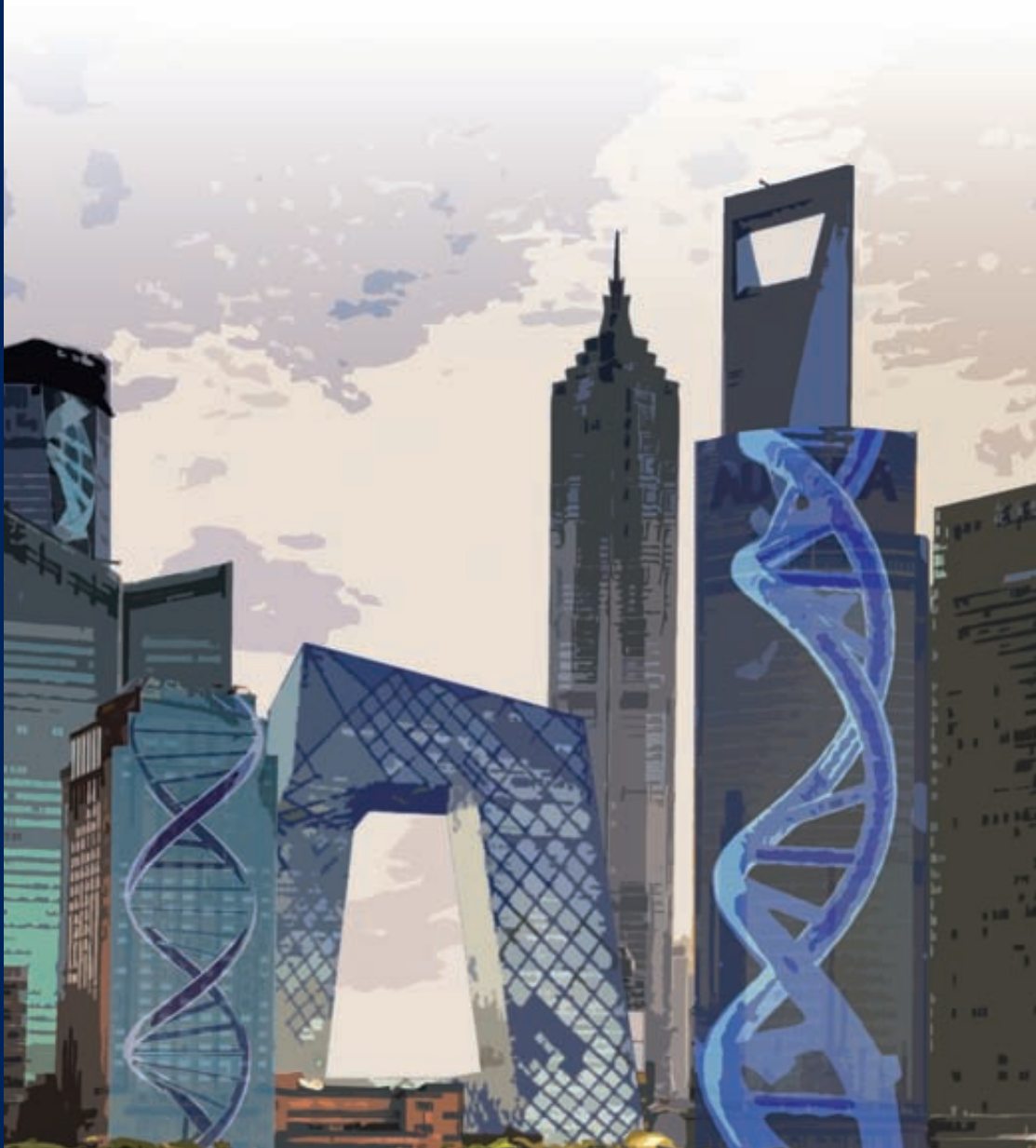


JOHANNES MIEGER

# Configurations of Inter-Firm Relations in Management Innovation

A Study in China's Biopharmaceutical Industry



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A Study in China's Biopharmaceutical Industry

**Configuraties van Interorganisatorische Relaties in Management Innovaties**

Een Studie van de Chinese biopharmaceutische Industrie

**Thesis**

**to obtain the degree of Doctor from the  
Erasmus University Rotterdam  
by command of the  
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## 1. Introduction

Some five thousand years ago around 3000 BC in Babylon, 80 kilometres south of Baghdad, the first concentration of settlers emerged as what is nowadays referred to as a *city* (Bragg, 2004).<sup>1</sup> With more than one hundred thousand people, Babylon did not differ from other, smaller settlements solely from the number of its inhabitants. More importantly, it constituted a highly complex social organism. Aside from people producing food and farming the fields, Babylon featured an administrative system of trade, law and order. Babylon ultimately became too complex to be managed merely by words and memories. Around this time, temple bureaucrats developed and implemented systems of numbers, known today as the Babylonian Numerals. These helped to predict, manage and control the land, the assets and the people working in the fields. This first use of numbers to administer complex organizations essentially represented nothing more than a new management tool.

Nowadays, the phenomenon of developing and implementing new managerial practices, processes and structures is referred to as management innovation (Birkinshaw, Hamel, & Mol, 2008). Yet while currently there is only little research on this subject, recent history has seen similarly revolutionary management innovations that have substantively affected the way organizations are managed. One of the first management innovations commonly associated with firms is the moving assembly line implemented at the Ford Motor Company in the beginning of the 20<sup>th</sup> century (Chandler, 1977). Instead of having workers move from one station to another assembling parts of each car individually, Ford introduced a system in which the product, not the producers, would move. This management innovation modularized the production process, allowed for specialization among operators and significantly improved the efficiency of the plant. Other management innovations followed and, especially between the 1960s and the 1980s, Japan's economy developed some of the most prominent examples. For instance, the concept of Quality Circles, self-administered teams that meet regularly under the supervision of a team leader, were first introduced in the Nippon Corporation in the late 1960s to develop solutions to work related problems (Hutchins, 1985). Another example can be found in Toyota's Lean manufacturing concept introduced during the 1980s, a bundle of practices aimed at eliminating, or at least reducing, wasteful efficiencies during the production process (Krafcik, 1988). Similar management concepts emerged shortly afterwards, such as Total Quality Management or Six Sigma, introduced by Motorola in the late 1980s and aligning business activities to improve the overall quality of goods and services (Cua, McKone, & Schroeder, 2001).

Practitioners and researchers alike are increasingly becoming aware of the crucial role of management innovation (Hamel, 2006) and are trying to understand when and how management innovation takes place, why some organizations innovate while others do not and what characterizes more innovative organizations (Baldrige & Burnham, 1975). Management innovation is believed to enhance a firm's overall efficiency by improving its competitive position, enabling rapid adaptation to new situations and ultimately increasing

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<sup>1</sup> This first paragraph largely draws on the radio program 'Babylon' in BBC Radio 4's series 'In our Time', broadcasted on June 4, 2004. It is available in the online archive of the program series.

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a firm's performance (Birkinshaw et al., 2008). It thereby creates sustainable advantages and dramatically shifts a firm's competitive position.

To avoid confusions, management innovation is *not* innovation management or the management *of* innovation. These terms relate to technological innovations that concern products, technical processes, and other technologies used to produce goods or "... render services directly related to the basic work activities of organizations." (Crossan & Apaydin, 2010: 1168-69). Instead management innovation, put simply "... changes how managers do what they do" (Hamel, 2006: 4) and is necessary to reap the benefits of technological innovation. It is intangible and directly relates to management aspects of an organization: its structure, processes and practices.

### 1.1. What we know about Management Innovation so far?

Currently, the literature on management innovation conceptualizes the phenomenon from two rather different perspectives. While some scholars argue that management innovation is a complex *process* of events and activities driven by certain actors (Birkinshaw et al., 2008), others understand management innovation as an *outcome* of individual, organizational and environmental determinants (Kimberly & Evanisko, 1981). Outcome or variance theories consider the *individual firm* as the unit of analysis and provide us with theoretical explanations for the influence of a range of different independent variables.<sup>2</sup> Process theories, in contrast, indicate how the management innovation process takes place within *inter-firm relations* and argue that merely the application of new management practices, processes and structures relies within individual firms. Furthermore, the process approach illustrates how conditions facilitating management innovation are interrelated and, in conjunction, explain when new management instruments are generated by the interaction between firms. The arguments of process models essentially render outcome models overly simplistic as the latter treat facilitating conditions as independent and competing explanations (Gopalakrishnan & Damanpour, 1994). However, the in-depth focus of process models leads this body of literature to neglect the organizational and environmental conditions under which inter-firm relations operate. Also, propositions of process models are difficult to substantiate as they rely on complex conceptual models and individual case studies.

A mediating approach is provided by contingency theories of management innovation. Scholars in this field, while in principle advocating an outcome perspective, suggest that the conditions under which management innovation takes place may be contingent on the appropriate alignment of individual, organizational and environmental factors (Burns & Stalker, 1961; Daft, 1978; Damanpour, 1996; Gopalakrishnan et al., 1994). Contingency theories thereby emphasize the notion of 'fit' among variables, and the idea that there are alternative, equally effective organizational systems that facilitate management innovation processes (Nicholson, Rees, & Brooks-Rooney, 1990; Pennings, 1975). These propositions are supported by illustrative evidence (Sapolsky, 1967), and by

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<sup>2</sup> In many bodies of literature the term 'variance theories' is usually preferred over the term 'outcome theories'. In the following, I continue using the term *outcome theories* as it seems to be more common in the innovation literature.

post-hoc and implicit theorization in outcome and process studies respectively (Birkinshaw et al., 2008; Corwin, 1972). Contingency theories provide an alternative to outcome and process approaches by acknowledging complexities among the contextual antecedents of management innovation while remaining sufficiently systematic to formulate testable hypotheses. However, they have so far not been used in management innovation research, as translating their hypotheses poses severe methodological difficulties (Fiss, 2007; Longenecker & Pringle, 1978; Parker & van Witteloostuijn, 2010).

## 1.2. Research Approach and Objectives

In this thesis, I take a holistic approach to contribute to the current literature on management innovation. I acknowledge the insights of process theories of management innovation and take the inter-firm relation as the unit of analysis (Birkinshaw et al., 2008). Inter-firm relations are essentially social action systems similar to individual firms. Both represent organizational systems that are subject to the same contextual influences (van de Ven, 1976). Subsequently, I adopt insights provided by outcome theories of management innovation and apply relational, structural and environmental variables to the inter-firm relation (Baldrige et al., 1975; Damanpour, Szabat, & Evan, 1989; Mol & Birkinshaw, 2009). Furthermore, I adopt theoretical arguments put forward by contingency theories aiming at substantiating the theoretically complex antecedents of management innovation. Instead of specifying what actors within inter-firm relations *do* to develop and implement new management instruments, I thereby ask *under what conditions* the management innovation process within inter-firm relations takes place. This thesis therefore aims at providing an answer to the following question:

*What configurations of relational, structural, and environmental conditions of inter-firm relations facilitate management innovation processes?*

To answer this question, I use a method that is relatively new to organization studies. Fuzzy set Qualitative Comparative Analysis (fsQCA) builds on set theory to holistically examine and compare the complex configurations of cases, instead of analyzing the net-effect of individual determinants (Ragin, 2008b). It uses Boolean logic, similar to queries in online search engines, to minimize data and to identify configurations, i.e. combinations of conditions, that explain a certain outcome. Thereby, fsQCA properly translates complex theoretical assumptions and is hence well suited for the analysis of configurations of inter-firm relations that facilitate the management innovation process (Grandori & Furnari, 2008; Ragin, 2008b).

## 1.3. The Biopharmaceutical Industry in China

The empirical study in this thesis takes place in China's biopharmaceutical industry. Between 2007 and 2008, I conducted 56 interviews with Chinese biopharmaceutical firms to examine the role of inter-firm relations in management innovation. Due to substantial unpredictability regarding the ultimate marketability of biopharmaceutical products and the complex nature of the industry's knowledge domains, biopharmaceutical firms operate under high degrees of uncertainty and strongly rely on ties to other organizations (Powell, Koput, & Smith-Doerr, 1996). The industry is known of its lack of appropriate managerial techniques to fully reap the benefit of the large number of technological innovations so



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characteristic for the industry (Pisano, 2006). In China, the biopharmaceutical industry is relatively young, the market for biopharmaceutical products is growing and the institutional framework is rapidly changing (Frew et al., 2008; Lakhan, 2006). In addition, the industry contains a highly diverse population of firms. Inter-firm relations consequently operate under volatile conditions that require the constant development of new managerial instruments to address these dynamics.

The background of the study, during China's emergence as an economic powerhouse, adds to its relevance. During the last two decades, the world has witnessed the rise of large Chinese corporations, which have become global leaders in their industries. And while Chinese high technology firms have certainly begun competing with technology leaders in the West (Greeven, 2009; Greeven, 2007), these advancements do not, in and by themselves, explain why Chinese firms outperform larger, more mature and technologically more innovative companies. Clearly, political factors play a substantial role (Child & Rodrigues, 2005; Dickson, 2003; Krug, 2004; Schueler-Zhou, Brod, & Schueller, 2010). A growing body of management literature, however, suggests that the most successful innovation employed by Chinese firms pertains to innovations in the way business is conducted, i.e. management innovation (Krug & Hendrischke, 2008; Zeng & Peter, 2003; Zeng & Williamson, 2007). Chinese entrepreneurship in high technology industries is directly and successfully competing with Western counterparts, and there is much reason to believe that Chinese biopharmaceutical firms will soon play a prominent role among Western industries, too (Chervenak, 2009; Ernst & Young, 2005; Langer, 2007a; Zhou, 2007). In light of significant recent economic developments taking place in rapidly developing countries understanding management innovation in China is increasingly urgent.

#### 1.4. Contributions

The results of this study will identify four distinctive configurations of relational, organizational and environmental conditions of inter-firm relations that facilitate management innovation processes. Operating under strong environmental uncertainties, decentralized decision-making systems paired with flat hierarchically structured firms unleash internal knowledge resources distributed across cooperating firms. This configuration enables organizational systems to develop new management instruments in reaction to new situations. Similarly, the second configuration feeds of on decentralized structures yet requires a high degree of heterogeneity among interacting firms. The results indicate that such organizational systems spread sensing devices that allow them to access resources available in their broader environment. The third configuration of inter-firm relations generates new management instruments on the basis of internal knowledge. Here, between mutually dependent and homogeneous partners, the formalization of rules and regulations provides for the necessary preconditions to establish trust within the inter-firm relation, subsequently enabling the exchange and recombination of knowledge to managerially innovate. Finally, in the absence of environmental uncertainties, inter-firm relations engage in management innovation when they are hierarchically designed. In this configuration, the role of top management and administrative cores is pertinent in developing and implementing new management instruments.

From a theoretical perspective, the results provide substantial support for configurational theories in management innovation. There is not a single determinant, a ‘one-size fits’ all solution, that satisfactorily explains when inter-firm relations trigger management innovation processes. To be clear, this is not merely a matter of how close one takes a look. fsQCA maintains distinct model coefficients that deem overall solutions as sufficiently consistent, or not. Consequently, by identifying equifinal configurations that exhibit multiple, conjunctural and asymmetric relationships among variables, this thesis uncovers substantial degrees of complexity among the contextual antecedents of management innovation. The results call for a stronger focus in theory development and suggest future research directions.

Moreover, I introduce a new methodological approach, fsQCA. This approach is relatively new to management and organization research (Fiss, 2010; Fiss, 2007; Greckhamer, Misangyi, Elms, & Lacey, 2008), and has so far not been used in the study of management innovation. A holistic approach is taken by fsQCA, systematically comparing entire cases with each other (Ragin, 1987, 2008b). It refrains from disaggregating cases into (seemingly) independent variables and thereby represents an alternative analytical technique that improves the alignment of management innovation theories with methods, by better translating theoretical propositions into models (Doty & Glick, 1994; Venkatraman, 1989). However, as with every method, fsQCA bears risks and limitations and, as the method is relatively young, it is subject to constant methodological developments.

Finally, configurational analyses ultimately develop taxonomies of viable, alternative design choices. These reduce complex phenomena to commonly shared elements and allow comparisons between alternative, equally effective organizational systems (Fiss, 2010; Martin-Pena & Diaz-Garrido, 2008). The taxonomy developed in this thesis provides managers with a simple and well-arranged instrument to optimize and re-design inter-firm relations according to their management innovation strategy. It thereby drafts intelligible and practical managerial implications. In particular it provides answers to questions such as how inter-firm relations need to be designed (or configured) to enable management innovation? Or how can inter-firm relations be changed in order to facilitate or obstruct management innovation processes?

Throughout this thesis, I provide empirical evidence and use short case studies from China’s biopharmaceutical industry to illustrate management innovation phenomena, and the functioning and mechanisms of inter-firm relations in the development and implementation of these instruments. The thesis thereby depicts China’s biopharmaceutical industry as a diverse population of organizations that, in interaction, creates new management instruments. The overarching picture that emerges is one of an industry that, as a whole, will soon take a prominent position among the dominant biopharmaceutical industries in the world.

## 1.5. Overview of the Dissertation

This thesis proceeds as follows. *Chapter 2* summarizes previous literature on management innovation. The chapter first discusses conceptual issues that pertain to the study of innovation in general. It then provides an overview of theoretical perspectives on

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management innovation and discusses their corresponding methodological approaches. *Chapter 3* introduces the two major deviations from earlier research on management innovation proposed in this thesis. Firstly, a theoretical shift that combines insights from outcome, process, and contingency theories alike to propose a configurational model of conditions of inter-firm relations that facilitate management innovation. Secondly, a methodological shift that introduces a new analytical technique, fsQCA, to the study of management innovation. These two elements provide the conceptual foundations of the empirical study presented in this thesis. *Chapter 4* describes in detail the empirical background in the Chinese biopharmaceutical industry. It provides an overview of the biopharmaceuticals industry and illustrates the specific business environment of biopharmaceutical firms operating in China. In *Chapter 5*, I report the empirical study among inter-firm relations in China's biopharmaceutical industry. I describe aspects pertaining to the collection and measurement of data, the calibration of membership scores and lead the reader through the analysis step by step. I subsequently report and discuss the results. Finally, *Chapter 6* summarizes the implications of the thesis and concludes.

## 2. Previous Research on Management Innovation

The purpose of this chapter is to summarize previous research on management innovation. Before illustrating literature specific to management innovation I introduce conceptual issues that pertain to the study of innovation in general. Understanding these conceptual issues is important as it facilitates capturing the complexity and subsequent variety of approaches used in the research of management innovation. I then proceed to theories of management innovation, discussing outcome, process and contingency theories separately. Finally, I illustrate corresponding modelling and methodological. The review serves to illustrate how a holistic, configurational approach contributes to our understanding of management innovation.

### 2.1. Conceptual Issues in Innovation Studies

Innovation has been the subject of enquiry in a variety of academic disciplines ranging from economics, sociology, and technology studies to organizational and management studies (Gopalakrishnan & Damanpour, 1997). However, the development of an integrative theory is challenged by a range of conceptual dimensions pertaining to innovation in general. First, two substantially different conceptualizations of innovation exist in the literature: in one, whereby innovation is understood as the outcome of contextual factors; in the other as a process of different events and activities. Second, the research distinguishes various stages of innovation. Outcome models of innovation commonly simplify innovation by considering none or only a few consecutive stages. In contrast, process models argue that innovation consists of "...complex, cumulative and conjunctural progressions of convergent, parallel, divergent activities" (Gopalakrishnan 1997: 16). Third, the most fundamental attribute of innovation pertains to its 'newness' (Gopalakrishnan et al., 1997). Yet, despite the fact that all innovation research agrees that innovation is essentially something new, there is wide disagreement over the definition, conceptualization, and measurement of 'newness'. This fundamental attribute deserves separate attention. Fourth, scholars have also examined other attributes specific to innovation that help to grasp the phenomena as a whole (Downs & Mohr, 1976; Fliegel & Kivlin, 1966). Fifth, partly by taking such attributes into consideration, various types of innovation can be distinguished. It is here where management innovation is contrasted against other forms of innovation, most notably technological innovation (Damanpour, 1987; Gopalakrishnan et al., 1997). I will discuss these five conceptual issues in the study of innovation in more detail one after another in the following sections.

#### 2.1.1. Two Conceptualizations of Innovation

Innovation has been described and defined from two different perspectives. Some scholars conceptualize innovation as an outcome, such as a product or idea (Damanpour & Evan, 1984; Kimberly et al., 1981). I will refer to these as 'outcome models'. Others have conceptualized innovation as a process (Birkinshaw et al., 2008; van de Ven & Rogers, 1988; Zaltman, Duncan, & Holbek, 1973). I will refer to these as 'process models'. Underlying both conceptualizations are processes of knowledge production or knowledge re-combination that allow new ideas to be developed and introduced (Kogut & Zander, 1992; Nickerson & Zenger, 2004; Powell et al., 1996; Thompson, 1967).

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Outcome models aim to identify individual, organizational, and environmental factors that influence the ability of an organization to innovate. Individual factors relate to the attitudes, knowledge, experiences, or affiliations of decision-makers who facilitate the sharing of knowledge and the development of shared 'languages'. Organizational factors relate to a firm's human resources (HR), and demographic, structural and strategic factors (Baldrige et al., 1975; Damanpour, 1996; Ettlie, 1983; Hage, 1980). Organizational variables clearly dominate outcome model research and it has often been argued that structural variables are the primary determinants of organizational innovation (Kim, Oh, & Swaminathan, 2006; Kimberly et al., 1981; Wolfe, 1994). Environmental factors relate to institutional theories, suggesting that firms respond to specific exogenous influences (Child, 1973; Powell et al., 1996). Conflicting contextual forces or institutional uncertainties are commonly regarded as triggers for innovative activities (Guler, Guillén, & MacPherson, 2002; Mintzberg, 1979).

In contrast, process models emphasize the complex interplay between actors, activities, events and stages as elements of the generative process that leads to innovation (Birkinshaw et al., 2008; Kline, 1985). Models in this tradition aim to identify types of events and sequences central to the innovation process. Emphasis is placed upon activities such as idea initiation and idea proposal, and events such as project definition, problem solving, prototype solutions, development of feasible solutions and implementation (Kline, 1985; Thompson, 1967). These models highlight the role of interaction between change agents and serve to describe and explain in detail the complex interdependencies within the innovation process (Gopalakrishnan et al., 1997). Scholars advocating a processual understanding of innovation criticize outcome approaches for simplifying and mis-specifying the nature and direction of causal factors (Anderson & Tushman, 1990; Kline & Rosenberg, 1986; Schroeder, van de Ven, Scudder, & Polley, 1989).

The distinction between outcome and process models of innovation carries significant consequences for the theorizing and modelling as well as the choice of methodological techniques. As a result, I will retain this distinction both in the section on theories of management innovation and in the section on modelling and methods.

### 2.1.2. Stages of Innovation

Outcome and process models differ in the emphasis they place upon their examination of innovation stages. Outcome models only consider either the generation or the adoption of a new idea (Roberston, 1974; Zaltman et al., 1973). This simplification of the innovation process allows researchers to develop empirical markers and to identify moments when a new idea or product is developed from an initial stage. Such models thus allow the researcher to distinguish the stage of 'generation' from subsequent stages such as 'implementation' (Kline et al., 1986).

Process models differ from outcome models in two ways. First, they take a holistic perspective and consider the entire innovation process. Pierce and Delbecq (1977), for instance, distinguish between the initiation, adoption, and implementation of innovation as well as between the corresponding activities of project definition, problem solving, design and development, and marketing and commercialization. Second, process models do not assume a linear and consecutive sequence of stages. Indeed, process model scholars

question the existence of discrete stages (Pelz, 1983; Rogers, 1983) and presume that even if such stages exist they should be conceptualized as interrelated, parallel, converging, diverging or overlapping (Kline, 1985; Schroeder et al., 1989).

### 2.1.3. Newness of Innovation

Because of its central role in innovation research, the notion of newness has received a lot of attention. While all scholars agree that innovation most fundamentally pertains to something new, there is wide disagreement over what level of adoption determines such newness. Consequently, one can find a variety of measurements for newness (Downs et al., 1976). In general, in-depth process models examine innovations that are new to a single organization, whereas larger studies use a stricter definition of newness. These definitions range from new to its 'local context or industry' (Sapolsky, 1967; Teece, 1980), or its 'first use ever' (Mansfield, 1963; Thompson, 1965) to more restrictive criteria such as 'new to the state of the art' (Birkinshaw et al., 2008; Gordon, Kimberly, & MacEachron, 1975; Kimberly et al., 1981).

In addition to these definitional differences, innovations by their very nature exacerbate the task of assessing 'newness'. They are transient, i.e. their classification changes over time so that one and the same innovation is rarely the same thing in two organizations (Downs et al., 1976; Winter, 1968). Moreover, the *perception of newness* by the relevant unit of adoption plays a crucial role (Dewar & Dutton, 1986; Zaltman et al., 1973). The relevance of perception in assessing 'newness' involves practical challenges. The more 'new' an idea or product is perceived to be, the stronger the resistance it faces during adoption (Kimberly et al., 1981). Similarly, for data collection purposes, managers tend to overstate the novelty of newly introduced instruments so that the use of self-reported newness is likely to contain measurement biases (Downs et al., 1976). To avoid these biases, the use of expert groups is a preferred method to validly determine newness in innovation studies (Dewar et al., 1986; Kelley, 1976).

### 2.1.4. Attributes of Innovation

Aside from this fundamental attribute of newness, scholars have examined other attributes of innovation. Instead of focusing on contextual variables, events or activities that affect innovation, some have argued that understanding the attributes of innovation itself is fundamental to employing typologies and relationships in the context of theory building (Downs et al., 1976; Tornatzky & Klein, 1982). The most exhaustive collection of attributes of innovation is provided by Fliegel and Kivlin (1966), who develop a list of attributes grouped into the following categories: cost, efficiency, risk and compatibility. Cost attributes refer to initial and continuing costs as well as economic returns. Efficiency attributes, on the other hand, consider savings in time or reduction of discomfort. Risk and uncertainty attributes relate to the regularity of rewards, the divisibility of trials (modularity), or the communicability of an innovation. Finally, to assess the possibilities of integrating innovations, Fliegel and Kivlin distinguish compatibility attributes such as mechanisms of attraction and pervasiveness and less tangible attributes such as social approval (Fliegel et al., 1966). Following this research, Downs and Mohr (1976) proposed to distinguish primary attributes, i.e. those that "...can be confidently classified without reference to a specified organization" (Downs and Mohr, 1976: 702), from secondary,

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context-specific attributes. A classification of the secondary attributes of an innovation essentially rests on assessing the organization that contemplates its adoption. The analysis of attributes remains a rather neglected field of research in innovation studies. Nevertheless, it facilitates understanding of the inherent uncertainties entailed in innovation processes and is necessary to essentially determine the economic effects of innovation activities, for instance on company performance.

### 2.1.5. Types of Innovation

The literature distinguishes between different types of innovation, partly based on various attributes. The term organizational innovation hereby captures all kinds of innovations generated by organizations. Within organizational innovation, scholars use various attributes to distinguish between material vs. non-material innovation (Ogburn, 1922), radical vs. incremental innovation (Dewar et al., 1986), process vs. product innovation (Ettlie & Reza, 1992; Pisano, 1996), technical vs. non-technical innovation (Jangwoo & Miller, 1996; Whitley, 2000), or administrative vs. technological innovation (Daft, 1978; Evan, 1966). In addition, specific terms have been coined based on the ultimate objectives of innovation: ‘strategic innovation’, for instance, refers to the development of new strategies (Hamel, 1998; Markides, 1997); ‘cost innovation’ refers to combinations of innovations that reduce costs and increase efficiencies (Zeng et al., 2007); and ‘social innovation’ concerns sustainable organizational innovation that supports local communities, such as ethnic communities, cities or entire nations (Drucker, 1987; Westley, 1991). Among these typologies, radical vs. incremental innovation and technological vs. administrative innovation have been most widely adopted (Baldrige et al., 1975; Damanpour, 1996). Technological innovations rather refer to the use of physical products, technical processes, and other technologies used to produce goods (Crossan & Apaydin, 2010).

### 2.1.6. Definitions of Management Innovation

In contrast, management innovation is best considered as an offspring of administrative innovation (Damanpour, 1987; Evan, 1966; Teece, 1980). Hamel (2006) describes it as “...a marked departure from traditional principles, processes, and practices, or a departure from customary organizational forms that significantly alter the way the work of management is performed.” (Hamel, 2006: 4). He adds that, in contrast to technical or operational innovation, management innovation affects a firm’s management processes.

While administrative innovation is confined to new administrative processes, organizational structures, and HR policies (Carroll, 1967; Damanpour, 1996; Gopalakrishnan et al., 1994), management innovation concerns a broader range of non-technical innovation pertaining to managerial issues (Birkinshaw et al., 2008). These include innovations in marketing, strategy or operations management (Hamel, 2006; Mol et al., 2009; Vaccaro, Jansen, van Den Bosch, & Volberda, 2009). Both administrative and management innovation are directly related to the overarching management of an organization, and thus are only indirectly related to the day-to-day activities of staff (Evan, 1966; Kimberly et al., 1981; Knight, 1967). Most scholars use the terms administrative and management innovation interchangeably as the differences between the two concepts are



marginal (Birkinshaw et al., 2008). In the remainder of this thesis, I use the term management innovation, yet when reviewing the literature, I include insights gained by research on administrative innovation.

Hamel's (2006) description points towards a number of peculiarities surrounding management innovation. Management innovation is assumed to involve significant set-up costs (Teece, 2007) due to necessary modifications in the structures and systems of organizations (Damanpour, 1996; Moon et al., 2004). Furthermore, the outcome of management innovation is subject to considerable uncertainty, is not necessarily successful or intentional (Baldrige et al., 1975). It is therefore difficult to directly relate its impact on organizational performance (Kimberly et al., 1981). Furthermore, management innovation is less tangible than for instance technological innovations, and consequently more difficult to implement (Damanpour, 1996). In contrast to technological innovation, its diffusion is not prevented by legal barriers (Teece, 1980). For these considerations, some researchers have suggested that incremental approaches to management innovation are unfeasible research directions (Damanpour, 1996). The distinction between radical and incremental innovation in fact appears rarely in the management innovation literature.

The different definitions of management innovation reflect the various conceptual issues involved in innovation research. These are illustrated in the following examples. Birkinshaw et al. (2008) define management innovation as the "...invention and implementation of a management practice, process, structure, or technique that is new to the state of the art and is intended to further organizational goals." (Birkinshaw et al., 2008: 825). Menz (2009) defines it as "...the adoption of a management concept, idea, practice, process, structure, technique, or tool that is new to the organization and is intended to improve firm performance (Menz, 2009: 3). Finally, Vaccaro et al. (2010) define it as "...the implementation of a management practice, process, or structure that is new to the adopting organization." (Vaccaro et al., 2010: 2).

These three examples show how definitions differ in terms of the stages that are considered, the criteria used to determine newness, and whether or not management innovation is regarded as furthering organizational goals. The definition of Birkinshaw et al. (2008) covers two consecutive stages of management innovation, whereas the latter two examples focus respectively upon adoption (Menz, 2009) or implementation (Vaccaro et al., 2009) of management innovation. Most scholars agree that management innovation entails new managerial practices, processes, and structures. However definitions alter according to the particular research focus, as indicated in the differences in determining 'newness' outlined in section 2.3, above. Whereas Menz (2009) and Vaccaro (2010) define 'newness' as 'new to the organization', Birkinshaw et al. (2008) consider management innovation to occur only when the practice, process or structure is 'new to the state of the art' – ultimately a rather restrictive criteria. Lastly, scholars' definitions of innovation also contain notable differences based upon the objectives of management innovation. These objectives are: those intended to further organizational goals (Birkinshaw et al., 2008); those used to improve firm performance (Menz, 2009); or those not used or intended to be used for any specific objective (Vaccaro, 2010). In the following, I maintain a preliminary definition of management innovation whereby:



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*Management innovation refers to the development (generation) and implementation (adoption) of a new management practice, process, or structure intended to further organizational goals.*

## 2.2. Theories of Management Innovation

Management innovation has been theorized as either an outcome of contextual factors or as a process of interrelated activities and stages. In the following section, I discuss theoretical contributions in both fields. I begin by illustrating the theoretical arguments put forward by outcome models of management innovation, highlighting the various factors taken into account in this field of research. I then proceed to discuss process theories. Last, I describe systematic, multi-dimensional theories of management innovation, which predominantly rely on contingency arguments, and summarize the findings of this subsection.

