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User-Manufacturer Integration – How User-Innovator Firms Exploit Their Innovativeness by Vertical Diversification

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Preface

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Annika Bock
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List of Abbreviations

AB	Aktiebolag (swedish: stock company)
AG	Aktiengesellschaft
Behav	Behavior
CAD	Computer aided design
Cat.	Category
CEO	Chief executive officer
Coeff.	Coefficient
DACH	Germany, Austria, and Switzerland
DevCosts	Development costs
EBIT	Earnings before interest and taxes
EPO	European Patent Office
EU	European Union
EUR	Euro
GmbH & Co. KG	Gesellschaft mit beschränkter Haftung und Compagnie Kommanditgesellschaft
GmbH	Gesellschaft mit beschränkter Haftung
Gologit	Generalized ordered logistic regression
GPS	Global Positioning System
IPC	International Patent Classification
IPO	Initial public offering
LU	Lead user
MB	Machine business
ME	Machine engineering
Mio./mio.	Million
MIP	Mannheimer Innovationspanel
MMSRO	Medizin-, Mess-, Steuerungs-, Regelungstechnik und Optik
n/a	not available

NACE	Nomenclature générale des activités économiques dans les Communautés Européennes
NAICS	North American Industry Classification System
Obs.	Observation
Ologit	Ordered logistic regression
OLS	Ordinary least squares
Org	Organization/organizational
OYJ	Osakeyhtiö (finish: stock company)
PATSTAT	Worldwide patent statistical database
PLC	Public limited company
RBV	Resource-based view
R&D	Research and development
SFE(B)	Specialist foundation engineering (business)
SIC	Standard Industrial Classification
Std. Dev.	Standard deviation
Std. Err.	Standard error
TCE	Transaction cost economics
UI	User innovation
UK	United Kingdom
US/U.S./USA	United States of America
Var.	Variance
VIF	Variance inflation factor
WIPO	World Intellectual Property Organization
WW II	World War II
WZ	Klassifikation der Wirtschaftszweige
ZEW	Zentrum für europäische Wirtschaftsforschung

Zusammenfassung

Die bestehende Nutzerinnovationsforschung kennt neben der Möglichkeit, selbst Nutzer der eigenen Innovation zu sein, zwei Alternativen wie Nutzerinnovatoren monetär von ihren Innovationen profitieren können. Erstens besteht die Möglichkeit der Lizenzierung des der Innovation zugrunde liegenden Wissens an andere Marktteilnehmer. Diese erhalten so die Erlaubnis und die Möglichkeit, dieses Wissen gegen Zahlung einer Lizenzgebühr für eigene Entwicklungen zu verwenden. Zweitens haben Nutzerinnovatoren die Möglichkeit Hersteller zu werden, indem sie ihre Innovation kommerzialisieren und von den Innovationsverkäufen monetär profitieren. In beiden Fällen ist der Grad der Interaktion zwischen Nutzern und Herstellern begrenzt. Während im ersten Fall der Nutzerinnovator nicht in die Herstellerfirma, die das Wissen der Nutzerinnovation verwendet, involviert ist, wechselt der Nutzerinnovator im zweiten Fall dauerhaft seine funktionale Rolle vom Nutzer zum Hersteller.

Die bestehende Nutzerinnovationsforschung beleuchtet in großer Breite die oben erwähnten Existenzgründungen von Endnutzern beziehungsweise von Nutzern, die in ihrem beruflichen Umfeld Innovatoren eines bestimmten Produktes werden (‘professional users’), während Unternehmen als Nutzer eines Produktes und spätere Entrepreneurs bisher wenig erforscht sind. Shah und Tripsas (2007) schließen diese Gruppe der Nutzerinnovatoren zum Beispiel explizit aus ihrer Forschung aus.

Um die bestehende Forschungslücke zu schließen, werden im Rahmen der vorliegenden Dissertation drei empirische Studien mit dem Ziel durchgeführt, das Phänomen der ‚integrierten Nutzer-Hersteller-Unternehmen’ sowie den Einfluss von derartigen organisatorischen Veränderungen auf die Innovationsaktivitäten von Unternehmen allgemein zu erforschen. Die erste Studie meiner Arbeit analysiert, welche Bedingungen begünstigend beziehungsweise hemmend auf die spezifische Form der Diversifikation der ‚integrierten Nutzer-Hersteller-Unternehmen’ wirken. Die zweite Studie basiert auf den Erkenntnissen der ersten Studie und beleuchtet die Beziehung zwischen Diversifikation und Innovation im Bereich der Nutzer-Hersteller-Firmen. Die dritte Studie

der vorliegenden Dissertation analysiert allgemeiner, inwieweit wichtige organisatorische Veränderungen die Innovationsaktivitäten von Unternehmen beeinflussen.

Der ersten Studie liegt ein Fallstudienansatz zugrunde, der auf 13 Interviews mit Mitgliedern der Unternehmensführung von fünf Nutzer-Hersteller-Unternehmen aus vier verschiedenen Branchen basiert. Die Informationen aus diesen Gesprächen werden angereichert mit Archivinformationen und Informationen aus Gesprächen mit Experten aus dem akademischen Umfeld sowie aus der Industrie. Die Hypothesen, die die Studienergebnisse widerspiegeln, sind vorwiegend aus einem Schwerpunktunternehmen abgeleitet, während die vier zusätzlichen Fallbeispiele dazu dienen, die Validität der Hypothesen über die Grenzen eines Unternehmens und einer Industrie hinweg zu überprüfen. Die Ergebnisse dieser Studie zeigen, dass der Erfolg einer Integration von Nutzer- und Herstellerbereich abhängig ist von Faktoren aus den Bereichen ‚Innovation', ‚Markt' sowie ‚Corporate Governance und Organisation'.

Basierend auf der Analyse von 416 Patenten in zwei dreistelligen IPC-Klassen gibt die zweite Studie meiner Arbeit Auskunft darüber, ob und inwieweit die Hersteller-Bereiche von Nutzer-Hersteller-Unternehmen innovativer sind als die der nicht vertikal diversifizierten Hersteller der gleichen Industrie. Dafür werden 75 Patente von Nutzer-Hersteller-Unternehmen aus der Bau- und Bergbaubranche mit 341 Patenten von reinen Herstellern in Bezug auf die Patentqualität verglichen. Die quantitativen Daten werden anhand von negativ-binomialen Regressionsmodellen ausgewertet. Die Ergebnisse der Studie zeigen, dass Patente von Nutzer-Hersteller-Unternehmen in einer der beiden IPC-Klassen qualitativ besser sind als die Patente von reinen Herstellern. Insgesamt legen die Ergebnisse dieser Studie nahe, dass Nutzer-Hersteller-Unternehmen in einzelnen Bereichen in der Lage sind, von der Dualität ihres Geschäftsmodells zu profitieren. Darüber hinaus erscheint eine weitergehende Untersuchung dieses Themenfeldes in Zukunft interessant.

Während die ersten beiden Studien meiner Arbeit das Phänomen der ‚integrierten Nutzer-Hersteller-Unternehmen' sowie den Einfluss dieser spezifischen Form der Diversifikation auf den Innovationsoutput untersuchen, ist die Entwicklung der Unternehmen zu dieser spezifischen Form der Diversifikation bedeutend schwieriger zu analysieren. Aus diesem Grunde untersucht meine dritte Studie den Einfluss

unterschiedlicher Formen des organisatorischen Wandels auf die Innovationsaktivitäten von Firmen in einem allgemeineren Umfeld. Dabei basiert die Studie auf Ergebnissen des ‚Mannheimer Innovationspanels', einer jährlich durchgeführten Studie des Zentrums für europäische Wirtschaftsforschung und vergleicht die Antworten hinsichtlich des Innovationsinputs und -outputs unterschiedlicher Firmen miteinander. Betrachtet werden dabei einerseits Unternehmen, die angegeben haben, in den vergangenen drei Jahren eine Akquisition, Desinvestition oder eine größere Umstrukturierung absolviert zu haben, und andererseits Unternehmen, die laut eigener Aussage keinen solchen Veränderungsprozess durchlaufen haben. Zur Beantwortung der Frage des Einfluss von organisatorischem Wandel auf die Innovationsaktivität von Unternehmen werden die Antworten von Unternehmen in zwei Stichproben verglichen und anschließend mittels multivariater Analysemethoden ausgewertet, insbesondere der generalisierten ordinalen logistischen Regression ('generalized ordered logistic regression'). Die Ergebnisse dieser Studie zeigen nicht den erwarteten systematischen negativen Effekt der verschiedenen Formen des organisatorischen Wandels auf den innovativen Input und Output der untersuchten Unternehmen.

Abstract

User innovation research considers two ways in which user innovators may benefit from their innovation (other than by using it). First, users may license others to use the knowledge of the innovation to develop their own products for a fee. Second, a user innovator may become a manufacturer, commercialize his innovation on the market, and benefit from it monetarily by selling it to others. In both cases, the interaction between the user innovator and the manufacturer is limited. In the first case, users are not a part of the manufacturing firms, whereas in the second case, the user innovator permanently changes his functional role to that of a manufacturer.

Existing research has investigated such user entrepreneurship among end users and professional users. However, user entrepreneurship by corporate users has not been explored so far. Interestingly, Shah and Tripsas (2007) even explicitly exclude corporate users from their study.

To address this gap, this dissertation employs three empirical studies to investigate the phenomenon of 'integrated user-manufacturer firms' and the influence of such organizational changes on the innovative activities of firms in general. The first study explores the circumstances that support or hinder this special type of diversification. The second study builds on the first and investigates the relationship between diversification and innovation in the field of user-manufacturer firms. The third study analyzes more generally the extent to which important organizational changes influence firms' innovative activities.

The first study employs a case study approach and is based on 13 interviews with executives of five user-manufacturer firms from four different industries. The information from these interviews is enriched with archival information from various sources and information from academic and industry experts. The propositions summarizing the results are derived from one main case, and the four additional cases ensure the validity of the results beyond the confines of one particular company or industry. The results of this study show that the viability of the integration of the user and manufacturer roles, as occurs in the

‘integrated user-manufacturer firms’, is determined by factors that relate to three different fields: innovation, market, and corporate governance and organization.

