade. But the single most important reason the vineyard chose this particular importer was that the general manager had worked in the company back in the 1960s and he has been close friends with the importer ever since, as evidenced in the following text unit:

"I worked for the [Firm C] in [the 1960s] and we are close friends ... We are all in bed together, and we are throughout

the world." *General manager* (Name of vineyard withheld for confidentiality reasons).

Commitment

The research findings suggest that successful export-importer relationships were characterised by a high degree of commitment from both parties. MD Foods - the Danish dairy firm - and its business partners (i.e., suppliers and customers) is a case in point: MD Foods will assess potential business partners and only when a partner demonstrates enough good will, skill and importance is the firm ready to invest in a relationship:

"With regard to importance, if a customer has only little importance for MD Foods then it really does not matter whether this customer has the necessary will and skill ... It is important to realise that we commit substantive resources to a business partnership." *Marketing director, MD Foods.*

When a partner shows promise, MD Foods seeks to build and strengthen the relationship. For example, MD Foods' only remaining bottle supplier is now conveniently located next to the headquarters of MD Foods and that makes co-operation and co-ordination easier: business processes are thus fully integrated through the SAP R/3 systems. Another example is Tesco, which is one of MD Foods' most important customers: In this case, MD Foods had to demonstrate will, skill and importance before it was nominated as one of Tesco's preferred suppliers of butter. The commitment to the business relationship in both cases is strong, as evidenced in the following text units:

"In the near future, a team of MD Foods employees will be working together with a team of Tesco employees. They will do this at the headquarters of Tesco." *Marketing director, MD Foods.*

"MD Foods brings the chief executive ... to Denmark in a private jet ... It is not a question of money ... We get value for our money because it is possible for us to become a player." *Marketing director, MD Foods.*

In conclusion, the evidence suggests that (1) it does make sense to employ relationship quality as a concept in relationship marketing and management, and that (2) the six dimensions that Roberts (1998) and Roberts *et al.* (2000) argue are indicators of relationship quality really are appropriate indicators.

5. Managerial Implications

One of the most important managerial implications of the research findings is that companies should now consider not only the quality of their products and services but also the *quality of their relationships with suppliers, customers and other important markets*. A high-quality relationship translates into customer retention and, subsequently, shareholder value creation (see the *Future Research* section). It is possible to improve the quality of a relationship by investing in one (or more) of six different areas: trust in credibility, trust in benevolence, commitment, conflict, satisfaction and social bonding. For example, employees might be encouraged to form social bonds with their business partners ("Obviously, it helps in business if you are friends as well as colleagues", *General manager, Boxford Wine*), perhaps to such an extent that it becomes difficult to distinguish between a business relationship and a friendship ("We are very good friends", *Marketing manager, Waiheke Vineyards*). Another example is for partners to demonstrate that they are trustworthy ("A word is a word ... If we have agreed on a price then we do not change that price", *Marketing director, ESS-Food*).

Another equally important managerial implication is that companies must *invest in their employees*, since relationships are formed between employees from separate companies ("It is about multi-level contact in each area in the organisation, regular and structured communication", *Export manager, Corbans Wines*). This again means that managers should assess not only the relationships with their business partners but also with the employees within their company.

A third managerial implication of the research findings is that managers should put less emphasis on developing close business relationships by using economic incentives or computer-based systems (as many customer relationship management systems appear to be doing), as these are easy to duplicate. Instead managers should *cultivate their relationships*, because it is difficult for competitors to offer similar ones, as it takes much effort and many years to build strong relationships ("It [the forming of close relationships] does not happen overnight. It can take quite a while", *Export manager, Villa Maria Estate*).

6. Future research

This article has focused on the indicators of relationship quality. However, the evidence from the research also suggests that relationship quality translates first into customer retention and then shareholder value creation (see figure 1): there is thus a positive relationship between all of the antecedents and relationship quality (except for conflict), and there is a positive relationship between

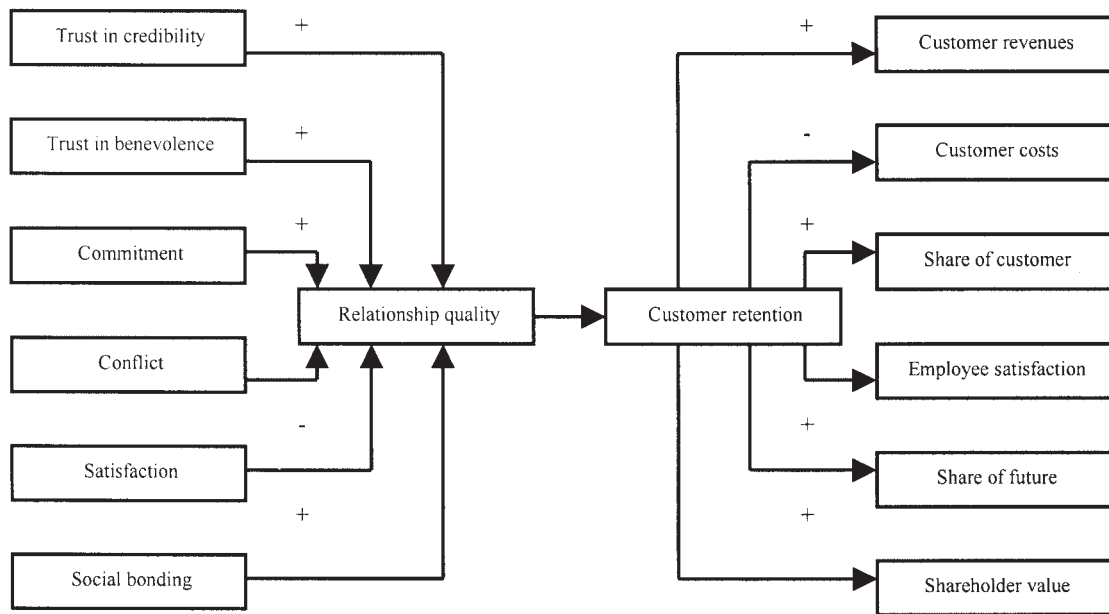


Figure 1. The relationship quality - customer retention theory of shareholder value creation.

customer retention and all of the consequences (except for customer costs).