### 2.2.1. Outcome Theories of Management Innovation

Between the 1960s and 1990s a remarkable number of theoretical contributions appeared which significantly shape today's understanding of management innovation. Research on innovation as the outcome of contextual factors is by now a large and established body of literature (Damanpour, 1991; Evan, 1966; Mol et al., 2009; Vaccaro et al., 2009). Its primary objective consists in analyzing the effects of individual, organizational, and environmental determinants of management innovation.

#### *Characteristics of Individual as Determinants of Management Innovation*

Some of the first theoretical contributions to the field of management innovation hypothesized that specific characteristics of individuals influence an organization's ability to managerially innovate. Carlson (1967) for instance argued that better educated, more mature males of high social status are more able to introduce new managerial practices due to their perceived higher authority and legitimacy (Carlson, 1967). Others suggest that general attitudes and values, such as cosmopolitanism, provide individuals with the necessary range of ideas and experiences to devise new management instruments (Rogers, 1983; Rogers & Cartano, 1962). Sapolsky, (1967) providing evidence from department stores, argues that the external communications of individuals outside their company promotes management innovation (Rogers & Shoemaker, 1971). However theories on the characteristics of individuals as determinants of management innovation have not been supported by empirical research (Baldrige et al., 1975). In fact most studies suggest that general characteristics of individuals are poor predictors of management innovation (Hage & Aiken, 1970). As an alternative, scholars have argued that, if one is to consider characteristics of individuals, one should also examine context-specific features of individuals (Baldrige et al., 1975).

#### *Organizational Determinants of Management Innovation*

The role of organizational factors has dominated research on management innovation, and essentially argues that organizational innovation is primarily an outcome to be explained by organizational determinants (Damanpour, 1991; Kim, 1980; Kimberly et al.,

1981; Wolfe, 1994). In a continuation of theories on the role of individuals in management innovation, researchers have considered factors associated with an organization's Human Resource (HR) system. In addition demographic, structural, and strategic factors have been within the focus of these analyses.

#### **Human Resource related Factors**

As indicated above, general characteristics of individuals have largely been dismissed as determinants of management innovation. Instead, theoretical focus has been directed onto context-dependent features of individuals (Aiken & Hage, 1968; Blau, 1970), i.e. factors that capture the role and function of individuals within organizations. First, scholars have examined the role of different leadership or administrative positions which are assumed to set, encourage, and approve the innovation process (Daft, 1978). Baldrige and Burnham (1975) for instance observe that administrative positions of individuals within an organization have an impact on innovation activities, and conclude that these positions are especially important to link "... demands and ideas from the outside and innovations adopted within the schools." (Baldrige and Burnham, 1975: 167). Second, different attitudes and behavioural styles of an organization's employees have been hypothesized to affect management innovation. As such, researchers examined employees' attitudes towards change (Kimberly et al., 1981) or the internal resistance to change within the organization (Corwin, 1972; Daft, 1978; Dewar et al., 1986; Mintzberg, 1968). The third group of HR related factors pertains to the diversity of knowledge and experience available within an organization. Researchers argue that management innovation requires the recombination of existing expertise, and that a more diverse repository of knowledge increases the likelihood that a firm will develop and implement new managerial tools (Hage, 1980). Hence the distribution of knowledge within an organization is hypothesized to positively affect management innovation (Dewar et al., 1986). A similar line of thought is pursued by scholars who consider the degree of specialization, or the depth or intensity of organizational knowledge (Baldrige, 1971; Kimberly et al., 1981; Zaltman et al., 1973). Others focus on the role of heterogeneity within management teams (Alexiev, Jansen, van den Bosch, & Volberda, 2010) or previous experience in different cultures (Chen, 2008). Finally, assuming that managers will be more inclined to introduce new instruments, scholars have argued that administrative intensity, i.e. the share of administrative staff in the total workforce, positively influences management innovation (Blackburn, 1982; Damanpour, 1991; Reinmann, 1973, 1974).

#### **Demographical Factor: Size**

A second group of factors hypothesized to affect management innovation relates to demographic features of organizations. Organizational size has been the most widely analyzed feature (Damanpour, 1992; Ettlé, 1983). Two rival hypotheses have been formulated. On the one hand, scholars argued that larger firms are more likely to innovate because they incorporate a larger span of role differentiation, problem solving experts, and supporting services to dedicate to innovative activities. On the other hand, it has been suggested that small firms are more likely to innovate because they are more flexible (Camisón-Zornoza, Lapedra-Alcami, Segarra-Ciprés, & Boronat-Navarro, 2004; Damanpour, 1992; Moch & Morse, 1977).

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Theories advocating a positive association between size and management innovation take a resource-based perspective (Feldman, 2004). This has led to refining the ‘size’ hypothesis by considering the amount of slack resources instead of size. The ‘slack’ resource hypothesis argues that firms with resources available for innovative activities are more likely to be managerially innovative (Baldrige et al., 1975). Similarly, researchers suggest that the change in output standards of organizations, and the resulting (and empirically observable) performance gap, are considered determinants of management innovation (Hage, 1980; March & Simon, 1958). Finally, heterogeneity has also been considered on the level of the organization. Researchers have further hypothesized a positive association between management innovation the geographical scope and diversity of larger organizations (Mol et al., 2009).

Empirical results for both the size and the slack resource hypotheses have been inconclusive. As early as 1974, Utterbach (1974) found no evidence for any association between size and innovation, a result supported by later studies (Aiken, Bacharach, & French, 1980; Ettlie, 1983; Evan & Black, 1967; Jervis, 1975). At the same time, others found evidence for a positive relationship between the two variables (Blau & McKinley, 1979; Dewar et al., 1986) while a third group provided evidence for negative relationships between the two variables (Hage, 1980). Motivated by inconclusive evidence, Damanpour (1992) conducted a series of meta-analyses on management innovation studies. He concluded that depending on the way size is measured a positive association can exist. He did not find that size affects different types of innovation, but rather identified different effects for different phases: size is more important during the implementation than during the initiation of an innovation. His results are confirmed by Camisón-Zornoza et al. (2004) even when applying advanced methods that allow distinguishing the size difference that result from different definitions of size.

### **Structural Factors**

Structural factors of organizations have long been examined in theories of management innovation. Central to these arguments is the idea that structure needs to be designed to allow the unobstructed flow of knowledge and to encourage employees to freely communicate and participate in activities that promote management innovation (Thompson, 1967). Taxonomies commonly identify the following dimensions of organizational structure: specialization, administrative intensity, formalization, centralization, and vertical differentiation (Blackburn, 1982; Pugh, Hickson, & Hinings, 1969). I have discussed the first two in the context of HR related factors as they primarily concern decision-makers and employees in organizations.

Early research argued that formalization discourages managerial innovation because it prescribes expected behaviour and requires administrators to enforce rules by providing incentives for compliance while at the same time penalizing non-compliance (Hage, Aiken, & Marrett, 1971; Thompson, 1967). Subsequent research questioned this logic and instead argued that formalization may also enable employees to participate in certain activities by providing for sufficient certainty and defining specific rights (Adler & Borys, 1996; Aghion & Tirole, 1997; Vlaar, van Den Bosch, & Volberda, 2006). Empirical evidence for the role of formalization in management innovation remains inconclusive, and results from

a meta-analysis have not been able to identify a significant effect of formalization on management innovation (Damanpour, 1991).

Similarly, it has been argued that a strong centralization of authority hinders innovation (Dewar et al., 1986; Thompson, 1967). In contrast, decentralized structures distribute responsibilities throughout the organization, thereby broadening the range of employees included in the decision making process (Becker, 1970; Normann, 1971). Zmud (1982), in his study on modern software practices, finds that centralization is positively related only for the initiation of management innovation. His results however are questioned by Damanpour's meta-analysis (1991) which clearly shows that centralization negatively influences innovation across different types of organizations, types of innovation, and stages of adoption.

Finally, researchers have considered the degree of vertical differentiation of an organization as an important determinant of management innovation (Blau et al., 1979; Hull & Hage, 1982). It has been argued that the more vertically differentiated a firm is, i.e. the larger number of hierarchical levels there are within an organization, the more difficult it is for crucial information to be communicated to the relevant change agents. However other scholars have theorized that vertical differentiation reflects the complexity of an organization supporting innovation. Empirical results support this latter view and indicate a positive association of vertical differentiation on management innovation (Damanpour, 1991).

#### **Strategic and Organizational Boundary Factors**

Aside from structural factors, scholars have examined the role of a firm's strategic orientation as a determinant of management innovation (Child, 1972; Ettlie & Bridges, 1982). Once innovation as a strategic objective has been realized, it materializes in the form of innovation policies and thereby affects organizational innovativeness (Ettlie, 1983). The realization of innovation as a strategic object is influenced by how effectively organizations communicate and exchange information with their environment (Tushman, 1977). Particularly important in this respect are cognitive aspects such as awareness and perception of key decision-makers (Ferreira, 2010). Consequently, some have argued that the cognitive element between environmental dynamics and strategic decisions is decisive for management innovation (Becker, 1970). Researchers consider external sources of information available to managers or the managers' use of local sources of information (Kaluzny, 1974; Kaplan, 1967; Mytinger, 1968); others have instead examined the roles of environmental scanning and other extra-organizational professional activities of top management teams as triggers for management innovations (Jervis, 1975; Miller & Friesen, 1982; Vaccaro et al., 2009).

#### *Environmental Determinants of Management Innovation*

Finally, a third group of factors associated with management innovation pertains to environmental conditions under which organizations operate. During the 1960s, scholars predominantly focused on environmental heterogeneity (Baldrige, 1971; Evan, 1965; Terreberry, 1968). Baldrige and Burnham (1975) for instance consider population density, urbanization and government expenses, and conclude that environmental heterogeneity is

“...likely to cause problems for organizations that promote the adoption of innovations.” (Baldrige and Burnham, 1975: 165). Mintzberg (1979) argues that organizations only adopt new organizational forms as a response to conflicting contextual forces. Consequently, environmental conditions were conceptualized along the two dimensions proposed earlier by Duncan (1972): simple vs. complex and stable vs. dynamic environmental conditions (Doty, Glick, & Huber, 1993; Duncan, 1972). In subsequent research, studies have predominantly considered an overall category representing environmental uncertainty (Damanpour, 1996; Ettlie, Bridges, & O’Keefe, 1984).

*Final Remarks on Outcome Theories of Management Innovation*

Outcome theories have considered a wide range of determinants to explain the conditions that enable organizations to managerially innovate. Their main contribution lies in compiling a range of individual, organizational and environmental determinants. Further, they contribute by specifying the underlying theoretical mechanisms. With few exceptions however, empirical evidence for the significance as well as the direction of their effect on management innovation have been widely inconclusive. The following Table 2.1 summarizes the findings of this section and provides an overview of the various determinants proposed in previous outcome research.

*Table 2.1: Factors in Outcome Theories of Management Innovation*

Characteristics of individuals	<ul style="list-style-type: none"> <li>• Level of education</li> <li>• Gender</li> <li>• Social status</li> <li>• Attitudes, values</li> </ul>	Insignificant
<b>Organizational factors</b>		
Human Resource Factors	<ul style="list-style-type: none"> <li>• Resistance to change</li> <li>• Leadership style</li> <li>• Specialization</li> <li>• Knowledge diversity</li> <li>• Administrative intensity</li> </ul>	Inconclusive
Demographical Factors	<ul style="list-style-type: none"> <li>• Size</li> <li>• Slack resources</li> <li>• Geographical heterogeneity</li> <li>• Cultural diversity</li> </ul>	Inconclusive
Structural Factors	<ul style="list-style-type: none"> <li>• Formalization</li> <li>• Centralization</li> <li>• Vertical differentiation</li> </ul>	Significant, direction unclear
Strategic and Boundary Factors	<ul style="list-style-type: none"> <li>• Strategic orientation</li> <li>• External communication</li> <li>• Environmental scanning</li> <li>• Extra-organizational activities</li> </ul>	Significant, direction unclear
Environmental factors	<ul style="list-style-type: none"> <li>• Environmental heterogeneity</li> <li>• Environmental change</li> <li>• Conflicting contextual forces</li> <li>• Environmental uncertainty</li> </ul>	Significant

### 2.2.2. Process Theories of Management Innovation

In contrast to outcome studies, theories advocating a processual understanding of management innovation represent a much smaller body of literature. Instead of understanding management innovation as a linear sequence of stages, theories in this field conceptualize management innovation "... as a complex process with multiple, cumulative and conjunctural progressions of convergent, parallel and divergent activities" (Gopalakrishnan et al. 1997: 16; see also Kline, 1985; Rogers, 1978, 1983). Process theories of management innovation can broadly be distinguished between those focusing on the generation of management innovations and those focusing on the adoption of management innovations (Gopalakrishnan et al., 1994). Within each group, research examines the various actors and activities involved in facilitating the management innovation process.

Theories of the generation of management innovation perceive innovation primarily as a problem-solving and decision-making process (Pinchot, 1985; Rothwell & Roberston, 1973; Utterback, 1971). Scholars in this field examine how new ideas are generated. They focus on innovations that are new to industry as well as only new to an individual firm (Myers & Marquis, 1969; Utterback, 1971) and indicate how external change agents and linkages to other organizations decisively contribute to the generation of ideas (Birkinshaw et al., 2008). Innovations *per se* contain a high degree of uncertainty regarding their outcome. Generation theories examine activities that reduce ambiguities related to innovation (Tornatzky, Fergus, Avellar, Fairweather, & Fleischer, 1980). Stages such as idea generation, problem solving, design, production and commercialization are commonly considered (Cooper & Kleinschmidt, 1990; Rothwell et al., 1973). In addition, generation models show how activities between firms, such as agenda setting and idea linking, are important during the motivation and invention phase respectively (Birkinshaw et al., 2008). Generation models regularly take into account distinctive attributes of innovations and their specificity to individual organizations (Gopalakrishnan et al., 1994).

Theories focusing on the adoption stage examine how management innovations are implemented and affect the internal functioning of an organization (Hamel, 2006). Innovations are usually considered to be new to the firm but not necessarily new outside the firm. Adoption studies thereby represent an intermediate stage linking generation process models with diffusion models (Chatterjee & Eliashberg, 1990; Coleman, Katz, & Menzel, 1957; Teece, 1980). Adoption models primarily ask under what circumstances innovations can be integrated into an organization, and concur that complete assimilation is reached once innovations can no longer be identified as being different from other organizational practices (Tornatzky et al., 1980). The interaction between organizations plays a role in testing ideas and providing a theoretical framework for new management ideas from results of 'in vivo', i.e. practical trial and error, and 'in vitro', i.e. conceptual experiments (Birkinshaw et al., 2008).

Process theories of management innovation emphasize the behaviour and activities of formal and informal, as well as internal and external, change agents (Ettlie, 1980; Pelz, 1985; Poole, 1981; Saren, 1984). The in-depth focus serves to describe and explain in detail how various events, sequences, activities and stages in the innovation process are interrelated (Gopalakrishnan et al., 1994). In addition, by depicting management

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innovation as a complex process, they show how these determinants interact to constitute new management instruments. Furthermore, process theories of management innovation provide substantial evidence for the role of inter-firm relations in management innovation. While outcome theories consider strategic boundary factors such as external communication or extra-organizational activities as alternative explanations, process theories in fact shift the focus of analysis to the inter-firm level. Most notably, the seminal contribution by Birkinshaw et al. (2008) explicitly conceptualizes management innovation as the result of the interaction between organizations.

Despite the significant contributions of process theories, their degree of detail comes at an expense. Scholars disagree about the specific pattern of the innovation process (Schroeder et al., 1989); their models contain an unsystematic range of stages and activities. This makes it difficult to substantiate theoretical propositions with empirical studies using large datasets. Consequently, process theories usually examine only a very limited number of innovations in the form of single or comparative case studies. Furthermore, by emphasizing the developments within inter-firm relations process theories commonly lose sight of the role of organizational and environmental determinants (Anderson et al., 1990; Cooper, 1983; Zaltman et al., 1973) so that insights from outcome theories remain rather neglected.

### 2.2.3. Contingency Theories of Management Innovation

A third group of theoretical contributions to management innovation pertains to systematic, multi-dimensional theories. To some extent this group of theories constitutes a bridge between overly simplistic outcome theories and overly complex process theories (Gopalakrishnan et al., 1994)<sup>3</sup>. Confronted with difficulties of developing an integrative theory of management innovation, scholars turned to Penning's (1975) structural contingency theory as a framework to explain differences in organizations and their deliberate changes in structure and strategy in response to environmental shocks (Child, 1972; Pennings, 1975). In the centre of Penning's (1975) theory lies the argument that, for firms to achieve superior performance, managers need to *align* organizational structure and practices to environmental changes. The most relevant contingency frameworks for management innovation are Evan's (1966) dual core model, and Burns and Stalker's (1961) distinction between organic and mechanistic organizational structures.

Building on Evan's (1966) dual core model, Daft (1978) argues that innovative ideas originate from different organizational cores and move in different directions through the organization. In particular, he hypothesizes that technical innovation emerges from an organization's technical core located in the lower levels of an organization's hierarchy. From there, technical innovation moves upwards towards a firm's administrative core located in the upper echelons. Technical innovation therefore is best conceptualized as a bottom-up process. In contrast, management innovation emerges from the administrative

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<sup>3</sup> As will be shown during the review of models and methods in management innovation research, contingency frameworks from a technical point of view belong to those approaches that implement management innovation as an outcome. From a theoretical stand however I consider them intermediate approaches between outcome and process theories as they acknowledge a considerable degree of complexity underlying the management innovation phenomenon.



core and from there ‘trickle down’ to lower hierarchical levels. It should thus be understood as a top-down process. These two organizational cores may only be loosely coupled, i.e. ties between the administrative and the technical core are weak and each locus of innovation retains a separate identity. In other cases, both cores might overlap, for instance in smaller, knowledge intensive organizations where administrative leaders are installed for their scientific expertise. Support for Daft’s (1978) dual core model of innovation exists in the form of illustrative evidence provided, for instance, by Sapolsky (1967) who observes that proposals for administrative changes usually originate from the executives in the central offices.

The organizational contingency theory of Burns and Stalker (1961) stipulates that there are various combinations of structural elements. Distinguishing between organic and mechanistic configurations, they argue that organizations can be aligned along a continuum between these ideal types. These can be used to characterize organizational structures in terms of their ability to perform tasks such as maintaining constant quality levels during production, guaranteeing procedural consistency, responding to environmental shifts or cultivating the flow of innovative ideas within its boundaries (Burns et al., 1961; Damanpour et al., 1989).

To distinguish ideal types, Burns and Stalker (1961) focus on a number of factors describing the structure of organizations. Mechanistic structures are characterized by specialization and task differentiation, high degrees of centralization, vertical differentiation, and formalization. They are hypothesized to be more appropriate in stable conditions. More attention is given to internal rather than external knowledge (Burns et al., 1961). In contrast, organic structures feature shared responsibility, commitment and objectives, flat hierarchical structures and low degrees of vertical differentiation. They permit lateral, instead of vertical, communication flows and pay attention to external sources of knowledge, skills and experiences. Organic structures are more appropriate in unstable environmental conditions.

In the context of management innovation it has been argued that mechanistic structures are less flexible and that they discourage both the development of new ideas by formalization and the underlying bureaucratic structures that penalize divergence from rules (Damanpour, 1996). In addition, centralization concentrates decision-making authority, and vertical differentiation hinders the flow of knowledge and ideas within the organization. In sum, mechanistic structures discourage innovation and are hence less likely to develop and introduce new managerial instruments (Gopalakrishnan et al., 1994). Conversely, organic configurations are characterized by antipodal structures and, consequently, are hypothesized to foster innovative activities within organizations.

Structural contingency theory offers theoretical explanations that help to implement and substantiate propositions of management innovation theories. Its core theoretical paradigm argues for an alignment, ‘fit’ or consonance among various conditions as an explanatory approach to organizational phenomena (Doty et al., 1994). This coincides with the insights gained by process studies illustrating that variables in fact are not independent, but instead jointly exert their effect. Baldrige and Burnham (1975), for instance, assume that “... the various indicators of size, complexity, and environmental stability should



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cluster together in meaningful groups.” (Baldrige and Burnham, 1975: 173) and note that it is important to examine their joint impact. This concept describing the inter-relatedness of variables is known as *conjunctural causation* and refers to the association of multiple variables with a given outcome (Donaldson, 2001; Ragin & Fiss, 2008). In addition, contingency theories suggest that there are different combinations of conditions, potentially explaining rivaling hypotheses and inconclusive results from empirical studies. This notion of *equifinality* refers to the idea that “... a system can reach the same final state from different initial conditions and by a variety of different paths.” (Katz & Kahn, 1978: 30). In fact, a number of management innovation studies point to the possibility that there are different, equally effective, combinations of organizational determinants of management innovation (Birkinshaw & Mol, 2006; Damanpour, 1996; Hamel, 1998). Finally, contingency theories have been criticized for being overly vague about the direction and type of relationships among variables. Some – as will be shown in the following section – methodologically implement contingencies as interaction variables and thereby implicitly assume a unidirectional, linear and additive relationship between variables. While the criticisms of vagueness certainly are justified, contingency theories have ultimately triggered a discussion on the nature and the direction of relationships between variables (Damanpour, 1992; Lieberman, 1987; Longenecker et al., 1978). In particular, the idea of asymmetry among variables came to be discussed (Schoonhoven, 1981), referring to “... the situation where the change in the causally produced phenomenon is not of the same order of magnitude or direction when the cause is added as when it is taken away.” (Lieberman, 1987: 174).

Empirical support for multi-dimensional contingency theories is rare. Burns and Stalker’s (1961) model has been used on various occasions in innovation studies (Damanpour, 1996; Gopalakrishnan et al., 1994). Normann (1971), for instance, finds partial support for the model yet concludes that formalization and formal control instruments guiding the innovation process are not necessarily detrimental to innovation. This supports the ambiguous effect of formalization on organizational mechanisms. Zmud (1982), focusing on centralization and formalization, finds in his study of 49 software development groups that the interaction of the two determinants with innovation is partly supported. However, he too is required to qualify his conclusions, as comprehensively implementing the theoretical propositions put forward by contingency theories poses severe methodological challenges.

#### 2.2.4. Final Remarks

This subsection has dealt with the various theoretical approaches to management innovation. Outcome theories contribute by providing a range of determinants and specifying causal mechanisms. Empirical support however has been inconclusive and it has been argued that outcome theories are too simplistic. In contrast, by taking an in-depth perspective process models describe how different interrelated factors determine management innovation. Furthermore, they emphasize inter-firm relations, instead of individual focal firms, as the appropriate locus of innovation. Process theories, however, are too complex and unsystematic to substantiate theoretical propositions. Finally, contingency theories constitute an alternative between simplistic outcome models and detailed process models by explicating complex theoretical propositions. These

specifically concern equifinality, conjunctural causation, and asymmetric relationships. At the same time, the increase in systematic complexity poses new challenges for substantiating theoretical propositions. Consequently, modelling and methodological issues are an important building block in the study of management innovation. These are subject of the following section.

### 2.3. Modelling and Methods in Management Innovation Research

During the last decades researchers have applied a variety of methodological approaches to substantiate management innovation theories. A particularly important aspect to testing and developing theories pertains to careful modelling by clarifying and refining underlying logics (Blablock, 1989a, 1989b). Inaccurate models that improperly translate the logical arguments neither validly represent, nor adequately test theory (Doty et al., 1994; Venkatraman, 1989).

In this section, I describe modelling approaches used in management innovation research. Process theories have predominantly used conceptual models, circumstantial evidence and in-depth case studies. Outcome studies model management innovation as a series of competing explanations and use regression analysis to test hypotheses. The more complex contingency theories have been validated using different approaches to modelling ideal-types, forms of fit and equifinality (Doty & Glick, 1989). A particular focus of this section lies in the extent to which models are capable of reflecting the theoretical complexities among variables such as equifinality, conjunctural causation and asymmetric associations. My discussion of other methodological aspects pertaining to data format, sources or collection, is a secondary focus.

#### 2.3.1. Process Models

Research focusing on the processes that lead to management innovation predominantly develops conceptual models. The aim of such models lies in identifying classes of events and sequences central to the innovation process. They strongly emphasize the role of agents in the development of new management instruments.

One of the first case studies on the management innovation process was provided by Golightly (1968), in a study of innovation in airline management. Beginning with the introduction of new organizational forms, Golightly (1968) emphasizes the important, interconnecting function of marketing messages, the conversion of planning processes to operational management tools, and the role of chief executives. He observes in particular that there is not one unique, solely effective organizational format, and that the element of planning suffers from the over- or under-involvement of chief executives. Lillrank (1995), in a comparative case study, examines the process of transferring two management innovations, namely the Quality Control Cycle (QCC) and Time-Based Competition (TBC), from Japan to the United States. His model builds on the abstraction of management ideas which are transferred and re-applied within different cultural, social and historical environments. Despite the fact that Lillrank's (1995) model takes place on a macro-level it points to the role of interaction between change agents and inter-firm ties deemed crucial for the development of innovative management instruments. In contrast, Carrero et al. (2000) contribute to management innovation literature with an in-depth,

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comparative case study of four companies. Based on interview transcripts, they apply a grounded theory method (Glaser & Strauss, 1967) and explain management innovation alongside various stages of three parallel processes of adoption, experience and corporate historical development (Carrero, Peiro, & Salanova, 2000). In the centre of their model lie the activities, perceptions and reflections of actors in their cooperation with other private and public organizations.

Finally, in a seminal contribution, Birkinshaw et al. (2008) develop a conceptual model supported by circumstantial evidence. Management innovation is modelled along interrelated phases, from motivation, invention and implementation, to theorization and labelling. These phases are linked in three ways. On the one hand, internal change agents engage in activities such as problem search, trial and error and reflection. On the other hand, external change agents contribute through activities such as contextualization, the refining of ideas and theorization. Most importantly, however, the activities between both are linked by agenda setting, idea linking and idea testing (Birkinshaw et al., 2008). The model combines the insights developed by previous process model and portrays management innovation as a phenomenon that results from activities that take place within inter-firm relations (Birkinshaw et al., 2008; Lounsbury & Crumley, 2007; Powell et al., 1996).

Characteristic in process models is the inclusion of multiple stages, events, activities and actors. The degree of detail within process models allows examination of the entire management innovation process and makes two contributions. First, it shows how different factors are interrelated in developing new managerial instruments. Second, in contrast to outcome theories that take individual firms as the unit of analysis, process models suggest that the development and implementation of new management instruments takes place within inter-firm relations. Ultimately, however, process models remain too complex to enable systematic testing of their theoretical implications (double arrows are common elements in conceptual models). Existing empirical work consists mainly of conceptual models, single or multiple case-studies (Birnbaum, 2000; Crompton, 1983; Lillrank, 1995) using qualitative data from interviews, questionnaires or archival data. The analysis of only a few cases limits the extrapolation of results. Process models implicitly acknowledge the existence of cases that function differently yet result in similar innovation. Also, the complexity of conceptual elements and the high degree of unspecified associations among them suggests that both conjunctural causation and asymmetry are taken into account.

### 2.3.2. Outcome Models and Linear Regressions

Most empirical research on management innovation has been conducted as outcome studies. During the past four decades a large variety of studies have measured the effect of individual, structural, organizational and environmental factors (Aiken et al., 1980; Damanpour, 1987; Kimberly et al., 1981; Nicholson et al., 1990; Ravichandran, 2000; Teece, 1980). In contrast to process models, outcome studies predominantly analyze large datasets using regression models to measure the net effect of a series of independent variables on the outcome.

Two examples of studies using regression models to probe into the effects of variables on management innovation can be found in Kimberley and Evanisko (1981), and

Ravichandran (2000). Kimberley and Evanisko (1981) comprehensively study individual, organizational and environmental determinants of the adoption of technological and administrative innovations in hospitals. To identify innovation they use an independent expert panel to survey hospital administrators and chiefs of medicine. Running regression analysis, they find that variables better predict technical innovation than administrative innovation, and that size is the best predictor for both types of innovation. However, rather than identifying concrete determinants of innovation, they discuss conceptual differences in innovation types that may explain the inconclusive insights. A similar methodological approach has been used by Ravichandran (2000) in his study on the swiftness and intensity of adoption of administrative innovations using the example of Total Quality Management (TQM). On a sample of 123 information system departments in Fortune 1000 firms, he tests two environmental factors, four organizational and two task-related factors. The results indicate that the quality orientation of the host organization, management support for quality, functional differentiation, and structural complexity explain the intensity of TQM adoption (Ravichandran, 2000).

Outcome models commonly rely on surveys to collect data. While the use of larger datasets seems attractive, especially regarding the extrapolation of results, there are problematic. Surveys commonly target senior managers of companies, such as CEOs, to fill out questionnaires. Especially in larger companies, these respondents are often not in possession of the necessary first-hand knowledge about their firm's managerial innovation or information on the various determinants. Moreover, the use of only one respondent carries risks. Single response biases taint results from innovation studies when one and the same individual provides information on both the dependent as well as the independent variables. In addition, innovation, as a phenomenon, carries certain social desirability biases. Innovation is commonly perceived as positive, and therefore desirable. When asking CEOs whether their organizations managerially innovate, one will most likely get overly positive answers. Finally, the transient nature of management innovation questions 'closed questionnaire' approaches with standardized items, as contextual specificities are hard to detect.

Furthermore, the use of regression analysis seems questionable in its suitability for appropriately reflecting management innovation theories. Technically, by holding all variables constant, they are in fact being treated as competing explanations of management innovation. Regression analysis thus does not consider conjunctural causations among variables, and stands in opposition to the theoretical understanding of management innovation as being context-specific and differently achievable by different kinds of organizations. Also, the method does not allow the testing of alternative, equifinal explanations. By nature, variance based methods such as regressions imply linearity and additivity among variables; two notions that, similar to the misspecification of equifinality, stand in contrast to the theoretical arguments that lie in the core of more complex, multidimensional theories (Meyer, Tsui, & Hinings, 1993).

### 2.3.3. Multi-dimensional, Contingency Models

As a consequence of using contingency theory to conceptualize the complexities in management innovation, researchers applied more sophisticated techniques to substantiate

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theoretical propositions. Methodologically, a contingency is “... any variable that moderates the effect of an organizational characteristic on organizational performance.” (Donaldson 2001: 7). While this seems straightforward, accurately implementing contingency models is in fact rather difficult (Longenecker et al., 1978; Luthans & Stewart, 1978; Schoonhoven, 1981). Three methodological challenges concern specifying the notion of ‘fit’, interpreting ideal types and conceptualizing equifinality (Doty et al., 1993).

Methodologically implementing ‘fit’ associations among variables lies at the core of any contingency model (Drazin & van de Ven, 1985). Although Donaldson refers to contingencies as moderating variables, there are alternative types of relationships between variables. As such, relationships among variables may as well be implemented as curvilinear, monotone increasing or decreasing, non-monotonic or asymmetric relationships (Lieberson, 1987; Moon et al., 2004). In fact most empirical studies model contingencies as selection, or interaction, variables (Doty et al., 1993). While these certainly approximate theoretical propositions, they do not fully scrutinize the mode of ‘fit’ among variables. The interaction approach ultimately tests the effect of a third (interaction) variable on management innovation. It thereby implies linearity of variables (Baker & Cullen, 1993). Often there is no theoretical support for the implicit assumption of linearity (Donaldson, 2001). For example, overwhelming evidence from research on the effect of organizational size on innovation suggests that the two variables, size and innovation, have a curvilinear relationship (Camisón-Zornoza et al., 2004; Damanpour, 1992). To further complicate matters, contingencies should be modelled as multi-dimensional constructs, composed of a variety of variables. However, techniques for testing the fit of multidimensional contingency are still being developed (see for instance Parker & Witteloostuijn, 2010).

