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What is a network:
An overview of theoretical explanations of inter-firm cooperation.

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Abstract

Accumulated empirical studies of the inter-firm networks are so numerous and diverse that it seems to be useful to jointly analyze them. This paper is aimed at comprehensive overview of theoretical background of inter-firm network explanations and traces the roots which led to the emergence of a new network paradigm in terms of the theory of the firm. It also provides an analysis of dynamics and theoretical formation of the paradigm itself.

We first analyze antecedent explanations of the inter-firm cooperation given by economics, sociology, and a number of other sciences. These explanations, though very diverse, have formed foundation for the development of a new network paradigm.

The second part of this paper is focused on the analysis of the network interpretations in theories constructing the theory of the firm paradigm. These theories resemble their antecedents as they combine already existing inter-firm network explanations. However, their major input is in seeing inter-firm networks as an integral part of the economic and social reality, which provide additional explanations of the firm's boundaries and existence.

Finally, directions of further inter-firm network research are suggested.

1 Scope of the review

"If you think you can go it alone in today's global economy, you are highly mistaken."
Jack Welch, CEO of General Electric

"Inter-firm collaborations offer a rich breeding ground for issues surrounding knowledge transfer."
Heiman and Nickerson (2002)

The business trend of inter-firm cooperation is consistently growing. According to a survey by Booz-Allen & Hamilton, the number of alliances worldwide has grown by 25 percent annually in the period 1987-1997 (Harbison and Pekar 1997) and the rate remained in the followed years (OECD 2002). Similarly, other forms of inter-firm cooperation were also increasingly exploited (OECD 2002).

Accumulated in the last decades empirical studies of the inter-firm cooperation, particularly its network form, are so numerous and diverse that it seems to be useful to jointly analyze them. This paper is aimed at comprehensive overview of theoretical background of inter-firm network explanations, it traces the roots which led to the emergence of a new network paradigm in terms of the theory of the firm, and provides an analysis of the paradigm itself.

First, the focus is made on the fundamental theories. Major theories offering explanations of inter-firm cooperation, such as economics and sociology, provide different interpretations of network existence, which stem from diverse backgrounds and, therefore, are hardly compatible. However, if synthesized, these interpretations could provide valuable synergies for explanation of inter-firm cooperation (see Figure 1).

Second, we analyze the theory of the firm, which offers a new network paradigm. Included in it theories have provided an important contribution, combining existing explanations with alternative, i.e. knowledge focused argumentation. For instance, the knowledge-based view of the firm, by placing knowledge as a main source of competitive advantage, offers alternative socially based knowledge protection mechanisms, which substantially enrich explanations of the inter-firm cooperation. Finally, it is argued that participation of the firm in a network provides both individual benefits for the firm and collective benefits, which could be only reached through participation of all members of the network. This perception implies that network form of organization is a natural part of the economic and social environment, which exists simultaneously with other organizational forms, could be equally important and possesses specific mechanisms, not attributable to the firm (hierarchy) or market.

The purpose of this review is not to provide a reader with a precise definition of a network. On the contrary, we have tried to present as broad understanding of network as possible, defining the major contributing theoretical bodies and pointing out particular important network explanations. In doing this, we attempted to trace the current development of the network theoretical explanations and show the direction of their future advancement.