The proposed relationship quality - customer retention theory of shareholder value creation is parsimonious, permitting no direct path from any of the antecedents of relationship quality to any of the consequences of customer satisfaction. The model implies a central nomological status for relationship quality - customer retention.

It is proposed to test the idea of Figure 1 in a confirmative, quantitative second part of the research. In structural equations modelling, however, rival models should be compared (Bollen *et al.*, 1992; Morgan *et al.*, 1994). A non-parsimonious rival model is one that positions only direct paths from each of the pre-cursors to the outcomes, thereby making relationship quality and customer retention nomologically similar to the antecedents of relationship quality and thus allowing no indirect effects (i.e., relationship quality and customer retention cannot mediate any of the relationships). There is a positive relationship between all of the pre-cursors (except for conflict) and the outcomes (except for customer costs).

The New Zealand-British wine sector is proposed as an appropriate research setting. There are many independent vineyards with only few elements of vertical integration. Because most of the vineyards carry only a small number of wine labels, their relationships with British importers are potentially important enough for the research issue to be meaningful. Restricting the sample to this homogeneous population, extraneous sources of variation are minimised. The relatively large number of vineyards (more than 300)

and extreme competitive pressures from other producing countries, such as Australia, the US and Chile, increase the likelihood of there being large variance to be explained (please refer to Appendix A).

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Innovative electronic auctions in supply and demand chains: Empirical research in the flower industry

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Abstract

Exploiting the Internet for commercial ends has become a key theme for most organizations. There are significant advantages for both buyers and sellers in using this medium. Savings are made as a result of reducing transaction costs, increasing the circle of potential customers, and improving the search-and-find capabilities for all parties concerned. At the moment there are several hundred Web-based auctions. And yet the place to see state-of-the-art auctions is not on the Web but rather in one of the dozen or so auction halls in Holland. This article analyses different electronic auction initiatives in the Dutch flower industry. These auctions use the "Dutch auction" as price discovery process. In a Dutch auction the auctioneer offers products at successively lower prices until his offer is accepted. Most auctions on the Web today use the English method. An English auction process involves a succession of increasing bids by potential buyers until the highest (and final) bid is accepted by the auctioneer. But the Dutch method offers advantages, as the flower auctions reveal. The Dutch method is much faster and tends to generate higher prices. This is illustrated by presenting the results of experimental economic research with different Web-based auctions. One of the analysed electronic auction initiatives, Tele Flower Auction, shows that electronic auctions have an impact on the chain configuration and its performance. Conclusions are formulated and further research is discussed.

Key words: chain management, Dutch auction, electronic markets, experimental economics, flower industry

1. Introduction

The rapid developments in information and communication technology (ICT) and its applications in business have resulted in electronic markets being increasingly popular. Significant benefits are obtained by reducing transaction costs, increasing the circle of potential customers, and improving the search-and-find capabilities for all parties concerned (Van Heck and Vervest, 1998). An electronic market is defined as an inter-organisational information system through which multiple buyers and sellers interact to accomplish one or more of the following market-making activities: (1) identifying potential trading partners, (2) selecting a specific partner, and (3) executing the transaction (Choudhury *et al.*, 1998). Examples include airline reservation systems such as SABRE and APOLLO (Copeland and McKenney, 1988); AUCNET for the sale of used cars (HBS, 1988); TELCOT in the cotton industry (Lindsey, 1990); Inventory Locator Service (ILS) in the aircraft parts industry (Choudhury *et al.*, 1998), and numerous auction examples on the Web (for example eBay.com, FastParts.com, Onsale.com, FreeMarkets.com).

The primary benefit offered by an electronic market is efficient market search, or electronic brokerage (Malone *et al.*, 1987). The impact of lower search costs might result in

dis-intermediation in the marketing channel and commoditization of the market, resulting in increased price competition (Bakos, 1991; Bakos, 1997; Malone *et al.*, 1987). However, little empirical evidence exists to support these claims. Choudhury *et al.* (1998) analysed an electronic market in the aircraft parts industry and showed that current models do not adequately capture the complexity of electronic markets. For instance, while ILS sometimes helped buyers to find a better price, in other cases it helped suppliers extract an extra premium by providing more accurate information on parts availability. ILS also had little impact on the extent to which brokers are used, although the specific nature of the value added by brokers appears to be changing. Finally, inventory levels in the industry have been unaffected by the use of ILS. However, as Choudhury *et al.* also describe, the ILS electronic market is limited in scope. It includes the capability of helping a firm to identify a set of potential trading partners for a transaction. In ILS it was not possible to select and execute a transaction. So caution must be exercised in generalizing the findings to systems that also support selection and execution. Therefore the impact of ILS on prices could not be measured directly.