A second methodological challenge pertains to the interpretation of ideal types. In contingency theories, such as Burns’ and Stalker’s (1961) distinction between organic and mechanistic structures, ideal types are *hypothetical constellations of specific structural features*. The central argument of contingency theory is that the deviation from such ideal types explains whether firms are more or less efficient (Doty et al., 1993; Mahoney & Goertz, 2006). To identify ideal types three different approaches are proposed in research literature. First, cluster analysis is regularly applied to identify commonalities among cases. Second, factor analysis is used to identify common factor loadings in the hope of finding meaningful underlying dimensions that together approximate a theoretical ideal type (Baldrige et al., 1975; Teece, 1980; Winch, 1947). Finally, some scholar suggest that the most accurate approach for determining ideal types would be to ask experts to define - based on substantive knowledge - thresholds on measurement instruments that reflect the theoretical propositions put forward by contingency models (Delery & Doty, 1996). Once ideal types have been identified, most researchers treat them as categories, and assigns empirically observed cases to certain groups (Schoonhoven, 1981).

All methodological approaches, however, come at a certain expense. Cluster analysis, for instance, bears the risk of identifying similarities based on theoretically irrelevant factors (Fiss, 2007). Factor analysis similarly fails to reflect theoretical propositions. Instead, it treats factors as continuous variables with an ‘infinite’ number of categories,

among which similarities can always be identified (Hagenaars & Halman, 1989). The pre-definition of categories, according to substantive theoretical models, is highly dependent upon the researcher's judgment, and thus might lead to instability and uncertainty in interpreting results (Fiss, 2007). More questionable, however, is the use of ideal types as categories. Assigning observed cases to one of the categories in fact treats all cases within one category equally (Schoonhoven, 1981). However, from a contingency perspective the deviation from these ideal types is more crucial (Doty et al., 1989), so that other techniques, such as deviation analysis, need to be applied.

Finally, the third challenge pertains to modelling equifinality. Equifinality postulates that there is a variety of combinations of conditions (configurations) that lead to management innovation (Donaldson, 2001; Fiss, 2007), each being equally effective. There is disagreement among contingency theorists whether there is only a limited number of configurations, as reflected by Miles and Snow's (1978) four strategic types<sup>4</sup>, or an unlimited number of configurations, as suggested for instance by Burns and Stalker's (1961) poles of mechanistic vs. organic structures (Donaldson, 2001). Either way, equifinality is a core element of contingency models and needs to be acknowledged by analytical techniques to substantiate contingency theories.

In summary, complex, multidimensional modelling aims at more accurately reflecting the statements developed by theories. The theoretical adequacy of complex modelling is measured against its ability to incorporate and substantiate the notions of 'fit', 'ideal types', and 'equifinality' (Doty et al., 1993). In the following section, I describe three modelling approaches: selection, interaction and system contingency. These partly reflect different understandings of 'fit' and contain explicit or implicit conceptualizations of ideal types and equifinality.

### *Selection Contingency*

The selection contingency approach has been used quite frequently in modelling management innovation theories. Analytically, it is based on a comparison of correlations or regression coefficients of two categorical groups. As such, scholars have used congruence models to test for the contingent effect of types of innovation, contrasting structures that improve technical vs. managerial innovation (Kimberly et al., 1981; Zmud, 1982); the radicalness of innovation (Dewar et al., 1986), the strategic orientation of firms (Miller et al., 1982) or stages of management innovation (Gopalakrishnan et al., 1994; Pierce & Delbecq, 1977). However, its suitability for substantiating management innovation theories is questionable (Doty et al., 1989). Without specifying the mode of interaction, the selection approach does not properly reflect the influence of various contingent factors. Furthermore, it does not take into account the concept of ideal types, and thus prohibits the measurement of deviation of empirically observed strategy-size-environment combinations (Pennings, 1975). Finally, by comparing observations in two categories, equifinality is only implicitly and at best partially incorporated in the selection contingency model.

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<sup>4</sup> Miles and Snow (1978) propose to distinguish four strategic types of organizations: prospector, defender, analyzer, and a residual type, the reactor.

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### *Interaction Contingency*

The interaction contingency approach represents an alternative to overcome the limitations of modelling conjunctural causations among variables. It features many traditional theories defining ‘fit’ as the statistical interaction (Schoonhoven, 1981; Venkatraman, 1989). In the late 1980s, scholars began using interaction variables to test the combined effect of two variables on management innovation, and until now it represents the most prominent contingency approach (Miller, 1988). For instance, Dewar and Dutton (1986) hypothesize that the conjunction between managerial attitudes towards change and centralization, positively affects the adoption of managerial innovations. Scott and Bruce (1994), studying individual innovative behaviour in working teams, argue that organizational climate (supportive vs. unsupportive) and task type (routine vs. non-routine) moderate team-level factors, such as quality of leader-member exchange or supervisor expectation. Although they propose the use of a single hierarchical moderated regression analysis, they note that by including six multiplicative interactions, substantial degrees of freedom are being lost, leaving only little room to test for such moderating effects. Instead, they use a series of six hierarchical regression analyses. To further examine interaction effects, they divide their data into various subgroups. This essentially represents a refined selection approach. More recently, Mol and Hamel (2009) have hypothesized increased effects of ‘fit’ interactions among internal sources, market-based sources, and professional sources, and analyzed their effect on management innovation and on firm performance. They hypothesize in total nine interaction effects which they test in separate hierarchical order logit regressions, finding support for most interactions. Although the discussion argues that some of the interactions have been theorized (by other scholars) to be moderated by additional factors (see Mol and Hamel 2009: 1227), the available data and methods do not allow for testing these associations. In post-hoc, sector-by-sector analysis the researchers provide additional insights into the contingency of industry type.

As the examples show, the interaction contingency approach is frequently used to identify conjunctural effects among variables. It certainly represents a more sophisticated technique for approximating the assumption of ‘fit’ as hypothesized in contingency theories (Donaldson, 2001; Drazin et al., 1985). However, despite its seeming attractiveness, the interaction approach offers few advantages to researchers intending to substantiate more complex theories. Most importantly, there is “... no reason why configurations could not easily consist of multiple interaction effects.” (Fiss, 2007: 1182). There is also no reason why such associations should be solely linear. Furthermore, *systematically* analyzing interactions between more than two systems is difficult to implement and to interpret. Statistical models lose degrees of freedom due to the exponential increase of interaction terms, and hence also lose their explanatory power. This essentially requires researchers to abandon deductive, hypotheses-driven approaches and pursue less systematic, inductive procedures.

### *System Contingencies*

The system contingency approach is the most comprehensive model, in that it aims to accommodate all theoretical complexities put forward by scholars (Delery et al., 1996; Drazin et al., 1985; Schoonhoven, 1981). It is based on the assumptions that there are various, equally effective organizational systems (equifinality), that each of these systems



is a multi-dimensional construct, and that the congruence among these systems explains the efficiency of systems. Further, some contingency scholars point out that relationships among variables do not necessarily need to be linear (Parker et al., 2010; Schoonhoven, 1981).

Unsurprisingly, implementing such theoretical complexity poses methodological challenges. Determining ideal types requires comprehensive theoretical understanding and, ideally, a multi-rater approach specifying values of items for each variable. Further, sophisticated techniques need to be applied to assess multi-dimensional fit contingencies (Parker et al., 2010), and non-linear associations among multi-dimensional constructs need to be implemented. Finally, once methods have been developed that accommodate multiple fits of various ideal types, the deviation from these ideal types needs to be analyzed to fully reflect system contingency hypotheses; i.e. the ultimate 'fit' is high when an empirically observed case shows low deviation from such ideal types (Cattell, 1949; Millar, 1978). Deviation analysis is a method specific to the system contingency approach. Here, each configuration has its own ideal type (e.g. Doty et al., 1993; Delery & Doty, 1996), and deviation scores for different variables can be used to measure how much the configuration deviates from the ideal type. Cases with low deviation scores, or high 'fit' with ideal types, represent more efficient configuration. These methods are useful, but often they are too dependent on how the ideal type is being defined and operationalized. Because ideal types are usually sample-dependent (for example, one standard deviation plus or minus the mean), they are sensitive to small estimation errors (Fiss, 2007).

#### 2.3.4. Final Remarks

This subsection has dealt with the different methodological approaches to substantiating management innovation theories. Modelling conceptual notions inherent in complex theories such as equifinality, conjunctural causation, and asymmetric associations are of particular concern. Models reflecting process theories are regularly overly complex, unsystematic and feature a large number of interrelated factors. Because it is difficult to empirically substantiate such models, single or comparative case study methods are the dominant analytical modes. By generating insights that are predominantly internally valid, these studies implicitly acknowledge equifinality. The lack of systemization also implies that both conjunctural causations among asymmetrically associated factors are an element of their dominant logic.

The most dominant modelling in management innovation pertains to outcome theories. Most studies in this field apply a universalistic approach using regression analysis to estimate net-effects of individual variables. Samples are usually large and allow broader generalization of results. However, using statistical, variance-based methods, these models in fact treat variables as competing explanations. Consequently, they neither allow for equifinality nor for conjunctural causation nor for asymmetric relationships. Some research has argued that the inconclusive results generated by such studies are due to the insufficient power of these methods (Ferguson & Ketchen, 1999; Fiss, 2007; Wolfe, 1994). Subsequently, research has moved towards more sophisticated methodologies that more accurately reflect theoretical propositions (Baldrige et al., 1975; Rogers, 1978; van de Ven et al., 1988). Contingency models differ in their degree of complexity by reducing



simplifying assumptions. More complex approaches found in contingency research, such as the selection, interaction, or system approach, offer alternative methods to ease the limitations of universalistic models. Both outcome models, as well as contingency models, essentially aim at measuring the effect of differently related (or unrelated) variables on a dependent variable. The following Figure 2.1 illustrates the logics underlying universalistic models and selection, interaction, and system contingency models.

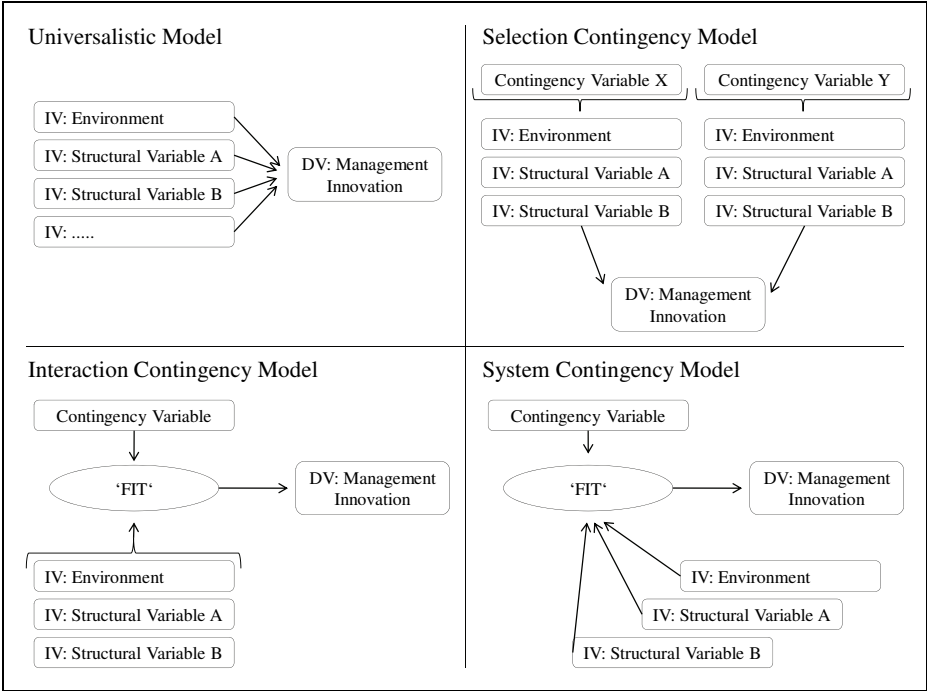


Figure 2.1: Illustration of Simple Outcome and Three Contingency Models

The system contingency approach seems most promising, as it aims at incorporating equifinality and conjunctural causation, and incipiently acknowledges that relationships between variables do not necessarily have to be linear. Nevertheless, all three contingency approaches have so far largely drawn on econometric methods. Despite the fact that theoretical discussions in this field emphasize nonlinearity, synergistic effects, and equifinality, such methods by nature imply linearity, additive effects and unifinality (Fiss, 2007). Furthermore, the more sophisticated the statistical techniques are to be used, the higher the requirements on the data quantity and quality.

The following Table 2.2 provides an overview of the different methodological approaches proposed in literature on management innovation. It first and foremost examines their ability to incorporate the notions of equifinality, conjunctural causation and asymmetry. It also describes the dominant analytical techniques and requirements for the empirical material to be used. Finally, advantages and disadvantages are contrasted.

## 2.4. Conclusion

In this chapter, I have described theoretical and methodological approaches to management innovation. As has been shown, management innovation theories conceptualize the phenomenon either as an outcome of various determinants, or as complex processes of stages, actors, and activities. Contingency theories, while portraying management innovation in principle as an outcome, represent an alternative between the two camps of outcome and process theories. They acknowledge the complexity of antecedents that generate management innovation on the one hand and, on the other hand, remain sufficiently systematic to allow the empirical substantiation of theoretical claims. Each group of research makes significant contributions to theories of management innovation. At the same time, by emphasizing particular theoretical elements, each also bears certain limitations.

Outcome theories provide a wide range of organizational and environmental determinants and develop sound theoretical arguments as to how these determinants affect management innovation. Empirical results however have been inconclusive. One of the reasons – as has been argued by scholars – lies in the universalistic perspective taken by outcome theories and in methodologically treating individual variables as competing explanations. Another reason is that focus is confined to the analysis to individual firms. Hypotheses on the strategic orientation of firms highlight the linkages of an organization to other firms and point towards inter-firm relations as the relevant locus of innovation.

This idea is substantiated by process theories of management innovation that develop highly complex models, portraying management innovation as a non-linear sequence of events, activities and actors. Case studies show how the interaction between firms leads to the development and implementation of new management instruments. Conceptual models in this field predominantly focus on inter-firm relations as the appropriate locus of innovation. In addition, they contribute to management innovation theory by illustrating how the various elements of the process are strongly interrelated. However, the explicit focus on the complex interaction between firms underemphasizes the role of organizational and environmental conditions under which inter-firm relations operate. After all, these contextual conditions provide the framework within which innovative activities take place. Last, the unsystematic and highly complex models developed by process theories prohibit the empirical substantiation of theoretical propositions.

Table 2.2: Theoretical and Methodological Approaches in Management Innovation

Theoretical perspective	Modelling takes into account			Analytical techniques	Empirical material	Advantages	Disadvantages	Examples in literature
	Equi-finality	Contingent causal relations	Asymetric relations					
Process Theories	Implicit	Yes	Yes	Conceptual models Qualitative approaches	Single to small N case study design	<ul style="list-style-type: none"> <li>Illustration of complexity</li> <li>Offers new insights for theory development</li> <li>Shifts focus IFR</li> </ul>	<ul style="list-style-type: none"> <li>Overly complex to validate</li> <li>Limited Generalization</li> </ul>	<ul style="list-style-type: none"> <li>Golightly (1968)</li> <li>Lilhrank (1995)</li> <li>Carro et al. (2000)</li> <li>Birkshaw et al. (2008)</li> </ul>
Universalistic Theories	No	No	No	Regression analysis	Comparison of correlation or regression coefficients of two regression analysis	<ul style="list-style-type: none"> <li>Provision of numerous independent factors and sound theoretical arguments for their link to management innovation</li> </ul>	<ul style="list-style-type: none"> <li>Overly simplistic</li> <li>No reflection of contingency theory propositions</li> </ul>	<ul style="list-style-type: none"> <li>Teece (1980)</li> <li>Kimberley et al. (1981)</li> <li>Ravichandran (2000)</li> <li>Pierce, Delbecq (1977)</li> <li>Zmund (1982)</li> <li>Damanpour et a. (1984)</li> </ul>
Selection Contingency	Limited	No	No	Comparison of correlation or regression coefficients of two regression analysis	Large samples; More complex modelling and stricter requirements of analytical techniques	<ul style="list-style-type: none"> <li>Considers dyadic equifinality</li> </ul>	<ul style="list-style-type: none"> <li>Three or multiple-way interactions almost impossible to test</li> <li>Difficult to conduct systematically, holistically</li> <li>Deviation from hypotheses' testing research design</li> </ul>	<ul style="list-style-type: none"> <li>Baldrige et al. (1975)</li> <li>Mol et al. (2009)</li> </ul>
Interaction Contingency	Limited	Limited	No	Bivariate or trivariate interactions MANOVA	requirements of analytical techniques demands an increase in the size of samples employed.	<ul style="list-style-type: none"> <li>Considers simplistic conjunctural causation by modelling variables as complementary pairs (or triplets)</li> </ul>	<ul style="list-style-type: none"> <li>Accommodates all complex theoretical propositions</li> <li>Systematic</li> </ul>	<ul style="list-style-type: none"> <li>Implementation difficult</li> <li>Large requirements to data quantity and quality</li> <li>Lack of appropriate techniques</li> <li>No example in research on Management Innovation</li> </ul>
System Contingency	Yes	Yes	Yes	Deviation analysis from pre-defined ideal types		<ul style="list-style-type: none"> <li>Accommodates all complex theoretical propositions</li> <li>Systematic</li> </ul>	<ul style="list-style-type: none"> <li>Implementation difficult</li> <li>Large requirements to data quantity and quality</li> <li>Lack of appropriate techniques</li> </ul>	<ul style="list-style-type: none"> <li>No example in research on Management Innovation</li> </ul>

Contingency theories offer an intriguing theoretical approach to amend some of the shortcomings of both (simple) outcome and (complex) process models. Particularly appealing are the complex theoretical propositions put forward by contingency theory. They assume that there is a variety of equifinal ideal types. In addition, these ideal types are not unicellular organisms but are comprised of multiple elements that require appropriate alignment, suggesting that sets of determinants may group together in meaningful substituting or complementary pairs. Finally, this focus has raised awareness for the variety in possible associations among variables – not limited to purely linear relations. Yet, despite the fact that contingency theories are commonly more systematic compared to process theories and in this respect facilitate their empirical implementation, the requirements for analytical techniques (for instance to measure the deviation from a multi-dimensional construct of ‘fit’) and quality and quantity of data (for instance when computing multiple interaction terms) are prohibitively high.

Finally, the literature review indicates a mismatch between theories and methods employed to examine and substantiate management innovation theories. Methodological challenges in the study of management innovation range from data collection to data analysis methods. Moreover, the very specific nature of management innovation poses methodological difficulties. It is highly context and time specific, and its value - if at all objectively measurable - is not known before it is implemented (Henrekson & Sanandaji, 2010). Second, data collection takes place as archival research, interviews with open or closed questions, or surveys. Surveys in particular allow the inclusion of a large number of observations in the analysis, yet bear the risk of tainting both the validity as well as reliability of responses. Third, analytical methods applied in management innovation research range from conceptual models, case studies and comparative case studies to simple and more complex quantitative methods. The choice of method for substantiating management innovation theories poses a multi-dimensional decision problem. The accuracy of models has to be balanced with the availability of analytical techniques and the potential extrapolation of results. Single case studies allow very precise analysis of management innovation yet are primarily internally valid. In contrast, larger, representative data allows for broader generalization of results. At the same time, incorporating theoretically complex propositions such as equifinality, conjunctural causation and asymmetric relations poses demanding requirements on data quality and quantity and is difficult, if not impossible, to implement technically.



### 3. Configurations of Inter-firm Relations in Management Innovation

I contribute to research on management innovation by matching a holistic, theoretical approach with a likewise holistic method of analysis. Acknowledging insights gained by process theories and post-hoc theorization in outcome theories, I shift the focus of the analysis to the inter-firm relation (Birkinshaw et al., 2008). Rather than the individual firm, I consider the inter-firm relation the social action system in which management innovation takes places (van de Ven, 1976). Subsequently, I make use of the contributions of outcome theories and select conditions of such social action systems hypothesized to facilitate management innovation. I thereby specify under which relational, structural, and environmental conditions inter-firm relations operate while developing and implementing new managerial instruments. Finally, I consider contingency arguments by formulating additional hypotheses directed at the theoretically complex antecedents of management innovation. To substantiate the theoretical claims I apply a novel analytical technique. Qualitative Comparative Analysis (QCA) holistically examines and systematically compares entire configurations of conditions (Ragin, 1987). Instead of analyzing net effects of independent variables, it thereby maintains the integrity of each case (Fiss, 2007). Minimization procedures based on Boolean logic are then applied to reduce the complexity of the data to the minimal number of configurations of facilitating conditions.

In this chapter, I first outline the theoretical framework and develop hypotheses on the basis of extant literature. I then introduce QCA as a methodological approach to illustrate how the method allows me to test the configurational model and to contribute to management innovation theory. The following two subsections provide the conceptual and methodological components for the empirical study on management innovation in China's biopharmaceutical industry.

#### 3.1. Theoretical Framework

##### 3.1.1. Shifting the Focus of the Analysis to the Inter-Firm Relation

Outcome theories, as well as process theories, provide a range of arguments suggesting that the generative mechanisms leading to management innovation are located within the interaction between firms. Outcome theories, hypothesizing on the role of firms' strategic orientation as observed in environmental scanning and external communication, hint at significant events taking place outside the boundaries of the firm. In addition, empirical evidence points towards the focal role of inter-firm relations. For instance, Sapolsky (1967: 505), in his study on department stores in the U.S., observes that "... the relationships [with controllers] in other firms are often a stimulus for change". Further, post-hoc theorization regularly focuses on inter-firm relations. For example, Corwin (1972), interviewing participants of the Teachers Corps program, concludes that the amount of cooperation and the nature of the inter-organizational relationship between schools are important factors for innovation. Even more compelling are conceptual models and theoretical arguments put forward by process theories. Case studies illustrate how interacting firms participate in the generative mechanism by which new management ideas are created and put into practice (Hamel, 2006). They also show that while these management ideas are created in the context of inter-firm relations, they are practiced

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within individual firms. In addition, conceptual process models provide theoretical explanations on how the various actors and their activities work towards developing and implementing new management instruments (Birkinshaw et al., 2008).

Where outcome and process theories give insights into the inter-firm relation as the locus of management innovation, general theories of inter-firm relations provide a more thorough theoretical groundwork as to why these social action systems are crucial in the development and implementation of innovative ideas. In addition, they show how inter-firm relations ought to be configured to support innovative processes. General inter-firm theories are predominantly embedded in two theoretical perspectives: the knowledge and learning perspective and the resource based view of the firm.

Lundvall (1992) concisely summarizes the knowledge and learning perspective as follows: knowledge is the most important resource for innovation, and learning its key process. Most scholars concur and advocate knowledge re-combination and development understanding (Kogut, 2000; Vlaar et al., 2006). The knowledge perspective conceptualizes organizations as entities of distinct knowledge and production domains. Their survival depends on the successful re-production of existing domains or the development of new domains (Grant, 1996, 2002; Grant & Baden-Fuller, 1995). These knowledge domains, however, extend beyond the legal and operational boundaries of firms (Brusoni, Prencipe, & Pavitt, 2001; Patel & Pavitt, 1994). Empirical research has, for instance, shown that services and products developed and commercialized by firms contain knowledge that cannot not be accounted for solely by the resources that exist within the firm. In support of this, Clayton et al. (2002) find that the modularization of product components only explains low performing firms and not high performance market players. They reach the conclusion that modularization is not a stable competitive strategy. The survival of firms ultimately depends on their engagement in 'iterative co-design' partnerships, which permit the incorporation of partners in the design specification of products (Gilson, Sabel, & Scott, 2009).

In contrast, the resource perspective is primarily based on transaction cost arguments explaining factors that reduce transaction costs and transaction-related risks (Nooteboom, 1999). Interactions between firms pose various relational risks. Thus, when faced with the question of why firms interact in the first place, scholars have pointed to an intensification of the firms' need for resources (Gilson et al., 2009). Ettlie (1983), studying equipment and packaging suppliers in the food industry, finds that the involvement of both suppliers and customers is an important factor for organizational innovation. He argues that their involvement demonstrates high priority and commitment, ultimately reducing perceived risks. Literature on inter-firm relations based on the transaction cost perspective, interestingly, suggests that a conceptualization of transaction costs that considers learning processes allows the analysis of relational risks and factors that reduce such risks (Nooteboom, 1999; Teece, 1986; Williamson, 1993). In the context of a dynamic transaction costs, the notion of trust, as a cost-reducing governance form, is crucial (Berger, Noorderhaven, & Nooteboom, 1995; Nooteboom, 1996; Nooteboom, Berger, & Noorderhaven, 1997).

The theoretical arguments put forward by the knowledge and transaction cost perspective have somewhat different origins. Yet, central to their theories of inter-firm relations are the notions of knowledge exchange and resource dependency. These mechanisms facilitate the sharing of knowledge and the development of a common language between interacting organizations (Aiken et al., 1968; Kogut et al., 1992; Nickerson et al., 2004; Nooteboom, 2004; Pierce et al., 1977; Sheppard & Sherman, 1998; van de Ven, 1976). In innovation studies, the role of inter-firm relations has predominantly been applied to research on technical innovation (Chompalov, Genuth, & Shrum, 2002; Pisano, 1990). Based on similar arguments, they suggest that inter-firm relations allow organizations to reduce fixed costs, increase flexibility, and enable joint-learning mechanisms. Others have provided evidence that a portfolio strategy, i.e. one that focuses on managing various inter-firm relations, is an exceptionally effective strategy to enhance innovation (Faems, Looy, & Debackere, 2005).

Inter-firm relations therefore constitute a unique system for the development and implementation of new managerial instruments. The explicit focus on inter-firm relations advocates a modified understanding of management innovation. Management innovation is conceptualized as a heuristic search process, in which interacting firms find solutions to complex problems by freely and extensively exchanging information (Nickerson 2004). It is thus the outcome of a process of interrelated conditions that facilitate the sharing of knowledge and the development of a shared language between firms (Grandori et al., 2008; Thompson, 1965). While the development and implementation of new management practices, processes, or structures takes place in the realm of inter-firm relations, the newly developed managerial instruments may be implemented in and applied by individual firms.

### 3.1.2. Facilitating Conditions of Management Innovation

Although inter-firm relations represent an intriguing organizational system for the exchange of knowledge, it is assumed that management innovation requires, on the one hand, the presence of diverse sets of knowledge and, on the other hand, the conditions for that knowledge to be exchanged (Vaccaro, 2010). In the following section, I develop hypotheses on the conditions of inter-firm relations that facilitate management innovation.

Inter-firm relations bear relational risks that need to be mitigated to reciprocally access unique resources. Loosely dependent partnerships contain risks such as indiscretion, unreliability, defection and poor coordination (Sheppard et al., 1998). Mutually dependent relationships, in contrast, established when firms dispose of unique resources of crucial interest to one another, reduce relational risks. Here, firms cannot act without taking into account the knowledge, experiences, ideas and preferences of their partner (Chaves & Moro, 2007) to the effect that "... agents are to be seen as each other's principles and agents at the same time." (Nooteboom, 2004: 18). Mutually dependent partnerships thereby avert unilateral enforcements, mitigate relational risks and establish the necessary preconditions for the circulation of information (Aiken et al., 1980). This leads to hypothesis 1:

*Hypothesis 1      Mutual dependence between interacting firms facilitates management innovation.*



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In addition to substantiating the role of mutual dependence in inter-firm relations, the general literature on organizational relationships has considered the effects of structural factors on the way firms interact. Most fundamentally, these theories rest on an understanding of inter-firm relations as alternative social action systems (van de Ven, 1976) that can be analyzed using similar factors considered in analyses of individual firms. Based on this argument, scholars have examined the role of decentralization (Aiken et al., 1968) or formalization (Vlaar et al., 2006) in inter-firm relations. I follow this tradition and make use of the range of determinants and their theoretical mechanisms developed by outcome theories on management innovation.

Specialization has been assumed to facilitate the development and implementation of new management ideas. Specialization provides repositories of professional expertise that can be used for the re-combination of knowledge. In inter-firm relations, it facilitates activities such as idea contextualization, linking, refinement and testing (Birkinshaw et al., 2008). Specialization is often interpreted as the depth of knowledge and manifests itself in the variety of professional specialties found among interacting firms. It is commonly measured by the number of different titles and occupational employments within an organization (Damanpour, 1991). For its provision of knowledge, I hypothesize that:

*Hypothesis 2      Specialization within inter-firm relations facilitates management innovation.*

Similarly, heterogeneity has been assumed to positively influence management innovation (Birkinshaw et al., 2008; Kogut et al., 1992). Whereas specialization describes the depth of knowledge, heterogeneity is often referred to as the breadth of knowledge. Arguments on the role of heterogeneity follow those on specialization by suggesting that it provides a pool of knowledge and experience that can be used in the development of ideas (Kimberly et al., 1981; Lounsbury et al., 2007). Heterogeneity has been considered on the individual (Hage & Dewar, 1973) as well as on the organizational level (Mol et al., 2009) for instance by taking into account the range of geographical, cultural, or organizational knowledge and experience present within inter-firm relations (Chen, 2008; Mol et al., 2009). This leads to hypothesis 3:

*Hypothesis 3      Heterogeneity within inter-firm relations facilitates management innovation.*

Centralization refers to the concentration of decision-making power within organizations. In centralized organizations, higher ranked employees have decision-making power over subordinates. Therefore it has been suggested that centralization discourages specialists from participating in processes which provide solutions (Nickerson et al., 2004). In contrast, de-centralized organizations delegate authority, and thereby encourage the participation of specialists in the pursuit of organizational goals by raising their levels of awareness, commitment, and involvement (Damanpour, 1991; Thompson, 1965). Decentralization thus facilitates the inclusion of employees offers incentives to participate in negotiations. Therefore, I hypothesize that:

*Hypothesis 4      Decentralization of inter-firm relations facilitates management innovation.*

Formalization refers to the provision of a specific kind of codified coordination mechanisms that define situations and prescribe expected behaviour (Thompson, 1965). To enforce rules, organizations provide incentives for compliance, while non-compliance is penalized. Therefore, formalization has been hypothesized to discourage innovation by inhibiting experimentation and divergence from available practices or techniques (Hage et al., 1971). However, empirical studies have not been able to provide conclusive evidence (Damanpour, 1991) and subsequent theorization has contested their negative association (Adler et al., 1996). In particular, in the context of inter-firm relations it has been argued that formalization triggers important sense-making mechanisms, such as focused attention, articulation, and reflection that facilitate interaction between firms (Vlaar et al., 2006). I include formalization, yet due to the inconclusive evidence and the conflicting theoretical arguments, I refrain from predicting the principle direction of formalization on management innovation. Instead, I formulate two competing hypotheses.

*Hypothesis 5a*      *Formalization of inter-firm relations facilitates management innovation.*

*Hypothesis 5b*      *Formalization of inter-firm relations obstructs management innovation.*

A high level of vertical differentiation, the number of hierarchical levels within an organizational structure, has originally been hypothesized to have a negative effect on innovation (Hull, Hage, & Azumi, 1985). It was argued that more hierarchical levels hinder the flow of information and prevent knowledge from reaching the locations where it is required. Evan (1966), however, theorized that management innovation, unlike technological innovation, originate from the administrative core of an organization (Daft, 1978), suggesting that vertical differentiation facilitates management innovation. This emphasis on the role of management in promoting management innovation has also received attention in knowledge-based models. Nickerson and Zenger (2004) for instance understand leadership positions as organizational elements that align interests, avoid disagreement and create consensus among interacting firms. In support of these arguments both case studies, as well as quantitative studies, revealed significantly positive effects of vertical differentiation on management innovation (Chompalov et al., 2002; Damanpour, 1991). This suggests that:

*Hypothesis 6*      *Vertical differentiation of inter-firm relations facilitates management innovation.*

Finally, environmental uncertainty, in the form of potential threats and unrealized opportunities, has been associated with management innovation (Child, 1972). Market, regulatory, or technical complexities, as well as rates of change, trigger problem-solving or opportunity-seeking processes within organizations. Research on administrative innovation considers the extent to which organizations communicate with their environment (Damanpour, 1991; Dewar et al., 1986). Process models of management innovation rely on the influence of external actors to contextualize and refine existing ideas for new managerial practices (Birkinshaw et al., 2008). Consequently, I argue that:

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*Hypothesis 7      Environmental uncertainties experienced by inter-firm relations trigger management innovation.*

In sum, I consider the following conditions of inter-firm relations as facilitating the development and introduction of new managerial instruments: heterogeneity, specialization, vertical differentiation, centralization, and environmental uncertainty. Further, the role of formalization is ambiguous in that it may facilitate or hinder management innovation processes. These facilitating conditions provide the contextual foundation for management innovation. On the one side, they provide a repository of experience and expertise, and on the other side the structural and environmental conditions that properly allocate these knowledge resources to the activities between firms crucial for the management innovation process.