Based on the analysis of 416 patents in two 3-digit IPC classes, the second study aims to investigate whether and to what extent the manufacturing units of user-manufacturer firms are more innovative than those of non-vertically diversified manufacturers in the same industry. To this end, 75 patents held by user-manufacturer firms from the wider construction and mining sector are compared in terms of patent quality with 341 patents held by manufacturer-only firms. These quantitative data are then analyzed using negative binomial regression models. The results of this study show that patents of user-manufacturer firms are qualitatively better in one of the two IPC classes. The findings of this study suggest that user-manufacturer firms may be able to benefit from the duality of their business only in certain fields. In general, a further investigation of this topic seems to be important in the future.

While the first two studies of my dissertation analyze the phenomenon of ‘integrated user-manufacturer firms’ and investigate the relationship between diversification and innovation in the field of user-manufacturer firms, it is more difficult to explore the development of firms towards this specific form of diversification. Thus, my third study explores the influence of organizational change on the innovative activities of firms in a more general setting. To this end, the study which is based on the results of a survey conducted annually among German firms, the ‘Mannheimer Innovationspanel’, compares answers regarding the innovative input and output of firms that reported conducting an acquisition, divestiture or major restructuring project in the previous three years with the innovative input and output information of firms that reported no such effort. These quantitative data are examined using generalized ordered logistic regression models. The results of this study do not show the expected systematic negative relationship between the different forms of organizational change and firms’ innovative input and output.

1. Introduction

Since Eric von Hippel's argument that, contrary to general assumptions, users are an important source of innovation (von Hippel, 1988), user innovation research has come a long way. Initial research in this field aimed mainly to provide evidence that users, and particularly lead users, are an important – or even the most important – source of product or service innovations in many fields (e.g., von Hippel, 1976; Urban and von Hippel, 1988; Shaw, 1985; Herstatt and von Hippel, 1992). Today, the field of user innovation research is multifaceted, with a broad range of research streams that include user entrepreneurship (e.g., Shah and Tripsas, 2007; Baldwin et al., 2006; Hienerth, 2006; Haefliger et al., 2010), user communities (e.g., Franke and Shah, 2003; Tietz et al., 2005), innovation policy implications of user innovations (e.g., Gault and von Hippel, 2009; von Hippel and Jin; 2008), and the involvement of (lead) users in firms' research activities (e.g., Morrison et al., 2000; von Hippel, 1999; Franke et al., 2006).

Today, the importance of users for product innovations is not only acknowledged in user innovation research, but also forms the basis for the efforts of many firms that actively involve users in their product development. Firms can involve users in new product development in different ways. Whereas some firms apply the lead user method as a tool to develop new product or service concepts (e.g., von Hippel, 1999; Fitzgerald, 2007), other firms involve regular users in new product development. These firms may address the community of users with the goal of developing new product features or a new product design that is later introduced and sold on the market.

In most cases, in both research and practice, individuals are considered user innovators if they are the end consumers of a product or, alternatively, if they are so-called 'professional users', meaning that they are exposed to a product and innovate a related product in their professional environment. This dissertation explores a third form of user innovation that is generated by corporations that, while using a product, become innovators of a related product.

The research questions of this dissertation are inspired by the American Airlines case that I present below in Section 1.1. In Section 1.2, I further outline these research questions, and I give an overview of the structure of this dissertation in Section 1.3.

1.1 Motivation – The Case of American Airlines

A number of examples exist in which firms become innovators of a product while using a related product. In some cases, other firms have similar needs, and the innovating firm commercializes its innovation to gain monetary benefits from both using the innovation and selling it to external customers. The two businesses of such innovating user firms are of a different nature; one business uses a product, whereas the other business manufactures this or similar products, which gives the two businesses different resource needs, such as infrastructure, technical knowledge, and customer base. In many cases, these firms decide to split the existing firm, consisting of at least two different business units, into two separate firms. Alternatively, these firms may change their business model and discontinue the user business activities to focus on the manufacturer business in the future. One key motivation for these shifts in the firm's structure and activities may be that such firms primarily see the difficulties that result from running such diverse businesses and are unaware of the benefits that might result from a dual business model.

The case of American Airlines is often mentioned with regard to this topic. In the 1950s, the firm faced serious problems with handling seat bookings quickly. Passenger volume greatly increased within a short time period, and the airline's booking systems were still entirely manual. In 1964, all the booking functions of American Airlines were taken over by the 'SABRE' system, which was the result of a joint development effort by American Airlines and IBM. The SABRE business was a business unit of American Airlines from its beginning. From 1976 on, the system that was originally developed for exclusive use by American Airlines was expanded to travel agencies, and other airlines later began using SABRE or similar booking systems. In 2000, American Airlines and SABRE separated. Sabre Holdings is now a publicly traded company that is active in the

travel technologies market, whereas American Airlines still operates primarily in the airline and transportation market.[1]

Although the motivation for the separation of American Airlines and SABRE has never been communicated, this case is quite typical in that innovating user firms often separate their businesses or discontinue the user business to focus on the manufacturer business. In contrast, some firms keep both the user and manufacturer businesses and become 'integrated user-manufacturer firms'[2].

1.2 Research Questions

In this dissertation, I explore the above described phenomenon of firms as the innovators of products or services that they use. In particular, I investigate why some firms keep both the user unit and the manufacturer unit, whereas other firms separate their business units into two different firms or discontinue the user business to focus on the manufacturer business.

To this end, I first analyze the phenomenon of 'integrated user-manufacturer firms' and derive general propositions regarding the circumstances that favor this special type of diversification. In the second step, I build on the findings of the first study and analyze the relationship between diversification and innovation in the field of integrated user-manufacturer firms. In other words, I investigate whether and to what extent the manufacturing units of user-manufacturer firms are more innovative than non-vertically diversified manufacturers in the same industry. In the third step, I analyze the extent to which important organizational changes[3] influence firms and their innovative activities.

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[1] For additional and more detailed information on American Airlines and the development of the SABRE system, please see http://www.sabretravelnetwork.com/home/about/history/ (accessed 29.11.2011) and http://en.wikipedia.org/wiki/Sabre_(computer_system) (accessed 29.11.2011).

[2] The term 'integrated user-manufacturer firm' describes firms that use a certain product or service and then diversify by additionally becoming manufacturer of the same product. For a more detailed description of this term, please see Section 3 of this dissertation.

[3] Major organizational changes can include, for example, the diversification of a firm from a user firm to a user-manufacturer or acquisitions and divestiture activities firm.

Research Question 1: *Are integrated user-manufacturer firms viable over the long run? Can the considerable commercial potential that such an arrangement holds be realized? What are the factors supporting and hindering such an arrangement?*

To address these questions, I use a case study approach, analyzing the history, organization and innovation management of five user-manufacturer firms from four different industries. These cases showed that a successful and fruitful integration of user and manufacturer businesses can be achieved. According to my results, the viability of such integration is determined by factors that relate to innovation, markets, and corporate governance and organization. With regard to innovation, I found that, among other factors, the prospect of receiving feedback from external customers and the risk of imitation are factors that favor commercialization in the market. Market-related factors that should function similarly include the visibility of an innovation and the reputation of the focal firm in its original market. Finally, I identified factors that are related to corporate governance and organization that positively affect the market commercialization of a firm's own user innovations. These factors include private ownership of the firm and a low level of conflicts between the employees of the two units.

This first study builds on two streams of literature: user innovation literature and firm diversification research. The lead user concept introduced by Eric von Hippel (1988, 2005) lays the foundation for user innovation research. In the literature, two methods by which users can benefit from their innovation (other than by using it) are discussed: users may license their innovation to others for a fee and second, the user innovator may commercialize the innovation on the market by becoming a manufacturer (Shah and Tripsas, 2007; Baldwin et al., 2006; Haefliger et al., 2010). Despite the commercial attractiveness of many user innovations, only a few lead users exploit the commercial potential of their innovations by becoming manufacturers. Von Hippel (1988) mainly attributes this fact to the difficulties in switching the functional role from user to manufacturer. These difficulties can be explained using the resource-based view (RBV), which argues that the resources that allow a competitive advantage are not perfectly mobile.[4] Nevertheless, some user innovators become manufacturers, as studied by Shah and Tripsas (2007) and Baldwin et al.

[4] For a more detailed description of the RBV, please see Chapters 2.2.1 and 2.2.2.

(2006). However, most of these firms quit the user role when they take over the manufacturer role and become manufacturer-only firms.

The second literature stream on which this first study is based is the firm diversification literature. Transaction cost economics, henceforth, 'TCE' (e.g., Williamson, 1975, 1979, 1995) and the RBV (e.g., Peteraf, 1993; Silverman, 1999; Wernerfelt, 1984) are the two main theories that are used to explain why firms engage in related diversification. The RBV argues that firms use excess firm-specific resources and capabilities to diversify into related fields (Penrose, 1959), whereas TCE postulate that firms make diversification or make-or-buy decisions based on a comparison of the transaction costs of the market transaction with the costs of internal management (Levy, 1985).

> ***Research Question 2:*** *Are the manufacturing units of user-manufacturer firms more innovative than non-vertically diversified manufacturers in the same industry? Is the quality of the innovative output of user-manufacturer firms better than that of manufacturing-only firms?*

To address these research questions, I compare the quality of approximately 415 patents in two 3-digit IPC-classes that are held by three vertically diversified and five non-vertically diversified firms in terms of their quality. I examine the quantitative data with multivariate models employing negative binomial regressions. Interestingly, the patents of user-manufacturer firms are qualitatively better (in the sense that they receive more forward citations) than those of manufacturer-only firms in the IPC class that the user-manufacturer firms in my sample focus on. In contrast, I found the opposite effect for patents in an IPC class in which most patents are held by manufacturer-only firms. In the overall sample, user-manufacturer firms generate qualitatively better patents. Although the effect is not very robust to variations in the model specifications.

This second study of my dissertation contributes to and extends existing literature of diversification by investigating synergies that result from a new and yet unexplored form of diversification. According to my results, 'integrated user-manufacturer firms' seem to benefit strongly from the duality of their activities in some fields.