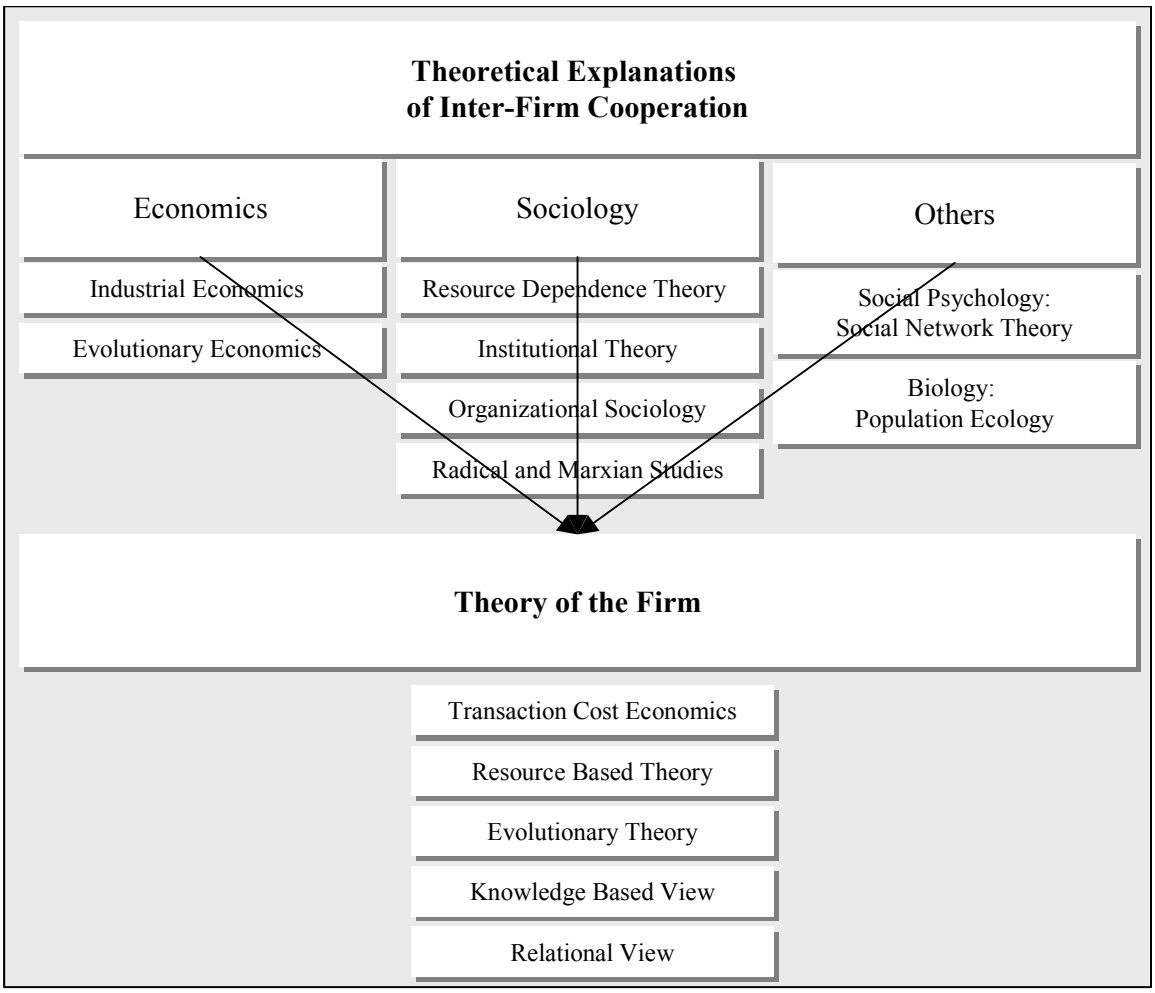

Figure 1. Theoretical explanations of inter-firm cooperation.

2 Definitions

Throughout this paper several terms describing inter-firm cooperation are used. To avoid possible confusion, it is meaningful to define their meaning and cohesion first.

The umbrella term in this work is "network" (Nohria and Eccles 1992). To better systematize existing theoretical explanations, we will use a relaxed definition of network and include a large range of coordination mechanisms from informal communication to inter-firm information and planning systems (alliances), to complex integration structures (joint ventures and franchising). Generally, an inter-firm network is a mode of regulating interdependence between firms which is different from aggregation of these units within a single firm and from coordination through market signals (prices, strategic moves, etc.). However, the attributes of a network, i.e. coordination processes and structures an inter-firm coalition may employ, are not necessarily hybrid with respect to those of firms and markets, they also need not be unique, as they usually have different mixes of both (Grandori and Soda 1995).

3 Theoretical antecedents: Economics and Sociology

Inter-firm cooperation, particularly its network form, is a theoretical field explained by a large number of different disciplinary approaches, which offer a rich ground for dialog. As it is widely used, the term "network" has partially lost its precision (Nohria and Eccles 1992) and

numerous borrowings and cross-citations between social science theories made it difficult to find the roots of particular explanation of the network. The following review is concentrated on two major contributing streams of economics and sociology, and is aimed at systematization of different explanations of network existence.

A pervasive theme that is either explicit or implicit in the majority of the theories is the simple notion of whether inter-organizational cooperation make sense, and whether the advantages outweigh the disadvantages. Therefore, our purpose is to review what is known about these two key points in the theories, underlying contemporary theory of the firm. This is particularly relevant, as in most approaches networks are analyzed as purely positive or negative (Grandori and Soda 1995). It seems that joint analysis of both advantages and disadvantages of the network could be beneficial.