### 3.1.3. The Complexity of Antecedents of Management Innovation

Based on contingency arguments and conceptual models, I explicitly acknowledge the conceptual complexity underlying the antecedents of management innovation.

Contingency theories have long argued that there are different structural configurations that may be equally appropriate in the pursuit of the same objective. In management innovation research empirical observations reported in case studies, as well as post-hoc theorization, suggest that there is a variety of inter-firm relations that allow the development and implementation of new managerial instruments. The objective of analytically reducing the diversity inherent in empirical observations is to minimize variations and report findings "... as simply as possible, but no simpler." (Citation by Einstein, referenced in Rihoux and Ragin, 2009: 10). Regression analysis has consequently been criticized for its restrictive assumptions of uncausality and linearity, and its generation of overly simplified results. Instead, it is suggested that there are equifinal configurations: inter-firm relations with facilitating conditions that allow the development and implementation of new managerial instruments. More importantly these configurations are conceptually different, in that they exhibit different core conditions (Martin-Pena et al., 2008). I consequently hypothesize that

*Hypothesis 8      Inter-firm relations that develop and introduce new management instruments group together in equifinal configurations that conceptually differ in that they feature alternative core conditions.*

Furthermore, previous theories on management innovation have suggested that there are substantial interdependencies among determinants, and that these structural complexities better explain management innovation (Mol et al., 2009). For instance, the impact of heterogeneous bodies of knowledge and experiences in inter-firm relations should be amplified under a decentralized structure that facilitates the access to such resources by allowing the participation of employees in the management innovation processes. This suggests that the two determinants might be complementary. In contrast, the function of mutual dependence is in reducing relational risks and providing a safe environment for participants to openly share information. This function may well be substituted by formalizing the relationship and using contracts and policies to provide for

such safety. Then again, overly coercive formalization may discourage employees from participating in the creative process – an effect intensified, for instance, by strongly centralized structures which allocate all decision-making authority to a few senior members of the organization. As argued by contingency theory, the various possible associations among determinants should reflect meaningful constellations (Damanpour, 1996; Donaldson, 2001). Through acknowledging these interdependencies it becomes possible to formulate a series of contingency hypotheses. This task, however, becomes rather difficult once multiple interdependencies are taken into account or even all possible configurations are to be considered. I therefore summarize all possible combinations of determinants of management innovation and hypothesize that:

*Hypothesis 9      Inter-firm configurations are multi-dimensional collections of relational, structural, and environmental determinants of management innovation that cluster together in meaningful ways.*

This hypothesis remains pointless without determining criteria that allow for its substantiation. As will be shown in this study, the analytical technique applied in this thesis provides for opportunities to specify consistency thresholds, i.e. levels measuring the extent to which the overall solution is consistent with the available data. The hypothesis can thereby be falsified if configurations encompassed by consistent solutions feature only one or two facilitating conditions.

Finally, critics of the empirical implementation of contingency models have pointed to the largely inappropriate modelling of the nature and direction of associations among variables. Originally, this had not been of concern. However, as researchers began implementing contingencies as statistical interaction terms, implying linearity while results from empirical research revealed a series of non-linear relationships, theorists grew aware of the multitude of alternative associations. The structural conditions identified above may well have asymmetric effects on innovation depending on the level of uncertainty. While statistically these have to be modelled as symmetric relationships (linear, curvilinear, monotone, etc.), some scholars have suggested that there are substantial asymmetries (Lieberson, 1987) among conditions, that need to be acknowledged in order to explain certain outcomes. Consequently, I expect that:

*Hypothesis 10      There are substantial asymmetries in nature and direction among associations of relational, structural, and environmental conditions that facilitate management innovation.*

Similar to the previous one, this last hypothesis requires further methodological specification to be substantiated. The method employed in what follows pursues a ‘controlled inductive’, i.e. systematic approach to specifying the nature of associations among conditions and is thereby suitable for substantiating this hypothesis.

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### 3.1.4. Final Remarks

In this section, I make use of previous theories on management innovation to develop the theoretical framework for the empirical study. In particular, I identify inter-firm relations as the unit of analysis – acknowledging post-hoc theorization of outcome approaches and substantial conceptual contributions in process approaches to management innovation. Following the literature on inter-firm relations, that considers inter-organizational relationships as social action systems similar to individual firms, I formulate seven hypotheses to describe the conditions facilitating management innovation. Finally, I explicitly acknowledge the complexity in antecedents of management innovation with three additional hypotheses related to equifinality, conjunctural causations and asymmetric relations.

### 3.2. New Methodological Approach: fuzzy set Qualitative Comparative Analysis

In order to substantiate and test the formulated hypotheses, I apply a novel analytical technique known as Qualitative Comparative Analysis (QCA). QCA is relatively new to organization theory, and differs substantially from more conventional analytical methods. I use this section to introduce QCA in more detail.<sup>5</sup> I describe its underlying logic and mechanisms using an example closely aligned with the empirical analysis on management innovation reported later in the thesis. I then discuss three epistemological aspects that are central to QCA. Finally, I compare QCA to case study and statistical methods to illustrate how the application of QCA provides an intriguing approach to improve the alignment of theory and methods. It thereby contributes to theories of management innovation by substantiating the role of inter-firm relations and developing a taxonomy of configurations facilitating management innovation.

QCA was developed during the 1980s by political scientists conducting empirical research on country level data (Ragin, 1987). Facing difficulties in applying statistical methods, due to the naturally limited size of their observations, scholars aimed at developing more appropriate analytical methods that, on the one hand would permit the exploration of interdependencies among conditions, and on the other hand avoid some of the pit-falls of non-experimental research (Eisenhardt, 1989; Pettigrew, 1990). The first comprehensive monograph published on QCA, by Charles Ragin, appeared in 1987 under the title *The Comparative Method*. Since then, methodological developments have continued and led to other seminal publications (Fiss, 2007; Ragin, 2000, 2008b; Rihoux & Ragin, 2009). In organization theory, QCA is a rather recent phenomenon (Fiss, 2010; Greckhamer et al., 2008; Kogut, MacDuffie, & Ragin, 2004; Öz, 2004; Pajunen, 2008) yet is increasingly applied as it accurately translates theoretical ideas into empirical models (Fiss, 2007).

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<sup>5</sup> QCA comes along with a specific terminology. 'Condition' refers to factors that causally explain the phenomena of interest. These can be compared with independent variables in statistical methods. Similarly, the term 'outcome' refers to the phenomena to be explained and is best compared to the 'dependent variable' in statistical methods. Please consult the Glossary in the back of the thesis for definitions of technical terms.

### 3.2.1. QCA: Set Theory and Boolean Logic

QCA is based on set-theory and uses Boolean comparative logic to reduce and identify combinations of conditions and configurations that, in conjunction, explain a given outcome (Ragin, 1987).<sup>6</sup> To illustrate the logics underlying QCA, consider the following four inter-firm relations, i.e. four pairs of cooperating organizations shown in Table 3.1. To explain under what conditions inter-firm relations managerially innovate, three conditions are considered: whether the interacting firms have a diverse background (C1) and whether the inter-firm relation contains hierarchical levels (vertical differentiation – C2) and decision-making authority is concentrated at the top (centralization –C3).

*Table 3.1: Exemplary Dataset*

Case/ Condition	C1 Diversity	C2 Vert. Differentiation	C3 Centralization	Outcome Management Innovation
IFR A	1	1	0	1
IFR B	0	1	0	0
IFR C	1	1	1	1
IFR D	0	0	1	1

The last column indicates whether the inter-firm relation had been observed to develop and introduce new management instruments. The first inter-firm relation (IFR A), for instance, developed a new business model and IFR C, as well as IFR D, developed and introduced new guidelines to improve customer satisfaction. In contrast, IFR B did not implement any new managerial instrument.

The basis of QCA in set theory consists in considering values of variables as membership scores within clearly defined sets. Using the example above (presented in table 1), one might specify the ‘set of centralized inter-firm relations’. Each observed case can then be assessed as to whether it falls into this set (1), i.e. when it is centrally organized, or falls outside of the set (0), i.e. it is not centrally organized. Cases A and B are not members of this set, whereas case C and case D show membership in the set of centralized inter-firm relations.

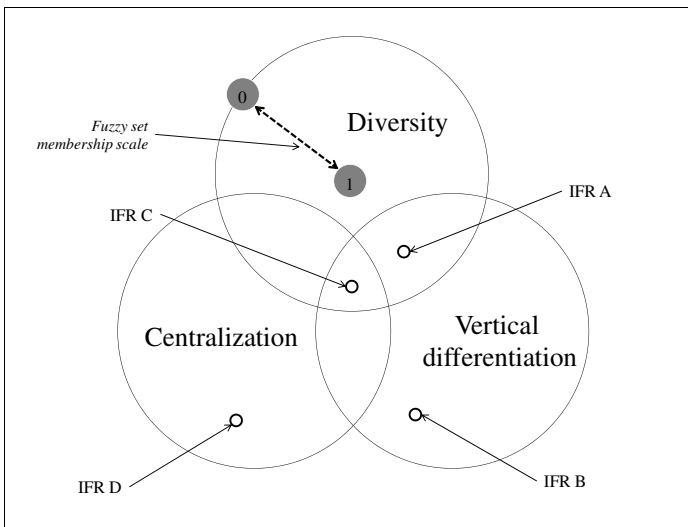
There are two dominant types of QCA. They differ in their approach to measuring membership scores for condition and outcome sets. In the example above, membership

<sup>6</sup> Set theory examines collections of cases and studies the relations of overlapping sets. In particular, subset and superset relations are analyzed with the help of set-theoretic operations such as union and intersection. Boolean logic is most commonly known from internet search engines (such as Baidu or Google). It refers to the logical relationships among items and uses the three logical operators OR, AND, and NOT.

scores are dichotomized, i.e. they are *crisp* in merely distinguishing inside or outside a given set. This type is consequently called crisp set Qualitative Comparative Analysis (csQCA). A more refined alternative is the use of fuzzy sets. Fuzzy set Qualitative Comparative Analysis (fsQCA) considers different degrees of membership. These range from no membership to full membership and are measured on a membership scale between 0 and 1. fsQCA hence allows a more accurate and detailed measurement of theoretical concepts and analytical constructs (Kvist, 2007). While fsQCA is more complicated, it shares underlying principles with csQCA. Therefore, for the purpose of illustration, I will continue with the crisp set example.

### *Set Theory as the Foundation of QCA*

The set-theoretical background of QCA is well illustrated using Venn diagrams. The following Figure 3.1 shows such a diagram using the example of the four inter-firm relations.



*Figure 3.1: Exemplary Venn Diagram and Fuzzy Set Membership Scale*

Each circle represents one of the specified sets. The upper circle outlines the set of diverse inter-firm relations, the set to the right shows those inter-firm relations that are vertically differentiated, and the final set to the left covers centralized inter-firm relations. The first case (IFR A) shows membership in the set of diverse inter-firm relations and in the set of vertically differentiated inter-firm relations; the second case (IFR B) shows membership in the set of vertically differentiated inter-firm relations, yet no membership in the set of diverse or centralized inter-firm relations. The third case (IFR C) is member of all three sets. Finally, the last case (IFR D) only has membership in the set of centrally organized inter-firm relations. Again, csQCA, as used for this example, only distinguished membership from no membership. In contrast, fsQCA allows measuring degrees of membership. The double arrow in the set of centralized inter-firm relationships indicates

such a fuzzy set membership scale. Cases with full membership would then be allocated in the centre of the set and given the membership score of one (1). This score gradually declines with lower membership scores towards the boarder of the set where it ultimately indicates full non-membership (0) once cases are located outside the set.

### *Minimizations in QCA*

In order to minimize data, QCA uses Boolean logic. It hereby closely follows Mill's method of difference, which stipulates that if two configurations differ only in a single condition but show the same outcome, this distinguishing condition is irrelevant and can be eliminated (Ragin, 1987). Case A and case C are both diverse in background and vertically differentiated. Both, in addition, have developed new managerial instruments. However, case A did so without centrally organizing their activities while the inter-firm relation in case C was centrally structured. In this example, neither the presence nor the absence of centralization explains when inter-firm relations engage in management innovation. It can therefore be eliminated from the solution. In contrast to case A and case C, the inter-firm relation of case D developed new management instruments in the absence of diversity and vertical differentiation but with centralized structures. On the basis of this data, a solution statement explaining when inter-firm relations engage in management innovation would then state the following: Inter-firm relations develop new management instruments *either* when partners have a diverse background *and* use a vertically differentiated structure (derived from case A and case C), *or* when their partnership is centrally organized (derived from case D).

To systematically compare observations, QCA makes use of a truth table. A truth table is a conventional instrument in logic that exhibits all possible combinations of present and absent conditions. It thereby "...allows *structured, focused* comparison (Ragin 2008: 23). The number of rows in a truth table is calculated as  $2^k$  (with  $k$  denoting the number of conditions taken into account). The truth table for the example above consequently lists eight ( $2^3$ ) rows, one for each logically possible configuration. By listing not only the empirically observed configurations but also those that only logically remain, truth tables directly address the issue of limited diversity (Lewis, 1973; Ragin & Sonnett, 2004). Limited diversity refers to the claim that social phenomena are naturally limited in their diversity (Ragin et al., 2004); one cannot expect to find empirical evidence for all logically possible configurations. Logical remainders, i.e. those configurations that have not been observed empirically, can be used to further minimize data. This is accomplished by conducting thought experiments which - beginning with Max Weber (1905) - have an established history in sociological analyses (Hicks, Misra, & Tang, 1995; Tetlock & Belkin, 1996; Weber, 1905/ 1949). For instance, consider a hypothetical case Y, the cooperation between two firms that is not diverse but shows both vertical differentiation and a centralized structure. In a though experiment, one might *assume* that the configuration of these conditions would also allow inter-firm relations to develop new management structures. Based in this assumption, this hypothetical case when compared to Case A differs only in the absence of diversity, so that diversity, as an explanatory condition, could be eliminated from the solution.



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### *Identifying Core and Contributing Conditions*

Depending on the plausibility of such ‘simplifying assumptions’ QCA identifies ‘core’ and ‘contributing’ conditions (Fiss, 2010). Core conditions are those that necessarily have to be part of any representation of the data. These are identified by permitting the inclusion of *any* simplifying assumption to minimize data. In the example above for instance, one would always make the assumption that under these conditions, the inter-firm relation of case Y would be able to develop new managerial tools. In contrast, to identify contributing conditions, minimization procedures on the basis of thought experiments are only conducted when the simplifying assumptions are in accordance with substantive and theoretical knowledge. For the hypothetical case Y, the researcher ideally has sound theoretical or substantive knowledge that make this assumption plausible.

### *Estimating the Quality of Results*

In order to assess the relevance and quality of results, QCA uses two model coefficients: coverage and consistency. Coverage considers the proportion of consistent cases that display a given outcome and thus “... gauges empirical relevance or importance” (Ragin, 2006: 2) of conditions to outcome. The coverage score somewhat resembles the  $R^2$  in regression analyses by determining the relevance of the solution term. There are only few guidelines to assess the appropriate coverage level. Smaller datasets that allow for more intimacy and consequently more context-specific calibration commonly exhibit higher coverage scores (Wagemann & Schneider, 2007); QCA models using larger datasets usually suffice with lower coverage scores (Fiss, 2010). Arguably more importance adheres to the consistency coefficient. Consistency describes degree to which cases exhibit the set-theoretical associations in a given solution term. It is calculated by taking the proportion of cases consistent with the outcome. Consistency scores of 0 and 1 indicate high levels of consistency. A consistency score of 0.5 indicates that results are most inconsistent (Ragin, 2008a). Among QCA scholars, there is somewhat disagreement concerning the appropriate consistency level. In general, values below 0.75 are considered to indicate inconsistency (Ragin, 2008a). Most scholars consider scores of 0.8 as sufficient (Fiss, 2010; Jackson, 2005; Ragin, 2006). As has been pointed out in hypotheses nine and ten, the consistency score is crucial for testing the two expectations. In case, management innovation is explained with unicausal (in contrast to multi-causal) and symmetric (in contrast to asymmetric) relationships among facilitating conditions, the results falsify both hypotheses.

### 3.2.2. Three epistemological Issues in QCA

Based on this structure, QCA addresses three epistemological issues that have been raised in the review of contingency theories of management innovation, and that are addressed in the theoretical framework for the empirical study reported in the following chapter. First, QCA allows for multiple, alternative solutions. As in the example above, one configuration of inter-firm conditions that lead to the development of new management instruments contained diversity in background in combination with vertical differentiated structures (IFR A). A second configuration features only centralization yet absent diversity and vertical differentiation (IFR D). Both are equally effective in facilitating management innovation. QCA thereby allows for equifinality. Second,

solutions focus on configurations not individual variables. By holistically comparing cases, QCA examines combinations of conditions that explain a given outcome. It thereby explicitly focuses the analysis on conjunctural causation, i.e. the association of two or more variables with a given outcome. Third, by considering conditions that are both present as well as absent, and by refraining from specifying the nature and direction of the relationships *a priori*, QCA enables the identification of asymmetries among conditions. As in the example, in one configuration (IFR D), the presence of centralization explains management innovation. In the other configurations however (IFR A, IFR C) neither the presence nor the absence of centralization are elements of the solution. Hypothetically (and methodologically) the absence of centralization may explain when inter-firm relations develop new managerial instruments, too.

### 3.2.3. Practical Issues: Case Selection and Scale Development

Before positioning QCA, in the context of case study analysis on the one hand and statistical on the other hand, two practical issues deserve further attention. First, a central concern in qualitative, case-oriented research lies in the selection of cases. A clear understanding of cases and their selection is consequently of considerable importance for studies using QCA. Ideally, the selection of cases should be informed by theoretical, instead of statistical reasons (Eisenhardt, 1989) and literature in comparative methods provides a list of criteria for selecting cases (Collier, Mahoney, & Seawright, 2004; King, Keonhane, & Verba, 1994). For instance it has been suggested that organizational theory research should focus on organizations that work in extreme situations, experience critical incidents or social dramas (Pettigrew, 1990). Furthermore, researchers might consider polarities that allow comparison with similar cases and contrast between disparate cases (Dion, 1998; Öz, 2004; Yin, 2003). Otherwise, one might examine sites with relatively high experience with the phenomena under study (Fiss, 2007; Pettigrew, 1990). These general rules for case selection also hold for QCA. While the selection of cases is an important criteria in small to medium size samples, that allow ‘intimacy’ between researchers and cases, more recent QCA studies on larger datasets move away somewhat from such a strong case oriented approach and aim, in addition, for external validity that allows a broader generalization of results (e.g. see Fiss 2010).

The second practical issue concerns the development of scales in fuzzy set Qualitative Comparative Analysis. Instead of constructing variables based on inductive, sample-specific standards, such as means or standard deviations (Ragin, 2008b), fuzzy scales in QCA ought to “...accurately reflect theoretical concepts and analytical constructs with precise meaning.” (Kvist 2007: 477). In order to accomplish this, QCA proposes calibration as an approach to coding data. Calibration is a technique adopted from the natural sciences that assigns, not relative but meaningful, floor and ceiling values to scales using external criteria such as definitional elements, theoretical reasoning or empirical knowledge.<sup>7</sup> Calibrated scales best correspond to ordinal scales used in statistical methods. Ordinal scales arrange ranked categories that are relative to one another, just as calibrated

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<sup>7</sup> A common example of a calibrated scale that illustrates this point well, is that of the Celsius scale, in which temperature is calibrated according to the changes in physical properties of water. At 0°C (frozen to liquid) and 100°C (liquid to gas) the Celsius scale entails anchors representing meaningful points.

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scales ideally specify membership scores that are reflected in empirical reality by arranging thresholds on the basis of substantive and theoretical knowledge.

There are two dominant approaches to calibration: the direct and the indirect method (Ragin, 2008c). The direct method specifies the value of an internal scale, corresponding to three qualitative breakpoints that are significant in set-theory: Full membership, full non-membership, and the crossover point. First, one is to specify points that determine either full membership or full non-membership in a given set. Assume one would want to assess whether a given organization belongs to the set of vertically differentiated organizations by counting the number of levels in an organization's hierarchy. A firm with only one or two levels would then be considered to have full non membership in the set of vertically differentiated firms. In contrast, a strongly hierarchically organized firm would receive full membership in the set of vertically differentiated organizations. Finally, the crossover point defines when observations 'migrate' from being full membership to full non membership in the set. This point is crucial as it represents the point of highest ambiguity (Ragin, 2008c). Essentially, the membership score of 0.5 indicates that the affiliation, or lack of affiliation, of a given case to the set cannot be determined. Having defined these three thresholds, researchers may then assign membership scores to individual cases. The main advantage of this method is that irrelevant variation is excluded from the dataset.

In contrast, the indirect method uses the qualitative assessment of the researcher (Berg-Schlusser, Meur, Rihoux, & Ragin, 2009). Using the indirect method, researchers assign cases into categories, and use simple estimation techniques to rescale the original measure. For instance, having asked respondents in questionnaires to select one of six categories ranging the number of hierarchical levels from (0-1), (2-3), (4-5), (6-7), (8-9), (10 or higher), the researcher would assign the following membership scores to each of the six qualitative anchors respectively: [0.0], [0.2], [0.4], [0.6], [0.8], [1.0]. The choice between the direct and the indirect method largely depends on the type, quality, and availability of data, and the substantive theoretical and empirical knowledge of the researchers. Most importantly, however, good practice in QCA stipulates that the decisions for calibration are to be made transparent and explicit (Wagemann et al., 2007).

### 3.2.4. Positioning QCA within the Context of Traditional Methods

Having discussed the technical, epistemological, and practical tenets of QCA, the method can be positioned within the context of the two most widely used methods in organization theory: quantitative statistical methods and qualitative case study methods. As has been mentioned above, one of the initial motivations for developing QCA was the naturally limited size of the datasets. QCA – as was suggested early on – was suitable for medium size samples. In contrast, statistical methods are suitable for large samples where case studies commonly focus on single or few observations. Another peculiarity of QCA lies in its consideration of all logically possible configurations. This sets practical limits on the number of variables included in the analysis as every additional condition exponentially increases the number of possible configurations (Marx, 2006). As in the example above, three conditions resulted in eight possible configurations. If one were to include eight conditions, the number of configurations would increase to 256. Statistical methods instead are capable of examining large numbers of independent variables

(although once interaction terms are included, the number of variables requires adjustment). Similarly, the rather exploratory nature of case study methods allows the examination of a large number of potentially influencing factors. Aspects concerning the size of samples and the number of included variables (or conditions) are certainly important. Nevertheless, in all three methods there are possibilities to balance the relation between sample size and the number of independent variables.

Most significantly, there are substantial epistemological differences between the three approaches. First, statistical methods aim at analyzing net effects of a range of independent variables on the dependent variables. They focus on identifying singular, 'one-size-fits-all' solutions, and they thereby imply unifinality. As has been shown above, QCA instead allows for multiple solutions and thus explicitly entails equifinality. Case studies are not explicit yet by their very nature acknowledge variation in empirical observations and are thus implicitly equifinal. Second, there are substantial differences between the ways in which the various methods understand of relationships between variables. Statistical analysis, by treating influencing factors as independent variables, considers net effects on the dependent variables. It is then possible to add together their joint effect. Statistical methods thereby assume additivity of variables. In contrast, by holistically examining and comparing entire cases, QCA directly focuses on the conjunctural impact of conditions. It maintains the integrity of each individual case and assumes that their joint impact, rather than the individual contribution, explains certain outcomes. Again, case study methods implicitly argue for conjunctural causation, although the in-depth focus commonly leads to context specific explanations. At last, the three methods make different assumptions about the nature of the relationship between variables. Statistical methods usually assume symmetric relationships, which are usually linear or curvilinear.<sup>8</sup> In contrast, QCA remains indifferent *ex ante* and takes an exploratory approach to determining the nature of the relationship between variables. QCA effectively makes no *a priori* assumption and thus allows for asymmetric relationships.

Differences between quantitative statistical methods and the rather qualitative QCA approach also exist in their respective approaches to scale development. The use of calibration techniques to meaningfully represent data within the selection of cases, clearly distinguishes QCA from quantitative, internally consistent measures used in statistical methods. The differences can mainly be traced back to the set-theoretic foundations of QCA. It requires coding (or better calibrating) conditions as membership scores in various sets. Ordinal scales in quantitative analysis, which rank categories and arrange values relative to each other, are transformed in QCA and arranged according to substantive and theoretical knowledge. Case studies predominantly rely on implicit calibration or ordinal scales.

Finally, the differences in sampling, inclusion of variables, epistemological assumptions and scale developed manifest themselves in the general research approach, the theoretical fit and the potential for generalization. Although exploratory elements exist, statistical methods are certainly more deductive, pursuing hypothesis driven research

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<sup>8</sup> I say usually because in fact there are statistical techniques to account for asymmetric relationships. These, however, are to my knowledge not or only rarely applied in management research.

agenda. QCA in contrast demands specifying a range of conditions that – similar to hypotheses – provide the general framework for the analysis. Once determined, QCA parts from this deductive approach and remains relatively open (or inductive) towards the solution. In contrast to QCA and statistical methods, case studies are inductive. The implicit assumptions, of statistical methods of singular causality and linearity, do not – as the literature review has shown – allow for an appropriate fit between theory and methods. QCA, in this respect, certainly provides a more suitable approach. Case studies are often rather exploratory and inductive, they are used to develop theory and consequently, it is not required that they conform to theory. Finally, there are differences regarding the extent to which one can generalize in regards to the results. Statistical analyses based on randomly sampled observations allow for the broad generalization in regards to the overall population. In QCA, researchers instead select cases on a certain theoretical rational, and allow merely for modest generalization (Ragin et al., 2004). The following Table 3.2 summarizes the comparison of QCA to quantitative statistical methods and qualitative case study methods.

Table 3.2: Positioning QCA in the Context of Statistical and Case Study Methods

	Statistical Analysis	QCA	Case Study Analysis
No. of observations	Large	Large, medium, small	Singular (descriptive or paired comparison)
No. of variables	Large	Medium	Large
Paradigmatic assumptions	Unifinality	Equifinality (explicit)	Equifinality (implicit)
	Additivity of variables	Conjectural impact	Contextual dependence
	Symmetric causality	Asymmetric causality	
Scales			
▪ <i>Development</i>	No calibration Ordinal scales . Ranking categories	Calibration Fuzzy set scale . Calibrated membership	Implicit calibration
▪ <i>Characteristics</i>	. No reference to set membership . Arranged relative to each other	. Specific reference to set membership . Arranged based on substantive and theoretical knowledge	Ordinal scales
Research approach	Deductive	Deductive/ inductive	Inductive
Theoretical fit	Somewhat tailored to fit theory	Tailored to fit theory	Not taken into account
Generalization	Broad generalization	Modest generalization	Limited generalization

### 3.2.5. Final Remarks

QCA holistically examines cases as configurations of conditions, instead of measuring the net effect of individual variables on the dependent outcome (Ragin et al., 2004). It thereby maintains the integrity of each case and considers all variables in conjunction with one another (Fiss, 2007). It does so by using set theory to organize the data, and Boolean logic to analyze interdependencies among conditions (independent variables) and the specified outcome (dependent variable).

QCA thereby opens opportunities to model complex theoretical propositions that are difficult to implement using statistical methods. Firstly, it allows a given outcome to be explained by various alternative results, thus entailing equifinality. Secondly, it specifically focuses on conjunctural causations among conditions, and there is no (methodological) limit to the number of interacting conditions included in solution terms. Finally, QCA does not make implicit assumptions about the nature of the relationship among variables but allows for the identification of asymmetries among conditions. These epistemological tenets of QCA help to overcome the "...fundamental mismatch between the analysis of linear relations – the central concern of the most popular and most used quantitative methods – and theoretical discourse." (Ragin 2000: xiv). This certainly seems true considering the complex theoretical propositions put forward by contingency theories of management innovation.

At the same time, there are disadvantages to using QCA. Calibration techniques and minimization procedures depend on the subjective assessment of the researcher. These judgments should certainly have substantial and theoretical foundations; nevertheless it is important to transparently report the various decisions made by the researcher (Wagemann et al., 2007). QCA only allows distinguishing core conditions from contributing conditions, it does not permit a more detailed assessment of the relative significance of individual conditions. Furthermore, there is little consensus among researchers concerning the appropriate level of quality indicators for models or results. So far coverage and consistency are the most widely used measures to assess the quality of QCA results; yet, depending on the size of the sample and the number of conditions included, there is variation among the two coefficients as reported in studies. Finally, QCA is relatively new it underlies continuous methodological developments (Wagemann et al., 2007). For instance, scholars are increasingly applying QCA to larger datasets to derive broader generalizations (Fiss, 2010; Grandori et al., 2008). This requires improvements in computational methods, and shifts the focus away from its initially qualitative focus. To develop new measures for the reliability of models, scholars are also working on type 2 fuzzy sets that allow estimating the level of uncertainty regarding whether or not a particular case does or does not belong to a particular set. In addition, while there is so far no QCA approach that permits longitudinal analyses, researchers are developing techniques to incorporate such alternatives. These developments should help to ameliorate some of the disadvantages that are currently related to QCA.

### 3.3. Conclusion

In this chapter I have laid the foundation for the empirical analysis that will be reported later. In particular, I propose to focus the analysis upon the inter-firm relation, instead of the individual firm. This shift is supported by narrative evidence and post-hoc theorization in outcome studies, and is substantiated by conceptual models and in-depth case studies by process research of management innovation (Birkinshaw et al., 2008). General theories of inter-firm relations, taking a governance perspective on the one hand and a structural knowledge perspective on the other, provide solid theoretical arguments for the dynamics of resource exchange and knowledge development between firms; these being the prerequisites of management innovation (Nooteboom, 2004). These theories point towards the crucial role of mutual dependence in providing the necessary level of

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trust between partnering firms to reduce relational risks. Only when such risks are mitigated will firms reciprocally exchange knowledge and information (Sheppard et al., 1998). In addition, this dynamic inter-firm environment requires both the presence of diverse sets of knowledge, as well as the conditions that allow the unobstructed flow and combination of knowledge. To specify these facilitating conditions of management innovation I follow established research that considers inter-firm relations as social action systems. These can be analyzed using similar factors as those that are being used for individual firms (van de Ven, 1976). I subsequently make use of determinants identified by outcome studies of management innovation, and develop hypotheses for conditions on the inter-firm level that facilitate the development and implementation of new management instruments. Hence, instead of speculating about what interacting organizations *do* to introduce new management practices, I analyze different combinations of conditions governing inter-firm relations that enable management innovation. Finally, acknowledging the theoretically complex antecedents of management innovation, as suggested by process studies and especially contingency theories, I formulate three additional hypotheses.

To test these and thereby contribute to the growing body of literature on management innovation, I propose the application of a relatively novel analytical technique. fsQCA holistically considers entire configurations of conditions instead of analyzing the net-effect of individual variables on the outcome (Fiss, 2007; Ragin, 2008b). It thereby maintains the integrity of each case and probes into the complex constellations of facilitating conditions. Underlying QCA is the organization of data into set-theoretical relationships, which are minimized using Boolean logic.