This study is mainly based on the firm diversification literature. As mentioned above, two main concepts that are used to describe the diversification of firms are the RBV (e.g., Peteraf, 1993; Silverman, 1999; Wernerfelt, 1984) and TCE (e.g., Williamson, 1975, 1979, 1995). In general, the literature distinguishes related and unrelated diversification and finds positive performance effects mainly for the former. Penrose (1959) postulates that firms use the excess capacities of their resources as a basis for diversification into related fields. Thus, as long as it is monetarily attractive for a firm to use its underused resources for diversification efforts, it will have an incentive to diversify (Penrose, 1959). In other words, if a firm is able to sell its underused resources on the market and generate higher profits compared to the profits it can achieve using the resources for diversification, it would discontinue its diversification efforts (Teece, 1980, 1982). However, according to Nelson and Winter (1982), the sale of resources on the market is difficult because intangible assets in particular are often deeply embedded in the structures and routines of a firm. The strategy literature postulates that those assets that provide a competitive advantage to a firm are typically those that are difficult, if not impossible, to transfer across firm boundaries (Lippmann and Rumelt, 1982). Similarly, these assets are usually difficult to transfer into another market or to use efficiently in another context and, thus, to use as a basis for diversification (Silverman, 1999).

TCE define the efficient boundaries of a firm (Williamson 1981) and thus provide an explanation of why firms engage in related diversification. According to Williamson (1979, 1981), firms choose the governance model for a transaction to minimize the transaction's costs. Thus, firms evaluate a make-or-buy decision based on a comparison of the costs of the market transaction with the internal costs of management (Levy, 1985). Decisions regarding whether to conduct a diversification effort are based on similar considerations.

Research Question 3: *How do different forms of organizational change affect firm innovative activities? What is the influence on the innovative input? What is the influence on the innovative output?*

While the first two studies of my dissertation analyze the phenomenon of 'integrated user-manufacturer firms' and investigate the relationship between diversification and innovation in the field of user-manufacturer firms, it is more difficult to explore the development of firms towards this specific form of diversification. Thus, my third study explores the influence of organizational change on the innovative activities of firms in a more general setting. To this end, my study uses data from the 'Mannheimer Innovationspanel,' a survey conducted by the Zentrum für europäische Wirtschaftsforschung. I compare information regarding the innovative activities of firms that have and have not undergone a major organizational change. To analyze the quantitative data, I use multivariate generalized ordered logistic regression models. Interestingly, the analyzed forms of organizational change do not influence the innovative input and output of the firms in my sample in the expected form. While I do not find any effect for divestiture activities, I find a positive effect for acquisitions on innovative input and a positive effect of major organizational changes on innovative output.

One of the major perspectives on organizational change that is supported by most management scholars postulates that organizational change happens when firms must adapt to shifting internal or external conditions. Key external factors that drive organizational change may be of a technological, regulatory, or legal nature. Another highly important factor is competition with other firms (Delacroix and Swaminathan, 1991). According to the literature (Lewin, 1947; Schein, 1996), major organizational change is an episodic event that occurs between phases of stability and that begins with an important step in which the factors hindering change are reduced and the organization becomes open to learning.

1.3 Structure of the Dissertation

The dissertation comprises six chapters that follow the three research questions introduced in Section 1.2.

This introductory chapter is followed by **Chapter 2**, in which I review existing literature from the fields of user innovation and user entrepreneurship (Section 2.1). In addition, I give an overview of the research on firm diversification and discuss two of the main literature streams that are used to explain firms' diversification activities (Section 2.2). Finally, I review the literature on organizational change (Section 2.3). All these topics lay the foundation for the further investigations included in my dissertation.

Chapter 3 analyzes the phenomenon of 'integrated user-manufacturer firms' in depth and provides evidence of the factors supporting and hindering such a business model. The results of this study extend existing understanding in the field of corporate user entrepreneurship by demonstrating that the user and manufacturer functions can coexist under certain conditions.

Chapter 4 builds on the findings of the previous chapter and compares the innovative activities of manufacturing units of user-manufacturer firms to those of manufacturing-only firms. Specifically, it analyzes the effect of a dual business model on the quality of patents held by these firms.

Chapter 5 analyzes the effect of major organizational changes on the innovative activities of firms. Whereas I investigate the effect of the dual business model of user-manufacturer firms on innovation quality in Chapter 4, I explore the influence of a change in the business model or other major organizational changes on the innovative activities of firms in Chapter 5.

Finally, **Chapter 6** summarizes key findings and contributions of this dissertation and suggests avenues of further research.

2. Foundations

2.1 Foundations of User Innovation and User Entrepreneurship

Users have been widely analyzed as an important source of innovations and broad entrepreneurial activities in the last 30 years (e.g., von Hippel, 1988, 2005; Shah and Tripsas, 2007; Franke et al., 2006; Lüthje, 2004). In the last decade, this research has been extended to examine the effects of user innovations and the process from an innovation towards a commercial product on the development of entire industries (e.g., Hienerth, 2006; Baldwin et al., 2006).

In this section, I first outline and discuss the importance of users as a source of innovation (Section 2.1.1). Next, I show how users can be integrated into a new product development process and how such efforts can benefit from lead user integration in Section 2.1.2. In Section 2.1.3, I discuss user entrepreneurship, how it differs from other forms of entrepreneurship by manufacturers, and the conditions that favor user entrepreneurship. This section is followed by a detailed description of the path from user innovations to commercial products and the influence of this development on the evolution of an industry (Section 2.1.4). Section 2.1.5 provides a summary.

2.1.1 Users as an Important Source of Innovation

Eric von Hippel (1988) defines the functional source of innovation based on the functional relationship by which the innovating individual benefits from a product, process, or service innovation. Individuals and companies benefiting from using an innovation are users, individuals and companies profiting from manufacturing an innovation are manufacturers, and individuals and companies benefiting from supplying parts that are used to build an innovation are suppliers. According to von Hippel (1988), each individual

typically plays multiple functional roles, being a user of one innovation while simultaneously being a supplier or manufacturer of another innovative product, process, or service.

Practitioners and innovation scholars long assumed that manufacturers develop product innovations. However, over the last 30 years, numerous studies in the industrial field and in consumer markets show that users often play an important role in the development of innovations (see Table 1 for an overview of exemplary industrial goods examples). Von Hippel (1976), for example, found in a study analyzing the sources of innovation in the industrial goods environment that 80% of the innovations that users judged to offer a significant increase in functional utility were developed by users instead of manufacturers. In addition, Urban and von Hippel (1988) present the results of a study in the field of computer aided design (CAD) systems. They found that two thirds of all the innovations in this field are generated by users and not by manufacturers or other parties. In addition, innovative users are often found in the clinical field, where surgeons and other doctors are the source of many (53%) product innovations (Shaw, 1985).[5] The field of consumer markets provides similarly striking observations. Shah (2000) found that it was always the end users in the windsurfing, snowboarding, and skateboarding markets who developed the first versions of basic equipment. In addition, users made 58% of the major improvements to this equipment. Tietz et al. (2005) and Lüthje et al. (2005) both analyzed specific consumer markets regarding the share of users that innovate. They found that 26% of Australian kite surfers and 19%[6] of US mountain bikers who responded reported that they develop solutions for their own use.[7]

Today, scholars and practitioners agree that many users (individual users or firms as users) innovate to develop those products, services, or processes that fit their individual needs exactly (von Hippel, 2005). The difference between user innovators and

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[5] Additional examples of user innovations in the field of industrial goods can be found in the studies of Herstatt and von Hippel (1992), Riggs and von Hippel (1994), or Morrison et al. (2000), among others.

[6] Even though a certain selection bias might increase the percentages, the observations still show a relatively high degree of innovation activities of users in the two observed fields.

[7] For additional examples of cases analyzing user innovations in consumer markets, please see Franke and Shah (2003), Baldwin et al. (2006), Hienerth (2006), Lüthje (2004), and Hyysalo (2009), among others.

manufacturer innovators lies in the functional relationship through which they aim to benefit from the innovation. Whereas manufacturer innovators innovate because they expect to benefit from selling the innovation, user innovators innovate to benefit from using the innovation themselves (von Hippel, 1988, 2005; Enos, 1962; Freeman, 1968; Shaw, 1985).

Table 1: Overview of the Functional Source of Innovation

	Innovation Developed By			
Innovation Type	**User (in %)**	**Manufacturer (in %)**	**Supplier (in %)**	**Other (in %)**
Scientific Instruments	77	23	0	0
Semiconductor and Printed Circuit Board Process	67	21	0	12
Pultrusion Process	90	10	0	0
Tractor Shovel-related	6	94	0	0
Engineering Plastics	10	90	0	0
Plastics Additives	8	92	0	0
Industrial Gas-Using	42	17	33	8
Thermoplastics-Using	43	14	36	7
Wire Termination Equipment	11	33	56	0

Source: von Hippel, E. (1988): The Sources of Innovation, p. 4

Studies that investigate who the users are that do not only use products, but that do also innovate find that most of them show characteristics of 'lead users'. Eric von Hippel (1988) defined two major characteristics of those advanced users. First, lead users are ahead of the general market with regard to an important market trend; second, lead users expect relatively high benefits from a solution to their problem. Morrison et al. (2004) provide empirical evidence for von Hippel's definition of lead users as they find that the two above mentioned lead user characteristics and the likelihood that a user that displays these two characteristics will innovate are highly correlated.

According to Franke et al. (2006), being ahead of the market drives the commercial attractiveness of an innovation generated by a lead user. Diffusion curves for products and services show that not every individual in a user population expects the same high benefit from an innovation at the same time; thus, some individuals adopt innovations earlier than others (Foxall, 1994, 1994a; Rogers, 1995). This fact, combined with the aspect that classic users are often unable to consider new products or uses beyond their own experience (Adamson, 1952; Adamson and Taylor, 1954; Allen and Marquis, 1964), makes leading-edge users the ideal individuals to understand the future needs of the general market. In contrast, the degree of the expected benefits serves as an indicator of the likelihood that a lead user really innovates (Franke et al., 2006). Various studies have shown that the greater the potential benefit is that the solution to a problem provides to an individual, the more the individual will invest in finding a solution (Mansfield, 1968; Schmookler, 1972).