3.1 Economics

3.1.1 Industrial economics

Among economic approaches, industrial economics has made its contribution to explanation of the inter-organizational cooperation through the focus on "industry organization" and its verifications (Richardson 1971), (Mariti and Smiley 1983). In terms of the traditional research on vertical and horizontal integration, this discipline has increasingly faced incomplete or mixed forms of "quasi-integration" (Blois 1972), which were respected as market failures and explained by optimization of production costs, i.e. economies of scale, scope, specialization and experience (Teece 1980), (Eccles 1981).

Another significant contribution of economics to network explanation is the recognition that alongside production cost economies network is efficient at reduction of governance cost. This approach initiated an understanding of network as an optimal hybrid form between markets and hierarchies (Williamson 1985), (Powell 1987), (Thorelli 1986). Here, variables predicting increase in market coordination costs and explaining network are asset specificity, context uncertainty and the frequency of transactions (Williamson 1981), as well as difficulties in measurement of performance (Barney and Ouchi 1984) and agents characterized by risk aversion (McGuire 1988), (Davis 1991).

3.1.1.1 Agency theory

Stemming from economics agency theory provides an in-depth analysis of transactions between firms and employed by them agency relationships (Jensen and Meckling 1976). The costs of relationships, or agency costs, are comprised of expenses for monitoring and bonding mechanisms designed to reduce opportunism and unavoidable conflicts between principals and agents. Employed by the agency theory governance mechanisms include various forms of contracts, ranging in character from formal to informal, explicit to implicit, and objective to subjective (Barney and Ouchi, 1986).

3.1.1.2 Transaction cost economics

The most influential contractual explanation of inter-firm cooperation is given by transaction cost economics (TCE) (Williamson 1975). Extended governance typology of TCE emphasizes transaction specific investments as a key factor in explaining when markets will fail and be replaced by intermediate market or hierarchical governance mechanisms. As TCE is one of the fundamental theories for contemporary inter-firm cooperation explanations, we will analyze and criticize it in more detail in the next chapter, which reviews current theoretical trends.

3.1.2 Evolutionary economics

The evolutionary stream within economics is based on Schumpeter's (1934) works on innovation. It is focused on major revolutionary technological shifts and dismisses price and other attributes of the firm as relatively unimportant in the long run. This does not suggest that these attributes are negligible, but rather that they are of secondary importance when describing the evolution of an industry. Further on, for Schumpeter, revolutionary innovations can be anticipated by firms only imperfectly. Sometimes firms in an industry may survive a revolutionary innovation and become important actors in a succeeding industry. Other times, a revolutionary innovation will have the effect of displacing all currently competing firms. What firms can do in these circumstances is learn. In line with this reasoning Alfred Chandler's work, added technology and learning related costs to explain the network (Nelson 1993).

A combination of both industrial economics and Schumpeterian approaches suggests a lifecycle model, where industries begin as a result of Schumpeterian revolutions. The revolutionary change defines the technological base of the industry and organizational resources that are strategically valuable, therefore, it defines, which firms are likely to be successful early on, which firms must modify their resource base to become successful, and which firms are least likely to survive. After Schumpeterian revolution has defined the competitive bases of a new industry, industrial economics competition becomes analytically more relevant, although Schumpeterian shocks that affect but do not displace the industry are also important features of the industrial landscape.

3.2 Sociology

3.2.1 Resource dependence theory

Sociologists have often focused attention on the network relationships among agencies in the same geographical area (Warren 1967). Subjects of these studies were primarily the characteristics of the collective patterns of survival, growth and sustainability, rather than competitive success of the single unit. Within the organizations literature, the inter-organizational field in which a firm was embedded was viewed as a characteristic of the firm environment (Emery and Trist 1965). A combination of these perspectives was followed in a number of studies emphasizing environmental influences on organizations and their survival and helped to lead to the emergence of resource dependence theory (Pfeffer and Salancik 1978).

Long studied in sociology, resource dependence theory is partially rooted in an open system framework, which argues that organizations must engage in exchanges with their environment in order to obtain resources (Evan 1966), (Pfeffer and Salancik 1978), (Aldrich 1979), (Jacobs 1974), where such engagement creates dependencies between organizations and outside players. A distinctive contribution of resource dependence studies is in analysis of particularly broad range of network forms, i.e. joint ventures, interlocking directorates, associations, cartels, social and personal networks (Pfeffer and Salancik 1978).