Given the preliminary state of current knowledge and evidence on the impact of electronic markets it is believed, also by Choudhury *et al.* (1998), that the appropriate strategy

for gathering empirical evidence is not a broad-based survey but rather in-depth studies of multiple electronic markets. The underlying premise in advocating this approach is that the use and impact of electronic markets may be influenced by product, transaction, system, and industry attributes that have not been identified in the literature to date. As Choudhury *et al.* (1998) point out “a cumulative body of case evidence that helps to identify these variables needs to be built”. This paper goes a step further toward that objective with a study of electronic markets which support identification, selection and execution: electronic auctions in the Dutch flower industry. Electronic markets in the Dutch flower industry are particularly interesting due to the perishable nature of the product with high time-specificity and complex product descriptions. The paper begins by presenting a stakeholder/process framework. This framework is useful in analysing electronic markets and auctions. In section 3 different case studies on electronic markets and auctions in the Dutch flower industry are presented. It is concluded that the traditional Dutch flower auctions - and their electronic versions, like Tele Flower Auction (TFA) and Buying at Distance auction (BADA), are successful in supply-oriented chains. These auctions use the “Dutch auction” as price discovery process. In a Dutch auction the auctioneer offers products at successively lower prices until his offer is accepted. Most auctions on the Web today use the English method. An English auction process involves a succession of increasing bids by potential buyers until the highest (and final) bid is

accepted by the auctioneer. But the Dutch method offers advantages, as the flower auctions reveal. The Dutch method is much faster and tends to generate higher prices. This is illustrated by presenting the results of experimental economic research with different Web-based auctions. Section 4 describes the electronic Web-based market system (including bilateral bargaining and different auction mechanisms) which will be used in these experimental settings. Results of one of the experiments are presented. The paper concludes in section 5 with implications and suggestions for further research.

2. Analysing exchange organizations

Kambil and Van Heck (1998) specified a generalizable model of exchange processes and developed a process-stakeholder analysis framework to evaluate alternative market designs. In this framework, see figure 1, five basic trade processes (search, valuation, logistics, payments and settlements, authentication) and five trade context processes (communications and computing, product representation, legitimation, influence, dispute resolution) are distinguished. This framework is applied to analyse a number of ICT initiatives in the Dutch flower markets. The ICT initiatives analysed are the Vidifleur and the Sample Based Auction, see also Van Heck and Groen (1994); the Tele Flower Auction, see Van Heck *et al.* (1997) and Van Heck and Ribbers (1998); and the Buying at Distance System.

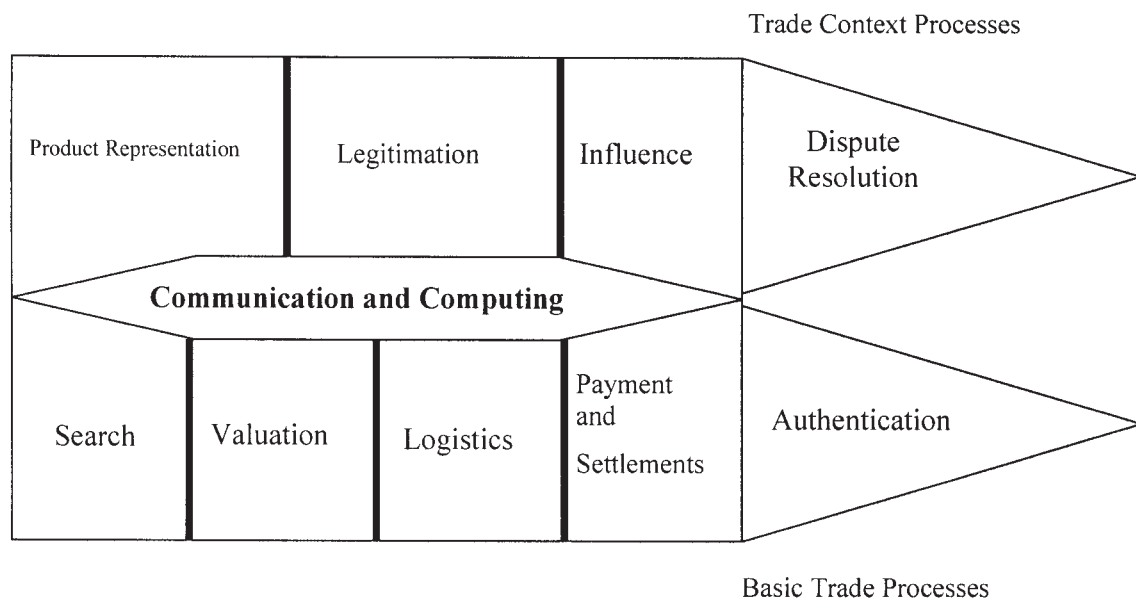


Figure 1. Generalized model of exchange processes (Kambil and van Heck, 1998).

3. Case studies in the Dutch flower industry

In this section we will discuss the characteristics of the Dutch flower industry, the Dutch auction method, and the four electronic auction initiatives in this industry.

The Dutch Flower Industry

The Netherlands is the world's leading producer and distributor of cut flowers. The Dutch dominate the world export market for cut flowers with approximately a 59 per cent share and for potted plants with a 48 per cent share. The world's two biggest flower auctions are in Aalsmeer (VBA) and Naaldwijk/Bleiswijk (BVH); where every day on average 30 million flowers - originating not only from the Netherlands but also from countries such as Israel, Kenya and Zimbabwe - are traded in 100,000 transactions. The Dutch flower auctions play a vital role in Holland's leadership of this industry, by providing efficient centres for price discovery and transactions of flowers between buyers and sellers. These auctions traditionally use the "Dutch auction" as the mechanism for price discovery. They are established as cooperatives by the Dutch growers.