The literature presents two options for how a user innovator can benefit monetarily from his innovation (other than by using it). First, a user innovator may license others to use knowledge of his innovation for the product development of an own product for a fee (von Hippel, 1988). This option seems to be the easiest one as the user need not change his functional relationship toward the innovation. Second, a user innovator may become a manufacturer, commercialize his innovation and benefit from it by selling it to others (Baldwin et al., 2006; Haefliger et al., 2010; Shah and Tripsas, 2007).

According to, for example, Urban and von Hippel (1988), Chatterji and Fabrizio (2008), Chatterji et al. (2008) user innovations are in many cases commercially highly attractive. Nevertheless, only few lead users exploit the commercial potential of their innovations by becoming a manufacturer and selling their innovations on the market. The reasons for this phenomenon are twofold. First, lead users innovate to find a solution to their own needs rather than to benefit from selling their innovation. Thus, their motivation to benefit commercially from their innovation is limited compared to that of a manufacturer innovator. Second, according to von Hippel (1988), changing from a user of a product to a manufacturer of the same product is difficult and may prevent many users from exploiting the commercial potential of their innovations. The main reason for the difficulty of switching functional roles is, according to von Hippel (1988), that the two roles require different resources, such as sales, organizational or production infrastructure, and a

different customer base.[8] Nevertheless, some users overcome these difficulties and become manufacturers (Baldwin et al., 2006; Shah and Tripsas, 2007; Haefliger et al., 2010). I will discuss this path from the user of a product to a manufacturer or a 'user-manufacturer' in detail in Section 2.1.3.

2.1.2 Lead Users and New Product Development

Many authors have shown that an accurate understanding of consumer needs is essential for developing commercially successful products (Henard and Szymanski, 2001; Becker, 1998; Gruner, 1997; Rothwell et al., 1974). Li and Calantone (1998) and Cooper and de Brentani (1991) go even further, postulating a clear relationship between firm customer orientation and corporate performance.

As mentioned in the previous section, classic market research methods do not seem appropriate for the generation of breakthrough innovations because classic users are often unable to imagine new products or new uses of a familiar product that go beyond their own experience (Adamson, 1952; Adamson and Taylor, 1954). Thus, classic market research methods often yield disappointing results when searching for radical innovations (Lynn et al., 1996, O'Connor, 1998). In contrast, many user innovations are of a high commercial attractiveness, meaning that many products developed by lead users would also appeal to 'normal users' (Franke et al., 2006; von Hippel, 2005; Franke and von Hippel, 2003). The reason for this attractiveness is that lead users are ahead of the general market with regard to important market trends. This fact, combined with the fact that 'normal users' are often unable to think beyond their current experience, makes lead users well suited for understanding the future needs of the general market.

Lead users can enrich the product development process in several ways. First, lead users can provide valuable information regarding user needs, especially in high-technology environments in which 'normal users' have problems expressing their unfulfilled needs

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[8] This argument is in line with the RBV, which states that resources that create a competitive advantage for one firm are typically not perfectly mobile and, thus, cannot be transferred from one firm to another. I will further outline this argument in Chapter 2.2.1.

(von Hippel, 1986). In addition, lead users can give far more insights than classic market research. Whereas classic market research typically generates insights regarding users' unfulfilled needs, lead users can additionally contribute rich information regarding solutions to these unfulfilled needs (von Hippel, 1976, 1988).[9] According to von Hippel (1986), this additional solution knowledge can make the product development process much more productive, especially in rapidly changing environments.

2.1.3 User Entrepreneurship

In Section 2.1.1, I outline that users represent an important source of innovation. According to Shah and Tripsas (2007) and Lettl and Gemünden (2005) as well as to research on entrepreneurship, users are not only an important source of innovation but also an important source of entrepreneurial activities. The key difference between other forms of entrepreneurship by manufacturers and user entrepreneurs lies in the fact that user entrepreneurs have experience using an innovation. In addition, user entrepreneurs benefit not only monetarily from their innovation but also from their own use of the innovative product or service. Thus, the paths toward entrepreneurship of entrepreneurs that are manufacturers and user entrepreneurs differ in the sense that the former group first assesses the economic potential of an innovation and then develops the final product, with the goal of commercializing it and gaining monetary benefits from selling it. Alternatively, this group of entrepreneurs may own a technology or product and brings it into the market based on the assumption that a need for such product exists and with the goal of gaining monetary benefits from selling it. In contrast, user entrepreneurs are 'accidental' entrepreneurs in the sense that they typically have an idea based on their own user activities that they develop without any plans of commercialization. Due to feedback from other

[9] One way to involve users in the product development process is the lead user method, which was developed by Eric von Hippel together with 3M (von Hippel et al., 1999). Franke et al. (2006) and Lilien et al. (2002) find that 3M records higher sales and profits from products developed based on the lead user method compared to products developed based on traditional idea generation methods. For further insights on the lead user methodology, please see von Hippel (1986), Herstatt and von Hippel (1992), and Morrison et al. (2000).

users, the user entrepreneur begins to see a general need for the innovation and decides to commercialize the product or service.

Shah and Tripsas (2007) define user entrepreneurship as "the commercialization of a new product and/or service by an individual or group of individuals who are also users of that product and/or service". In addition, the two authors distinguish end-user entrepreneurs[10], who are individuals who use a product in their day-to-day life, and professional-user entrepreneurs[11], who are confronted with a product in their professional life and must leave the organization to which they originally belonged when they start commercializing their user innovation.[12]

Shah and Tripsas (2007) and Baldwin et al. (2006) identify several conditions that favor user entrepreneurship. First, user entrepreneurship is likely if a user innovator derives enjoyment from the use and the initial production of a user innovation. According to Gimeno et al. (1997), Scott et al. (2002), and Klepper (2007), many entrepreneurs commercialize their innovation not only to gain monetary benefits from selling it, but also for intrinsic reasons, such as being part of a certain community, doing something 'meaningful,' being more autonomous through self-employment, or enjoying a particular lifestyle. Thus, as individuals expect both monetary benefits and enjoyment from their work, one would expect user entrepreneurs to be more common in industries in which the use and the initial production of an innovation provide enjoyment in addition to monetary benefits. A low level of opportunity costs for the user innovator has a similar effect (Shah and Tripsas, 2007). If individuals who innovate do not have other options that would allow

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[10] Various examples of end-user entrepreneurship exist. Shah (2003) found that over 40% of key innovations in the windsurfing, skateboarding, and snowboarding markets were commercialized by end-user entrepreneurs instead of manufacturers. Other examples that underline the important role of end users in the development of industries are Baldwin et al. (2006) for rodeo-kayaking, Franz (2005) for automobiles, Lüthje et al. (2005) for mountain biking, and Franke and Shah (2003) for snowboarding, sailplaning, canyoneering, and handicapped cycling equipment.

[11] An important example of professional-user entrepreneurship is a hotel owner in Massachusetts who became successful in the ice-harvesting industry in the 19th century (Utterback, 1994). Other important studies that describe forms of professional-user entrepreneurship are Enos (1962), Morrison et al. (2000), and von Hippel (1977).

[12] Although Shah and Tripsas acknowledge that firms can also act as users, user innovators, and user entrepreneurs, they do not include them in their study because they expect a completely different process of user entrepreneurship for corporate users than for end-user or professional-user entrepreneurs.

them to gain high monetary benefits (e.g., stay-at-home parents who would not take another job opportunity), the likelihood that these individuals will commercialize their user innovations is higher compared to situations in which the individuals have other opportunities (e.g., a software developer who is employed by a software firm would have to leave his secure job to commercialize his user innovation idea). Furthermore, industry structure is important; user entrepreneurship is less likely in mass markets, whereas industries characterized by small-scale niche markets are conducive to user entrepreneurship (Shah and Tripsas, 2007). The reason for this difference is that the attractiveness of such niche markets for established organizations is much lower than that of mass markets. As user entrepreneurs do not commercialize their innovations with the same goals as established firms (i.e., to achieve the highest profits and grow as quickly as possible), niche markets are relatively attractive for user entrepreneurs. Additionally, turbulent markets increase the likelihood of user entrepreneurship (see Baldwin et al., 2006, for a formal model of this issue) as the information regarding users and their needs, to which user entrepreneurs have direct access, is most valuable in such turbulent markets. In established markets, such user preferences can also be identified using classic forms of market research (Shah and Tripsas, 2007). In contrast, the need for complementary assets increases the difficulty and decreases the likelihood of market entry by a user entrepreneur and especially by an end-user entrepreneur.

Shah and Tripsas (2007) report two primary differences between the paths toward entrepreneurship of ‘classic’ entrepreneurs and user entrepreneurs. First, the two authors consider the process toward user entrepreneurship as emergent in the sense that users conduct the first steps of product development and optimization without the goal of exploiting the innovation commercially. In contrast, a classic entrepreneur starts with an evaluation of the commercial potential of an innovation idea before undertaking the first steps toward the foundation of a firm. Second, the time at which an entrepreneur receives feedback on his innovation differs between user entrepreneurs and classic entrepreneurs. In many cases, a user entrepreneur exposes his innovation to the community long before he founds a firm to exploit the innovation commercially and, thus, receives feedback prior to the foundation of a firm. In contrast, a classic entrepreneur typically receives user feedback after founding the firm and entering the market.

Haefliger et al. (2010) describe a two-phase approach to user entrepreneurship. In the first phase, user entrepreneurs begin 'under the radar' of incumbent firms by gaining industry and project experience and attracting initial customers. In the case that Haefliger et al. (2010) studied – movies filmed in video games – this process is facilitated by the fact that the final product is created using an entirely different process than those originating from incumbent firms. In the second phase, the user entrepreneurs engage in commercialization.

As I describe above, users that are not embedded in an organization represent one important form of entrepreneurship. However, there is evidence that these users are not isolated individuals but that they receive feedback and assistance from other users regarding the development of their products (Franke and Shah, 2003). User communities in which this exchange happens are characterized by voluntary participation, a relatively free flow of information and less hierarchical structures than occur in firms. Typically, community members provide free assistance, and the user innovator shares his innovation with the community members for free. User innovators who actively participate in a user community may benefit from community members' participation in two major ways on their path toward user entrepreneurship. First, they receive firsthand information regarding the needs of potential users and direct user feedback on their innovation. Second, the discussion of an innovation in a user community increases novelty levels and helps to improve products because the creativity of many users is incorporated into the product development process instead of just one individual's ideas (Franke and Shah, 2003; Shah and Tripsas, 2007; Hienerth, 2006; Tietz et al., 2005).