Part of the network variables used in these works are close to those of organizational theory, i.e. critical uncertainty, interdependence and asymmetry in the resources and information controlled (Grandori and Soda 1995). However, an important alternative variable appearing in this view is the strategic manipulation of transactions and games aimed at changing the relationship of interdependence to one's own advantage, which helps to understand the trajectory of network relationship development (Reve 1992), (Stern and Reve 1980).

Further, resource dependence theory distinguishes among types of dependence both in quantitative and qualitative terms. The quantitatively measured breadth of relationships is a

good predictor of the complexity of the network (Alter and Hage 1993). Quantitative types of dependence account, first, for "horizontal" interdependence, i.e. interdependence based on resource-pooling with possible symbiosis and complementarity. And, second, "vertical" interdependence, which requires different coordination mechanisms and is based on resource-transferring from one firm to another (Pfeffer and Salancik 1978). Besides simple situations of wholly cooperative interdependence among few firms characterized by informal networking (Evan 1966), (Aldrich and Whetten 1981), studies have indicated that complex "horizontal" alliances are mostly regulated by associational agreements, while complex "vertical" alliances are characterized by various forms of relational and obligational contracting. Further empirical work has shown that there may be a trade-off between horizontal and vertical alliances used by the same firm (Reve 1992).

3.2.2 Institutional theory

Institutional theory (DiMaggio and Powell 1983) suggests that environment imposes pressures on organizations to appear legitimate and conform to prevailing social norms. Applying this theory in a business context, institutional pressures presumably motivate firms to pursue activities that will increase their legitimacy and cause them to appear to be in agreement with the prevailing rules, requirements, and norms of their business environment (Oliver 1990). One way firm can do this is through participation in inter-organizational relationships. The institutional approach, similar to resource dependence theory, places dependence as a core concept, and in contrast to resource dependency theory, refers not to material resource or transaction dependence, but solely to a social dependence or legitimation. Social linkages, networks, formal contracts and all other tools to avoid isolation are expected to predict firm's survival (DiMaggio 1986), (Baum and Oliver 1991). Firms could only legitimate reciprocally by belonging to particular network.

The implication of legitimation on network could be described with the notion of "institutional embeddedness". The effectiveness and ease of formation of inter-firm cooperative structures is contingent to the larger social environment in which these relationships are embedded, i.e. legal system, bank system, labor market (Whitley 1990), (Aoki 2000).

3.2.3 Organizational sociology

The broader acknowledgement and use of the notion "embeddedness" was initiated by organizational sociology. Mark Granovetter (1983), (1985) first introduced "social" and "cultural embeddedness" and put forward an argument that economic relations between firms take place within a web of pre-existing social relationships. These social networks constrain the direction and forms in which economic relationship can be developed. In line with this approach, Boisot (1986) and Hamilton (1990) argue that institutionalized social norms and the values internalized by economic actors are likely to influence the emergence of inter-firm network. Atmosphere and, to a much larger extent, organizational culture have been respected as predictors of inter-firm cooperative behavior (Ring 1993).

3.2.4 Radical and Marxian studies

A valuable contribution, which could not be justified using notions of efficiency and effectiveness, was made by radical and Marxian studies. This approach explains existence of some networks as purely power structures for reproducing elites (Whitt 1980). The empirical investigation of this hypothesis was made in the traditions of sociology and concentrated primarily on clubs, interlocking directorates and informal power networks (Moore 1979), (Perucci and Potter 1989).

3.3 Other explanations of network

3.3.1 Social psychology: Social network theory

The tradition of study of network in social psychology is attributed with the social network theory. The contribution of this approach is in the study of the positions of individual firms within networks. Combined with traditional categories of network analysis such as centrality (Lomi 1991), structural equivalence (Burt 1978), (Gerlach 1992) and clique analysis (Benassi 1993) it produced new insights on change of informal structures (Lomi 1991), the process of corporate cooptation (Burt 1983), interlocking directorates (Burt 1980), etc. Social network analysis also contributes to research of network dynamics, as it focuses on a particular network structure at a certain time.

3.3.2 Biology: Population ecology

A natural-selection perspective is, to a certain extent, final in that it concerns the survival of the organization or network irrespective of explanation of its existence. Economic effectiveness and efficiency will play a role in the selection of inter-firm arrangements as long as they are modes for regulating economic activities in market economies, however, other factors are also becoming influential in the current economic and social environment (Carrol 1988). Organization ecology studies have generally confirmed that networking (both formal and informal) does have an impact on firm's survival, (Lomi and Grandori 1993).