The Dutch flower auction concept

In this section we shall describe the auction rules of the Dutch flower auction concept. Dutch flower auctions use a clock for price discovery, as follows. The computerized auction clock in the room provides the buyers with information on producer, product, unit of currency, quality, and minimum purchase quantity. The flowers are transported through the auction room, and are shown to the buyers. The clock hand starts at a high price determined by the auctioneer, and drops until a buyer stops the clock by pushing a button. The auctioneer asks the buyer by intercom, how many units of the lot he or she will buy. The buyer provides the number of units. The clock is then reset, and the process begins for the left-over flowers, sometimes introducing a new minimum purchase quantity, until all units of the lot are sold. In the traditional way, buyers must be present in the auction room. The Dutch flower auction is an extremely efficient auction mechanism: it can handle a transaction every four seconds.

Four electronic auction initiatives

Table 1 describes the main characteristics of the electronic auction initiatives and their processes.

The vidifleur auction

Vidifleur intended to use video auctioning to decouple price determination and logistics, and to allow buyers to trade

from outside the auction hall. When the product arrived at the auction, a picture was taken, digitised and stored in auction computers. The computer transferred the picture for display to a screen in the auction hall, where buyers could bid for the product based on the image of the product. Buyers were also able to bid for and look at the potted plants on computer screens in their private auction offices. The computers in the private offices provided a screen-based representation of the clock, which was synchronized with the clock in the auction hall.

Buyer reaction to screen-based trading was negative and led to the termination of the experiment in late 1991. Buyers cited three main reasons for not adopting the new system. First, the clock-based trading system provided no new efficiencies for the buyer. Second, the quality of the auction hall video display was perceived as poor, and trading from outside the auction hall created an informational disadvantage. In floor-based trading the buyers could observe each other, and the reactions of other major buyers to specific bids. Third, at the back of each auction hall is a coffee shop where buyers interact informally and share information about the market. Again, access to the social interaction and information was more difficult through screen-based trading.

The sample-based auction

Flower Auction Aalsmeer began a sample-based auction for trading potted plants in 1994. In this concept, growers sent a sample of the product to the auction house along with information on available inventory. During the auction the sample represented the entire inventory available to buyers who could bid for the product and specify product packaging and delivery requirements. Growers then packaged the product, as specified, and delivered it the next day to the buyer location in the auction complex or to other buyer warehouses. Buyers had to be physically present in an auction room. Growers, buyers, and the auction used electronic data interchange (EDI) to share all information required in this process. This trading model reduced the number of times a product was handled, reducing overall packaging costs and damage.

The different actors, the growers, the buyers, and the auction, expected a number of different benefits. First, by uncoupling logistics and price determination, the auction and growers expected the number of transactions per hour to increase. In reality the number of transactions per hour decreased as buyers had to specify terms of delivery. Second, while the auction expected 45% of the supply of potted plants to be transacted in the sample-based auction, only 10% of the product was transacted this way. Thus, SBA also did not effectively reduce storage requirements at the auction. After numerous attempts to increase the volume of sample-based

Table 1. Characteristics of four electronic auctions in the Dutch flower industry.

Variables	Indicators	Vidfleur Auction (VA)	Sample-Based Auction (SBA)	Tele Flower Auction (TFA)	Buying at Distance Auction (BADA)
General Parameters	Intermediary	Flower Auction Holland (BVH)	Flower Auction Aalsmeer (VBA)	East African Flowers (EAF)	Flower Auction Holland (BVH)
	Sellers	Dutch growers as members of cooperative	Dutch growers as members of cooperative	Non-Dutch growers	Dutch growers as members of cooperative
	Buyers	Wholesalers	Wholesalers	Wholesalers	Wholesalers
	Products	Potted plants	Potted plants	Flowers	Flowers
	Start (End) Year	1991 (1991)	1994 (1994)	1995	1996
Basic Trade Processes	Search	Buyers can have a look in the storage rooms	Buyers can have a look in the storage rooms	Buyers can search supply data base	Buyers can search supply data base
	Valuation	Dutch auction clock	Dutch auction clock	Dutch auction clock	Dutch auction clock
	Logistics	Via auction room to buyer's place	Directly from grower's to buyer's place	Directly from storage room to buyer's place	Via auction room to buyer's place
	Payments and settlements	Within 24 hours; guaranteed by intermediary	Within 24 hours; guaranteed by intermediary	Within 24 hours; guaranteed by intermediary	Within 24 hours; guaranteed by intermediary
	Authentication	Quality grading on lot	Quality grading on sample	Quality grading on lot	Quality grading on lot
Trade Context Processes	Communication and computing	Computerized clock in room and on PC screen, video image on screen in room	Computerized clock, EDI with growers and buyers	Computerized clock on PC screen, 1 digital image on PC screen, EDI with growers and buyers	Computerized clock in room and on PC screen, no digital image on PC screen, some buyers use video system, EDI with growers and buyers
	Product representation	Real lot on site; video image on screen	Sample of lot	1 digital image on PC screen	Real lot on site
	Legitimation Influence	By intermediary Growers are owner of intermediary	By intermediary Growers are owner of intermediary	By intermediary Intermediary is importer of foreign flowers	By intermediary Growers are owner of intermediary
	Dispute resolution	By intermediary	By intermediary	By intermediary	By intermediary
Overall result		Failure	Failure	Success	Success

auctions they were discontinued in late 1994. The system had a negative effect on the functioning of growers, the auction house, and buyers. The sample-based auction system ended as a complete failure.