QCA is well suited to advance our understanding of management innovation. It improves the alignment between theory and empirical models threefold. QCA allows for solutions to express equifinality, i.e. in case there are conceptually different combinations of conditions that equally explain when inter-firm relations develop and implement new management instruments, these will be reported as separate, equifinal paths. In addition, by considering entire cases, and not disaggregating these into individual variables, QCA explicitly identifies conjunctural causations among facilitating conditions. These extend beyond the possibilities offered by statistical methods and allow the identification of "...complementarity, additive, substitution or suppression effects." (Fiss, 2010: in press). Finally, QCA does not limit associations to linearity but allows for complex asymmetries to exist among conditions. In sum, QCA's ability to accurately reflect complex theoretical arguments within empirical models makes it a promising methodological approach. Furthermore, QCA offers a few advantages with regards to the practical aspects of empirical research. On the one hand, it is suitable for the analysis of small to medium size samples. As has been shown earlier, management innovation is a rather transient and context dependent phenomenon that requires careful attention to data collection. On the other hand, the technique for coding collected data, namely calibration, permits taking into account the context specificities of observed management innovations.

Ultimately, this approach allows the development of a taxonomy of configurations of conditions which facilitate the development and implementation of new managerial tools. It identifies multiple sets of complex associations and identifies underlying complementarities and substitution effects. As decision-making tools taxonomies are



appealing, as they allow for the reduction of complex phenomena through the emphasis and comparison of common features between observations.

The next chapter introduces the empirical background of the configurational study of inter-firm relationships within China's biopharmaceutical industry. This industry imposes severe technical, market and regulatory challenges upon the firms which operate within it. In addition, due to the various complex knowledge domains which are so characteristic amongst activities pertaining to biopharmaceuticals, firms strongly rely on relationships with other firms. This industry in China is particularly young, and contains a highly diverse population of firms. Its market growth is outpacing other markets around the world and its regulatory framework is highly unstable. Inter-firm relations consequently operate under extremely volatile conditions that require the constant development of new managerial instruments to address these dynamics. The biopharmaceutical industry in China is, therefore, an appropriate research field to empirically validate the link between inter-firm configurations and management innovation. The next chapter will highlight the empirical relevance of this study in the investigation into the conditions under which new managerial tools are being developed and introduced.





## 4. The Biopharmaceutical Industry in China

The biopharmaceutical industry in general is widely acknowledged to lack the appropriate managerial practices which would allow firms to benefit from the variety of scientific approaches<sup>9</sup> and to economically coordinate research and development (R&D) and commercialization activities (Pisano, 2006). In China, a modern biopharmaceutical industry has emerged during the 1990s, but only recently, during the past five years, has it begun to flourish (Frew et al., 2008). The industry is populated with a large variety of organizations and institutional arrangements are either absent or changing rapidly. Hence, the business environment of China's biopharmaceutical industry adds to the challenges faced by biopharmaceutical firms in general. Under such conditions, management innovation as one form of organizational change is expected to take place frequently.

Information on the biopharmaceutical industry in China is difficult to obtain. SIC (Standard Industrial Classification) codes, categorizing firms according to their output, cannot be used to identify biopharmaceutical firms, as these instead share the technologies underlying their products. Also, the industry lies at the intersection of the pharmaceutical and the biotechnology industry. While information on these two is readily available, there are only a few supranational or national organizations that systematically collect data specifically on biopharmaceuticals. Finally, the rapid developments within China's biopharmaceutical industry complicate the collection of data. This chapter therefore employs a variety of sources to comprehensively describe the industry in China. These include secondary sources, such as newspaper and scientific articles as well as industry and trade reports. Also, I make use of observational and anecdotal evidence collected during field research undertaken in China between 2007 and 2008. In addition, I use in a few instances information gathered during 56 interviews with managers of firms in China's biopharmaceutical industry. The data was predominantly collected for the empirical study reported later in next chapters. Selected items however provide interesting insights into China's institutional environment.<sup>10</sup>

I proceed by introducing the biopharmaceutical industry in general, focusing on the complexity of drug design, the technologies developed during the last decades and highlighting organizational challenges in the management of biopharmaceutical firms. I then focus on the biopharmaceutical industry in China in particular providing a short historical introduction and describing the large diversity in organizations operating within China's biopharmaceutical industry. Further, I provide information on the recent developments in China's institutional architecture to illustrate the specific business environment in China. The concluding section summarizes the uncertainties under which organizations in China's biopharmaceutical industry operate.

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<sup>9</sup> Modern technologies for identification and validation of targets are for instance Genomics, Proteomics, Systems biology, or RNAi. Modern technologies used for lead identification and optimization are rDNA, MAb, rational drug design, combinatorial chemistry, or high throughput screening (Pisano, 2006)

<sup>10</sup> More information on the interview partners and the interviews themselves is provided in *Chapter 5*, the empirical study in China's biopharmaceutical industry. I refer to this source throughout this chapter as the survey.

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## 4.1. Biopharmaceutical Business

Biopharmaceutical business is concerned with the development and commercialization of medicinal products based on biotechnology (Pisano, 2006). Biopharmaceuticals differ from 'traditional' pharmaceutical products in two general ways. First, whereas pharmaceutical companies focus on small molecules to chemically engineer drugs, biopharmaceutical firms focus on complex macromolecules. Second, they use modern drug discovery tools to identify new therapeutic agents (Pharmahorizons, 2001).

The origins of the biopharmaceutical industry are found in the discovery of recombinant DNA (rDNA) in the early 1970s. Based on this discovery, Genentech, the first biopharmaceutical company was established in 1976. Since then, the industry has grown rapidly especially in North America, Japan, and Western Europe. More recently, biopharmaceutical industries have emerged in developing countries such as India, Brazil or China (Lakhan, 2006). Biopharmaceuticals is a core sector of any knowledge based economy and heavily relies on highly skilled and educated employees. Because of its crucial role, national industries are strongly influenced by the initiatives of governmental programs, in frameworks of National Systems of Innovation (Devine, 2005; Europe Innova - Innovation and Clusters, 2007; Lakhan, 2006; Whitley, 2000). In most countries, the financial investment from public sources exceeds those from the business community (Zhao, 2006). Because of the potentially severe consequences of biopharmaceutical products upon humanity, the industry is subject to strict regulatory regimes. Even after approval by regulatory authorities the economic success of biopharmaceutical products remains uncertain, due to the difficulties in estimating the acceptance of drugs by both patients and doctors. These peculiarities are the reason for the poor economic performance of the industry. Even in the U.S., with the most developed biopharmaceutical industry it is estimated that as a whole a net loss of more than US\$ 100 billion has been accumulated (Pisano, 2006). This staggering underperformance cannot be accounted for by a lack of revenues which have consistently increased and were estimated to lie around US\$ 37 billion annually in 2004. Profits however have remained well below zero. In 2006, only 54 out of 342 listed U.S. biotechnology firms were profitable (Ernst & Young, 2006).

Biopharmaceutical business is characterized by distinctive features that pose specific challenges to making *science a business*. Consequently firms face organizational challenges arising from substantial and persistent uncertainties, the complex and integral nature of the underlying science, and the need to develop mechanisms for organizational learning, which I discuss below (Pisano, 2006).

### 4.1.1. Long, Costly, and Uncertain Development Cycles

Even though medicinal drugs reach consumers in a relatively simple form, whether they are pills, ointments, powders, or liquids, the manufacturing processes of drugs can be far more sophisticated and complex than most other technologically-intensive goods. Due to the complexity of human biology there is high uncertainty regarding the effect of these products upon patients. Biopharmaceutical products may therefore have severe negative effects on patients. Therefore, biopharmaceutical R&D is subject to extensive regulations. The process of developing and marketing a biopharmaceutical product is therefore

particularly expensive, time-consuming, and risky. It can broadly be separated into five phases.

1. The *discovery phase* aims at identifying and validating targets, such as genes or proteins, that cause disease by interfering with biological mechanisms (Ficenec et al., 2003). Identification of the disease-causing target requires a thorough understanding of the chemical, biological, and physical mechanisms involved. After having identified such a target, researchers search for a molecule that will inhibit enzymes which speed up the process of the target interfering with the subject's biological mechanisms. The resulting enzyme-inhibiting compound is synthesized and optimized against the target, in the hope that it will slow or prevent the disease caused by the target.
2. The molecules then proceed to *pre-clinical trials*, where they undergo safety and efficacy tests. Research is conducted in the form of in-vitro trials (controlled experiments in test tubes) and in-vivo trials (experiments involving living organisms). The active, enzyme-inhibiting, compound and the inactive ingredient, used either for delivering the active compound or for changing the taste and colour of the medicine, are highly interdependent in their formulation so that successful research often depends on the scientist's tacit knowledge and experience with the compound.
3. Filing an Investigational New Drug (IND) application with the regulatory authorities permits proceeding to *clinical trials*. Depending on the research results and the field of application, clinical trials may include tens of thousands of patients, and are thus time and cost intensive. They serve to test and guarantee the safety and efficiency of the designed drug in the human biological system and help to make initial estimations about its market potential.
4. With satisfying results during the clinical trial phase, a firm can file a New Drug Application (NDA). In case of approval, a *manufacturing* base has to be set up according to Good Laboratory (GLP) and Good Manufacturing Practices (GMP).
5. During *commercialization*, the company will try to maximize the acceptance of the drug, prepare for the time when the patent protection runs out and fight against generic copies. During this phase the focus is upon the marketing of the drug towards health care providers (doctors) and patients, and protecting revenue from Intellectual Property (IP) Rights infringements.

The process may take up to twenty years and involves substantial costs and regulations. Succeeding from one phase to the next is highly uncertain. From the ten to twelve thousand compounds initially screened, only one will eventually be brought onto the market. This technological uncertainty is a consequence of the variety of different scientific approaches available to researchers and the complexity of human biology.

#### 4.1.2. The Complex, Heterogeneous and Integral Nature of Biopharmaceutical Science

In contrast to 'classical' drug design primarily based on medicinal chemistry and small molecules, modern biotechnology developed and applied several new and independent approaches to the drug development process. These can be distinguished

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according to three functional groups: first, approaches to the synthesis of large molecules, such as rDNA, monoclonal antibodies or combinatorial chemistry; second, new approaches to understanding biological processes such as structural genomics, proteomics, RNAi, or system biology; and third, new approaches to the design and screening of the match between compounds and targets such as ‘rational’ drug design, high-throughput screening, or random drug design (Pisano, 2006). These new technological approaches are supplemented with developments in bio-informatics or imaging techniques (Ficenec et al., 2003).

In the early years of the biopharmaceutical industry it was argued that with newly available means provided by improvements in technology, the complex and uncertain traditional processes of drug design would be revolutionized. By creating fundamentally novel diagnostics and therapeutics, and increasing the quantity of marketable compounds (Hamilton, 1993) both time, as well as the uncertainty involved in the development process, could be reduced and a large number of new drugs brought onto the market. Despite the fact that the new biological mechanisms that were the subject of biopharmaceutical research proved to be more complex than anticipated, research into these mechanisms also led to a series of ‘technological revolutions’, which significantly extended the range of instruments that were available to researchers for the development of new drugs. However, as has been shown (Marsili, 1999), these technological regimes differ in the logics and languages used in the identification, formulation, and solution of problems, and are responsible for difficulties in communication between scientists. As a consequence, biopharmaceutical firms not only need to deal with technological uncertainties, but are also challenged in finding viable organizational solutions.

#### 4.1.3. Organizational Challenges

Each of the scientific disciplines of biotechnology (rDNA, MAbs, genetics, etc.) helps to shed light on a given problem, but none of these disciplines by themselves can give a comprehensive answer. Instead, problem-solving requires integrating several technological approaches and depends on a continuous exchange of knowledge and experience, as well as the effective coordination of research to allow cumulative learning. Choices taken in one scientific discipline significantly affect the researchers’ understanding of the other biological features of a molecule. Therefore, drugs cannot be designed by separately solving isolated problems. The necessity of integrating a large number of technological regimes adds to the challenges of drug R&D. Because of the technological complexities and the variety in scientific approaches that are necessary, firms are required to cooperate with numerous organizations (Powell et al., 1996; Zhenzhen et al., 2004). The biopharmaceutical industry is known for its diversity of inter-firm relations in which organizational partners range from public domestic research institutes to large multinational pharmaceuticals (Pisano, 2006; Zhao, 2006).

To make things worse, the difficulties in finding solutions to organizational challenges are exacerbated by frequent changes in the values, norms and practices that govern the research throughout the different phases. During the early phases of research, knowledge needs to be shared; this requires openness amongst those researchers that are both inside and outside of the organizations. In contrast, secrecy is required in the later

stages to prevent misappropriation of generated IP. Furthermore, parameters for assessing the quality of work change. Substantial scientific achievements require validity, whereas marketable goods need to exhibit utility to find acceptance among doctors and patients. Different performance measurements are closely linked to these shifts in parameters. For a young biopharmaceutical company, success is measured and potential is assessed by considering the reputation and publication history of the senior scientists that are involved with the company. However, later on these indicators shift and economic indicators, measuring the financial performance of the firm, gain more importance.

In general, biopharmaceutical business is challenged by the profound and persistent uncertainty that is involved in the research, development and commercialization of its products. The industry's complex scientific nature and its requirement of cumulative learning challenge firms to find appropriate organizational structures and management techniques. In addition, the industry significantly depends upon broader institutions such as education systems, financial instruments, and regulatory regimes. As the following subsection will show, in China these challenges are exacerbated by either an absent, or a rapidly changing, institutional infrastructure relating to regulation, finances, marketing, HR, and intellectual property rights.

#### 4.2. The Chinese Biopharmaceutical Industry

In 1973 Professors Cohen and Boyer discovered rDNA, thereby clearing the way for the biotechnological scientific advancements that were to follow. Meanwhile China was in the midst of the Cultural Revolution (1966 – 1976). This decade of long agony not only had devastating effects on the Chinese population, but also severely damaged the nation's educational system and scientific endeavour. Intellectuals, academics and researchers were stigmatized as imperialists and suffered persecution. Universities and other research institutions were closed (Lakhan, 2006). The consequences of the Cultural Revolution on the development of China's scientific community were immense. Not only did the country lose a decade of adolescent scientists: due to the widespread scepticism among the Chinese people, science was not an attractive career path among younger generations. Those that did choose this path, or those that had done so before the Cultural Revolution were ill-equipped for modern research, both because they were unfamiliar with the current literature and because they had been barred from performing their work in laboratories and libraries.

Shortly after the Cultural Revolution, the Chinese government, under Deng Xiaoping, took steps towards the development of an advanced biotechnology-based knowledge sector in China. In 1982, the Chinese Academy of Science (CAS) re-opened its institutes and began teaching regular courses. By 1983 the government had initiated the China National Center for Biotechnology Development (CNCBD), responsible for the management and distribution of funds for biotechnological research. Increasingly, public investments were directed towards the biopharmaceutical industry. In 1986, the 'Frontiers in High Technology Program Fund' was created dedicated to projects in the applied sciences. From the 1990s on, a central objective of the government's Five Year Plans lay the development of a modern biopharmaceutical industry. During the 7<sup>th</sup> Five Year Plan (1986 – 1990) public spending significantly increased and concrete policy objectives for the

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biopharmaceutical sector were formulated (Hamer & Kung, 1989). From the 1990s onwards, the industry has represented the core knowledge-intensive industry in China, and the government is heavily investing in its activities.

This emphasis on the biopharmaceutical industry however was not only economically motivated. An efficient and successful domestic biopharmaceutical industry is considered crucial to guarantee the health and safety of the Chinese population (Liu, 2006). The political challenges arising from a rather peculiar public health profile are enormous (Jackson & Howe, 2004). Consequently, the latest Five Year Plan (2006 – 2010) set ambitious objectives, such as fostering the development of five to fifteen innovative, domestic drugs and vaccines, exporting at least five pharmaceutical drugs developed in China to the U.S. and Europe, and consolidating the industry by supporting the development of five large scale pharmaceutical groups (Zhou, 2007).

Until the end of the 1990's, the industry was dominated by large, state-owned pharmaceutical companies; most of them economically inefficient and technologically un-innovative. By 1997, it was estimated that some 5000 firms were operating in China's biopharmaceutical industry (Cataldo, 1998).<sup>11</sup> Only seven years later, the number significantly declined to an estimated 900 firms (Chen, Wang, Wen, & Wang, 2007; Ding, 2007). This collapse was mainly ascribed to the reforms of the regulatory system in 2005 which lead to stronger local competition and significantly improved the scientific and business environment for biopharmaceutical firms. Although reliable numbers are difficult to obtain, it was estimated that by 2008, between 300 and 500 biopharmaceutical firms remained operating within China (Chervenak, 2009; Langer, 2006). Nowadays, the industry not only comprises old state-owned, or formally state owned enterprises, but also foreign firms, and a growing number of young and innovative private Chinese firms.

What attracts firms is the rapidly emerging market for biopharmaceutical products in China. Between 2005 and 2009 alone, the market expanded by 211% to an estimated output value of 13.5 billion USD (CCM Int. Ltd, 2009). Although it only represents about 2% of the global market, putting China on 10<sup>th</sup> position worldwide, it is expected to continue growing between 20 – 30% annually (compared to 7% growth for the global market) throughout the next decade (Zhou, 2007). China's market for biopharmaceutical products is expected to become the fifth largest in the world within the next three to five years (Langer, 2006) and the world's largest by 2050 (Anon, 2009). These perspectives are the consequence of a growing and aging population, increasingly suffering from 'modern' health problems such as diabetes, obesity and cancer (Jackson et al., 2004). Both the

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<sup>11</sup> The abovementioned difficulties in finding reliable information for the biopharmaceutical industry in China also holds for estimations concerning the number of operating firms. The quantities above are based on information from various sources. In 1997, Cataldo (1998) reports on 5000 firms. In 2005, Chen (2007) estimates that 500 companies operate in China's biopharmaceutical industry. This number is supported by Ding (2007) with a reference to the Bio-industry in China annual report 2005. In contrast, Wikipedia's (2009) entry for the industry speaks of 900 firms. Another source, the National Center for Drug Screening of the Shanghai Institute of Materia Medica estimates that 1.000 small to medium size biopharmaceutical companies operate in China (Wang et al. 2005). In 2007, according to Teh (2007) there are 400 firms. Finally, in 2008, BioPlan Associates (2008), a U.S. based consulting company, claims that 500 biopharmaceutical firms are active in China while Chervenak (2009) in the most recent article I found states estimates some 300 firms.

government and individuals are spending more on health care and the coverage of medical insurance has been extended. Alongside market opportunities, the initiation of preferential policies and the de-politicization of the Chinese economy have stimulated entrepreneurship (Greeven, 2009; Krug, 2004). The significant increase in public spending, targeting innovative, technology-intensive companies, encourages overseas Chinese, so called *Hui Gui's*<sup>12</sup>, and local scientists alike to establish domestic biopharmaceutical companies.

During the last few years, the industrial structure of biopharmaceuticals in China has been radically transformed, and firms operating in this business environment have experienced, and participated in, rapid and fundamental developments towards a modern biopharmaceutical industry. How this transformation has taken place and how it affects organizations in China's biopharmaceutical industry is subject of the following sections.

#### 4.2.1. Industry Structure

Literature on the biopharmaceutical industry commonly differentiates three types of organizations (Pisano, 2006). First, so called Dedicated Biotechnology Firms (DBF), spin-offs from universities usually founded by scientists (OECD, 2005). Second, pharmaceutical firms that specialize in the development of 'traditional' drugs and their global commercialization. And third, service-providing firms supporting the industry with platform technologies, training and financial or legal consulting services (Pharmahorizons, 2001). The diversity of firms operating in China however requires further distinguishing the following three types of DBFs: those founded by domestic researchers, those founded by Chinese Returnees, and those financed by diversified Chinese business groups. Each carries features similar to North American or European firms, such as indigenous innovation, international competitive product pipelines, or global patenting behaviour. In addition, however, they exhibit unique features that require and allow them to operate in the Chinese business environment (Zhenzhen et al., 2004). Furthermore, I discuss foreign firms and traditional Chinese firms separately. To give an indication as to how many firms belong to each of these groups, I provide rough estimations based on discussions with interview partners, industry experts and colleagues. However, since there is not a single organization comprehensively collecting data specifically on the biopharmaceutical industry in China, these estimations should be used with caution.

#### *Foreign Pharmaceutical Companies*

Foreign firms in China are mainly large, multinational pharmaceuticals. The number of small to medium size foreign firms operating within China is insignificant. Most foreign pharmaceuticals had established subsidiaries in Hong Kong and Taiwan as early as the 1980s and began re-locating to Mainland China in the 1990s. Initially, foreign pharmaceuticals were motivated by the low wages and costs of raw materials, as well as access to the Chinese market.

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<sup>12</sup> *Hui Gui* literally translates into 'sea turtles'. Born at the shore, they grow up at sea, and eventually return to the same place to lay eggs. Similarly, Chinese Returnees grow up in China, move abroad for studying and working, and eventually return to China. The term was coined in Taiwan in the 1960s, referring to returning Taiwanese that significantly contributed to the country's economic success during that period. I use the term *Hai Gui's* to refer to Chinese who have studied and worked outside China for more than five years.



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By 2009, nearly all foreign multinational pharmaceuticals operated R&D centres in China, predominantly in Shanghai and Beijing. While they continue to benefit from lower costs, estimated to lie at 20% of operations in Western countries, seizing R&D opportunities in China is emerging as their primary motivation (Chervenak, 2009).

Despite this general trend, strategies pursued by foreign multinationals to exploit R&D opportunities in China vary significantly, as the following three examples illustrate. GlaxoSmithKline (GSK) opened an R&D centre in Shanghai in 2007 with more than 100 scientists, conducting neurological research. The reasons for this R&D are found in the strengths of China's education system in neurology and oncology. In contrast, Eli Lilly's R&D operations in China began with the opening of a small office in Shanghai in 2003. The company selected two local firms as exclusive partners and strategically built up these firms capability in regards to the drug delivery process. Eli Lilly did not hire personnel specifically for its activities in China. Instead, they flexibly assigned professionals from their American R&D centre to China. Their research focuses on disease groups relevant to China's public health profile. Third, Hoffmann-La-Roche began its operations in China at the end of the 1990s and nowadays employs 1,700 workers across China. In 2004, it opened its fifth global research centre in Shanghai with approximately 80 researchers (Tremblay, 2006) and is planning to host some 250 scientists in the near future. Also, Roche has started a program supporting spin-offs by its domestic scientists.

As these examples have shown the strategies pursued by foreign pharmaceuticals differ substantially, both with regards to setting up R&D activities, as well as regards to developing the Chinese market. The flexible trial and error approach chosen by Eli Lilly indicates that there is not a single best strategy. Yet, the economic, scientific and institutional impact of foreign MNCs has been considerable. They not only invest in manufacturing facilities and R&D, offer attractive workplaces for scientists and transfer technologies to China, but also collaborate closely with local and central governments. From discussions with industry experts, foreign multinationals represent approximately 2% of the organizations in China's biopharmaceutical industry.

#### *Traditional, Domestic Pharmaceuticals*

Most of the traditional Chinese firms are spin-offs of former state owned pharmaceutical manufacturers or public research institutes. Despite their privatization, many remain responsible for the supply of basic medicinal products (such as vaccines), the manufacturing of raw materials, generics, Traditional Chinese Medicine (TCM) products, and other over-the-counter (OTC) drugs. Many function as wholesalers for the distribution of pharmaceutical products. Due to their history and size, traditional Chinese pharmaceuticals usually maintain strong relations to central, provincial and local governments guaranteeing the sale of their products and offering favourable operating conditions.

Before 2004, traditional Chinese pharmaceutical firms were relatively well equipped and well disposed towards advanced technologies. However, they were severely inhibited by out-dated manufacturing processes, weak international trading competitiveness, duplicate production processes and inflexible management structures (Fu, 2010; Zhenzhen et al., 2004). According to my interviews, by 2008 most traditional Chinese

pharmaceutical firms had experienced a radical deterioration of their management structure and drug pipeline. With disappearing technological capacities, most of the traditional Chinese firms abandoned R&D activities and focused solely on commercializing their remaining, often uncompetitive drugs.

Traditional, domestic pharmaceuticals were mostly affected by the regulatory reforms after 2004 (Wang, Chen, & Chen, 2005). With out-dated manufacturing processes and research facilities, and without the opportunities to raise the capital for investing in GMP and GLP facilities, a large number of traditional Chinese pharmaceutical companies were shut down. Others were acquired by more innovative, younger Chinese biopharmaceutical companies in order to build up manufacturing and sales networks. These developments explain the significant decrease of the organizational population of China's biopharmaceutical company after 2004. While management changes, foreclosures and acquisitions should continue to further reduce the number of traditional, domestic companies, they currently remain the largest type of firm operating within China's biopharmaceutical industry, accounting for approximately 70% of the population (Zhenzhen et al., 2004).

#### *Domestic Dedicated Biotechnology Firms (DBFs)*

During the last decade, the Chinese biopharmaceutical industry has witnessed the emergence of domestic Dedicated Biotechnology Firms (DBF) described by the OECD (2005) as any biotechnology firm whose predominant activity involves the application of biotechnology techniques to produce goods or services. These are either established by returning scientists, domestic scientists, or financed by diversified business groups. Altogether, they account for approximately 28% of firms operating in China and are rapidly growing in number.

#### **DBFs established by *Hui Gui's***

Chinese DBFs established by returning scientists are now between five and six years old. Their founders spent four to fifteen years overseas and obtained graduate university degrees. They gained experience in academia or in corporate research centres working for multinational pharmaceuticals and larger biotechnology firms, or through running their own companies. One distinctive feature of Chinese exchange students during the last decades is that they almost exclusively went to highly reputable universities, such as Harvard Medical School, Stanford University Medical School, or the Karolinska Institute in Stockholm.

The motivations of *Hui Gui's* to return to China are manifold. On the one hand, from interviews and discussions I have learned that many had faced discrimination when they were abroad. In particular, they felt that this discrimination prevented them from achieving career goals which would lead to the highest levels at corporate headquarters or to tenured university posts. Others returned for personnel reasons, for instance finding it difficult to adequately integrate into their host-society. On the other hand, pull factors have increasingly motivated Chinese scientists to return to China (Gross & Connor, 2007). For instance, on the personal side, the wish of spouses, or the urge to care for parents in China often motivated Chinese scientists to return. In addition, the Chinese government actively

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encourages their return by designing preferential public policies and funding programs. These include direct financial support for professional activities, such as low interest start-up capital, but also other financial support, such as coverage of tuition fees for children, guaranteed access to top universities and the provision of flats or company cars (Edunet, 2007; Zweig, 2006). Furthermore, Returnees enjoy a very high reputation in Chinese society, granting them access to government officials or public administrators (Cheng, 2005). However, *Hui Gui's* also face difficulties upon their return (Fan, 2008). Some may have forgotten the customs necessary to manoeuvre within Chinese society, especially those that have lived abroad for many decades. While some were able to re-activate their domestic network of family and friends, others have complained that for them these relationships were much weaker than those of researchers that had not left to study abroad. *Hui Gui's* thus seem to suffer from weak embeddedness.

Despite the disadvantages, Chinese DBFs established by *Hui Gui's* predominantly benefit from the quality of the education and the knowledge and experience of their founders. Also, they clearly benefit from a language advantage that facilitates forming international cooperation. Within the total firm population within China's biopharmaceutical industry, DBFs established by Returnee's account for approximately 12% and are probably the fastest growing and most successful firms nowadays.

#### **DBFs established by Domestic Researchers**

The second group of Chinese DBFs comprises firms established and managed by Chinese scientists without overseas experience. These firms are in general up to five years older than the group founded by Returnees. Scientists were attracted by central and provincial policies introduced in the beginning of the 1990s and targeted at establishing a viable biotechnology industry in China. Chinese DBFs established by domestic researchers usually are not well disposed to of the modern scientific knowledge and experience of those scientists that studied abroad; nor do they have equivalent language skills (Le Bail & Shen, 2008). Nevertheless, their research projects and their products are not necessarily less innovative. In many cases it was not the lack of skills and opportunities that kept scientists in China, rather they were prevented from continuing their careers abroad by a government decision that aimed at keeping these scientists, and their unique professional skills, within the country. Nowadays, the domestic researchers establishing biopharmaceutical firms face several challenges. First, unlike *Hui Gui's*, they suffer from reputation problems, as private entrepreneurship still enjoys only low social status in China's society (Cucco, 2008; Goodman, 2008). Especially in the biopharmaceutical industry, with its long development cycles and severe uncertainties, the effect of this poor reputation discourages scientists from engaging in entrepreneurial activities which would mean leaving universities or public institutes where they enjoy a high social status. Moreover, they find it harder to establish international collaboration with foreign scientists and are regularly denied access to preferential policies, as most policies explicitly aim at attracting overseas Chinese scientists. Overall, the number of Chinese DBFs found by domestic scientists represents approximately 15% of the total firm population.

#### **Diversified Business Groups**

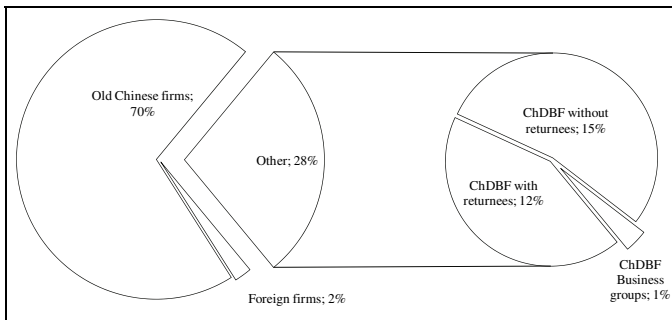
Finally, a few of the emerging DBFs in the Chinese biopharmaceutical industry have been established through investments made by diversified business groups. During the last

decade both central and provincial governments in China have promoted this corporate form (Keister, 2001). While they have declined in absolute numbers, their importance for China's economic development has increased throughout the 1990s (Ma & Lu, 2005). These business groups are able to diversify risks by investing in unrelated industries and, by installing information channels that allowed them to tap into local knowledge, identified investment opportunities within China (Keister, 2000).

Despite the unpromising economic performance of biopharmaceutical firms, a few Chinese business groups began heavily investing in the industry. They share a number of features. First, they usually had not previously operated in biopharmaceuticals so that decision makers usually lack the necessary knowledge to evaluate technologies in regards to their development uncertainties or market potential. Second, they rely on a very different set of evaluation criteria to allocate investments and to guarantee the commitment of their contract partners. One interview partner, for example, was required to convince his family to return to China in order to receive financial support from the business group. Third, these conglomerates have substantial financial resources at their disposal. Finally, by preferring to place in-group peers in decision making roles, they risk being badly advised (Keister, 2000; Nooteboom, 2004). Their motive to move into such a high risk industry seems counterintuitive. Hence, it remains uncertain how business groups will, in the long run, balance their need for sustainable economic return. Their share in the total number of firms in the Chinese biopharmaceuticals industry is assumed to account for 1%.

#### *Final Remarks*

As illustrated, the industry structure of China's biopharmaceutical industry is rather diverse. The following Figure 4.1 illustrates the proportion of firms in each category describe above according to the rough estimations gathered during interviews and discussions with managers and industry experts in China in 2008.



*Figure 4.1: Organizational Population in China's Biopharmaceutical Industry*

In the following section, I describe managerial challenges arising from China's rapidly changing institutional environment. In particular, I discuss current developments within the regulatory framework, its new financial infrastructure and development within the Chinese education system.

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#### 4.2.2. China's Regulatory Regime for Biopharmaceutical Products

Because of their potentially harmful effects on humans, R&D, manufacturing and commercialization of biopharmaceutical products are governed by strict regulatory regimes. China first issued the *Pharmaceutical Regulations* in 1978, containing detailed rules governing research, clinical trials, test approvals, and manufacturing. These were updated in 1984 and substantially revised in the *2001 Drug Administration Law* to strengthen the regulation of drugs, improve quality and safety standards, and protect the health, legitimate rights and interests of the people (Zhonghua Renmin Gongheguo Fagui Haibian [Official Decree of the PRC], 2001). Most significantly, the updated law contained a licensing framework similar to the one used in the U.S., Japan, and EU, issued new regulations for imported drugs and allocated the licensing authority from the Ministry of Health to the independent State Food and Drug Administration (SFDA).

Despite the established similarity with other regulatory systems, China's regime suffered substantial problems related to its enforcement (Lakhan, 2006). The SFDA is severely understaffed making it difficult to monitor the biopharmaceutical firms and their diverse activities. Further, the administration lacks the necessary scientific expertise to assess the validity of laboratory and clinical trial results. Most severe, however, have been the effects of a series of corruption scandals among public officers on the enforcement of China's regulatory regime (Zhang, 2009).