3.4 Summary and critique

In summary, revised theories generally accept a basic premise of population ecology that by operating collectively organizations share common fates (Hannan and Freeman 1977), (Carrol 1984). Consistently with this premise, resource dependence researchers find that organizations often build cooperative ties, which then mutually affect their performance (Pfeffer and Salancik 1978). Institutional theories depict organizations as operating within "fields" or "sectors" of shared purposes and expectations (DiMaggio and Powell 1983). Even industrial economists allow for "hybrid" forms characterized by extra-market linkages among organizations (Williamson 1991).

There is a variety of approaches and interpretations of costs and benefits of inter-firm collaboration.

Economics: Network is caused by market failure and is aimed at increase of firm's efficiency. Benefits of the network are explained primarily by reduction of coordination and production costs.

Sociology: Network is a tool for social control and informal cooperation issues.
Network is explained both by coordination costs and social linkages, i.e. embeddedness, legitimation and power mechanisms.

A unified conceptualization of inter-firm cooperation could be valuable.

4 Theoretical background: Theory of the Firm

An ambitious aim of organization and management theories is to build a comprehensive theory of the firm, which combines both existing theoretical insights and provides alternative explanations of the firm existence. To be clear in terminology, we further on use definition given by Foss (1996): "…"a theory of the firm" is a theory that addresses the issues of the existence, the boundaries, and the internal organization of the multiperson firm." For the purposes of this review, we will primarily concentrate on the second issue of the firm boundaries, influencing its survival. In explanation of boundaries scholars increasingly use network collaboration patterns. Though streamed with organization and management theories, these explanations often resemble a mix of arguments drawn from economics, sociology, social psychology, and a number of other fields (Ohmae 1989), (Contractor and Lorange 1988), (Contractor and Lorange 2002). However, new emphasis on resources and knowledge assets as a core for the firm's competitive advantage, acknowledgement of a need for continuous learning under conditions of highly uncertain technological environment, path-dependency and limited absorptive capacity initiated re-evaluation of the role of inter-firm cooperation and led to quite a different interpretation of the network phenomenon.

4.1 Limitations of the transaction cost economics and contribution of the resource-based theory

The core assumption of management theories is that competitive advantage of the firm stems from valuable, difficult to imitate resources (Barney and Ouchi 1986), (Collis and Montgomery 1995). If so, then the boundary choices define the ownership and composition of such resources (Chesbrough and Teece 1996).

Over the past 20 years, a predominant theoretical explanation of boundary choice was developed by a transaction cost economics (TCE) (Coase 1937), (Williamson 1975), (Williamson 1988), (Williamson 1991), (Madhok 2002). Apparently, TCE still remains one of the principal theoretical approaches in management for understanding formation of strategic alliances (Hennart 1991), (Pisano and Teece 1989), (Shan 1990). The emphasis on transaction cost efficiency as the motivation for cooperation is broadly accepted. At the same time, the opportunism and counter playing incentives stressed in TCE obviously do not cover all motivations and there could be other reasons for a company to participate in a network. The opponents of this perspective argue that contractual explanations on the existence of the firm neglect the firm's role as a repository of competences, which implies that the processes of learning, creation of legitimacy or success of new technical strategies play a wholly subordinate role (Eisenhardt and Schoonhoven 1996). To make it clear, the contractual conceptualization of the firm is static and implies that a firm is a purely reactive entity, which does not behave in a profit-seeking way aiming at focus on distinctive competencies and achievement of competitive advantage.

The competence perspective, on the contrary, explains economic organization where inputs, outputs and technology are constantly changing. The core of the competence perspective, the resource-based theory of the firm (RBT), assumes that firms are boundless of resources (Penrose 1959), (Wernerfelt 1984), which can serve as a foundation for strengths and competitive advantages, and as Wernerfelt (1984) observes, can be either tangible or intangible. Applying the logic of RBT to explain inter-firm cooperation will imply that non-communicable, idiosyncratic and non-contractible competencies attributable to different companies will need integration to be jointly managed.

4.2 Evolutionary theory of the firm

The outlined duality of static and dynamic conditions are broadly used for studies of the firm, particularly in evolutionary perspectives. Distinctive characteristics of this perspective for explanation of the inter-firm collaboration are, first, that it provides in-depth analysis of the learning process, and second, that it sees static and dynamic conditions as attributes of the firm's external environment. The dynamic environment causes behavior variations of firms participating in network and predetermines network forms.