The tele flower auction

An important effect of the import restrictions imposed by the Dutch flower auctions was the creation of TFA by East African Flowers (EAF) (Van Heck *et al.*, 1997). EAF is one

of the biggest importers of cut flowers; they specialize in supply from East Africa (Kenya, Tanzania, and Uganda). For EAF, the effect of the import restrictions was that 30% of their imports could no longer be traded via the Dutch auction clocks during the traditional import season; in the summer season 100% of their imports could not be traded at all. EAF announced the creation of TFA in December 1994. On March 24, 1995, TFA was launched with 2 growers and 70 buyers. After some months, EAF decided that growers from other countries (for example, Spain, Colombia, France, India, and Israel) were allowed to use TFA. After one year, approximately 35 growers and 150 buyers were connected to TFA.

In the TFA, buyers can bid via their personal computer (PC) screens. Each PC is connected to a fully computerized auction clock. Logistics and price discovery are uncoupled. Flowers are no longer visible for buyers, and buyers are no longer physical in an auction room. The PC provides the buyer with information on the next flower lots. On a PC, the buyer can earmark interesting lots, so at the time those lots will be auctioned, the PC will warn the buyer. The PC provides information on the producer, product, unit of currency, quality, and minimum purchase quantity. For each lot one image is presented on the PC screen. The underlying auction concept remains the same: the Dutch flower auction. On the PC screen the buyer sees the Dutch auction clock. The clock hand starts at a high price, and drops until a buyer stops the clock by pushing the space bar on the keyboard of the PC. The auctioneer asks the buyer, via an open telephone connection, how many flowers of the lot he or she will buy. The buyer provides the amount. The clock is then reset, and the process begins for the next units, until the remainder of the lot is sold.

Growers send the flowers to EAF, and EAF stores these flowers in Amstelveen. Logistics and price discovery are uncoupled within the auction hall. The distribution of the flowers from the Amstelveen area to the buyer's addresses (nearby the traditional auctions of Aalsmeer, Naaldwijk, and Rijnsburg) is done by transporters of EAF. Transport costs are paid by EAF.

Compared with SBA, buyers can trade at a distance. TFA provides better and more frequently updated supply information. The speed of the TFA system is amazing. Not only the auctioning process, but also the after-sales process is very fast; sometimes within half an hour products are delivered at the buyer's address. It soon became clear that one of the main propositions of TFA was that the quality of the flowers determines the buyers' trust in the TFA concept. TFA's motto is: "Buyers have to trust the quality blindfolded", because buyers cannot physically see the product anymore. Still, buyers who are nearby TFA can inspect the imported flowers; 30% of the buyers do so regularly. Reliable product

information and stable quality control are essential. Quality control is done by TFA's quality inspectors at the grower's place, at the distribution point in Nairobi (Africa), and at TFA in Amstelveen. Buyers also trust the IT innovations. One of the reasons seems to be that the Dutch auction clock is still the price discovery mechanism; buyers are used to that mechanism. Buyers were enthusiastic about the quality and the delivery time of the auctioned products, and about the service level of TFA. The prices were on average not higher or lower than in the traditional Dutch flower auctions. TFA expected a turnover of 50 million dollars for the growing season 1995/1996. Compared with the seven Dutch flower auction, TFA ranks fourth.

The buying at distance auction

Flower Auction Holland started in June 1996 with the concept of "buying at distance", elaborating on their previous experiences with the Vidifleur project. The concept is that buyers can connect their PC with a modem to several auction clocks in the auction rooms. On their PC screen they can click on an icon and open up a window for every clock available. The "buying at distance" project started with 6 clocks and 16 buyers. In 1997 already 60 buyers were on the waiting list. In 2000 approximately 90 buyers were connected to the system. The other flower auctions in the Netherlands also implemented their buying at distance auctions. The connected buyers perceived buying at distance as successful due to the lower search costs - one can search in the supply database for certain products or growers - and due to the better overview of the marketplace - one can easily switch among different auction clocks. Also, lower travel costs were reported. A reported side-effect of this system was that one of the members of the purchasing crew had to come back into the office - for the online purchasing - and therefore communication with the sales department improved. The auction house mentioned that the amount of buyers (physically or electronically connected) in one marketplace will be stable or increase, and that might increase the auction prices.

Lessons learned

The following lessons were learned from the experiences with electronic auctions in the Dutch flower industry.

Lesson 1: The application of information technologies to trading can enable increased efficiencies and separation of informational and physical trading processes. This in turn will permit more varied forms of trading customized to different user requirements (Kambil and van Heck, 1998).

The four cases illustrate the use of IT to separate the informational and physical trading processes. In all cases the valuation and logistical processes are increasingly de-coupled in time and space. TFA de-couples logistics and price discovery in the auction hall. Therefore, the internal logistics of the auction hall are much simpler, compared with the traditional auction system. This explains why TFA has a much better logistical performance and service level, in the opinion of the buyers. EAF paid much attention to its after-sales program (providing transport to the buyers). The TFA case shows the impact of the electronic auction on the supply chain configuration and its performance. In this case the use of electronic auctioning leads to simpler logistics and distribution and a better logistical performance of the total supply chain. For consumers it could mean fresher flowers for the same price.

Lesson 2: Conformance of the actual and the perceived quality of the product, logistical performance, and IT performance result in high trust; high trust contributes to a successful electronic auction system (Van Heck *et al.*, 1997).

In the SBA the buyers chose to discount the prices bid for non-sample lots by nearly ten percent because they could no longer authenticate quality by visual inspection. Logistical performance was questioned by growers, and buyers. No problems were reported about the IT performance as such. In the TFA case, sellers and buyers find that TFA keeps their promises concerning quality of products, delivery time of products, and reliability of IT performance. Buyers trust the TFA products. Usually, they get better products than expected from the data and images provided on the PC screen, due to a centralized quality control program. Buyers also trust TFA, because the underlying auction concept is the same: the Dutch flower auction. Buyers trust the IT innovation: if a buyer is the first to push the space bar on the PC keyboard, he or she is certain that the computer network transfers this signal quickly and reliably, regardless of the distance between the buyer's computer and the auction computer.