##### *Corruption Scandals*

In 2006, a major scandal shocked China's biopharmaceutical industry. Leading officials of the SFDA including the administration's highest commissioner, Zheng Xiaoyu, were charged for bribery. The scandal attracted wide international attention from governments, media, and industry (Barboza, 2007; Jia, 2007; The Economist, 2007) and the unusually quick execution of the death sentence of Zheng was widely interpreted to reflect the damage the scandal had done to the reputation of the Chinese regulatory framework and its domestic products. During the following years a number of smaller scandals concerning milk-powder scandal or poisoned pet food scandal followed.

The series of scandals had two immediate effects on the daily operations of the SFDA. First, it required re-evaluating a large number of applications that had been granted by the former administration. This resulted in lengthened processing times for clinical trial or drug market approvals. Regularly, during field research, interview partners complained about the slow 'grinding mills' of the SFDA. Second, it led to substantial uncertainties on the side of SFDA officers. Although some of the licensing violations had been facilitated by corruption, in most cases the SFDA simply did not dispose of the necessary monitoring capacity. SFDA officers realized that punishment would follow political motivations and be disproportionately severe in order to restore public confidence in the regulatory system. This situation discouraged administrators from cooperating with firms seeking regulatory approval. As one interview partner commented "...officers seem to have disappeared, and they certainly do not want to be seen in public with corporate representatives out of the fear of being charged on the grounds of bribery."

### *Significant Improvements during the Last Years*

The scandals have led to a number of significant changes in China's regulatory environment. In 2006, the government reduced the autonomy of the SFDA by merging it with the Ministry of Health (Chen et al., 2007). The Ministry, not the SFDA, is now responsible for drafting the rules and regulations and as the Ministry had previously been responsible for regulating hospital affairs, the reforms improve the alignment of the interests of hospitals with those of the biopharmaceutical industry. Shortly after the merger, the Ministry of Health began implementing new levels of reviews and officialdom. One of its first measures aimed at reducing corruption among doctors during clinical trials (Holden, 2008a). In addition, new GMP guidelines were introduced, facilitating the monitoring by increasing the number of enforcement officers and imposing joint liability on Chinese agents of foreign device manufacturers. Finally, an agreement between the Chinese and the U.S. government resulted in the establishment of three U.S. FDA offices in China to streamline international approval projects (Holden, 2009).

### *A Regulatory Challenge: Regulate Fair or Efficient?*

The variety of firms in China's biopharmaceutical industry continues to be a challenge to the monitoring and enforcement duties of the SFDA. Firms differ significantly in their quality of R&D, their inclination towards compliance (or non-compliance) with IP, their willingness to use political power or their strategies towards pricing, marketing and distribution. This heterogeneity poses severe challenges. Strict regulations have to be implemented and enforced to minimize the risk of further scandals. At the same time, innovative projects need to be supported by regulations that allow efficient management of applications and approval processes. By treating all firms equally, the authorities reduce the likelihood of further scandals, yet at the same time obstruct the innovative potentials of Chinese DBFs.

The frequent and unpredictable changes in China's regulatory framework pose significant uncertainties for biopharmaceutical firms. The introduction of stricter regulations has already reduced the number of traditional Chinese biopharmaceutical firms. With growing competition, brought about by the release of more innovative products, and a stronger focus of government policies upon Chinese DBFs, the survival of those still operating in China remains threatened. Young innovative Chinese biopharmaceuticals, despite their globally competitive products, face severe reputation problems outside China, most notably in key markets in North America, Japan and Western Europe. In addition, as the SFDA has no mechanisms to distinguish between corrupt and innovative activities in nearly any phase of the development cycle, innovative firms are being lumped together with all other firms and thereby suffer from 'regulatory discrimination'.

### *The Intellectual Property Right System in China*

The Intellectual Property Right (IPR) system in China was first introduced in 1984 and amended in 1992 and 2000. The latest revision came into effect in 2009 containing important amendments such as the mandatory 'China-first' requirement, the mandatory disclosure of genetic sources when filing inventions, and the law forbidding the use,

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production and import of patented drugs (Lam & Liu, 2009). In addition, the government implemented new regulations concerning counterfeit drugs, permitting prosecutors to level criminal charges against drug producers. However the wording of the amendment remains vague. For instance, prosecution is allowed when counterfeit products ‘cause substantial harm to human health’, a position that is far from easily established (Holden, 2008b).

In the opinion of Western Media, the protection of IPR in China remains of concern (Economist, 2010). However, IPR disputes in the biopharmaceutical industry in general are fairly common (Slutsker, 1991) and hardly only happen in developing countries. The first agreement in biotechnology for instance, signed in 1982 between Genentech and Eli Lilly, resulted in a decade long legal dispute over the IP rights to a human growth hormone.

IP protection in fact represents a greater or lesser threat to different sectors of the industry, affecting each depending on the knowledge underlying its products. For biopharmaceutical R&D at an early stage, patents primarily serve to secure rights on future earnings and attract investments. Projects at this stage are complex and dependent upon tacit knowledge, so that even copying results is usually not sufficient to misappropriate technologies. Concerns about China’s IPR system are mainly raised by foreign multinationals and larger domestic pharmaceuticals, especially when generating substantial revenues in China or when expecting to do so in the near future. More problematic however are illegal counterfeits of commercialized drugs. Infringements of IP lead to uncertainty amongst customers, both inside and outside of China, damage the reputation of individual products and of Chinese products in general.

R&D activities in China, however, do not seem affected by IP enforcement problems. The new generation of Chinese DBFs seems to have imported global patenting norms, a trend interpreted as an important step for China to develop a fully functioning IPR system (Teh, 2007). Consequently, hardly any of the interview partners of younger biopharmaceutical firms were overly concerned with IP issues. Traditional domestic and DBFs founded by domestic researchers usually do not patent their technologies, and some industry experts raised concerns that this naïve patenting behaviour might pose a serious risk to the domestic industry in the future. Foreign firms and those found by Hui Gui’s tend to favour international patents. Although confidence in China’s IPR exists, many firms invest the time, effort and significantly higher costs to obtain patents in the U.S. or EU because government grants and investors evaluate the innovativeness of firms according to their international patent portfolios. In sum, as one interview partner in Shanghai commented, “IP is of concern in China, but would be a concern elsewhere in the world”.

#### 4.2.3. HR in China’s Biopharmaceutical Industry

Success and failure in the biopharmaceutical industry is closely linked to the professional qualification of employees. In the early years of China’s emerging biopharmaceutical industry cheap labour was one of the main reasons for foreign firms to relocate to China (Wang et al., 2005). Nowadays, foreign firms are relocating more R&D activities to China; a trend is partly accounted for by improvements in China’s human resources.



China's government has greatly increased the admission numbers for students in higher education. Some articles on the state of China's universities are both bewildered by and admiring of the opportunities that have come along with such rapid change (Langer, 2007b). Others, while acknowledging the government's efforts, are more cautious in their judgment. The capacity extensions at universities significantly increases demand for new faculty members. Young faculty however lacks research and teaching experience, negatively affecting the quality of education (Xin & Normile, 2008). As a result, a large number of less well prepared young scientists arrive in the industry. Another notable trend has been the decrease in employee turnover rates. Until 2007 managers complained about high HR turnover rates, some of which lay above 30% with employment periods of fewer than six months. Recently, this situation has drastically changed. The larger availability of employees has made it more difficult for 'high-turnover' candidates to find new positions. Newcomers on the labour market, especially, recognize the benefits of long-term participation in research projects.

The increase in the universities' capacities was initially welcomed by firms in the biopharmaceutical industry. However, its main transitory effect is the deterioration of the quality of education. The significant decrease in employee turnover rates encourages firms to invest more in training, since employees are more likely to remain with the organization, this training ultimately benefit the firms.

#### 4.2.4. An Emerging Financial Infrastructure

The lack of financial resources is a chronic complaint within the biotechnology industry. The relatively long duration of research cycles, the above average degree of uncertainty, and the strict regulatory constraints, have made biopharmaceuticals, overall, an economically unviable industry (Pisano, 2006). In developed countries, government funding, public and private investors, Venture Capitalists (VC), and larger companies finance R&D. In China, most of these financial sources either do not exist or are emerging. Chinese firms, for instance, have only limited access to start-up capital provided by banks (Hu, 2004). China's stock exchanges in Shanghai or Shenzhen contain high hurdles intended to protect investors, yet also discouraging firms from going public. Some of the larger Chinese biopharmaceuticals have instead been listed abroad on stock exchanges such as the NASDAQ or the Canadian Stock Market in Toronto. In addition, restrictions on exporting capital make long term investments less attractive for foreign investors (Frew et al., 2008). Consequently, the main financial source for most domestic biopharmaceutical companies remains the central and in some cases provincial governments.

Many smaller companies – especially those found by Returnees – seek investment from informal networks among family and friends. These investments are by no means minor figures. In those cases interviewed ranged between five and \$US 20 million. In addition, the number of foreign VC firms that attended science and research fairs in China has increased significantly. These firms have at least investigated China's biopharmaceutical industry for attractive investment opportunities.



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#### 4.2.5. Industry Associations in China

Industry associations take a mediating function between groups of firms of a certain industry and local and national governments. They offer a platform for firms to voice concerns and express criticism. At the same time, by requiring members to reach consensus over relevant issues, they allow governments to conceive a conjoined perspective on current issues within a sector (Greenwood, Suddaby, & Hinings, 2002). In China, industry associations due to their history in a socialist economy do not perform this function. Instead, they serve as a top-down information channel for the government.

The survey results reflect this situation, yet show a more nuanced picture of the regulatory environment. Half of the participants disagreed with the statement that industry associations hold substantial practical knowledge, while 34.8% only slightly agreed, and none of our partners strongly agreed. At the same time, 81.4% complained about the high amount of policies that they had to comply with, and 55.1% argued that policies change frequently. More than two thirds (70.2%) did not believe they were in any way able to participate in the design of policies or regulations. Yet, on the other hand, interviews in Beijing and Shanghai revealed the formation of informal networks of DBFs functioning as quasi-industry associations. These are consulted by central and provincial governments when designing new policy instruments and are thereby taking over the function of industry associations.

#### 4.3. Conclusion

Firms in China's biopharmaceutical industry face the same technological and organizational challenges as biopharmaceutical firms elsewhere. They need to find mechanisms to manage the long, costly, and profoundly uncertain R&D cycles, as well as developing procedures that allow cumulative learning to benefit from the variety of available technologies. One widely acknowledged strategy to integrate various technological approaches is that of engaging in inter-firm relations with different organizations. The Chinese business environment aggravates these challenges through a rapidly changing institutional architecture and a variety of organizations operating in different manners. China's regulatory regimes, particularly in respect to licensing, clinical trials, commercialization and IPR protection have undergone significant changes. These changes, especially the recent developments around the regulatory body responsible for drug approvals in all stages (the SFDA), significantly challenge biopharmaceutical businesses. The lack of adequate human resources can be accounted for by the unbalanced changes in China's education system. This issue, in combination with the demand for highly skilled employees significantly challenges firms. The government pressures the industry as a whole to develop innovative drugs, economically motivated to develop a viable knowledge sector and politically forced to develop the competences to deal domestically with a deteriorating public health profile. As a result, China's biopharmaceutical industry is expecting to begin commercializing a large number of new drugs within the coming years. The success of this objective is inhibited by incapacities in regards to logistics and marketing and the bad reputation of Chinese biopharmaceuticals in key markets abroad. The lack of effective representation and subsequent communication between policy makers and organizations in China adds to these challenges.

The absence of appropriate managerial techniques, the diverse range of firms operating in China, and the subsequent diversity in inter-firm relations make the biopharmaceutical industry in China a unique setting for studying management innovation on an inter-firm level. The hope in China's biopharmaceutical industry to become the largest consumer market in the world by 2050 significantly depends on the development of effective organizational structures and managerial techniques. How and when management innovation takes place in China thus is not alone of theoretical concern but for policy makers and managers of significant empirical relevance as well.



## 5. Empirical Study in China's Biopharmaceutical Industry

Between 2007 and 2008, I contacted Chinese firms in the biopharmaceutical industry to explore how they interact with other firms and how these interactions lead to management innovations. I used four independent contacts to identify and approach Chinese biopharmaceutical firms. These initial contacts were two managers of technology parks focusing on biotechnology in Shanghai and Beijing, a former CEO of a large European multinational pharmaceutical firm who had been working in China's biotechnology industry for over 15 years, and a former classmate at the China Europe International Business School (CEIBS) who helped me identify other alumni working in the industry. All four contacts were instrumental in getting access to interview partners and gaining their trust. Having identified local firms, I continued with a snowball sampling technique to locate additional interview partners. In snowball sampling, interview respondents are asked after the interview to recommend at least one other company for interviews.

### 5.1. Data Collection and Measurements

I used a mix of collection techniques to gather information. A one page summary of the research project was sent to potential interview partners beforehand.<sup>13</sup> Upon a positive response, I conducted protocol guided interviews with senior and middle managers of Chinese biopharmaceutical companies.<sup>14</sup> Interviews were conducted in English or with the help of Chinese translators. The interviews were facilitated by the fact that most of the interview partners were well educated and regularly communicated in English for professional reasons. The interview protocols contained both open and closed questions. In addition, I used a closed questionnaire which respondents filled out after the interview and usually returned via mail.<sup>15</sup> The questionnaire was available in both languages. To guarantee accuracy in the Chinese documents, the English questions went through a process of back and forth translation by three professional and independent translators. The interview protocol and the questionnaire were used to collect background data on the interviewed firm, one of their cooperation partners and information on the relational, structural and environmental conditions under which the partnership operated.

#### 5.1.1. Interview Partners

In total, I conducted 64 interviews, of which eight were eliminated because respondents were either unwilling or unable to disclose enough information. Three of the interview partners did not return the questionnaire, so that important data for the analysis was missing. Others claimed not to have any ties to other organizations, provided highly implausible information, or statements which were later falsified by their colleagues. For the analysis, I only considered inter-firm relations when one of the partner firms could be identified as a Chinese biopharmaceutical firm, i.e. a firm registered and operating within

<sup>13</sup> The project description is available in Appendix A (English) and B (Chinese).

<sup>14</sup> The protocol used during the interviews is available from the author upon request.

<sup>15</sup> I will occasionally refer to the closed questionnaire as survey. The document is available from the author upon request.

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China, owned or managed by Chinese and engaged in the development or commercialization of pharmaceutical products based on biotechnology. I only interviewed one partner of each inter-firm relation. Although there are disadvantages associated with the use of single informants, I opted for this strategy in order to be able to interview a large number of organizations whilst remaining within the constraints of both time and budget. Despite its disadvantages, there are certain advantages of using single informants, such as reducing the "... variation in informational and motivational biases across organizations ..." (Doty et al., 1993: 1210).

On average the interviews took one hour and twenty-six minutes and were mainly conducted on the company premises (in 85% of the interviews). I interviewed senior managers (81% of the interviewees) and middle managers with firsthand knowledge on the partnerships of their company. In most cases, my interview partners were the founder or a founding member of the company.

For instance, a typical interview partner was Dr. Yu, who received his PhD from Harvard Medical School, where he continued to work for a few years after his graduation. In 2003, he and three Chinese scientists, who were studying and employed overseas established a company in Shanghai's Zhangjiang High Tech Development Park. All founding members had lived abroad for many years, were educated in the U.S., some continued working abroad. Another, rather remarkable, interview partner was Dr. You who was born in the 1950s into a middle class family. During the Cultural Revolution his parents were accused as counterrevolutionaries so that Dr. You was prohibited from attending school. At the age of 15 he joined the Communist Youth Movement, working on an oilfield in the Northern Province of Heilongjiang. There, he prepared for the university entry exam and after the Cultural Revolution, when the education system was re-opened, he was admitted to medical studies. After his studies Dr. You was teaching at various universities in China. In the meantime a Canadian university accepted his application for enrolment in a PhD program in biochemistry. After graduation, he held various positions at biopharmaceutical companies in the U.S. and managed the biometric R&D department of a large American based telecommunications corporation. In 2003, attending an event of the Overseas Chinese Club, he was approached by a government official offering him a substantial amount of money to open a company in China. One year later, Dr. Yue returned to China and opened a firm developing devices for molecular diagnostics. A third partner, Mr. Xu, provides a contrast with the previous two interview partners, as he never left China. He finished a bachelor degree in biochemistry at Beijing's Tsinghua University and worked for foreign pharmaceuticals, such as Astra Zeneca and Novartis in China. He also received an MBA from a U.S. university, through distance education. In 2004, Mr. Xu and two other friends, both of whom were scientists, founded a biopharmaceutical company developing cancer detection and diagnostics technologies in Beijing.

As in the case of the three examples, most interview partners were predominantly Chinese (85%) with international experience (60.4%), holding a PhD degree in medicine (43.6%), chemistry (23.6%), or biology (14.5%). Only three (5%) respondents indicated that they were a member of the Chinese Communist Party (CCP); about 91% stated that they were not a member of the CCP, 4% of respondents did not say whether or not they

were members of the CCP. Hence, the particular political background of China does not play an apparent role in this industry.

### 5.1.2. Interviewed Firms

The firms they established or worked for were mainly registered in Beijing (25.0%) and Shanghai (56.7%) and rather young, on average 7.5 years old. They were predominantly private firms (68.3%), some being collectively owned (18.3%), and a few firms were state-owned (10.0%). Most were biopharmaceutical firms (68.3%), some biotechnology service firms (13.3%), and pharmaceutical firms (10.0%). As has been mentioned in the previous chapter, the organizational population in the Chinese biopharmaceutical industry is rather diverse, differing in size, origin, or ownership form. While it is therefore difficult to describe typical cases, the following three examples provide some insights into the diversity.

WolwoPharma was founded in 2002 by two Chinese scientists who studied and worked in Boston for nearly a decade. In 2000, they decided to return to China and established WolwoPharma, located in Coahejing Hi-Tech Park, one of the older and smaller technology parks in Shanghai. At the time of the interview, the company employed around 300 employees, developing and producing allergy tests and vaccinations. Whereas many firms focus on a selection of product development phases, Wolwo covers the entire product cycle from basic research to commercialization. Its main market remains in mainland China, but from 2008 onwards the company began exporting products to countries in South-East Asia, the Middle-East, and South America. In contrast to WolwoPharma, OrienGene is typical of smaller and more research oriented Chinese biopharmaceutical firms. The company was founded in 2005 and is located in Beijing's Zhongguancun Biotech Park. OrienGene's founder, a Chinese scientist who received his PhD in Sweden, had already gained experience managing his own biotech company in England, which he sold in 2004. Returning to China, he opened his second company for the development of therapeutic products. At the time of the interview, the firm employed 15 scientists and was struggling to develop a strong position both within Beijing's high-tech community and within China's market for therapeutics. Lastly, Wison Biopharma is a division of the Wison Group, a typical Chinese business group with operations in engineering, chemical machinery, telecoms, and real estate. Wison's founder had already ventured into drug development during the 1990s, then strongly focusing on Traditional Chinese Medicine (TCM). Although this venture failed, his interest in medicinal drug design remained. Wison's biopharma division was established in 2004 with investments of US\$49 million from its larger business group. It is located in Zhangjiang Hi-tech Park in Shanghai, China's largest and most modern technology park and the firm develops and commercializes therapeutics and human vaccines.

### 5.1.3. Inter-firm Relations in the Analysis

Although most of the interviewed firms cooperated with more than one organization, I insisted on focusing the interviews on only one of their partnerships in order to collect enough in-depth information. At the beginning of each interview, I asked respondents to think about one ongoing inter-firm relation that they consider important for their firms'

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overall success. The control question in the survey showed that most interview partners considered the discussed partnership as very important (56.7%) or important (30.0%).

The inter-firm relations that were discussed during the interviews existed predominantly between, either two biotechnology firms (19%) or a biotechnology firm and a biotechnology service firm (21%). With few exceptions inter-firm relations were formed in order to pursue scientific projects for drug or diagnostics development, or to commercialize products. AUAM Biotech, for instance, cooperated with a clinical trial hospital in Beijing to test a monoclonal antibody for cancer treatments, which required developing and implementing operating procedures and training modules for trial doctors. In other cases, young biopharmaceutical firms began cooperating to provide an array of research services to third parties. This strategy was commonly pursued in order to remain financially viable and cross-subsidize R&D activities. Inter-firm relations with foreign firms were regularly established to get access to technologies, or to make use of the significantly lower R&D costs in China. On average, the firms on which I am focusing had worked together for two and a half years; only 16 (28%) had a contractually agreed upon time limit upon their cooperation, whereas 41 (72%) did not limit the duration of their cooperation. About half (51%) were either initiated by a Chinese individual who had either studied or worked abroad for more than 5 years, or had hired an employee who had done so. Among the 56 inter-firm relations examined, 51% were purely domestic, i.e. between two Chinese firms; six had a partner outside of China but within Asia (usually in Hong Kong or Japan), and 22 (39%) had a partner outside of Asia, either in the U.S. or in Europe. Most of them met weekly (52%), about a quarter met daily (24%) and a similar number met only monthly (21%). The majority (82%) did not share physical facilities. Others used offices or laboratories jointly. For instance, the partnership between a local biopharmaceutical company and the research division of a large multinational pharmaceutical firm shared office space and production facilities on the same premises. The close proximity involved in this partnership served to facilitate collaboration on research projects.

#### 5.1.4. Identifying Management Innovations

To identify and assess management innovations developed by inter-firm relations, I asked respondents towards the end of each interview to describe how the relation with their partner allowed them to cope with existing challenges or to seize opportunities. This last part of the interview was open, and was used as a first step towards identifying management innovation. This section took approximately one third of the interview's duration. During this time, respondents described how they tried to deal with difficulties arising from China's regulatory environment, financial pressures, R&D challenges or problems with employees. Furthermore, interview partners regularly illustrated new organizational structures and business models that had been implemented in order to take advantage of emerging market opportunities within China. I focused these interviews on management instruments that had been recently developed and introduced *after* the formation of the partnership and that would not have been possible without the participation of both inter-acting firms. To gain further understanding of the underlying motivations, logic and objectives I used non-directive questions and, after each interview, cross-checked observations with assistants.

Some of the inter-firm relations between Chinese and foreign biopharmaceuticals, for example, introduced HR development schemes which included video conference training for employees, presentations by foreign scientist, and exchange programs which allowed employees to visit research facilities in Europe or the U.S. These cases of management innovation were used to facilitate joint research between the cooperating firms, or to decrease HR turnover by providing employees with attractive workplaces. In other cases, firms in cooperation with consulting companies or VCs established ties with inefficient pharmaceutical companies, essentially integrating downstream activities in preparation for the market approval of their products. This new organizational structure required the implementation of various practices to connect and integrate these activities. In another case, triggered by the cooperation with a foreign institute, a firm implemented a management structure to address requests from domestic and foreign customers separately.

### 5.1.5. Three Dimensional Assessment of Management Innovations

Any empirical analysis of management innovation essentially rests on determining the degree of newness of a given practice, process, or structure. As has been shown in the literature review, there are a variety of approaches to determine the 'newness' of an innovation. Aside from disagreement regarding the appropriate unit of adoption, i.e. to whom, what, or where something has to be new, there are substantial cognitive aspects related to determining newness. Most importantly, single response and social desirability biases have to be reduced (Dewar et al., 1986; Kelley, 1976). To assess the newness of identified management innovations, I used 35 additional open-end interviews with industry experts, consultants, politicians, IP lawyers, university professors and managers of technology parks. I conducted these interviews whilst conducting my field research.

During the expert interviews, I discussed management innovations that we had previously identified. Experts regularly made statements in reference to either an industrial context, i.e. biopharmaceutical, or to a national context, i.e. Chinese, in order to assess the newness of particular innovations. A common argument ran as follows: "This is fairly common in China but I have not seen this among biopharmaceutical firms". For instance, investment practices by diversified business groups were not new to China but were newly introduced to the biopharmaceutical industry. It was also argued that "This is standard practice in the U.S., but it's the first time I hear about it in China". For instance, establishing an external scientific board was considered common in the industry but had not been used before within China. In addition, reference was made to a practice being applied in one region of China but being new to another region. These regions usually referred to China's larger biopharmaceutical clusters in and around Beijing, Shanghai and Guangzhou. Thus, instead of using a single dimension, experts in the industry used three contextual dimensions to assess the newness of management innovation. These dimensions were not mutually exclusive. Management innovations could be new to the biopharmaceutical industry or new to China. They could, however, also be new to both contexts. To reflect this contextual diversity in assessing the newness of managerial innovations, I developed a three dimensional coding scheme. In this scheme the newness of a management innovation was determined by considering its newness in the biopharmaceutical industry (industrial context), its newness in China (national context), or



its newness in one of China’s main biotechnological regions, namely Beijing, Shanghai, or Guangzhou.

Using these criteria, I presented experts with cases of management innovations and asked them to specify whether a given case was new to any of the three contexts. This process of coding management innovations was inductive, with parallel running processes of coding and recoding throughout the year. Additional interviews provided further information that corroborated or falsified previous assessments. To measure the newness of management innovations in China’s biopharmaceutical industry, I implied a ranking order between the three dimensions based on the difficulty of introduction. In particular, I considered introducing a new management idea to China easier than introducing a new management idea to the industry. The high degree of specialization of the industry and the large number of highly qualified returning Chinese scientists (Frew et al., 2008; Xu, 2009) seemed to facilitate the transfer of management innovations to China. I consequently prioritize the industry dimension over the country dimension.

In sum, this multi-dimensional assessment of the newness of management innovation (Gupta, Tesluk, & Taylor, 2007) is empirically grounded by the fact that it considers the assessment of industry experts; it avoids pro-innovation biases by relying on independent judgments and it is strongly context dependent due to the fact that it allows a separate assessment of management innovations as being newly introduced to the biopharmaceutical industry or newly introduced to China. The following Venn diagram in Figure 5.1 illustrates the assessment of the newness of management innovations.

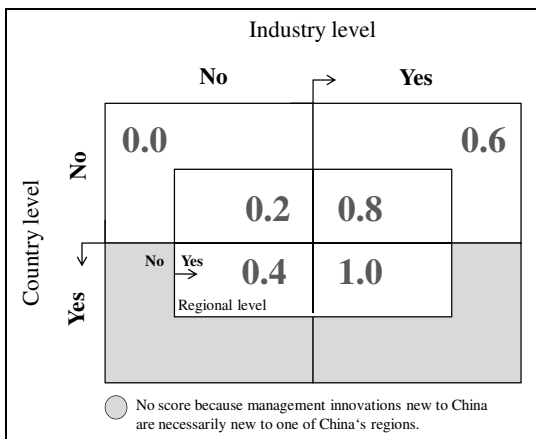


Figure 5.1: Calibration for Assigning Newness of Management Innovation

Management innovations that are new to both the biopharmaceutical industry in general and new to China received the overall newness score of 1. Those that are neither new to the industry, nor to China or to one of the Chinese regions receive the score 0. The implied ranking allows the assignment of gradual newness scores to each management innovation on a scale from 0 to 1.

In total, I identified 72 management innovations. Within this set, 16 (22.2%) were coded as new to both the biopharmaceutical industry and to China. For instance, reversed outsourcing of R&D activities from China to the U.S., was considered new to the industry and new to China. Most management innovations were considered only new to the industry (26.4%, n=19) or new to China (33.3%, n = 24). The upstream integration of manufacturing capacities made available by acquiring inefficient state-owned pharmaceuticals for instance was considered new to the biopharmaceutical industry, yet was not necessarily new to China. Merely seven were new to only one of China's regions (6.9%, n = 5), such as the implementation of standardized HR development systems. Table 5.1 provides descriptive statistics for the three dimensional construct of newness. As should be expected, industry and country dimensions are negatively correlated, indicating that it is most difficult to develop and introduce management instruments that are new to both China and to the industry. The significantly positive correlation between the country and the regional dimension is explained by the natural subset relation between the two dimensions.

Table 5.1: Descriptive Statistics and Cross Correlation for Newness Dimensions

		Mean	SD	1	2
1	Industry	.569	.498		
2	Country	.555	.500	-.383*	
3	Cluster	.708	.457	-.435*	.717*

Note: \* Correlation significant at the 0.01 level (2-tailed).

## 5.2. Calibrating Managerially Innovative Inter-firm Relations

Based on set-theory, QCA entails the definition of gradual membership scores from full *non* membership [0.0] to full membership [1.0]. To calibrate the set of managerially innovative inter-firm relations, I assigned membership scores in the set of managerially innovative inter-firm relations according to four guidelines:<sup>16</sup>

- (1) Inter-firm relations with more than two management innovations, or partnerships with two management innovations of which one is new to China and the industry receive the full membership score [1.00] in the set of managerially innovative partnerships.

<sup>16</sup> Some inter-firm relations developed more management innovations than others. Computing simple weighted averages among all partnerships, however, would disproportionately penalize a partnership with a single highly innovative management tool in comparison to one with two management innovations, one highly innovative one and one 'incrementally' innovative.

- (2) Inter-firm relations with two management innovations received the full newness score of their most innovative managerial tool and an additional 10% of the second management innovation. For instance, the partnerships between a research hospital and a Dutch biotechnology firm led to the introduction of an Ethical Oversight Committee. This was considered new to China but not new to the biotechnology industry [0.4]. In addition, they introduced standards for dispensing trial medicine, again considered new to China but not new to the industry [0.4]. The overall membership score of this particular inter-firm relation is  $0.4 + 0.4 * 10\% = [0.44]$ .
- (3) Inter-firm relations with only one management innovation, have had the newness score of their management innovation reduced by 10%. For instance, two firms established a legal office to manage their IP. An organizational structure considered new to China but not new to the biopharmaceutical industry [0.4]. Its membership score in the set of managerially innovative inter-firm relations is  $0.4 - 0.4 * 10\% = [0.36]$ .
- (4) Inter-firm relations with no management innovation received full non-membership [0.0].

The following Figure 5.2 provides the distribution of membership scores of managerially innovative inter-firm relationships. The calibration method allows clearly distinguishing between high innovating inter-firm relationships and poorly innovative partnerships.

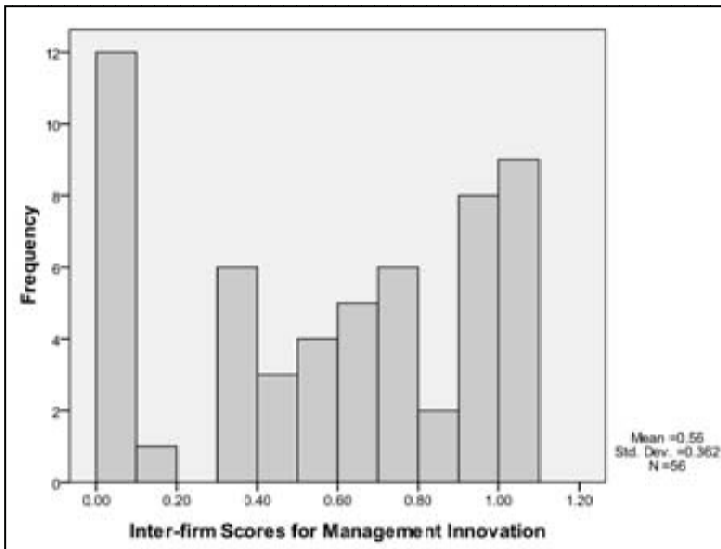


Figure 5.2: Distribution in the Set of Managerially Innovative Inter-Firm Relations

### 5.3. Calibrating Sets of Facilitating Conditions

To measure the membership scores of each inter-firm relation in the six sets of facilitating conditions, I used interview and questionnaire items that are common in studies on management innovation (Damanpour, 1991; Mol et al., 2009). Due to the nature of the

empirical data in a high-tech industry I was not able to develop a scale for specialization. Most studies operationalize specialization as the percentage of professionals in the workforce, or as the range of professions present in an organization (Damanpour, 1996). I collected some of the information but nearly all employees engaged in the partnerships were professionals and it was not possible to meaningfully separate their educational background. Consequently, I could not include specialization as a facilitating condition in the configurational analysis. The following paragraphs list the items and explain the logics underlying the calibration technique for the remaining six facilitating conditions. The numbers in squared brackets indicate the assigned membership scores.