2.1.4 The Path from User Innovations to Commercial Products

Hienerth (2006) and Baldwin et al. (2006) analyze the development of user innovations towards commercial products and the influence of this development on the evolution of a complete industry. Both studies use the rodeo kayaking industry as the context to study these phenomena. According to Baldwin et al. (2006), the first phase of the development from user innovations to commercial products is initiated by the opening of a

design space[13]. Each individual user will compare the amount of time, money, and effort it will take him to develop a design for his own use with the benefits he expects from his own design. Based on this comparison, each user decides whether he should start developing his own design within the boundaries of the new design space. According to Hienerth (2006), these individual efforts clearly occur with the goal to create a product for the innovator's own use and to fulfill his individual needs instead of with the goal of earning money by selling the product. In this first phase of the transition from user innovations to commercial products, neither communities nor rivalries between user innovators exist. Innovators reveal their innovations freely with the goal to develop the best product for their own use instead of developing a product that is best suited to gaining a monetary benefit (Hienerth, 2006). According to both Baldwin et al. (2006) and Hienerth (2006), the next step in the development of commercial products is the transition from development efforts conducted by isolated individuals to joint efforts of a number of community members. In this phase, it becomes increasingly important to be part of a community as information and innovations are no longer shared with every individual but only with a selected group of people (Hienerth, 2006). The result of the community's innovation efforts is typically a number of radical innovations. This second phase usually ends as soon as rivalry and competition between community members begin to occur. This effect becomes even stronger as soon as the first community members become user-manufacturers and compete with other user-manufacturers for customers. At this point, the incentive for these user-manufacturers to share their ideas with other community members disappears (Henkel, 2006; Baldwin and Clark, 2006). Thus, the benefits of belonging to a community decrease as the willingness of community members to freely reveal information declines (Franke and Shah, 2003). The second stage in the transition from user innovations toward commercial products gives way to the third phase, the 'commercialization phase.' This phase is characterized by manufacturing firms that remain hesitant to enter the market. Eventually, user-manufacturers form firms and begin commercializing their innovations. While the overall

[13] According to Baldwin et al. (2006), a 'design space' can be considered as the field "in which design search takes place" and includes all possible design variations (e.g., color, form, and material) of the product in focus. A 'design space' opens up and then is 'mapped' by users and manufacturers searching for the best design in the existing space. When the 'best design' is found, all search activities stop. As soon as a new design space is identified, individuals or firms begin their search activities again within the boundaries of the new design space (Baldwin et al., 2006).

community is still relevant, smaller teams begin to exploit the commercial potential of the innovations. The commercialization phase also represents the phase in which the segment grows from a niche segment into a larger market that also addresses hobbyist users (Hienerth, 2006). According to Baldwin et al. (2006), in the commercialization phase, the design that most individuals consider best is identified. In addition, the number of individual activities by users decreases, and the number of users in the field increases. Thus, the field increasingly develops the characteristics of a classic mass market. The last phase is the phase in which a user innovation becomes a commercial product. According to Hienerth (2006), classic manufacturing firms and user-manufacturers are both active on the market during this phase. User-manufacturer firms often focus on a niche, targeting expert users with high-quality, high-priced products, whereas traditional manufacturer firms serve the amateur market with a different and cheaper technology (Baldwin et al., 2006). Innovations in this stage shift from radical user innovations to incremental innovations. Information is no longer shared freely, and classic manufacturing firms hire lead users to drive their own development efforts. The frequency with which user-manufacturers and pure manufacturers enter the market with a new product design is high, and the quality has reached a very high level. The goal of the manufacturers serving the market shifts from radical innovations for the lead users in the field toward innovations that make the product more user-friendly for amateur users. Although user communities no longer exist in the form they took in the early phases of the process, user platforms serve amateur users seeking information exchange about existing products.

2.1.5 Summary

As described in Sections 2.1.1 and 2.1.3 users are an important source of innovation and of entrepreneurial activities.

The literature describes two ways for users to benefit from their innovations monetarily (beyond using the innovations). First, users may license other individuals or firms to use the knowledge of the innovation and integrate it into a new product for a fee (von Hippel, 1988). Second, a user innovator may change his functional role and commercialize his innovation by permanently becoming a manufacturer of the product

(Baldwin et al., 2006; Shah and Tripsas, 2007; Haefliger et al., 2010). The former option seems to be easier as, according to von Hippel (1988), the switch in the functional role from user to manufacturer is difficult. The main cause of this difficulty lies in the different resources, such as sales or production infrastructure, technical knowledge, and a different customer base, that are required for each of the two roles. These difficulties in switching the functional role and the fact that most user innovators are driven by both monetary reasons and the goal of developing a product that fulfills their needs are why user innovators often do not exploit the commercial potential of even highly commercially attractive innovations (e.g., Urban and von Hippel, 1988; Franke et al., 2006).

In both of these options, the user and manufacturer do not interact for long, either because the user is not part of the manufacturing firm or because the user innovator permanently switches his functional role from user to manufacturer. However, a close relationship between a user innovator and a manufacturer of a product is conceivable if the user innovator keeps his user business while additionally adopting a manufacturing business. In Chapter 3 of this dissertation, I outline this third way in which established corporations, as users of a product, may benefit from their own innovations. I will further investigate this form of generating monetary benefits from a user innovation, and I will also derive general propositions regarding the circumstances that favor this specific form of diversification.

2.2 Foundations of Firm Diversification

Firm diversification is widely analyzed in the industrial organization, strategy and financial economics literature. TCE (e.g., Williamson, 1975, 1979, 1995; Shelanski and Klein, 1995; Klein et al., 1978) and the RBV (e.g., Barney, 2001; Peteraf, 1993; Silverman, 1999; Wernerfelt, 1984) are widely used to explain why firms engage in diversification.

In this chapter, I first introduce both concepts in Section 2.2.1 (resource-based view of the firm) and Section 2.2.3 (transaction cost economics). Following the introduction, I discuss how each of these two concepts serves as a theoretical foundation for the diversification activities of firms in Section 2.2.2 and 2.2.4. In Section 2.2.5, I summarize

the discussion regarding the effect of the form of diversification (i.e., related versus unrelated) on firm performance. I provide an overview of the diversification strategy discussion in Section 2.2.6. In Section 2.2.7, I summarize.

2.2.1 The Resource-Based View of the Firm

The RBV aims to understand why some firms consistently outperform others (e.g., Barney and Arikan, 2001; Barney, 2001). The RBV postulates that the sources of this competitive advantage[14] can be found in the resources of firms. According to, e.g., Barney (1997) and Peteraf (1993), four characteristics of a firm's resources are necessary to generate a sustained competitive advantage: value, rareness, imperfect imitability and no direct substitutability.

Valuable: Resources that are valuable are sometimes also labeled 'superior'. A valuable or superior[15] resource enables a firm to increase the efficiency or effectiveness of the firm's value creation process.

Rareness: A competitive advantage of a firm is considered "a value creating strategy not simultaneously being implemented by any current or potential competitors" (Barney, 1991). Thus, only a valuable resource that is not owned by many competing firms can serve as a source for a competitive advantage.

Imperfect imitability: Valuable and rare resources, on which a firm builds its competitive advantage, cannot be imitated by other firms. This dimension ensures sustained competitive advantage.

Substitutability: Only a resource that cannot be substituted for another equally valuable resource can serve as the source of competitive or sustained competitive advantage.

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[14] 'Competitive advantage' in the context of RBV is typically the basis for superior financial performance and, thus, monetary success.

[15] 'Superior' in this context means "superior in use relative to others (resources)" (Peteraf and Barney, 2003).

The RBV provides a resource-level and firm-level explanation of firm performance and competitive advantage of firms. Other theories focus on other levels of analysis, such as the industry level (Porter, 1980), group level (Dranove et al., 1998) or dyad level (Grimm and Smith, 1997).

The conditions under which firms may gain a competitive advantage and what makes a competitive advantage sustainable for a firm are, among others, key aspects of the RBV. In this context, a *competitive advantage* for a firm results from a strategy that improves the value creation and/or value appropriation process and that is not implemented by a current or potential competitor at the same time. A *sustained competitive advantage* requires, in addition to the above mentioned criteria, that the competing firms be unable to duplicate the benefits that the firm gains from its strategy[16] (Barney, 1991).

Furthermore, the RBV links the generation of a competitive advantage with the resource position of the firm (Barney and Arikan, 2001). In contrast to other theories, the RBV assumes that firms in the same industry differ from each other in terms of the strategic resources that they control. Second, according to the RBV, the resources that are the basis for a sustained competitive advantage and that fulfil the above mentioned criteria are not perfectly mobile and, thus, cannot be transferred from one firm to another without losses in terms of time and quality. Thus, firms can gain a competitive advantage as described above if they control strategic resources that allow them to increase the efficiency and effectiveness of their value creation process compared to their competitors (Barney, 1991).

2.2.2 Firm Diversification in the Resource-Based View of the Firm

The RBV serves as an explanation for firm diversification because it links a firm's resource position and strategic resource management with the strategy of the firm such that

[16] According to Rumelt (1984) and Lippmann and Rumelt (1982), a competitive advantage can only be considered sustainable if competing firms try to duplicate the strategy or other strategies to reach this competitive advantage without actually doing so.

it considers a firm's level of profit and diversification (i.e., the breadth of a firm's portfolio) as a function of its resource base (e.g., Wernerfelt, 1984; Montgomery, 1994).

According to Wernerfelt (1984), the key questions of a firm's diversification strategy that are addressed by the RBV are the following:

- On which current resources[17] should a firm base its diversification efforts?

- Which resources should a firm develop by diversification?

- Into which markets/industries should a firm diversify? In what sequence?

- Into which type of firms should a firm invest?

The basis of the RBV as an explanation of firm diversification was laid out by Penrose (1959). Penrose (1959) considers firms as "collections of sticky and imperfectly imitable resources or capabilities" that compete in the market against other firms, each having a unique set of resources (Wernerfelt, 1984; Barney, 1986).