The evolutionary approach to understanding network behavior assumes that companies experiment with and learn from their contacts without strictly following efficiency maximization goal. Argumentation of this approach overlaps these of evolutionary economics (Nelson and Winter 1982) and behavioral theory (Simon 1956), (Simon 1987), (Cyert and March 1963). A central element of this approach is the concept of bounded rationality, with companies demonstrating a satisfying behavior under conditions of imperfect knowledge. It also stresses the positive effect of learning behavior on company performance in a dynamic context (Ciborra 1991), (Oster 1992), (Powell et al. 1996). Silverberg and Verspagen (1994) empirically confirmed this in the case of high-tech industries, where firms do not necessarily demonstrate short-term optimal and efficient behavior. Instead, a long-term, learning-oriented behavior was found to generate higher returns.

Generally, argumentation of the evolutionary theory suggests that in a dynamic environment characterized by technological change and openness of market, continuous learning through redundant network contacts is preferable to efficiency-oriented behavior, which is more adequate for static well established markets.

4.3 Knowledge-based view of the firm

Attention to high-tech industries as more salient for the explanation of inter-firm cooperation indicates a special role of technology and knowledge in this setting. The knowledge-based view of the firm (KBV) utterly focuses on the knowledge resources and explicitly considers firm's function as a repository of distinct technological and organizational knowledge. The firm is respected as an entity, which can learn and grow on the basis of its knowledge (Dosi et al. 1992).

Predictably, a number of KBV contributions have emerged from the RBV literature of the firm (Conner 1991) and evolutionary theory (Langlois 1992), (Dosi 1992), (Kogut and Zander 1992), which were significantly enriched with the insights from epistemology (von Krogh et al. 1994), (von Krogh and Roos 1995). The KBV primer focus on knowledge has initiated novel, partially provoking explanations of inter-firm cooperation.

Although KBV theorists studying alliances and networks do not completely exclude transaction costs or strategic considerations, the learning perspective implies that transaction cost savings and immediate returns are not as critical as gains in technological capability, tacit knowledge, or understanding of rapidly changing markets (Kogut 1988), (Teece et al. 1997). In this literature, alliances are an important part of learning process for firms, a process in which they discover new opportunities in a flexible setting of multiple partnerships (Ciborra 1991), (Hagedoorn 1995).

The ability to discover knowledge and then implement it may vary under different administrative forms of cooperation (Osborn and Baughn 1993). According to KBV, a variety

of non-equity forms for organizing cooperation are expected to provide a more effective environment for discovery of new knowledge than equity forms provide (Hagedoorn and Narula 1996). More flexible, exploration oriented non-equity forms may promote reciprocal information exchange better than joint ventures and partial equity alliances, which are more likely to stress issues of control. Significantly, research-intensive cooperation often involves both the exploration and exploitation of tacit knowledge. The more search-oriented non-equity cooperation forms may not promote exploitation as more hierarchical administrative forms do. Thus, it is hypothesized that then learning needs focus on development, joint production or other activities contributing to the later stages of the value chain, equity-based administration may be more appropriate than a non-equity structure. Here control may be more important than developing common understanding.

The revised explanations seems to be well-grounded in KBV. However, KBV alone, does not cover all aspects of contemporary business environment and should be used together with other interpretations. Already when one tries to combine it with the logic of economics and TCE in particular, it becomes obvious that in the case of inter-firm collaboration the easy match of these theories will not happen. The issues of opportunism and need for safeguards sharply contrast the logic of KBV, where literally no formal knowledge protection is required. It seems that further joint empirical validation of both approaches could be very useful.

At the same time, inter-firm cooperation viewed from KBV perspective remains to be a puzzle as there is not enough empirical evidence to the hypothesis put forward in the literature (Hagedoorn and Duysters 2002).

4.4 Relational view

Presumably one of the most comprehensive attempts to explain the network existence and role is made by Dyer and Singh (1998). Following a tradition of management studies, their work is an elegant compilation of already existing theories, which in particular combines economics, KBV, RBT and TCE perspectives, respectively emphasizing the role of investments, knowledge, resources and governance.

Dyer and Singh claim that the relational view of the firm explains how a network of firms is capable of generation of competitive advantage shared by all participating companies. Such a network can produce its own rent - a supernormal profit jointly generated in an exchange relationship that cannot be generated by either firm in isolation (Dyer and Singh 1998).