### 5.3.1. The Set of Mutually Dependent Inter-firm Relations

Membership in the set of mutually dependent inter-firm relations is calibrated using five questionnaire items that measure the level of trust existing between the two firms. Scores of all five items were weighted equally and normalized to represent membership in the set of mutually dependent inter-firm partnerships.

*Table 5.2: Items in the Set of Mutually Dependent Inter-firm Relations*

Item no.	Question	Answer option	Membership score
1	How did you identify your partnering firm?	Prior social ties	[1.0]
		Third party referral	[0.7]
		Impersonal circumstances	[0.0]
2	Did any of you make significant investments for the partnership?	Yes	[1.0]
		No	[0.0]
3	Did the other party match that investment?	Yes	[1.0]
		No	[0.0]
4	Age of inter-firm relation (in years): <i>Membership scores assigned by percentiles</i>	5 - 8 (12%)	[1.0]
		3 - 4 (35%)	[0.6]
		2 (28%)	[0.3]
		0 - 1 (25%)	[0.0]
5	How frequently do you meet?	Daily (24%)	[1.0]
		Weekly (52%)	[0.6]
		Monthly (21%)	[0.3]
		Less frequently (3%)	[0.0]

### 5.3.2. The Set of Heterogeneous Inter-firm Relations

Membership in the set of heterogeneous inter-firm relations indicates the degree to which partnering firms differ in operations, organizational forms, and geographical or cultural origins. I used the following five items to define the set of heterogeneous inter-firm relations. All items were weighted equally to represent membership scores ranging from full non membership [0.0] to full membership [1.0].

Table 5.3: Items in the Set of Heterogeneous Inter-firm Relations

Item No.	Question	Answer option	Membership score
1	Categorical distance on value chain <sup>17</sup>	Other <sup>18</sup>	[1.0]
		Pharmaceutical firms	[0.8]
		Biotechnology Service	[0.6]
		Research Hospital	[0.4]
		Univ. labs, Research Inst. Biotechnology firm	[0.2] [0.0]
2	Age difference between firms (in years)	> 40	[1.0]
		9-15	[0.6]
		4-8	[0.3]
		0-3	[0.0]
3	Difference in ownership form	Private & SOE	[1.0]
		Private & Coll./ Coll. & SOE	[0.7]
		Same ownership	[0.0]
4	Place of registration	Intercontinental	[1.0]
		Continental (Japan/ Korea)	[0.7]
		Domestic, incl. HK & Taiwan	[0.0]
5	Presence of Returnees	Yes	[1.0]
		No	[0.0]

The presence of a Returnee did not make it more or less likely that firms would establish partnerships with foreign companies, so the two items independently accounted for geographical and cultural heterogeneity. Scales were equally weighted and normalized to range from no membership [0.0] to full membership in the set of heterogeneous partnerships [1.0].

### 5.3.3. The Set of Decentralized Inter-firm Relations

To measure membership in the set of decentralized partnerships, I used three questionnaire items. These were equally weighted and transformed linearly to indicate membership in the set of decentralized partnerships ranging from no membership [0.0] to full membership [1.0].

Table 5.4: Items in the Set of Decentralized Inter-firm Relations

Item No.	Question	Answer option	Membership score
1	Describe the style of decision making in the partnership	Consensual	[1.0]
		Neither consensual nor hierarchical	[0.5]
		Hierarchical	[0.0]
2	Employees are included in the decision-making process	Seven point Likert scale <sup>19</sup>	[1.0]
			[0.0]
3	Leadership groups take most of the decisions within the partnership	Seven point Likert scale	[1.0]
			[0.0]

<sup>17</sup> I have used a standard value chain of the biopharmaceutical industry (Ernst & Young 2006; Pisano 2006).

<sup>18</sup> Others include: Industry associations, technology parks, VCs and public authorities.

<sup>19</sup> Throughout the closed questionnaire I used a seven point Likert scale measuring the agreement of respondents with statements from [0] disagree to [1] agree.

### 5.3.4. The Set of Formalized Inter-firm Relations

Membership in the set of formalized inter-firm relations is measured by four binary items from the questionnaire. I have weighted all items equally and transformed the values to a scale ranging from 0 to 1. Inter-firm relations that had installed all four elements received the full membership score [1.0] in the set of formalized partnerships; those with three out of four formalization elements were counted as nearly full members [0.9], those with only two out of four alternatives received the membership score of [0.6], and those with only one element were counted as not quite being members in the set [0.3]. All others received a membership score of [0.0].

*Table 5.5: Items in the Set of Formalized Inter-firm Relations*

Item No.	Question	Answer option	Membership score
1	Existence of a contractual agreement	Yes	[1.0]
		No	[0.0]
2	Presence of a system of rules and regulations governing the activities of the inter-firm relation	Yes	[1.0]
		No	[0.0]
3	Presence of formalized training programs	Yes	[1.0]
		No	[0.0]
4	Clear division of labor between the partnering firms	Yes	[1.0]
		No	[0.0]

### 5.3.5. The Set of Vertically Differentiated Inter-firm Relations

To measure the degree of vertical differentiation within inter-firm relations, I used four items in the questionnaire. Theories on administrative innovation find that administrative leaders have a stronger impact on management than scientific leaders (Chompalov et al., 2002). Therefore, I have ranked administrative leadership positions higher than scientific leadership positions. I have weighted the two items on the hierarchical structure and the form of decision-making processes equally. Given administrative and scientific leadership positions and hierarchical structures and decision-making processes, partnerships receive the membership score of [1.0] in the set of vertically differentiated inter-firm relations.

*Table 5.6: Items in the Set of Decentralized Inter-firm Relations*

Item no.	Question	Answer option	Membership score
1	Are there designated administrative leadership positions within the partnership?	Yes	[1.0]
		No	[0.0]
2	Are there designated scientific leadership positions within the partnership?	Yes	[1.0]
		No	[0.0]
3	Compared to a university department, how hierarchical is your partnership organized?	Less hierarchical	[1.0]
		Equally hierarchical	[0.5]
		More hierarchical	[0.0]
4	To what extent are decision-making processes within your inter-firm relationship organized hierarchically?	Seven point Likert scale	[1.0] [0.0]

### 5.3.6. The Set of Inter-firm Relations Experiencing Environmental Uncertainties

Membership in the set of partnerships experiencing environmental uncertainties is composed of three subscales measuring the degree of market uncertainty, technological uncertainty and regulatory uncertainty. The subscales for market, technological and regulatory uncertainty have been weighted equally and normalized to represent membership in the set of partnerships experiencing environmental uncertainties ranging from no membership [0.0] to full membership [1.0].

Table 5.7: Items in the Set of Inter-firm Relations with Environmental Uncertainty

Item No.	Question	Answer option	Membership score
<i>Market uncertainty</i>			
1	Is the number of competitors	Increasing	[1.0]
		Stable	[0.5]
		Decreasing	[0.0]
2	Is the strength of competitors	Increasing	[1.0]
		Stable	[0.5]
		Decreasing	[0.0]
<i>Technological uncertainty</i>			
3	How easy is it for competitors to copy your products?	Easy	[1.0]
		Neither easy nor difficult	[0.5]
		Difficult	[0.0]
4	Preferences of customers change frequently.	Seven point Likert scale	[1.0] [0.0]
5	'It is crucial for our collaboration to match these changes.	Seven point Likert scale	[1.0] [0.0]
6	'Technology changes rapidly in our field.'	Seven point Likert scale	[1.0] [0.0]
7	'It is important for our partnership to match these changes'	Seven point Likert scale	[1.0] [0.0]
<i>Regulatory uncertainty</i>			
8	'In the biopharmaceutical industry our field of research is relatively labour intensive'	Seven point Likert scale	[1.0] [0.0]
9	'In the biopharmaceutical industry our field of research is relatively capital intensive'	Seven point Likert scale	[1.0] [0.0]
10	'There is a high amount of regulations and policies we need to comply with'	Seven point Likert scale	[1.0] [0.0]
11	'Regulatory requirements affecting our partnership are straightforward'	Seven point Likert scale	[1.0] [0.0]
12	'Policies and regulations affecting our partnership change frequently'	Seven point Likert scale	[1.0] [0.0]
13	'The legal mechanisms already in place sufficiently safeguard the interests of both our collaboration partners'	Seven point Likert scale	[1.0] [0.0]
14	'We are able to participate in the development and changes of national and provincial policies'	Seven point Likert scale	[1.0] [0.0]

#### 5.4. Data Analysis

In the following section I will proceed step-by-step through the analysis, explaining first the function and computation of a truth table, continuing with the minimization procedures, and, finally, summarizing the results in a configuration chart (Ragin et al., 2008). In some instances I repeat technical steps that have already been described in the introduction to QCA to facilitate the reading of the procedure. Throughout the analysis I used fsQCA freeware available online (Ragin, Drass, & Savey, 2006)

The first step in fsQCA is to compute a truth table. A truth table exhibits all logically possible combinations of present and absent conditions (configurations). The number of rows in a truth table is calculated as  $2^k$  (with  $k$  denoting the number of conditions taken into account). For the model of management innovation, with six facilitating conditions ( $2^6$ ) the number of logically possible configurations is 64. *Hypothesis 1* to *Hypothesis 6* thus constitute the conceptual and methodological framework for the analysis. Each facilitating condition constitutes one dimension in a six dimensional property space (Rihoux et al., 2009).

For each configuration, the truth table indicates the number of cases in which management innovation is observed or the number of cases in which management innovation is not observed. In addition, it specifies logical remainders. Logical remainders are those configurations that logically exist, but for which no empirical observation is made. *Appendix C* provides the truth table for inter-firm configurations of management innovation in China's biopharmaceutical industry. There are 27 different inter-firm configurations in which new managerial tools have been developed and introduced. With 64 logically possible configurations, there are 37 logical remainders.

The truth table is then minimized in order to determine which configurations are considered in the analysis. For this purpose, one determines the consistency and the coverage threshold. The consistency threshold indicates the degree to which cases confirm the configurations expressed. I use a consistency threshold of 0.785 which is above the usually recommended minimum (Fiss, 2010; Ragin, 2006; Ragin, 2008b). Further, the coverage threshold determines the minimum number of cases that a configuration needs to exhibit. I set the solution frequency threshold at one case.

In a second step, fsQCA uses Boolean logic to minimize configurations and formulate simpler statements. I compute two solutions, a parsimonious solution and an intermediate solution. These differ in their inclusion of logical remainders. The parsimonious solution extensively uses logical remainders to minimize statements without any evaluation of their plausibility. It thereby identifies core conditions, i.e. those that have to be part of any representation of the data. The intermediate solution uses logical remainders to reduce statements only if they are consistent with theoretical and substantive assumptions. It serves to identify contributing conditions (Fiss, 2007; Ragin et al., 2008). For the analysis, I only allow minimization if logical remainders conform to the formulated hypotheses: inter-firm relations are mutually dependent and heterogeneous, decentralized and vertically differentiated and they experience environmental pressures. Due to the



inconclusive evidence provided by previous research, I do not restrict the minimization procedure concerning the role of formalization.

In a third step, the results from the parsimonious and intermediate solution are summarized in a configuration chart (Ragin et al., 2008). Core conditions are illustrated using large circles; contributing conditions are displayed in small circles. When the presence of a condition is necessary to explain management innovation, the circle is filled; when its absence is required, the circle is hollow. Empty spaces indicate 'don't cares', i.e. neither the absence nor the presence of a condition is necessary to explain management innovation. Figure 5.3 provides the chart for the inter-firm configurations in China's biopharmaceutical industry. The solution covers 66% of all cases with a consistency of 79.2%.

Inter-firm Configurations of Management Innovation						
	A <sub>1</sub>	A <sub>2</sub>	B <sub>1</sub>	B <sub>2</sub>	C	D
<b>Relational</b>						
Mutual dependence		●			●	
Heterogeneity				●	⊙	●
<b>Structural</b>						
Decentralization	●	●	●			●
Formalization	●		●	●	●	
Vertical differentiation	⊙	⊙	●	●		●
<b>Environment</b>						
Uncertainty	●	●	⊙	⊙	●	
Consistency	77.71%	82.51%	82.28%	80.48%	81.64%	78.67%
Raw coverage	30.46%	35.83%	26.17%	27.76%	44.92%	44.98%
Unique coverage	5.40%	2.98%	9.53%	6.04%	9.88%	7.75%

*Note:* ● = core causal condition present; ⊙ = core causal condition absent; ● = contributing causal condition present; ◐ = contributing causal condition absent (no incidence in this empirical set)

Figure 5.3: Configuration Chart: Inter-firm Relations in Management Innovation

## 5.5. Results

Overall, I identify six different configurations of inter-firm relations that lead to the introduction of new managerial instruments. On the basis of shared core conditions, four equally effective inter-firm configurations can be singled out. These are referred to as first order equifinalities. Within these, and especially within the first two types, contributing conditions illustrate neutral permutations or second order equifinal types that equally contribute to management innovation (Fiss, 2010).

### 5.5.1. Organic Structures as Foundations of Management Innovation

The first inter-firm configuration that leads to management innovation features two core conditions: decentralization and the absence of vertical differentiation. In this configuration, environmental uncertainties contribute to the development and introduction of new management instruments. As Figure 5.3 shows, there are two neutral permutations, these are equally effective contributing conditions that surround the core composition of this configuration. Management innovation is facilitated either by formalization ( $A_1$ ) or by mutual dependence ( $A_2$ ).

The following case illustrates the first neutral permutation featuring formalization as a contributing condition. In 2005, a collectively-owned biotechnology firm based in Shanghai formed a partnership with a privately owned biotechnology firm in San Diego. The firms' managers met at a conference in the U.S. and began loosely cooperating by outsourcing research projects to China. After two years, with the help of its American partner, the Chinese firm opened its main science division in the U.S. to circumvent appropriation risks in China and make use of the scientific community abroad. This 'reverse' outsourcing was both new to China as well as to the industry. The partnership was decentralized, because decision-making power was distributed among the employees of joint research activities. Furthermore, they did not install hierarchical structures, which explains the absence of vertical differentiation. Under financial and regulatory uncertainties the partners formalized their cooperation via the installation of a system of rules and regulations and the signing of a contractual agreement. The combination of these four conditions explains management innovations in the cases specific to this configuration.

The following case illustrates the second neutral permutation that features formalization instead of mutual dependence as a contributing condition. In 2006, four Chinese Returnees founded a biotechnology firm in Shanghai to engage in R&D and trade biopharmaceutical products. They formed a partnership with a pharmaceutical firm from Shanghai, which produced multi-vitamin supplements and dietary products. To increase their international competitiveness, they introduced quality control mechanisms similar to the ones regulating the Chinese food industry. This form of management innovation existed in other Chinese industries, but not in the Chinese biopharmaceutical industry. Additionally, there were concerns regarding IPR, brought about by these firms' main international rival, who was based in Hungary. The firms decided to establish an office in Europe, where all of their IP would be registered. It was argued that this would improve the protection of their core business by facilitating access to law enforcement agencies in Europe. Despite the differences in size and operations between the two firms, their partnership was decentralized. Alongside the absence of vertical differentiation, due to the involvement of upper management only, the decentralization of this partnership explains their capacity for management innovation. Exogenous uncertainties and opportunities contributed to the introduction of these two new management instruments. However, as the partnership was originally formed via prior social ties and both partners had made significant investment, mutual dependence contributed to explaining management innovation.

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The cases above illustrate the two neutral permutations of a configuration characterized by decentralization and the absence of vertical differentiation. A flat hierarchical structure, combined with dispersed decision-making rights, permits the use of external knowledge to develop and implement new management instruments within inter-firm relations. Operating in a relatively turbulent environment contributes to these processes. In addition, formalization reinforces management innovation by providing for safeguards that allow the exchange of knowledge; a mechanisms that can be substituted in this particular configuration by mutual dependence. This organizational system entails features previously associated with organic structures of organizations (Burns et al., 1961; Hage et al., 1970). The findings supports the proposition of the enabling effect of formalization (Adler et al., 1996). Formalization, which previously has been associated with mechanistic structures, in fact contributes in the first neutral permutation of this configuration.

### 5.5.2. Mechanistic Structures fostering Management Innovation

Vertical decentralization and the absence of environmental uncertainty are necessary to explain management innovation in the second inter-firm configuration. Formalization contributes to the introduction of new managerial instruments and two neutral permutations indicate that, in addition, either decentralization ( $B_1$ ) or heterogeneity ( $B_2$ ) facilitates management innovation.

The following case illustrates the role of decentralization as a contributing condition in the first neutral permutation. In 2008, a privately owned biotechnology service firm, specialized in marketing in rural China, formed a partnership with a large biopharmaceutical firm. Originally, the service firm was hired to professionalize the sales network of its partner. After a short period, the consulting project was modified. Instead of training sales representatives, both partners agreed to use the sales network as a trial platform for experimenting with different marketing strategies. The marketing firm was thereby able to offer services to other clients outside the original relationship. In return, its partner managed to significantly improve the efficiency of its sales network. Neither of the firms acted in response to environmental uncertainties. However, to systematically monitor the various experimentation activities, they appointed administrative leaders at different hierarchical levels. Decentralization contributed to management innovation because sales employees in the field were given enough flexibility to make decisions. Furthermore, to circumvent risks involved in using the sales network as a trial platform, their partnership formalized a contract, the rules of which governed their joint activities.

The second neutral permutation features heterogeneity, instead of decentralization, as a contributing condition. This difference is illustrated by the case of a partnership between a large U.S. pharmaceutical and a small, privately owned Chinese biotechnology firm, engaged in the investigating new drugs. In 2000, the partnership was formed with the objective of outsourcing research activities to China in order to take advantage of the significantly lower labour costs. In the course of their partnership, the firms began introducing what the interview partner described as flexible 'plug and play' modules for training personnel in different scientific fields. Both firms were well established in their respective industries and their partnership was not particularly challenged by

environmental uncertainties. Furthermore, by appointing administrative leaders as well as scientific leaders and implementing strict decision-making protocols the partnership was vertically differentiated. The formalization of joint activities, in both contracts and rules and regulations, contributed to the introduction of this new HR training system. Hence, instead of decentralization, the heterogeneity of the firms, a consequence of their diverse international background, contributed by providing the necessary experience to specify the required type of training and to manage larger numbers of scientific staff in this case of management innovation.

Vertical differentiation and the absence of environmental uncertainty are the two core conditions that explain management innovation emerging from partnerships in this configuration. In both neutral permutations formalization contributes to the development of new managerial instruments. In this configuration, management innovation processes rely predominantly on knowledge internal to the partnership. They closely resemble mechanistic structures which, in contrast to previous assumptions, have been assumed to constrain innovation (Burns et al., 1961). As in the previous configuration, a substituting pair can be identified. In mechanistic organizations, a decentralized structure may be replaced by a diverse and heterogeneous background among the cooperating firms.

### 5.5.3. Formalization as Initiator of Management Innovation

The third configuration (C) of inter-firm conditions that explains management innovation in China's biopharmaceutical industry contains three core conditions: mutual dependence, the explicit absence of heterogeneity, i.e. homogeneity, and formalization. Environmental uncertainties contribute to the development of new managerial instruments. The following partnership, for instance, led to the introduction of a number of new managerial instruments. In 2006, a diversified Chinese business group, predominantly engaged in petrochemicals, initiated a partnership with a privately owned Chinese biotechnology firm. With this partnership, the owners of the business group intended to ensure the company's long term survival by diversifying into a modern high-technology industry. Despite the difference in their operations, both firms were entirely Chinese and had no international background. Therefore, the inter-firm relationship was considered to be homogenous. The firms shared physical facilities, in the form of research laboratories and offices, and made significant investments into the partnership. They consequently showed high mutual dependence in their relationship. The financial resources, made available by the business group and formalized in contracts and regulations, allowed their biotechnology partner to introduce a number of new managerial instruments, such as outsourcing HR training to a professional consulting company, establishing an external scientific board with reputable international scientists and, most importantly, systematically scanning the global technology landscape to acquire IP and technologies, especially from North America. The market uncertainty faced by the business group, and the technological pressure exerted on the biotechnology firm, contributed to the introduction of these management innovations.

Mutual dependence within inter-firm relations of this configuration provided the initial condition among homogenous partners to reciprocally access each other's core competencies. The re-combination process of predominantly internal knowledge required

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and was reinforced by formalization. Under the given relational conditions, formalization proves to be the decisive governance mechanism to experiment with, and introduce, new managerial tools. As partnerships in this configuration fall into neither organic nor mechanistic organizational structures, the results provide additional support for the enabling role of formalization in management innovation (Adler et al., 1996; Vlaar, van den Bosch, & Volberda, 2007).

#### 5.5.4. The Network Innovator: Heterogeneous Decentralization

Finally, the last configuration (D) features heterogeneity and decentralization as core conditions. Introducing a vertically differentiated organization for joint activities contributed to partnerships developing new management innovation. The following case serves as an illustration. In 2005, a collectively owned biotechnology firm based in Shanghai and founded by Chinese Overseas formed a partnership with a privately owned VC from Hong Kong. A lack of access to financial resources was the most severe threat to the biotechnology firm. The support of the VC helped to continue the financing of research projects. In addition, the VC partner allowed the biotechnology firm to introduce new elements in its business model. As two of the firms projects went into further clinical trials, both partners decided to prepare for the commercialization of the products. To this end, the VC partners identified an old and economically unsuccessful Chinese pharmaceutical company. Jointly, both partners decided to acquire this company. This strategy of upstream integration is new to the biopharmaceutical industry. Acquired firms usually commercialize generic products but do not dispose of the necessary innovative capabilities to sustain their operations on the long run. The acquirers pursue a number of objectives. First, such acquisitions provide minor, yet immediate, revenues to bridge the period of time in the lead up to the approval of their new products. More importantly, acquirers are able to integrate the production and sales capabilities of the acquired company into their operations. In the case of the partnership described above, heterogeneity in the relationship provided a diverse set of knowledge and experience with which to identify and assess the value of the pharmaceutical firm. Also, being fairly specialized in their respective fields of business, they allowed different employees to participate in the decision-making processes. For evaluating the potential of the acquired firms both administrative and scientific leaders were appointed to contribute to management innovation.

Inter-firm relations of this configuration take advantage of the heterogeneity in knowledge and experience among the participating firms. The presence of top management leadership positions complemented by distributed decision-making rights among members permits accessing resources external to the partnership. Such 'network innovators' make use of heterogeneous resources available in their broader environment to develop and introduce new management instruments.

### 5.6. Discussion of Results

The results of the configurational analysis present themselves as four equally effective combinations of contextual factors that allow partnerships to managerially innovate. The holistic approach indicates that determinants used to analyze single firms aptly apply to inter-firm relations as social action systems (van de Ven, 1976). *Hypothesis 1* to *Hypothesis 7* as presented in *Chapter 3* formulated relational, structural and

environmental determinants of inter-firm relations assumed to facilitate the management innovation processes taking place within these organizational systems. However, the purpose of formulating hypotheses in the context of fsQCA differs from their purpose in statistical methods. Instead of directly testing the proposed associations, I used the first seven hypotheses to define the property space for the analysis.

The results therefore provide only limited insights into the unicausal effect of single determinants on management innovation. They tend to confirm previously hypothesized associations (Damanpour, 1991) yet allow a nuanced assessment of the complexities underlying management innovation. Specialization (*Hypothesis 2*) was not included in the analysis because of the particular empirical background of the study. The data did not allow me to develop a meaningful scale for specialization that would allow distinguishing between cases. Strictly speaking, all other hypotheses are rejected. Not a single determinant was identified that, in and by itself, explains management innovation. The strongest support from this study is for the role of decentralization (*Hypothesis 4*) in facilitating management innovation. In organic, as well as in network innovators, decentralization is a core condition. Furthermore, the results support for hypothesis that formalization facilitates management innovation (*Hypothesis 5a*), and rather unambiguously reject the competing hypothesis (*Hypothesis 5b*). The results support the enabling role of formalization (Adler et al., 1996) and highlight its function within inter-firm relations for providing the necessary condition for partners to deeply interact (Vlaar et al., 2006). In particular, formalization has been identified as the sole governance mechanism in mutually dependent, homogenous partnerships reinforcing management innovation. It also clearly contributes to management innovation processes in mechanistic systems and may contribute in organic systems. The results for heterogeneity (*Hypothesis 3*), vertical differentiation (*Hypothesis 6*), and environmental uncertainty (*Hypothesis 7*) indicate that either their presence or their absence, depending on their configurational context, facilitates management innovation.

Using the hypotheses on single conditions of inter-firm relations as dimensions in a property space, fsQCA allows examining the complex relationships among conditions with management innovation. More specifically the results uncover complementarities as well as substitutions among facilitating conditions. Substitutions can furthermore be distinguished into first order equifinalities, i.e. equally effective combinations of core conditions, and second order equifinalities or neutral permutations, i.e. substitution pairs of contributing conditions within configurations. fsQCA thereby allows substantiating the remaining three hypotheses directed towards the more complex theoretical propositions.

The identification of four configurations of core facilitating conditions indicates first order equifinality, i.e. substitutions of equally effective combinations of contextual conditions. Considering the satisfactory consistency score, this finding clearly supports the equifinality hypothesis (*Hypothesis 8*). Furthermore, the results allow specifying complementarities among core conditions within configurations. First, in case of perceived environmental uncertainty, inter-firm relations innovate when they establish a decentralized and flat, i.e. not vertically differentiated, structure. In contrast, in situations of environmental stability, vertical differentiated and formalized inter-firm relations facilitate the management innovation process. Third, partnerships among mutually

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dependent and homogenous firms develop new management instruments when formalization reinforces their interactions. Finally, the set of inter-firm relations analyzed shows that heterogeneous inter-firm relations managerially innovated when their partnership is decentralized and vertically differentiated. Here, decentralization facilitates access to a diverse set of experience that extends beyond the boundaries of the inter-firm relation and benefits from the network resources available to both partners. The identification of configurations consisting out of two or three core conditions that are conceptually different supports the hypothesis on conjunctural causation in management innovation (*Hypothesis 9*).

Last, the results reveal two substituting pairs; neutral permutations of first order equifinal configurations (Fiss, 2010). First, within organic structures mutual dependence may serve as a substitute for formalization. In light of the theorized function of formalization within inter-firm relations this is particularly interesting as it shows that by establishing high levels of trust which consequently mitigate relational risks partnering firms are pressed to focus attention, articulate, deliberate and reflect, and maintain interaction (Vlaar et al., 2006). The primary use and exchange of external knowledge for the development and implementation of management instruments in organic systems is facilitated by mitigating relational risks either using trust or formalization. Second, within mechanistic structures a decentralized structure substitutes heterogeneity between firms. This in contrast specifies conditions for making use primarily of internal knowledge in the management innovation process (Carpenter & Westphal, 2001). Whereas heterogeneity provides for sufficient diversity in expertise and experience within the partnership, decentralization permits accessing diverse knowledge external to the organization. Partnerships may materialize on the knowledge existing within its structure or alternatively materialize on external knowledge by ‘activating’ the diversity of its network ties. As in the hypothesis on conjunctural causation – given the appropriate consistency level of the overall solution – the results identify substantial asymmetries among relational, structural, and environmental conditions that strongly support the asymmetry hypothesis (*Hypothesis 10*).

The results overall provide systematic evidence for Burns and Stalkers (1961) distinction between archetypical organizational systems ranging from mechanistic to organic structures. By identifying additional intermediate structures, the results are consistent with their contention that “... the two forms [...] represent a polarity, not a dichotomy” (Burns and Stalker, 1961, p. 122). They also support the hypothesis of contingency theories linking organizational structure to environmental uncertainty (Child, 1972; Donaldson, 2001). This finding supports previous theories claiming that in turbulent environments, organizations tend to be rather organically structured in order to swiftly respond to changing circumstances (Child, 1972). Processes of agenda setting, idea linking and idea testing are predominantly directed at developing mechanisms that help firms to hedge the risks of and benefit from the opportunities arising from such changing environments (Birkinshaw et al., 2008). However, the evidence does not support the proposition that organic systems foster whereas mechanistic systems constrain management innovation (Blau et al., 1979; Damanpour, 1996; Miller, 1983). Instead, the results show that mechanistic structures trigger management innovation processes as well.

Finally, the study in China's biopharmaceutical industry shows how a diverse population of firms actively develops and implements new managerial instruments that address gaps or rapid changes in the institutional infrastructure. Inter-firm relations in this industry do not merely imitate available approaches but develop and implement new management practices, processes, and structures. These management innovations, as implicitly suggested by the management innovation literature, represent a source of competitive advantage by improving the overall efficiency of a firm. However, management innovations may also be diffused within the industry. From this perspective they represent prototypical arrangements of future common or best-practices. China hosts a young, vibrant, and viable biopharmaceutical industry that while it faces specific challenges exhibits a tendency to develop managerial instruments that allow coping with these difficulties. Some of these may eventually be adopted from developed industries in the West.





## 6. Implications and Conclusion

In this thesis, I have taken a holistic, configurational perspective on inter-firm relations that facilitate management innovation. The review of theories in management innovation provided in *Chapter 2* identified two broad conceptualizations. Outcome models offer substantial theoretical explanations for the influence of various organizational determinants of management innovation (Damanpour, 1991; Mol et al., 2009). However, theories in this field underemphasize the complex interplay between these factors and limit the analysis to the focal firm as the unit of analysis. Alternatively process models illustrate in detail how the activities *between* firms results in the development and introduction of new management instruments (Birkinshaw et al., 2008). A theoretical alternative is provided in the form of contingency theories of management innovation (Gopalakrishnan et al., 1997). Contingency theories postulate that there are different organizational systems that may be equally effective, suggesting that the efficiency of such systems largely depends on the alignment of structural and environmental factors. By incorporating the notions of equifinality, ‘fit’, and ideal types, contingency theory allows for a greater degree of complexity, while remaining sufficiently systematic to allow empirical validation (Doty et al., 1994; Drazin et al., 1985; Fiss, 2010).

The review of modelling approaches in management innovation literature follows a similar structure. Outcome models predominantly apply regression analysis, thereby simplifying theoretical propositions by treating facilitating conditions as competing explanations. Implicit assumptions of linearity and additivity in statistical methods limit the insights developed by these studies (Ragin, 2008b) and might be one cause for the inconclusive results that are so characteristic in this field (Damanpour, 1991). Process approaches predominantly develop conceptual models and use single or comparative case study methods to explore and develop theories. They are often too complex to allow for a broader validation of their theoretical propositions. Contingency methods provide an intermediate solution by more accurately translating theoretical propositions into models. Contingency research predominantly uses quantitative methods. Their complexity, however, poses high demands on statistical techniques, as well as the quantity and quality of data (Longenecker et al., 1978; Schoonhoven, 1981). Due to these challenges, the system contingency approach has so far not been used to advance the understanding of management innovation.

To address these gaps in management innovation literature, I have proposed, in *Chapter 3*, a configurational approach to management innovation. The thesis most generally asks what configurations of inter-firm relations facilitate management innovation. Acknowledging insights provided by process models, I shift the unit of analysis from single, focal firms, as common in outcome models, to the inter-firm relation. I have then formulated seven hypotheses that specify relational, structural, and environmental conditions of inter-firm relations facilitating management innovation. Further, acknowledging theoretical propositions of contingency and process theories on the complex antecedents of management innovation, I have developed three additional hypotheses. These address expectations of identifying various, equally effective configurations of inter-firm relations facilitating, and of uncovering conjunctural causations, the association of multiple variables with a given outcome, and asymmetric

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relationships among variables (Liebersohn, 1987). I have then introduced fuzzy set Qualitative Comparative Analysis (fsQCA). Based on set-theory, fsQCA holistically compares the complexity of entire cases and thereby fundamentally differs from conventional methods. In particular, fsQCA allows us to test for equifinality, conjunctural causation and asymmetric relations, and is suitable for exploring the theoretically complex antecedents of management innovation (Fiss, 2007; Ragin, 2008b). In addition, fsQCA requires researchers to calibrate measurements which are in line with the transient nature of management innovations. It specifically demands the development of meaningful, context-sensitive scales based on theoretical and substantive knowledge.