Penrose (1959) and other authors (e.g., Caves, 1971; Gorecki, 1975; Teece, 1982) postulate that diversification is based on the existence of excess capacity of existing resources. They argue that the excess capacities that are not needed in current operations are the result of failed market activities. The transfer of this surplus into a new field offers an efficient way to generate profits from this surplus, even though the transfer process from one field to another in most cases causes certain efficiency losses. Based on this perspective, one would assume that as long as it is monetarily attractive for a firm[18] to use its underused resources for diversification efforts a firm will have an incentive to diversify (Penrose, 1959, p. 68). In other words, if a firm is able to sell its unused resources on the market to generate higher profits compared to the profits it can achieve by using the resource for diversification, one would expect a firm to stop its diversification efforts (Teece, 1980,

[17] Penrose (1959, p. 67) introduces a very narrow definition of resources and refers only to the "physical things a company buys, leases or produces for its own use, and the people hired on terms that make them effectively part of the firm". In contrast, I follow the work by Teece (1982), Macdonald (1984), and Montgomery and Hariharan (1990) and use a broader definition of resources by distinguishing three types of resources: physical assets, intangible assets and financial resources.

[18] Monetarily attractive compared to all other existing options to exploit the financial potential of a certain resource.

1982). However, especially in the case of intangible assets, which are often deeply embedded in the structures and routines of a firm (Nelson and Winter, 1982), the sale of resources on the market is highly difficult and a rare phenomenon. Strategy literature (e.g., Lippmann and Rumelt, 1982) postulates that those characteristics of a resource that make it difficult to transfer across firm boundaries to other firms are the characteristics that make it difficult for potential imitators to reproduce the respective resource and are thus a source of competitive advantage for the firm that controls the resource.

The literature on RBV and diversification suggests that the flexibility of applying a resource is of particular importance. Similar to the above mentioned logic[19], the same characteristic that makes one resource highly valuable for a firm and that allows a firm to generate rents from this resource often makes it difficult (in some cases even impossible) to transfer this resource to another market and to efficiently use it in another context or, in other words, to use it as a basis for diversification (Silverman, 1999). According to Montgomery and Wernerfelt (1988), the flexibility of a resource is typically inversely proportional to its ability to serve as a competitive advantage for the owning firm. Thus, the better a resource can be transferred across firm boundaries the lower will be the competitive advantage this resource can create (Wernerfelt and Montgomery, 1988). According to literature, the same characteristics that make a resource difficult to transfer across firm boundaries make it also difficult for competitors to imitate (e.g., Lippman and Rumelt, 1982).

Many RBV scholars link the industry type into which firms diversify to the type of resources that firms control (e.g., Farjoun, 1994; Mahoney and Pandian, 1992; Silverman, 1999). The common assumption is that firms choose to diversify into those markets that provide the firm with a competitive advantage. Porter (1980) states that the critical resources that firms can transfer from one market to the other can serve as the basis for such competitive advantage. Lemelin (1982), Stewart, Harris, and Carleton (1984), and Montgomery and Harhiharan (1991) find empirical evidence in their studies that firms choose primarily those industries for diversification that build on resources similar to those

[19] Those characteristics that make it difficult for a firm to transfer this resource across firm boundaries are in many cases those characteristics that serve as the source for competitive advantage.

that the firms already control. In addition, according to Chatterjee and Wernerfelt (1991), a systematic relationship between the resources a firm controls and the market type that it chooses to enter exists. Linking the diversification type to the resource flexibility and building their research on the three above mentioned resource types[20], they assume that physical and intangible assets are more inflexible and, thus, lead to diversification into related markets[21], while financial resources can be employed in many markets and are thus used for any type of diversification.

Many RBV scholars who study the links between the resources of a firm and the industries into which firms diversify postulate that, in general, the attractiveness of an industry is dependent on the resources of the diversifying firm (Andrews 1971). In addition, the 'right' level of diversification depends on the specific characteristics of the firm. Firms that control very specific resources might be the most successful with a relatively low level of diversification, while for firms that control more flexible resources, a high level of diversification might be optimal (Montgomery, 1994). On the other hand, the more widely a firm diversifies, the lower are the rents that it can expect from the diversification step because less specific resources typically lead to a lower competitive advantage compared to highly specific resources (Montgomery and Wernerfelt, 1988).

According to Penrose (1959), a firm can only conduct a certain number of market entries in a given time. Thus, the better a firm is at applying its technological resources in a certain industry (relative to other industries), the more likely it is that the firm diversifies into this market.

While the RBV serves as a rather good explanation for firm diversification, some shortcomings still exist. First, the RBV postulates that diversification decisions depend on how suitable a resource is in another industry (i.e., R&D-intensive firms tend to diversify into R&D-intensive industries). However, the RBV does not serve to predict into which of

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[20] Physical assets, intangible assets, and financial resources.

[21] Rumelt (1974, p. 29) describes two businesses as "related to one another when a common skill, resource, market, or purpose applies to each". In contrast, unrelated markets are those fields that are not linked by a common skill, mechanism or resource. I will further explore this field and provide a detailed discussion of both types of diversification and their effects on firm performance in Section 2.2.5 of this dissertation.

two equally R&D intensive industries that are both build on similar resources a specific firm should enter. Second, the RBV underemphasizes other strategic arguments for diversifying into one industry or another. Third, the fact that firms can exploit resources through market arrangements rather than through diversification is not taken into account (Silverman, 1999).

2.2.3 Transaction Cost Economics

TCE[22] studies how the parties of an exchange of products or services protect themselves from the risks that are associated with such an exchange. The reason why hazards for the trading parties exist lies in the basic assumption of the TCE that contracts are incomplete (e.g., Williamson, 1975, 1985, 1994; Klein et al., 1978). Thus, parties that invest in relationship-specific assets risk the possibility that, if circumstances change, their trading partners will try to expropriate the rents related to these specific assets (Shelanski and Klein, 1995). To protect themselves from these risks, trading parties choose a governance structure that is best suited for the specific transaction relative to all other governance structures. The decision to select a governance structure for a particular transaction is typically based on considerations regarding the efficiency of the respective governance structure relative to that of others (Williamson, 1998; Williamson, 1994). Efficiency in this context means the capacity of a governance structure to economize the costs of the respective transaction (e.g., Williamson, 1979; Williamson, 1981). The two leading governance structures that are considered by the TCE are firms and markets, although hybrid modes also exist (Williamson, 1979; Shelanski and Klein, 1995).

The TCE is a microeconomic theory that focuses on the single transaction – not on the commodity – as the unit of analysis (Williamson, 1975, 1979, 1994). In contrast, a variety of suggestions for the appropriate unit of analysis in the context of the economic organization exist. In the structure-conduct-performance approach, the ‘industry’ is the unit of analysis (e.g., Bain, 1956; Scherer, 1970), while Jensen (1983) focuses on the

[22] TCE is based on three different streams of literature: New Institutional Economics, organization theory and contract law literature (Williamson, 1981).

'individual' as the unit of analysis in his studies of positive agency theory. The suggestion that the transaction should be understood as the basic unit of analysis was first made by Commons (1924, 1934). He postulated that various governance structures exist to mediate product or services exchange between different parties.

Concluding the above mentioned aspects, according to Williamson (1981), some of the key questions the TCE aims to shed light on are the following:

- Which factors make a transaction easy or difficult to mediate?
- Is it possible to identify alternative governance structures within which transactions can be organized?
- Can we match governance structures with transactions in a way that economizes transaction costs?

2.2.4 The Transaction Cost Economics Perspective on Firm Diversification

With regards to firm diversification, TCE serves to define the efficient boundaries of a firm (Williamson, 1981) and thus provides a way to explain why firms engage in related diversification, especially in vertical integration.

According to Arrow (1969), the transaction costs that a firm faces are the "costs of organizing the economic system". As I outlined in Section 2.2.3, the choice of the appropriate governance model for a transaction is made by the trading partners, with the goal of minimizing the transaction costs (Williamson, 1979; Williamson, 1981). The appropriateness of a governance model for a specific transaction depends on four parameters that determine if it is more advantageous for a firm to buy a product or to produce it internally and thus integrate vertically: the asset specificity, the uncertainty of the future relationship, the complexity of the good, and the frequency of the transaction (Shelanski and Klein, 1995). Although various hybrid governance models exist (e.g., franchising, joint ventures), typically only the 'make' (vertical integration, transaction on the firm-level) or 'buy' (transaction on the market) types are considered. Firms evaluate

this make-or-buy decision based on a comparison of the costs of the market transaction with the internal costs of management that occur if a firm decides to integrate the production of a good (Levy, 1985).

The internal costs of management are, according to Levy (1985), primarily the ability of an organization to evaluate and monitor employees and the ability to effectively discover and process information. Both abilities depend on the size and structure of an organization. If the assets that are needed for a transaction are nonspecific, the attractiveness of a market transaction-governance model is high due to the fact that the economies of scale in both dimensions – governance and production – can only be fully exhausted by buying a product instead of producing it in a firm's own facilities (Williamson, 1981).

According to Levy (1985) and Shelanski and Klein (1995), the existence of transaction-specific assets is one of the key factors that drives the costs of a market transaction. The higher the value and the specificity of the transaction-specific assets, the higher the attractiveness of an integrated governance model to avoid the opportunistic behavior of the trading partner will be. Thus, the governance costs (e.g., writing and enforcing contracts) to prevent such opportunistic behavior increase the total costs of a market transaction. The level of governance or contracting costs depends on to what extent such opportunistic events can be anticipated (Levy, 1985). In addition, a high uncertainty regarding the future of the relationship decreases the likelihood of a market transaction and favors an integrated governance model.

The advantages of firms over markets in terms of the level of transaction lie especially in the field of harmonizing potential conflicts related to the trade of goods or services (Williamson, 1981). First, being part of one common organization reduces the incentives of trading partners to behave opportunistically. Second, costly legal disputes with the autonomous trading partner are not needed because disputes can be solved at the intra-firm level. Third, firms are better able to access all relevant information that is needed to ease potential tensions between the internal trading parties.