Lesson 3: Market organizations are the meeting point for multiple stakeholders: buyers, sellers, and intermediaries with conflicting incentives. Given existing or competing market alternatives, no new IT-based initiative is likely to succeed if any key stakeholder is worse off after the IT-enabled innovation (Kambil and van Heck, 1998).

In the two cases of failure, the application of the process-stakeholder framework clearly identified that either the

grower or the buyer was worse off from the innovation. For example, the SBA failed to meet expectations for many reasons. First, the incentives and benefits to buyers and growers (in particular) did not change substantially to encourage their participation in this market. Specifically, growers received no extra compensation for modifying packaging and delivery practices to suit the customer. Second, the growers perceived that they got lower prices in a slower auction. To overcome this disadvantage growers would break the same product into different sample lots so that it would be priced multiple times during the auction hoping it would lead to higher prices. Third, the auction rules initially did not provide incentives to buyers by supporting transactions on large lots. Instead, the auction maintained rules to favor transactions in small lots. Thus, an insufficient number of buyers and sellers initially adopted this new form of trading. In the Vidifleur auction, the buyers did not perceive a new benefit from the system. The video quality was poor, authentication of quality less convenient, and trading online did not provide all the information available in the auction hall.

Lesson 4: New entrants, facing established dominant players, can quickly build competitive advantage with an innovative auction system concept (Van Heck *et al.*, 1997).

The TFA case demonstrates the way a new entrant may use IT in an innovative way, in order to enter a market and compete with dominant players in that market. The efforts to reduce foreign access to the traditional Dutch auctions, led buyer organizations and foreign growers to announce the creation of competing auctions. Indeed, EAF's development and introduction of TFA is one of the initiatives created in response to these import restrictions by the traditional Dutch flower auctions. It was the first time in Dutch history that an importer organization performed this function. Traditionally, the Dutch flower auctions are established as cooperatives by the Dutch growers. Another interesting point was the high speed of entrance. The import restrictions came into effect in October 1994. At that time EAF developed the first ideas about TFA. TFA started in March 1995. So EAF developed and implemented TFA in a few months. This case shows that new entrants can quickly build a competitive advantage. It illustrates the conclusion derived by Clemons *et al.* (1996) concerning the strengths of new entrants in a competitive market. Besides the strengths of TFA, the weaknesses of the traditional Dutch auctions partly explain the success of TFA. The cooperative structure of the Dutch auctions (every single grower has one vote), the complexity of the after-sale logistics (due to the coupling of the logistics with the price discovery process),

and their inability to implement IT innovations quickly further decreased the market share of TFA's competitors. In the near future we expect that the Dutch auction method will become popular on the Web (Van Heck, 2000). The Dutch auction method offers advantages. For one thing, the Dutch method is much faster. When a large quantity of easily evaluated goods must be sold quickly, it is ideal. Second, the Dutch method tends to generate higher prices. To avoid losing a particular lot, buyers will often stop the clock at a higher price than they would have offered in competitive bidding. To investigate this proposition we built a Web-based market system, which can be used to conduct experimental research on different aspects of innovative electronic markets and auctions.

4. Innovative electronic auctions and experimental research

In this paper we will discuss one of the experiments. In this experiment we compared bilateral bargaining, with English and Dutch auctions. We are particularly interested in the existence of the winner's and loser's curse. The winner's curse refers to the phenomenon that the winning bidder will be the bidder with the most optimistic estimate of the good's value, so he or she may end up paying too much for the good. This contrasts with a situation in which a failure to anticipate the informational content of a bid's acceptance will cause one to bid *below* the optimal bid, resulting in a loser's curse (Holt and Sherman, 1994). In a laboratory experiment, it is possible to select parameter values so that the winner's curse bias dominates the loser's curse bias, and vice versa. It is also possible to choose parameters so that these two effects exactly balance each other, for a "no curse" treatment. So, we considered three bargaining situations (bilateral, English auction, Dutch auction) under three different treatment conditions (winner's curse, no curse, loser's curse).

Web-based system and experimental design

In the laboratory experiment we used a Web-based market system. The Web-based market system consists of four different subsystems:

- Bilateral brokerage method;
- English auction method;
- Dutch auction method;
- Auction control functions.

The auction control functions enable the auctioneer to select an auction from the database and execute it. For the platform of the Web-based market system we use a TCP/IP network (Internet or Intranet) with 1 *server* running Windows NT

4.0 Server with Internet Information Server (ISS) version 4 and 20 *clients* running Windows NT 4.0 Workstation with Microsoft Internet Explorer. CommercePack version 1.5 from InfoCommerce was selected as server application software.

The laboratory experiments took place in the ENECO RSM trading room. This room facilitates electronic trading systems and is equipped with 20 PC's. The experiment was done with 13 subjects on May 12, 1999. Subjects were recruited from graduate business administration and information management classes at Rotterdam School of Management (RSM). Upon arrival in the laboratory, subjects were seated at personal computers, they read the instructions and the instructions were also read aloud. Each subject made bidding decisions for 10 trials in the bilateral bidding method and 5 trials in the English and Dutch auction bidding methods. For the detailed instructions see Appendix 1. Cumulative earnings were set to the initial level of NLG 10.00. Subjects were paid at the end of the experiment.