Summarizing, further analysis of the inter-firm cooperation could be organized according to the three interdependent factors. First, the identified costs and benefits of cooperation could be further on validated and most important of them could be revealed. Second, as it is vividly shown in KBV, social factor could play significant role in such cooperation, therefore, it could be studied separately. Third, as it is repeatedly emphasized, dynamics of the firm and industry development could also play an important role in the inter-firm cooperation.

4.5 Summary and outlook

Given by theories of the firm analysis of inter-firm cooperation is based on a creative mix of arguments derived from economics, sociology, and other sciences.

Emphasis on knowledge as a main competitive resource of the firm has advanced analysis of inter-organizational networks and brought new explanations of this

phenomenon.

If the need for combination of economics-, sociology-, and theory-of-the-firm-based explanations of inter-firm cooperation is apparent, the optimal balance between these approaches still has to be clarified.

This is particularly relevant for combination of formal and equity based knowledge protection mechanisms with informal and social safeguards, suggested by KBV.

Inter-firm networks are seen as an integral part of the economic and social reality, which provide additional explanations of the firm's boundaries and existence.

5 An outlook

Summarizing, the rationales for the inter-firm cooperation and their costs and benefits are given in the following table. [1]

Table 1. Overview of economics, sociology and other theories contributing to inter-firm network research

Theoretical antecedents	Theory	Description of costs/benefits	Rationale for inter-firm cooperation	Authors
Economics	Industrial economics	Reduction of production and coordination costs	Economies of scale, scope, specialization and experience	(Richardson 1971), (Blois 1972), (Teece 1980), (Eccles 1981), (Dunning 1982), (Mariotti 1984), (Katz 1986), (Turati 1990), (Vonortas 1994)
			Asset specificity, context uncertainty, frequency of transactions	(Mason 1939), (Bain 1956), (Williamson 1985), (Thorelli 1986), (Powell 1987)
			Difficulties in measuring of performance	(Barney and Ouchi 1984)
			Risk aversion of agents	(Grossman and Schapiro 1987), (McGuire 1988), (Davis 1991), (Martin 1994)
			Agency costs of monitoring and bonding mechanisms	(Jensen and Meckling 1976), (Barney and Ouchi 1986)
			Transaction specific investments	(Williamson 1975)
	Evolutionary economics	Technology and learning related costs	Organizational cooperation for survival in times of radical technological shifts	(Schumpeter 1934), (Schumpeter 1950), (Chandler 1992), (Nelson 1993)
Sociology	Resource dependence theory	Dependency costs	Strategic manipulation of transactions and games	(Evan 1966), (Jacobs 1974), (Benson 1975), (Pfeffer and Salancik 1978), (Aldrich 1979), (Reve 1992), (Schmidt and Kochan 1977), (Axelrod 1984), (Contractor 1984), (Jarillo 1988), (Hill 1990), (Grandori 1991), (Scharpf 1993)
			Intensity of inter-firm interdependence	(Van de Ven 1979), (Oliver 1990)
			Complexity of activities	(Van de Ven 1979), (Killing 1988), (Osborn and Baughn 1990)
			Asymmetry in the control of resources	(Balcet and Viesti 1986), (Gray 1987)

[1] Only the authors mentioned in the text are indicated in the literature index.

			Types of dependence: breadth of relationships	(Alter and Hage 1993)
			Horizontal interdependence (resource-pooling)/ vertical interdependence (resource-transferring)	(Pfeffer and Salancik 1978), (Aldrich and Whetten 1981)
	Institutional theory	Social linkages as predictor of firm's survival	Legitimation	(DiMaggio 1986), (Baum and Oliver 1991)
			Institutional embeddedness	(Aoki 1988), (Whitley 1990), (Whitley 1991), (Grabher 1993)
	Organizational sociology	Social linkages as predictor of firm's position	Social embeddedness	(Granovetter 1983), (Granovetter 1985)
			Cultural embeddedness	(Boisot 1986), (Hamilton 1990), (Ring 1993)
	Marxian studies	Network as a power structure	Power mechanisms (elites)	(Moore 1979), (Whitt 1980), (Perucci and Potter 1989)
Social psychology	Social network theory	Costs/benefits of particular network structure at a certain time	Centrality	(Lomi and Grandori 1993)
			Structural equivalence	(Burt 1978), (Gerlach 1992), (Lomi and Grandori 1993)
			Clique analysis	(Benassi 1993)
Biology	Population ecology	Natural-selection perspective	Legitimation	(Carrol 1988), (Barley 1991), (Lomi and Grandori 1993)
			Common fate	(Hannan and Freeman 1977), (Freeman and Hybels 1991)

Table 2. Overview of theories of the firm contributing to inter-firm network research.