2.2.5 The Effect of Related versus Unrelated Diversification on Firm Performance

The question of which business to compete in is one of the fundamental questions of strategic management research (e.g., Markides and Williamson, 1994; Robins and Wiersma, 1995). According to RBV scholars, the basis for multibusiness firms and thus the reasoning behind diversification decisions lie in the strategic resources of a firm that are valuable in the different businesses in which a firm is active (Coase, 1937; Penrose, 1959; Teece, Pisano, and Shuen, 1991). According to Robins (1982), firms that do not control such strategic resources, which are the basis for all of their businesses, or firms that do not base their diversification efforts on such common strategic resources will achieve lower performance than the sum of their separate businesses. The RBV (e.g., Rumelt, 1974) postulates that these strategic interrelationships between businesses of a firm do have a positive impact on a firm's performance; thus, firms with interrelated business portfolios tend to outperform firms with unrelated portfolios.

Rumelt (1974) originally classified firms' business portfolios [23] into 'related diversified portfolios' [24], 'unrelated diversified portfolios', 'vertically-integrated businesses', and 'single-business firms'. This approach has been further developed by management scholars (e.g., Montgomery, 1982; Caves et al., 1980; or Montgomery and Wernerfelt, 1988), who measure diversification efforts on a continuous scale from related[25] to unrelated.

In his 1974 study, Rumelt finds empirical evidence that the profitability of a firm varies with the diversification strategy that it follows. Firms that diversify primarily into those businesses that are related to the field of the current activities of a firm achieve the

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[23] Rumelt considers a firm's business portfolio at one point in time, assuming that the current portfolio of a firm is the result of a row of diversification decisions that might have been related or unrelated and thus result in a related or unrelated business portfolio of a firm.

[24] Rumelt (1974, p. 29) describes two businesses as "related to one another when a common skill, resource, market, or purpose applies to each". Unrelated portfolios are businesses that are not interrelated by such a common base.

[25] In many cases, also labeled as 'horizontal' as diversification into a horizontal business is considered the most related form of diversification.

highest profitability levels, while firms that are vertically diversified or follow an unrelated diversification strategy achieve the lowest levels of profitability.

In the following decades, several studies were presented with the aim of supporting or disproving Rumelt's position. Today, a series of studies with equivocal findings exist[26] – some of them supporting Rumelt's findings (e.g., Bettis, 1981) – while other researchers have found that industry structure (e.g., Bettis and Hall, 1982; Montgomery, 1985; Christensen and Montgomery, 1981; Lecraw, 1984) or firm characteristics (e.g., Grant and Jammine, 1988; Montgomery, 1985) have an important influence on the profitability level of firms and have thus shown that the importance of the relatedness of the acquired business field is limited in many cases.

Although the empirical studies on the effects of related diversification on firm performance produce equivocal results, theoretical arguments – mainly from the perspective of the RBV – exist regarding why firms with related business portfolios outperform firms with unrelated business portfolios (Robin and Wiersma, 1995). The RBV even argues, based on Coase (1937) and Penrose (1959), that the rationale for the existence of multibusiness firms lies in the sharing of strategic resources between businesses (Mahoney and Pandian, 1992; Teece, 1982; Teece et al., 1991). Scope economies are one of the key effects from which related diversified firms can benefit (Teece, 1984; Hill et al., 1992).

Markides and Williamson (1994) based on an empirical study support Rumelt's position and consider related diversification superior to unrelated diversification because it allows for the exploitation of the common resource basis of the different businesses of a firm. The two authors see disagreement in the questions of 'how' and 'when' diversification can be used to achieve a sustained competitive advantage due to two main reasons. First, in the eyes of Markides and Williamson, the measures of relatedness have been incomplete in the past because most of them focus on relatedness at the market or product level. In contrast, the relatedness of the strategic resources of two businesses, which is difficult to measure, is of much higher importance. Second, the authors mention

[26] Please see Hoskisson and Hitt (1990) and Ramanujam and Varadarajan (1989) for a fairly comprehensive overview of this field.

that researchers in many cases focus too much on the short-term benefits of relatedness[27] instead of considering the more strategic long-term benefits.

2.2.6 The Effect of Diversification versus Focus on Core Competencies on Firm Performance

Many studies discuss the benefits of related diversification and find evidence of a curvilinear relationship between the extent of firm diversification and firm performance such that related diversified firms outperform single-business firms and unrelated diversifiers (e.g., Palich et al., 2000; Singh and Montgomery, 1987).

The early literature on the relationship between the degree of diversification of a firm and its performance postulates that firms can reach a positive linear relationship between their degree of diversification and their performance by employing a number of tools to exploit market power advantages (e.g., Caves, 1981; Scherer, 1980; Sobel, 1984), internal market efficiencies (e.g., Froot et al., 1994; Lang et al., 1995), or the utilization of excess resources (e.g., Markides, 1992).

In contrast to the above mentioned position that an increase in a firm's diversification level is always associated with a positive influence on a firm's performance level, independent of the current degree of diversification of the firm, strategy scholars have developed curvilinear models. These models[28] postulate that a moderate level of diversification (i.e., related diversification) allows firms to exploit the synergies of a common strategic resource and, thus, has a positive influence on firm performance. According to Lubatkin and Chatterjee (1994), firms that focus on one industry (i.e., single-business firms according to Rumelt's (1974) definition) do not have the opportunity to exploit the synergies of resources used in more than one business unit to the extent that moderately diversified firms do. Furthermore, such single-business firms face a higher risk

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[27] Short-term benefits of relatedness include economies of scope or the amortization of a firm's existing assets.

[28] Two alternative curvilinear models have been introduced in the literature: the 'inverted-U model' and the 'intermediate model'.

because they cannot mitigate potential negative market developments in one business unit by sales in another field.

The intermediate model then assumes that the positive effect of each additional diversification efforts decreases and turns zero at some point. Markides (1992) explains that the more diversified a firm is the more it moves away from its core business and the lower the synergies of existing strategic resources become. Similarly, the inverted-U model posits that as soon as a certain level of diversification is reached and a firm continues to diversify (typically by unrelated diversification efforts), the performance level of the firm declines again (Palich et al., 2000). A strong increase in costs[29] associated with every additional diversification effort creates this optimal level of diversification of the inverted-U model. While empirical studies seem to support the inverted-U model (e.g., Hoskisson and Hitt, 1990; Lubatkin and Chatterjee, 1994), other cases also exist (e.g., Bettis and Hall, 1982; Hitt and Ireland, 1985; Palepu, 1985).

Prahalad and Hamel (1990) take up the point that related firms that diversify based on a base of broadly applicable knowledge outperform unrelated diversifiers and develop this argument towards a clear focus on a core-competences strategy. The two authors argue that managers should move away from viewing a firm as an accumulation of businesses and instead understand it as a bundle of core competences. These core competences provide firms with the potential to access various markets. Quinn and Hilmer (1994) base their work on Prahalad and Hamel (1990) and analyze how firms can determine their core competences and which production steps should be outsourced based on these considerations. Gilley and Rasheed (2000) empirically test the effect of outsourcing peripheral and core tasks on the performance of firms. While they cannot find direct evidence that outsourcing efforts do have a positive effect on the performance of firms, they do find indirect effects moderated by firm strategy and environmental dynamics.

The shift in economic research from a clear focus on unrelated diversification in general (Quinn and Hilmer, 1994) to more related diversification in the mid 1970s and then towards a focus on core competences as the basis for diversification and outsourcing

[29] According to Markides (1992), the major costs include control and effort losses and coordination costs due to organizational inefficiencies.

activities from the mid-1980s onward (Palich et al., 2000) is also reflected in empirical studies. While researchers agree that the level of diversification of larger firms in general declined from the mid-1980s onward (e.g., Lichtenberg, 1990; Williams, Paez and Sanders, 1988), a consensus for the largest corporations does not exist. Montgomery (1994) argues that "some changes at the margin [of the 500 largest US companies – the author of this dissertation] must not obscure the fact that these firms remain remarkably diversified". Lichtenberg (1992) underlines this statement by finding that while the general level of diversification decreased between 1985 and 1989, it increased for the largest 500 US firms during the same period. In contrast, Markides (1995) uses different measures for diversification and refocusing activities and finds that 50% of the 500 largest US firms pursued refocusing activities during the 1980s.

2.2.7 Summary

In summary, I discuss two streams of literature that are widely employed to explain why firms engage in diversification: the resource-based view of the firm and transaction cost theory.

Many scholars consider related diversified firms as superior to unrelated diversified organizations and to single-business firms (e.g., Palich et al., 2000; Barney, 1991; Singh and Montgomery, 1987). Thus, many arguments exist regarding why firms may benefit from diversification in general and related diversification in particular. First, pure size arguments resulting from the early research regarding the relationship between diversification and firm performance exist. While these arguments are based on a theory that observes a positive linear relationship between diversification and firm performance, they do also hold for moderate (related) forms of diversification. Arguments in this field include the idea that firms may benefit from market power advantages or the possibility of utilizing excess resources, which both result purely from the size of a firm.

The second class of arguments why firms may benefit from (related) diversification is of a strategic nature. Activities in different businesses allow for a certain risk diversification and may thus reduce the dependency on one specific business of the firm. In

addition, the market circumstances may make it strategically favorable[30] to conduct a certain business activity within the boundaries of the firm instead of as an exchange relationship with a trading partner.

The last class of arguments of particular relevance for related diversified firms is, according to management scholars, one of the key reasons why related diversified firms tend to outperform non-related diversified firms: the ability to use synergies that result from the use of common strategic resources in more than one business. If diversification efforts are based on strategic knowledge or a strategic technology of a firm, then high synergies and cross-fertilization effects between different business units can be achieved, from which related diversified firms may highly benefit.

Based on the foundations of related diversification that I outline in this chapter, I will investigate the positive effects of a specific form of related diversification that has so far been neglected[31] on the innovative output of firms in great detail in Chapter 4 of this dissertation.

2.3 Foundations of Organizational Change

There are two major theoretical perspectives on organizational change (Barnett and Carroll, 1995). The first perspective, which is supported by most management scholars, is the understanding that organizations change to adapt to shifting external conditions or to changes in the organization itself. Theories that support this approach include transaction cost economics (Williamson, 1975, 1985), institutional theory (Meyer and Rowan, 1977), resource dependence theory (Burt, 1983, 1992), and contingency theory (Woodward, 1965). The second approach postulates a selectional effect of organizational change. This approach assumes that organizations are unable to change easily or quickly and that changes in the

[30] A high uncertainty related to a market transaction relationship and a high amount of transaction-specific assets may be such arguments.