Results

In the experiment the following results were obtained related to the winner's curse, no curse, and loser's curse. Table 2 presents the bid results related to the winner's curse, no curse, and loser's curse for bilateral bargaining, English auction, and Dutch auction. The results indicate that the bid levels of the English auction are significantly higher compared with bilateral bargaining; and that the bid levels of the Dutch auction are significantly higher compared with the English auction. Under conditions of the loser's curse the bid levels of English and Dutch auctions came close to the rational bid level. Under the conditions of winner's curse the results of English and Dutch auctions were significantly above the rational bid level. It is also concluded that for the bilateral bargaining the average loser's curse bids are closer to the predictive naive bids and for English and Dutch auctions they are significantly above the rational bids. So, we discovered the interesting phenomena that when the parameters in an experiment were set so that the naive bidder's tendency to underbid dominates (the loser's curse treatment), bids were above the optimal level. Thus in English and Dutch auctions, a loser's curse effect is dominated by systematic overbidding due to increased competition. Consequently, a naive-bidding rule does not predict bidding quite well under the loser's curse.

5. Conclusions and further research

This paper makes three key contributions to the literature on electronic markets and chain management. First, we identify a series of distinct processes that underlie exchange

Table 2. Summary bid data by treatment.

Calculation	Bilateral bidding Average bid (standard deviation)			English Auction Average bid (standard deviation)			Dutch Auction Average bid (standard deviation)		
	Winner's curse	No curse	Loser's curse	Winner's curse	No curse	Loser's curse	Winner's curse	No curse	Loser's curse
Theoretical Prediction, Rational	3.00	2.00	1.00	3.00	2.00	1.00	3.00	2.00	1.00
Theoretical Prediction, Naive	3.56	2.00	0.81	3.56	2.00	0.81	3.56	2.00	0.81
Data ($n=13$)	3.64 (0.69)	2.10 (0.39)	0.89 (0.68)	5.01 (1.60)	2.67 (0.71)	1.06 (0.19)	7.30 (0.38)	3.93 (0.21)	1.36 (0.06)
Holt & Sherman (1994) Experiment, Data ($n=50$)	3.78 (0.58)	2.03 (0.21)	0.74 (0.08)						

relations. We propose and illustrate the use of the process-stakeholder analysis for comparing different forms of trading, and evaluate the impacts on different market participants. The cross-case analysis of ICT initiatives in the Dutch flower markets results in a useful guide to evaluate or explain the successes and failures of ICT-based initiatives in new markets.

Second, we expect that in the near future the Dutch auction method will become popular on the Web. The Dutch auction method offers advantages, because it is much faster, and it tends to generate higher prices. The results of an experiment, comparing bilateral bidding with English auction and Dutch auction methods, illustrate the higher price proposition.

Third, the cases in the Dutch flower industry reveal that application of information technologies to trading can enable increased efficiencies and separation of informational and physical trading processes. This in turn will permit more varied forms of trading customized to different user requirements. The TFA case shows the impact of the electronic auction system on the supply chain configuration and its performance. In this case the use of electronic auctioning leads to simpler logistics and distribution processes and a better logistical performance of the total supply chain. For consumers it could mean fresher flowers for the same price.

The cases highlight new questions for research. As the Internet evolves into a powerful and reliable infrastructure for electronic commerce and business, Dutch auctions become more important as a trading mechanism. However, there is little empirical research on the Dutch auction mechanism and the effects of clock speed, transaction

volume, and other information variables on prices, buyer strategies and net benefits. Further research will focus on experimental research which includes these variables.

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Appendix 1: Instructions

Introduction

This experiment deals with the economics of decision making under uncertainty. If you follow these instructions and make good decisions, you can earn a significant amount of money, which you will receive in cash privately at the end of the experiment. You are to act as a potential buyer in this experiment. You will be asked to choose an amount to bid on a product, without knowing the exact value of the product. The current owner of the product, who is the potential seller, knows more about the product's basic value than you know as the potential buyer. On the other hand, the product will be worth more to you than it is to the current owner. In this experiment three different price discovery mechanisms are investigated:

- Bilateral bidding
- English auction
- Dutch auction

Bilateral bidding

In a bilateral bidding game you will bid on an offer made by one seller. The potential transactions can be described in the following way. During each period, you may bid on a product. The product's value to its current owner will lie in a "Range" of values between a "Lower Limit" and an "Upper Limit." All penny values within this range will be equally likely. For example, if the Lower Limit is 1.00 and the Range is NLG 2.00, the product will be worth between NLG 1.00 and NLG 3.00 to its current owner. Every value in that range, such as NLG 1.00, NLG 1.01,..., NLG 2.99, will be equally likely. The product's value to you, should you acquire it, will be 1.5 times as much as the value for its current owner. The product's value to you, should you acquire it, will thus be calculated as follows:

value to you = 1.5 times the value to current owner.

For example, if the product is worth NLG 1.00 to its current owner, it will be worth NLG 1.50 to you should you acquire it; if the product is worth 2.00 to its current owner, it will be worth 3.00 to you if you acquire it. Your decisions will be recorded on a decision sheet (Table A1). Note that there are 5 numbered columns. Column (1) contains the period number. Column (2) contains the Lower Limit of the range of possible seller values. Column (3) contains the Upper Limit of the range of possible seller values. Once you have entered a bid, it will be recorded in column (4), labelled "your bid" on the decision sheet. In each period, you will make a single bid, which must be either accepted or rejected by the current owner. After you have entered your bid, the product's value for its current owner will be determined by a random number between the upper and lower limits. The value of the Lower Limit will initially be NLG 1.00, and the Range of seller values will initially be 2.00, so the random number will be between 1.00 and 3.00. Each number 1.00, 1.01,...,3.00 will have an equal chance of being selected. Then the value to you will be calculated by multiplying the seller value by 1.5. (This figure will be rounded off to the nearest integer number of pennies. This figure is, of course, your value for the product if you acquire it.) If your bid is greater than or equal to the product's value to its current owner, you will acquire the product. In this case, your gain or loss will be the product's value to you, which is 1.5 times the value to its current owner, minus your bid. If your bid is less than the product's value to its current owner, you will not acquire the product and will neither gain nor lose anything. Your earnings are zero in a period in which you do not acquire the product.