To test these hypotheses, I have in *Chapter 4* used information on 56 inter-firm relations in China's biopharmaceutical industry. Due to substantial unpredictability regarding ultimate marketability of their products, and the industry's complex knowledge domains, biopharmaceutical firms operate under high degrees of uncertainty and strongly rely on ties to other organizations (Nooteboom, 2004; Powell et al., 1996). In China, the biopharmaceutical industry is relatively young, the market for biopharmaceutical products is growing and the institutional framework is rapidly changing (Pisano, 2006). In addition, the industry contains a highly diverse population of firms. Inter-firm relations consequently operate under volatile conditions that require the constant development of new managerial instruments to address these dynamics (Frew et al., 2008). China's biopharmaceutical industry therefore provides a suitable environment to improve our understanding of the link between relational, structural, and environmental conditions of inter-firm relations and management innovation.

In *Chapter 5*, I provide information on the empirical study. I describe the data gathering process, the calibration of the set of managerially innovative inter-firm relations, and the sets of facilitating conditions (Fiss, 2007). I then go step-by-step through the analysis, beginning with the computation of the truth table and explaining the minimization procedures that allow the identification of core and contributing conditions. I then summarize the results in a configuration chart (Ragin et al., 2008).

## 6.1. Summary of Findings

The results identify four distinct configurations of inter-firm relations that facilitate management innovation in China's biopharmaceutical industry. The first configuration is characterized by a decentralized and a flat hierarchical structure, which provides the context for management processes to take place. The second configuration features a structure highly vertically differentiated structure in the absence of environmental uncertainties; this second configuration also allows for the development and introduction of new managerial instruments. Lastly, two intermediate configurations are identified. Homogenous inter-firm relations with mutually dependent partnering firms, that specifically rely upon formalization to foster trust and enable both partners to reciprocally access knowledge, for the development and introduction of new management instruments. Another homogenous inter-firm relation that was identified consists of network innovators that extensively rely on external sources of knowledge, which they access via the broader linkages of partnering firms in their environment.

The results allow drawing modest conclusions in regards to the individual determinants of management innovation, as proposed by outcome theories: *modest* because the effects of facilitating conditions on management innovation have not been tested individually and independently, as in conventional quantitative studies. Instead they have been used to define a six-dimensional property space in order to consider the association of all logically possible combinations of conditions facilitating management innovations. The results in this respect provide support for the role of decentralization (*Hypothesis 4*) and formalization (*Hypothesis 5a*). They refute the idea that formalization, in ‘straight-jacketing’ employees through an overly bureaucratic structure, acts as a coercive mechanism (*Hypothesis 5b*). Lastly, the results for heterogeneity (*Hypothesis 3*) and vertical differentiation (*Hypothesis 4*) provide evidence that these determinants are highly asymmetrically related to management innovation. In partnerships that rely on the enabling role of formalization, the absence of heterogeneity is an essential (core) condition to facilitating management innovation processes. In contrast, network innovators require heterogeneity between partnering firms to facilitate such processes. The role of vertical differentiation in management innovation is similarly asymmetric. In decentralized inter-firm relations, and supported by environmental uncertainties, the absence of vertical differentiation is needed to develop new management instruments. In contrast, when there is no environmental uncertainty, new management tools are only introduced when inter-firm relations are vertically differentiated. The results modestly support the hypothesized role of mutual dependence (*Hypothesis 1*) and refute the unidirectional role of environmental uncertainties (*Hypothesis 7*) in facilitating management innovation.

Table 6.1: Overview of Results (\* indicates modest implications)

	Theoretical Factor	Results
H1	Mutual dependence	Weakly supported*
H2	Specialization	Not tested
H3	Heterogeneity	Strongly asymmetric, not supported*
H4	Decentralization	Strongly supported*
H5a	Formalization (facilitates)	Strongly supported*
H5b	Formalization (obstructs)	Clearly rejected*
H6	Vertical differentiation	Strongly asymmetric, not supported*
H7	Environmental uncertainty	Asymmetric, not supported*
H8	Equifinality	Supported
H9	Conjunctural causation	Supported
H10	Asymmetric associations	Supported

Arguably more significant is the corroboration of the remaining three hypotheses, directed at uncovering the complex contextual antecedents of management innovation processes. As already suggested above, there are four equally effective organizational systems that facilitate management innovation. This finding clearly speaks in favour of equifinality (*Hypothesis 8*). Moreover, all configurations are multi-dimensional constellations of facilitating conditions. Matching prominent contingency theories, these

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are conceptually different, supporting the notion of conjunctural causation (*Hypothesis 9*). Finally, as has been discussed, strong asymmetric relationships have been identified in regards to the role of heterogeneity and vertical differentiation. The following Table 5.8 summarizes the main findings of this thesis.

## 6.2. Implications

As a result of its holistic approach, this thesis has a range of theoretical, methodological and managerial implications, which are outlined in the following paragraphs.

### 6.2.1. Theoretical Implications

By incorporating insights provided by process models, the thesis asks for outcome studies to shift the focus of the analysis to the inter-firm relation as the appropriate unit of analysis. By identifying complex contextual antecedents of management innovation, it suggests that outcome studies should rather develop theories that explicate the interdependencies among relational, structural and environmental factors enabling management innovation. This seems particularly significant in light of the results concerning hypotheses one through seven. As the findings clearly show, the sole focus on single, competing explanations does not further our understanding of the antecedents of management innovation. In regards to process theories, it reaffirms the idea that the inter-firm relation is the appropriate locus of innovation and provides evidence for the complex interplay between conditions that allow firm partnerships to develop and introduce new management instruments. The results of this study contribute to process theories by identifying four substantially different configurations of contextual conditions that facilitate the management innovation processes that take place between firms. Process theories, however, have largely neglected the role of contextual factors in the management innovation process. This thesis suggests that by considering relational, structural and environmental conditions, further insights may be generated regarding the specific role that these conditions play in providing internal or external knowledge to the management innovation process.

Finally, the results confirm the relevance of contingency or, more appropriately, configurational theories in management innovation. The taxonomy that accrues from the analysis closely corresponds to prominent contingency theories, in particular to Burns and Stalker's (1961) distinction between organic and mechanistic structures. However, the results do question the proposition that organic structures provide a superior context for management innovation processes. Instead, the findings have clearly shown that mechanistic structures are equally effective in developing and introducing management innovation. Instead of discerning between organizational systems as being more or less conducive to management innovation, the findings show rather that management innovation differs depending on the organizational system from which it emerges.

### 6.2.2. Methodological Implications

A few methodological approaches that have been applied in this thesis deserve further attention. While they are not all unknown within the field of research into management

innovation, they are crucial for future studies. First, I have used a three-dimensional framework to assess the newness of management innovations. According to this framework, novelty to the industry, to the nation and to the region has been assessed separately. This approach is new to management innovation studies and allows for a more fine-grained assessment of newness. In addition, the three-dimensional framework has been adapted from the pre-existing language, reasoning and understanding of experts in the industry. The assessment of newness thereby contextualizes management innovations and provides an alternative to uni-dimensional measurement approaches (Gupta et al., 2007). Second, I have followed earlier management innovation studies in using an independent group of experts to evaluate the newness of management innovations (Dewar et al., 1986; Kelley, 1976). This is an important aspect in innovation studies which often remains neglected, especially when using larger datasets that rely on standardized items and that do not allow for the consideration of either the transiency or the specific context of management innovation. This thesis calls for future management innovation studies to put stronger emphasis on the internal validity of datasets, and focus less on the external validity of observations across datasets. Finally, I have introduced fsQCA and have shown how the configurational analysis provides new insights into a specific aspect of management innovation, namely the configurations of inter-firm relations that facilitate its process. fsQCA provides an intriguing alternative to conventional methods. The method advocates a measuring technique, namely calibration, that in and by itself asks for a meaningful representation of the data within its substantive and theoretical context (Ragin, 2008c). It thereby directly addresses the requirement that management innovation research be contextualized. Furthermore, by improving the alignment of theories with models, fsQCA represents a tool that both explains and reconciles inconclusive results provided by previous empirical studies.

### 6.2.3. Managerial Implications

By developing a taxonomy of inter-firm configurations that facilitate management innovation, this thesis not only draws attention towards the design and management of inter-firm relations, but also provides an instrument with practical managerial implications. By providing a limited number of equally alternative decision-making choices, taxonomies reduce the complexity of a perceived phenomenon to a degree that permits us to emphasise the most important determinants and compare possible alternative design choices (Fiss, 2010; Martin-Pena et al., 2008). Managers that seek to develop and implement new management practices, processes and structures may, for instance, adjust the structural dimensions of existing inter-firm relations in order to facilitate management innovation processes. For instance, during times of environmental turbulence, the introduction of a decentralized structure and the abolishment of hierarchical levels in inter-firm relations are likely to lead to management innovation. In contrast, in the absence of environmental uncertainties, introducing levels of hierarchy will facilitate management innovation mechanisms that are supported by formalization. When interacting in a mutually dependent and heterogeneous partnership, the introduction of formalized rules and regulations encourages processes that lead to the development and introduction of new managerial instruments. Lastly, heterogeneous inter-firm relationships induce management innovation by installing a decentralized structure and facilitate these processes through vertical differentiation.

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Empirically, the results show that firms in the Chinese biopharmaceutical industry do not merely copy existing management instruments. Instead, new management instruments are developed and introduced rapidly and effectively. With its grounded conceptualization of novelty, the study suggests that these new management instruments contain elements of both local and global knowledge and may serve as templates for new standards for the global biopharmaceutical industry as a whole. What is emerging in China is a young, vibrant and viable biopharmaceutical industry that, while facing specific challenges, exhibits a tendency to develop managerial instruments that allow firms to cope with these difficulties.

### 6.3. Limitations

The present study carries certain limitations that, on the one hand reflect the challenges of studying a complex organizational phenomenon, such as management innovation, and on the other are inherent to the empirical approach that has been pursued in the thesis. From a theoretical perspective I have not distinguished between the stages of development and implementation in management innovation. As management innovation observed in China's biopharmaceutical industry have already been applied when conducting the interviews, stages in the process were not discernable. Configurations facilitating the processes within each of these stages, however, might well be different. For instance, the development of new ideas and their subsequent formulation and connection with other ideas might require more external knowledge. Whereas the implementation of management innovation into a complex organizational system might be facilitated when internal knowledge is introduced to the generative processes. In addition, this study does not specifically consider attributes of innovations; yet the four configurations identified might well facilitate the development of qualitatively different management innovations.

Furthermore, the use of a medium size comparative case method challenges data collection and data analysis procedures and naturally limits the contributions of this study. In particular, it requires a careful balance between maintaining intimacy with individual cases, the empirical context, and the systematic collection and analysis of data. I have tried to include as much detailed information in order to transparently report the approach and findings of the study. However, the conditions under which interviews were conducted, variations amongst the respondents and the difficulties of documenting all of the information received, have led to variations occurring from interview to interview. Relying on single key informants to assess inter-firm conditions neglects the perspective of the interacting partner. Furthermore, while it is advantageous to use experts to evaluate newness, this assessment essentially relies on the subjective judgement of these experts. Also, the sampling approach taken in this study was based upon convenience rather than theoretical rational, due to the need to collect as much data as possible whilst being constrained by both time and budget. The rapidly changing environment in China's biopharmaceutical industry carries biases that are specific to the country, the time, and the industry. Management innovation is transient by nature (Downs et al., 1976), and empirical research into its antecedents involves challenges. These biases are partly circumvented by calibrating, instead of measuring, i.e. by meaningfully representing the data within its empirical context (Ragin, 2008c). The three-dimensional construct which has been used to measure the newness of management innovation is proposed as a new and alternative

approach. While this measurement approach bears certain limitations, it might serve to revitalize discussions into how management innovation ought to be measured. This aspect seems particularly important considering the relevance of maintaining a high internal validity of datasets.

Finally, fsQCA bears certain limitations as an analytical technique. Except for distinguishing core from contributing conditions, it does not estimate the relative importance of individual conditions of management innovation. In addition, fsQCA cannot directly account for omitted variables and it is difficult to perform systematic robustness tests for given solutions. Recent methodological developments which, for instance, allow us to estimate the robustness of membership scores by using type 2 fuzzy sets may ameliorate some of the limitations associated with fsQCA.

#### 6.4. Future Research

While limitations are naturally undesirable, they do point out directions for further studies. Improving our understanding of how configurations change over stages in the innovation process will contribute to contingency and management innovation theories alike. Also, future research may more explicitly examine the different configurations, i.e. it may identify complementarities and substitutions. It has been shown that, in contrast to our current understanding, there are mechanistic organizational systems that develop and implement new managerial instruments. The different structures may in fact be connected to different secondary attributes of management innovations and may well generate qualitatively different management innovations. By substantiating these ideas, future research might be able to address some of the following issues of theoretical interest in management innovation studies. Much of the innovation literature suffers from a pro-innovation bias. Most research implicitly assumes that innovation *per se* is desirable. In this study, I did not qualify management innovations as desirable. In fact, the empirical data contains new managerial instruments which are clearly undesirable, in that they are either illegal or economically unsound. Future research may therefore focus on developing better means of determining the soundness and desirability of managerial tools. This may also help to clarify mechanisms between management innovation and firm performance. Despite the fact that some research has been able to establish a positive association between innovation and performance (see for instance Mol & Birkinshaw 2009) the underlying mechanisms remain vague. Moreover, there is a need for more research examining the role of intentionality in management innovation. As most definitions maintain, management innovation ought to be *intended to further organizational goals*. Similar to the bias towards the desirability of innovation, research on management innovation suffers from a pro-intentionality bias. Yet, despite the fact that nearly all partnerships interviewed for this study were formed to pursue scientific projects, many also developed and introduced new managerial instruments. This suggests that management innovation remains an unintentional side-effect of firm interaction. Considering the economic and social importance that is ascribed to management innovation, future research may further explore the role of intentionality.

Finally, a much neglected aspect in organizational innovation studies pertains to the simultaneous introduction of technological and management innovations. Since the



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beginning of innovation studies, scholars have pointed out that the interplay and alignment between different types of organizations requires theoretical substantiation (Damanpour, 1991; Sapolsky, 1967; Tichy & Sandstrom, 1974; Zeng et al., 2007).

## 6.5. Conclusion

The purpose of this thesis was to identify and test configurations of inter-firm relations in management innovation. The configurational approach that has been pursued is holistic, in terms of both theory and method. It bridges theoretical arguments from different conceptual camps and introduces fsQCA to the study of management innovation, a methodological approach that allows the systematic incorporation of a substantial amount of complexity into the analysis. The empirical study into China's biopharmaceutical industry indicated that inter-firm relations develop and implement new management instruments, addressing institutional uncertainties. The results revealed four different configurations of inter-firm relations that facilitate management innovation. The findings contribute to outcome theories, process theories and contingency theories of management innovation. They ask for a better integration of the various theoretical arguments put forward in each field. On this basis, I have pointed out a number of future research directions with a potential to contribute to our understanding of management innovation.

## Appendices

## Appendix A: Project Description (English)



## Managing challenges

### International collaboration in China's biopharma industry

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Thank you for your interest and cooperation in our study '*Managing challenges: International collaboration in China's biopharma industry*'. The aim of the study is to assess difficulties and opportunities of international cooperation between companies in China.

The study focuses on how you organize collaborative activities in the Chinese business environment and how you develop ways of dealing with its challenges. During the interview we will ask questions on the following topics:

I Characteristics of your firm	IV Features of your business environment
II Characteristics of collaborative partner	V Strategies of dealing with challenges
III Characteristics of a collaboration	

Pretests have shown that the interview can be completed in 45 minutes. Some discussions might take more time, depending on complexity.

INFORMATION COMMUNICATED HERE IS CONFIDENTIAL! The final report will only contain summary statistics on aggregated groups. No individual or individual firm will be identified. No one will see your questionnaire except the academic staff working on the analysis. After your data is added to the analysis, notes taken will be destroyed or returned to you (as you wish).

The results of the study will be published in industry reports and international scientific papers. Presentations will be held at Biopharma associations, trade fairs, and S&T Parks. The study thereby raises awareness about opportunities offered by China's biopharma industry. Contrasting your firms' characteristics with our results, enables you to assess and adapt your current strategy to improve your conditions to effectively operate, collaborate, and innovate.

IF YOU HAVE ANY QUESTIONS OR COMMENTS, DO NOT HESITATE TO ADDRESS THEM NOW! To promote accurate results of this study it is crucial that your answers be as complete as possible.

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**RESEARCHERS' BACKGROUND**  
 Johannes Meier studied int. management in Germany and Spain, continuing with an MSc degree in Economics in Hungary. In 2005, he studied in the MBA program at the *China Europe International Business School* (CEIBS) in Shanghai and conducted a research project on China's economic integration to the WTO. Mr. Meier joined the *ESM Research Centre on China Business* at Erasmus University in 2006 ([www.erasm.nl/chinabusiness](http://www.erasm.nl/chinabusiness)) as a research fellow where he is continuing his research on management issues in China.

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## 管理的挑战

### 在中国生物制药工业方面的国际合作

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感谢您对我们此次调查——管理的挑战：在中国生物制药工业方面的国际合作——的关心与支持。我们这次调查的目的是对在中国的企业，其国际合作的困难与机遇作出评估。

在中国的商业环境下如何组织合作及如何应对相应的挑战，是这次调查主要关心的问题。我们将会就以下话题对您进行采访：

- |               |               |
|---------------|---------------|
| I. 你们公司的特点    | IV. 你们商业环境的特色 |
| II. 你们合作伙伴的特点 | V. 应对挑战的对策    |
| III. 合作的特点    |               |

我们预测此次采访将会在45分钟内完成。基于复杂程度的不同，有一些讨论可能会花费更多时间。

**我们在这里交流的信息都会完全保密！**最终的报告将只包括一些经整理后的总结性的数据，不会出现个人或公司的身份信息。除了分析这些数据的专业人员以外，没有人会看到您的问卷。在将您的数据录入之后，我们将会销毁记录的笔记或者将其归还给您（您可以自主选择）。

此次调查的结果将会发表在一些行业报告和国国际科研报刊上。并且我们将会在欧洲，生物制药协会，药品交易会及科技园发表我们此次调查的报告。因此，此次调查将会使我们对中国生物制药行业提供的机遇给予更充分的关注。通过将您公司的特点与我们的调查结果进行评估对比，您可以对您公司的现行策略进行相应调整，从而让您的公司在经营，合作与创新各方面都得到极大的促进。

**如果您对此有任何问题或者评论，请不吝赐教！**为了让此次调查的结果更准确，请您的作答尽可能完整。

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#### 研究者的背景

Johannes Meuer在德国和西班牙学习国际营销以后，在匈牙利获得了经济学硕士学位。2005年，他在上海的中欧国际商学院（CEIBS）学习MBA课程，并就中国入世的经济一体化进行了研究设计。2006年，Meuer先生加入了鹿特丹管理学院的商业研究中心（[www.emm.nl/chinabusiness](http://www.emm.nl/chinabusiness)），成为其中的一名科研人员，并且继续他在管理商务方面的

Appendix C: Truth Table for Inter-firm Configurations

No.	Mutual dependence	Heterogeneity	Decentralization	Formalization	Vertical Differentiation	Environmental Uncertainties	No. of observations	Included in Analysis	Consistency
1	1	0	1	1	1	1	0	Y	0.857
2	1	0	1	1	1	0	0	Y	0.851
3	1	0	1	1	0	1	2	Y	0.844
4	1	0	0	1	1	1	3	Y	0.831
5	0	0	1	1	1	0	1	Y	0.827
6	1	0	1	1	0	0	0	Y	0.825
7	1	1	1	0	0	1	2	Y	0.824
8	1	0	0	1	1	0	0	Y	0.823
9	1	1	1	1	1	0	1	Y	0.821
10	1	0	1	0	0	1	1	Y	0.818
11	0	0	1	1	1	1	0	Y	0.817
12	0	0	0	1	1	0	0	Y	0.810
13	1	1	1	0	1	1	0	Y	0.805
14	1	1	1	0	1	0	0	Y	0.801
15	0	1	1	1	1	0	0	Y	0.797
16	0	0	1	1	0	0	0	Y	0.795
17	1	0	1	0	1	0	0	Y	0.795
18	1	1	0	1	1	0	0	Y	0.794
19	1	1	1	0	0	0	0	Y	0.793
20	1	1	1	1	0	1	2	Y	0.789
21	1	0	0	1	0	1	5	Y	0.788

No.	Mutual dependence	Heterogeneity	Decentralization	Formalization	Vertical Differentiation	Environmental Uncertainties	No. of observations	Included in Analysis	Consistency
22	0	1	0	1	1	0	1	Y	0.788
23	1	0	1	0	0	0	0	Y	0.788
24	0	1	1	1	1	1	1	Y	0.788
25	1	1	1	1	0	0	0	Y	0.787
27	1	1	1	1	1	1	5	Y	0.785
28	0	0	0	1	1	1	0	N	0.782
29	0	0	1	1	0	1	1	N	0.782
30	0	1	1	0	0	0	0	N	0.772
31	0	1	1	1	0	0	0	N	0.767
32	1	0	0	1	0	0	0	N	0.767
33	0	0	1	0	1	0	0	N	0.762
34	0	0	0	1	0	0	0	N	0.762
35	1	1	0	1	1	1	6	N	0.759
36	0	0	1	0	0	0	0	N	0.758
37	0	1	1	0	0	1	0	N	0.757
38	1	0	1	0	1	1	1	N	0.754
39	0	1	1	0	1	1	0	N	0.754
40	0	0	1	0	0	1	0	N	0.748
41	0	1	1	1	0	1	0	N	0.747
42	0	1	0	0	1	0	0	N	0.745
43	0	0	1	0	1	1	0	N	0.745
44	1	1	0	0	1	1	0	N	0.743
45	0	1	0	1	1	1	2	N	0.740

No.	Mutual dependence	Heterogeneity	Decentralization	Formalization	Vertical Differentiation	Environmental Uncertainties	No. of observations	Included in Analysis	Consistency
46	1	1	0	0	1	0	0	N	0.739
47	0	1	0	1	0	0	0	N	0.738
48	1	0	0	0	1	1	0	N	0.737
49	1	1	0	1	0	0	0	N	0.736
50	0	0	0	1	0	1	3	N	0.736
51	1	0	0	0	□	0	0	N	0.733
52	0	0	0	0	1	0	0	N	0.728
53	1	0	0	0	0	1	3	N	0.727
54	0	1	0	0	0	0	0	N	0.721
55	1	1	0	0	0	1	0	N	0.718
56	0	0	0	0	0	0	0	N	0.702
57	0	1	0	0	1	1	0	N	0.699
58	1	0	0	0	0	0	0	N	0.693
59	0	1	0	0	0	1	2	N	0.689
60	0	0	0	0	1	1	0	N	0.688
61	1	1	0	0	0	0	1	N	0.684
62	1	1	0	1	0	1	5	N	0.677
63	0	0	0	0	0	1	1	N	0.676
64	0	1	0	1	0	1	6	N	0.672

Y = Yes, N = No. The continuous line between row 27 and 28 indicates the consistency cut-off point.



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## *Samenvatting (Dutch Summary)*

Het doel van deze dissertatie is te pleiten voor een holistische benadering van de studie van management innovatie door theorieën, methoden en empirisch onderzoek op één lijn te krijgen. Eerder onderzoek heeft management innovatie geconceptualiseerd als hetzij de uitkomst van onafhankelijke determinanten van individuele bedrijven, dan wel een complex proces van samenhangende factoren tussen samenwerkende bedrijven. In tegenstelling tot eerdere studies probeert deze dissertatie een brug te slaan tussen uitkomsten proces-georiënteerde theorieën, daarbij de complexiteit van contextuele antecedenten van management innovatie in acht nemende. In plaats van de specificatie van hetgeen actoren binnen interorganisatorische relaties doen om nieuwe management instrumenten te ontwikkelen en implementeren, richt deze dissertatie zich op de condities waaronder het management innovatie proces binnen interorganisatorische relaties plaats vindt. Met andere woorden, het stelt een configurationele benadering voor om interorganisatorische relaties die management innovatie faciliteren te bestuderen.

De empirische analyse maakt gebruik van data van 56 interorganisatorische relaties in China's biofarmaceutische industrie, welke verzameld is gedurende een extensief, een jaar durend veldonderzoek in China (Beijing en Shanghai) tussen 2007 en 2008. De populatie van bedrijven in China's biofarmaceutische industrie is jong en bijzonder divers en is derhalve sterk afhankelijk van relaties met andere organisaties. Als een gevolg daarvan opereert de industrie onder risicovolle condities, die een constante ontwikkeling van nieuwe management instrumenten vereisen om de hoge onzekerheid het hoofd te bieden. Deze industrie is daarom een veelbelovende context om de rol van interorganisatorische relaties in management innovatie te bestuderen. Empirisch gezien draagt de analyse bij aan een beter begrip van hoe management innovatie Chinese bedrijven in de wereldwijde biofarmaceutische industrie integreert.



Deze dissertatie maakt gebruik van Fuzzy Set Qualitative Comparative Analysis (fsQCA), een techniek die voortbouwt op settheoretische benaderingen om configuraties zoals deze zijn volledige context te bestuderen en te vergelijken; dit in tegenstelling tot het analyseren van netto effecten van individuele determinanten. fsQCA is nieuw voor de studie van management innovatie en is gekozen vanwege zijn mogelijkheid om complexe theorieën op een geschikte manier in modellen te vertalen. De verwachting is dat hierdoor theoretische proposities en empirische data meer op een lijn komen. Om die reden is de methode ook geschikt voor de bestudering van interorganisatorische configuraties die management innovatie faciliteren.

De empirische resultaten wijzen op vier configuraties van interorganisatorische relaties. Zij verschillen in de combinaties van aanwezigheid of afwezigheid van relationele-, structurele- en omgevings-condities. Elk van deze combinaties is even effectief in het faciliteren van management innovatie, maar gebruiken interne en externe kennis op een verschillende manier om nieuwe management praktijken, processen en structuren te ontwikkelen en te implementeren. Daarmee bieden de resultaten substantiële empirische ondersteuning voor de complexiteit tussen de contextuele antecedenten van management innovatie. De daarop volgende analyse van complementariteit en substitutie tussen deze configuraties suggereert de richting voor toekomstig onderzoek.

De resultaten leiden tot een taxonomie van interorganisatorische configuraties die de essentiële condities en alternatieve organisatiemodellen voor management innovatie benadrukken. De taxonomie biedt een simpel en gestructureerd besluitvormingsinstrument om begrijpbare en praktische management strategieën te ontwikkelen. Daarnaast laat de empirische studie zien dat bedrijven in China's biofarmaceutische industrie niet achteloos bestaande management instrumenten overnemen. In tegen deel, de nieuwe management instrumenten maken gebruik van zowel lokale als wereldwijde kennis en worden snel ontwikkeld en geïmplementeerd. Deze kunnen als voorbeeld dienen voor de wereldwijde biofarmaceutische industrie en suggereren dat wat in China opkomt binnenkort een prominente positie zal innemen in de leidende biofarmaceutische industrieën.

## *English Summary*

This dissertation advocates a holistic approach to the study of management innovation by improving the alignment of theories, methods and empirics. Previous research conceptualizes management innovation as either the outcome of independent determinants of individual firms or a complex process of conjunctural factors between interacting firms. In contrast this thesis attempts to bridge outcome and process theories while acknowledging the complexities among contextual antecedents of management innovation. Instead of specifying what actors within inter-firm relations do in order to develop and implement new management instruments, this thesis examines the combinations of conditions under which the management innovation process within inter-firm relations takes place. In other words, it proposes a configurational approach to the study of inter-firm relations which facilitates management innovation

The empirical analysis builds on data from 56 inter-firm relations in China's biopharmaceutical industry collected during an extensive, one year field research period in China (Beijing and Shanghai) between 2007 and 2008. The population of firms in China's biopharmaceutical industry is young and highly diverse and strongly relies on ties to other organizations. As a result the industry operates under volatile conditions that require the constant development of new managerial instruments in order to mitigate high levels of uncertainty. Thus, the setting offers a promising case for examining the role of inter-firm relations in management innovation. On the empirical side the analysis contributes to understanding how management innovation integrates Chinese firms in the global biopharmaceutical industry.

This thesis employs Fuzzy Set Qualitative Comparative Analysis (fsQCA), which builds on set theory, to examine and compare the configurations expressed in entire cases, instead of analyzing the net-effect of individual determinants. fsQCA is new in the study

of management innovation and has been chosen for its ability to properly translate complex theories into models. It is expected to improve the alignment of theoretical propositions and data and is hence suitable for examining inter-firm configurations that facilitate management innovation.

The empirical results identify four configurations of inter-firm relations. They differ in the combinations of present or absent relational, structural and environmental conditions. Each is equally effective in facilitating management innovation yet employs internal and external knowledge differently to develop and implement new management practices, processes or structures. Thereby the results provide substantial evidence for complexity among the contextual antecedents of management innovation. The subsequent analysis of complementarities and substitutions among these configurations points to future research directions.

Further, the results lead to a taxonomy of inter-firm configurations emphasizing essential core conditions and alternative organizational designs for management innovation. The taxonomy provides a simple and well arranged decision-making tool for drafting intelligible and practical managerial strategies. Moreover, the empirical study indicates that firms in China's biopharmaceutical industry do not merely copy existing management instruments. Instead, new management instruments containing both local and global knowledge are swiftly developed and rapidly introduced. These may serve as templates for the global biopharmaceutical industry and suggest that what emerges in China will soon take a prominent position among the leading biopharmaceutical industries in the world.

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## About the Author

Johannes Meuer was born in Mainz, Germany, on December 27, 1978. He attended the Bunsengymnasium in Heidelberg where he received his Abitur in 1998. Johannes completed his Civil Service and went on to study International Business at the ISM Dortmund where he obtained his Diploma in 2003. During his undergraduate, he was an exchange student at EBS Madrid and interned for Roche Diagnostics in Barcelona, and Rödl & Partner in Köln and Budapest. Between 2003 and 2005, Johannes studied at the China Europe International Business School in Shanghai (CEIBS) and Corvinus University Budapest (CUB) where he received his M.Sc. in International Economics.

In September 2006, Johannes enrolled in the ERIM PhD Program with the Department of Organization and Personnel Management at Erasmus University. Under the supervision of Prof. Dr. Barbara Krug, he conducted field research in China between 2007 and 2008 interviewing companies in the biopharmaceutical industry for his dissertation. In early 2009, during a three month research visit he received training in comparative analysis and set-theoretic methods from Prof. Dr. Peer Fiss at USC Marshall Business School in Los Angeles.

During his time as a doctoral student, Johannes presented his work at international conferences such as the Organization Science Winter Conference, IACMR, EGOS and the Academy of Management. Further, Johannes won AESE's Case Writing Competition 2010 with Lori DiVito and Barbara Krug for a study on Chinese firms in Europe. Parts of his work have been published as book chapters with Edward Elgar and Springer, and in the Academy of Management Best Paper Proceedings.

## CONFIGURATIONS OF INTER-FIRM RELATIONS IN MANAGEMENT INNOVATION A STUDY IN CHINA'S BIOPHARMACEUTICAL INDUSTRY

This dissertation proposes a configurational approach to the study of inter-firm relations facilitating management innovation. Previous research conceptualizes management innovation as either the outcome of determinants of individual firms or a complex process of conjunctural factors between firms. In contrast, this thesis attempts to reconcile the two camps by examining the conditions under which the management innovation process within inter-firm relations takes place. The empirical analysis employs data from 56 firm partnerships in China's biopharmaceutical industry collected during field research in 2008. The population of firms in China's biopharmaceutical industry is young, highly diverse and strongly relies on ties to other organizations. Operating under volatile conditions requires constant development of new managerial instruments. Methodologically, this dissertation employs a technique new in the study of management innovation. Fuzzy Set Qualitative Comparative Analysis (fsQCA) has been chosen for its ability to properly translate complex theories into models and its suitability for configurational analyses.

The results identify four configurations of inter-firm relations differing in their combinations of relational, structural and environmental conditions. Each is equally effective in facilitating management innovation yet employs internal and external knowledge differently to develop and implement new management instruments. The results provide a simple and well arranged decision-making tool for drafting intelligible managerial strategies and indicate that firms in China's biopharmaceutical industry swiftly develop and introduce management instruments which soon may serve as templates for the global biopharmaceutical industry as a whole.

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