Theory	Description of costs/benefits	Rationale for inter-firm cooperation	Authors
Transaction Cost Economics	Reduction of transaction costs	Opportunism	(Williamson, 1975), (Williamson, 1990), (Kogut 1992), (Parkhe 1993), (Shelanski and Klein 1995)
		Incentives mechanisms for cooperation	(Coase 1937), (Williamson 1988), (Kogut 1988), (Williamson, 1991), (Zajac and Olsen 1993), (Dyer 1997), (Madhok 2002)
		Protection with property rights	(Osborn and Baughn 1990), (Hennart 1991), (Williamson 1996), (Poppo and Zenger 1998), (Argyris and Liebeskind 1999)

Resource-based Theory	Access to external complementary resources	Valuable, rare, inimitable and imperfect substitutable resources	(Penrose 1959), (Wernerfelt 1984), (Rumelt 1984), (Winter 1987), (Barney 1988), (Prahalad and Hamel 1990), (Barney 1991), (Peteraf 1993), (Collis and Montgomery 1995)
		Learning	(Levinthal and March 1993), (Eisenhardt and Schoonhoven 1996), (Teece 1997)
		Coordination mechanisms	(Malmgren 1961), (Silver 1984), (Langlois 1992), (Ghoshal and Moran 1995), (Ahuja 2000)
Evolutionary Theory	Coordination of innovation process	Learning	(Simon 1956), (Cyert and March 1963), (Nelson and Winter 1982), (Simon 1987), (Nelson 1991), (Ciborra 1991), (Oster 1992), (Winter 1995), (Powell 1996), (Barnett and Burgelman 1996), (Zollo and S.Winter 1999), (Winter and Szulanski 2001)
		Coordination mechanisms	(Allen 1988), (Dosi 1988), (Kogut 1989), (Dosi 1992), (Heide and Miner 1992), (Silverberg and Verspagen 1994), (Gulati 1995), (Foss 1996), (Saxton 1997), (Wade 1996), (Hagedoorn 2001)
Knowledge-based View	Enhancement of the firm's key knowledge resources	Learning from knowledge processes	(Teece 1989), (Kogut and Zander 1992), (Foss 1993), (Nonaka 1994), (Nonaka and Takeuchi 1995), (Leonard-Barton 1995), (Inkpen and Crossan 1995), (Liebeskind 1996), (Edvinsson 1997), (Khanna 1998), (von Krogh 2000), (Dyer and Nobeoka 2000), (Grant and Baden-Fuller 2002)
		Higher order organization	(Marshall 1925), (Nelson and Winter 1982), (Kogut and Zander 1992)
		Co-specialization	(Silver 1984), (Conner 1991), (Foss 1996)
		Internal variety and absorptive capacity	(Cohen and Levinthal 1990), (Spender 1993), (Grant 1996), (Kogut 2000)
		Exploration-exploitation	(Argyris and Schön 1978), (Fiol and Lyles 1985), (March 1991), (Langlois 1992), (Hagedoorn and Schakenraad 1992), (Osborn and C.C.Baughn 1993), (Mowery, Oxley et al. 1996), (Lane and Lubatkin 1998), (Hagedoorn and Narula 1996), (Hagedoorn and Duysters 2002)
Relational View	Relational/network rent	Mutual investments	(Dyer and Singh 1998)
		Resources	
		Knowledge processes	
		Governance	
		Alliance capabilities	(Gulati and Lawrence 1999), (Kale and Singh 1999), (Kale, Singh et al. 2000)

These explanations could form a solid theoretical foundation and provide tools useful for further research, which, despite already existing multidisciplinary approach, could still be developed in a number of ways.

First, operationalization of the theory and development of concrete applied measures of network performance could be very beneficial for the network research.

Second, further development of multidisciplinary approach to network explanation will lead to clearer balance between identified economic, social, and other key factors. For instance, currently developing knowledge-based network interpretations could be a rich field of further contributions.

Third, increasing density of inter-firm cooperation and growth of firms interdependence will imply that the next level of inter-firm cooperation research could place management of the entire network as a central issue.

Fourth, further research is needed to clarify requirements, which have to be met by individual firms in the process of collective competitive advantage formation.

Finally, constantly growing population of networks is a subject to further in-depth longitudinal theoretical analysis. Here, dynamics of network development could be best predicted using already existing research.

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