Value to current owner = random number between Lower Limit and Upper Limit

(1) If $BID \geq VALUE$ to current owner, $EARNINGS = 1.5 \times VALUE$ to current owner - BID

(2) If $BID < VALUE$ to current owner, $EARNINGS = 0$

Please look at the decision sheet again. The seller value and the buyer value are recorded in column (5) and column (6). At the end of each period, your gain or loss will be recorded in column (7) on the decision sheet. You will begin the experiment with an initial earnings balance of NLG 10.00. When you gain money during a period, your earnings will

Table A1. Decision sheet.

(1) Period Number	(2) Lower Limit	(3) Upper Limit	(4) Your Bid	(5) Seller Value	(6) Buyer Value	(7) Gain/Loss
1	1.00	3.00				
2	1.00	3.00				

increase by the amount that you gain. When you lose money during a period, your earnings will decrease by the amount you lose. Your gain or loss will be recorded in column (5) for each period, and your cumulative earnings will be recorded in the bidding screen (earnings so far). At the beginning of the experiment, your cumulative earnings equal the initial balance of NLG 10.00.

At the end of the experiment, YOUR CUMULATIVE EARNINGS WILL BE MULTIPLIED BY A FACTOR OF 2.0, and the result will be paid to you privately in cash. If this product of 2.0 and your total earnings falls below NLG 10.00, then the experiment will end and we will pay you the amount NLG 10.00.

English auction

In an English auction game several bidders will bid on an offer of one seller. In an English auction mechanism the price is raised sequentially. During each period, you may bid on a product. The value rules are the same as in the bilateral bidding:

- The product's value to its current owner will lie in a "Range" of values between a "Lower Limit" and an "Upper Limit." All penny values within this range will be equally likely.
- The product's value to you, should you acquire it, will be 1.5 times as much as the value for its current owner.

You will acquire the product if you are the highest bidder (the last bidder). In this case, your gain or loss will be the product's value to you, which is 1.5 times the value to its current owner, minus your bid. Your earnings are zero in a period in which you do not acquire the product.

Dutch auction

In a Dutch auction game several bidders will bid on an offer of one seller. In a Dutch auction mechanism the price is lowered sequentially. During each period, you may bid on a product. The value rules are the same as in the bilateral bidding:

- The product's value to its current owner will lie in a "Range" of values between a "Lower Limit" and an "Upper Limit." All penny values within this range will be equally likely.
- The product's value to you, should you acquire it, will be 1.5 times as much as the value for its current owner.

You will acquire the product if you are the highest bidder (the first bidder). In this case, your gain or loss will be the product's value to you, which is 1.5 times the value to its current owner, minus your bid. Your earnings are zero in a period in which you do not acquire the product.

Common questions

Some common questions: How is the random value to the seller generated? The computer will first generate a random fraction between 0.00 and 0.99. The seller value is calculated by 1) multiplying the random fraction times the difference between the Upper and Lower Limits, and 2) adding this product to the Lower Limit. To summarize:

$$\text{Seller Value} = \text{Lower Limit} + [\text{Random Fraction}] \times [\text{Upper Limit} - \text{Lower Limit}]$$

Since any fraction from 0.00 to 0.99 is just as likely as any other, it follows that any seller value in the range between the lower and upper limits is equally likely.

Another common question: What does “equally likely” mean? Suppose that there is a roulette wheel with 100 equally spaced stopping points, which are labelled: 0.00, 0.01, 0.02, ..., 0.99. Then a hard spin would make the chance of stopping on any one point exactly the same as the chance of stopping on any other, so all values are “equally likely”. The computerized randomisation routine makes any fraction from 0.00 to 0.99 equally likely in this sense.

Are there any questions? [Two practice periods for bilateral bidding, English auction, and Dutch auction followed.]

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 - Avoid large **tables**: the book size will be 20x27 cm, keep in mind that tables should fit this size. To acquire the column structure of tables use the tabulator [TAB] only. Avoid using MS Word table function, spaces, or any other ways. Tables should be clear without reading the text. Column headings should be brief and clear. Vertical lines should not be used to separate columns. Any necessary explanations essential for understanding the table should be given as a footnote at the bottom of the table.
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- In the list of references, these should be arranged as follows:

For periodicals:

Pluske, J.R. and I.H. Williams, 1996. Split weaning increases the growth of light piglets during lactation. *Austr. J. Agr. Res.* 47, 513-523.

For edited symposia, special issues, etc. published in a periodical:

Noordhuizen, J.P.T.M., W.D.J. Kremer and H. Jorritsma, 2000. Quality (health) risk management through HACCP application on dairy farms. In: Blokhuis, H.J., E.D. Ekkel and B. Wechsler (editors), *Improving health and welfare in animal production*. Wageningen Pers, EAAP series 102: 65-74.

For books:

Engelen, G.M.A. and A.F.B. van der Poel, 1999. *Post-pelleting application of liquid additives*. Wageningen Pers, 96 pp.

For multi-author books:

Pluske, J.R. and G.Z. Dong, 1998. Factors influencing the utilisation of colostrum and milk. In: M.W.A. Verstegen, P.J. Moughan and J.W. Schrama (editors), *The Lactating Sow*. Wageningen Pers, the Netherlands, pp. 45-70.

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