[31] A firm may use its capability as a user innovator to expand its business vertically to become a supplier to its own and its competitors' businesses. I will further introduce and discuss the concept of the 'user-manufacturer firm' at the beginning of the next section 3 and present the concept in detail in Chapter 4.1.

environment of organizations cause some organizations to fail, while new organizations may appear in response to the changed external conditions. Theories based on this approach consider the replacement of old organizational forms by new forms to be the basic mechanism of change in the 'average organizational form' to be observed. Theories that follow this approach include organizational ecology (Hannan and Freeman, 1977, 1989) and, in some cases, evolutionary economics (Nelson and Winter, 1982).

The perspective that organizations change as a reaction to internal changes as well as to changes in the external environment is widely supported by scholars in the field of management research. Because I analyze many firms from different industries and do not focus on the evolutionary development of one industry in this study, I focus on the former approach to organizational change in the theoretical foundations chapter of my dissertation.[32]

In this theoretical foundations chapter, I first outline the driving factors of organizational change and provide a brief overview of typical restraining factors in Section 2.3.1. In Section 2.3.2, I describe one fundamental process model of organizational change in detail and present an overview of other existing process models. Following the process of organizational change, I present different forms of organizational change in Section 2.3.3, and I discuss the effects of organizational change in Section 2.3.4. In Section 2.3.5, I summarize the essential ideas of this section on theory.

2.3.1 The Driving Factors of Organizational Change

According to Mintzberg and Westley (1992), organizations change constantly and cannot survive without changing. In many cases, this change is intended to adapt an organization to shifting external or internal conditions. At the same time, stability is essential to maximize the benefits of changes. Accordingly, change and stability are interrelated, with periods of change embedded in the stability of successful organizations.

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[32] For a more detailed perspective on the theories based on the second approach to organizational change, I recommend Hannan and Freeman (1977, 1989) and Nelson and Winter (1982).

Changes in the organizational structure of a firm are typically fostered by changes in the firm's environment or within the organization itself. Thus, the 'internal factors of change' and 'external factors of change' can be distinguished (e.g., Mintzberg and Westley, 1992; Armenakis and Bedeian, 1999; Barnett and Carroll, 1995).

External factors: A broad range of external factors have been studied empirically. In this work, I concentrate on the most important of these factors. In their study of the health-care industry, Meyer, Brooks, and Goes (1990) find that revolutionary changes occur mainly in response to regulatory changes from the government. Similar findings are presented by Edelman (1992) and Sutton et al. (1994), who find that changing legal conditions lead to structural adjustments in organizations. In addition, external changes may be of a technological nature, such as when the technology that is the basis of a firm's business model changes (Tushman and Anderson, 1987; Pettigrew, 1988). Competition is another important external factor that fosters organizational change. Organizations may change their structure because the competitive environment forces them to do so or to preemptively avoid a highly competitive environment (Delacroix and Swaminathan, 1991).

Internal Factors: In addition to these external factors, internal factors may also foster organizational change. Lippitt and Schmidt (1967) state that the growth of a firm requires adaptation of the firm's structures and procedures to match the increased firm size.[33] Other researchers argue that the need for change in the structure of an organization is not related to the size of the firm but to the firm's age or its products. (e.g., Boswell, 1973; Abernathy and Utterback, 1978). Additional internal change factors include changes in key personnel (Doz and Prahalad, 1988), an intentional change in the culture of the firm, and the development of a new operational strategy (Schulte-Zurhausen, 2010).

There are also factors that restrain organizational change, which can be grouped into factors that are either internal or external to an organization. External restraining factors may include unfavorable legislative changes, a lack of adequate technology, or the actions

[33] While all processes can be controlled by the firm's owner in a start-up firm, certain control and communication structures must be implemented as soon as a firm increases in size.

of third parties that inhibit changes for various reasons (Bea and Göbel, 2010).[34] Internal restraining factors may include the personal psychological factors of an organization's employees. The more radical an organizational change is, the more uncertain is the employee's future. This situation may provoke restraining behavior, such as low morale, decreased productivity, or an increase of the amount of sick time taken by employees (Schmidt, 1996).

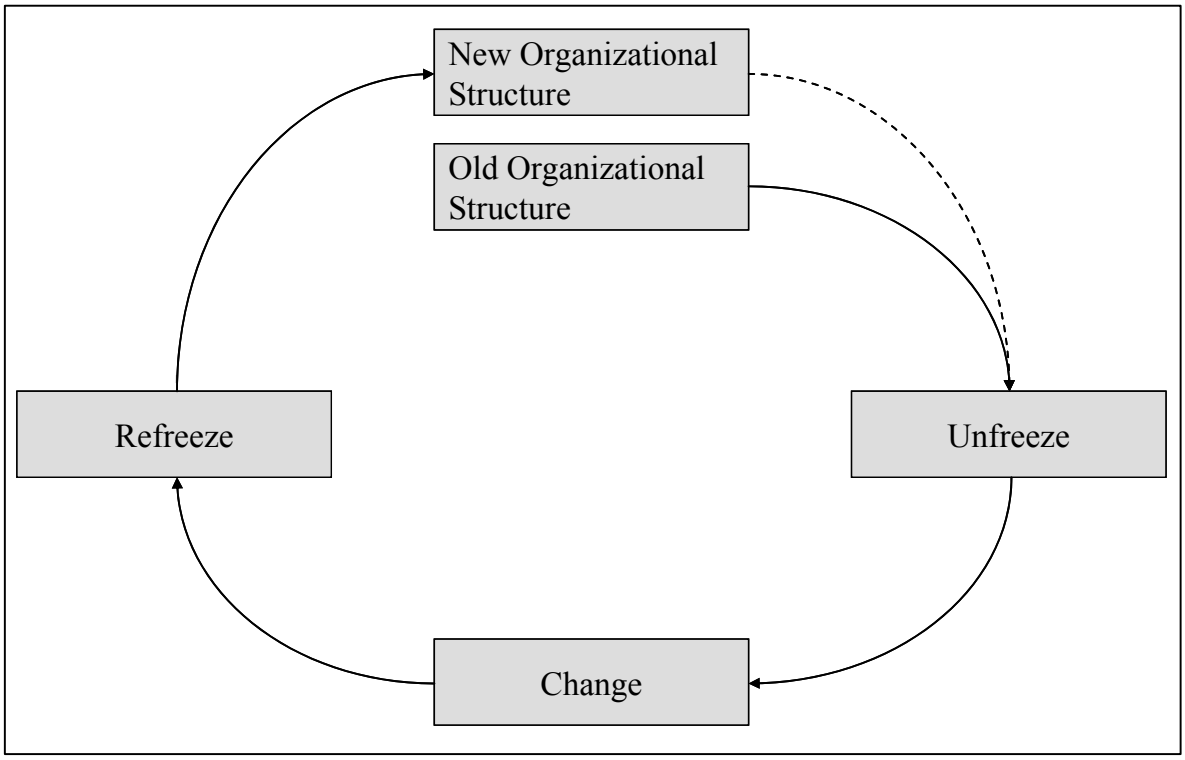
2.3.2 The Process of Organizational Change

As outlined above, the term 'organizational change' describes an intra-organizational process of change that, in many cases, becomes necessary in response to changes in the environment of an organization or changes within the organization itself. The environmental changes may be of a political, regulatory, or technological nature, and the internal changes may include changes in the firm's strategy or an intentional cultural change. These changes may require the organization's structure and procedures to be adapted to the new conditions (Greenwood and Hinings, 1996).

Although different concepts can describe the process of organizational change, the work of Lewin (1947, 1951) lays the foundation for this field of research. Lewin's concept of the three stages of organizational change – 'unfreeze', 'change', and 'refreeze' – continues to be referenced by many scholars (Figure 1).

[34] For example, banks may not provide the monetary resources needed by an organization to implement an organizational change if the banks consider the change a danger to the firm rather than a chance for successful future development.

Figure 1: Lewin's Model of Change (According to Schulte-Zurhausen, 2010)



Lewin's model is based on the fundamental understanding that the stability of an organization – and of human behavior, in general – is defined by a tension between driving and restraining forces that create a 'quasi-stationary equilibrium' (Lewin, 1947; Schein, 1996).

The first step of Lewin's (1947) change process is the 'unfreezing phase'. For unfreezing to occur, the tensions that support the equilibrium must be disrupted. However, introducing a driving force with the goal of disrupting the equilibrium often leads to the immediate development of an additional restraining force that ensures a new equilibrium. Therefore, it is often easier to eliminate an existing restraint to enable unfreezing and allow for organizational change. Eliminating restraining forces is difficult because these forces are often personal psychological barriers or group norms that are embedded in the organizational culture and are difficult to address (Schein, 1996). A key driving force for change in the 'unfreeze phase' is the disconfirmation of the expectations or hopes of organizational members that act as restraining factors. One important reason that change

may be restrained is ‘survival anxiety’, the fear that organizational changes will lead to a loss of effectiveness or, even worse, the loss of an organization's identity (Schein, 1996).

When an organization is unfrozen (i.e., it is open to change and ready to learn), the process of change begins. According to Schein (1968), in the ‘change phase’, one of two mechanisms may drive the learning process: learning through ‘positive or defensive identification with a role model’ and ‘learning through a trial-and-error process based on scanning the environment for new information’. The first mechanism describes the wholesale application of a role model's perspective on a situation. The second mechanism involves a scanning phase in which the learning organization exposes itself to existing information with the goal that these information might reveal a solution to the specific problem. The trial-and-error-phase serves as a test of the invented solution and the opportunity to better adapt it to the specific context.[35]

The last phase of the process, which increases the stability of the changes enacted during the second phase, is the ‘refreezing’ phase. The key factor in successfully stabilizing changes is that the new behavior must be consistent with the rest of the organizational behavior and with the existing organizational culture and rules. If this consistency is not present, the changes will only lead to new disconfirmations of the expectations of organization members and, in turn, to new rounds of organizational change. The ‘refreezing’ phase ends with a ‘quasi-stationary equilibrium’ of the new organizational structure, which remains stable until new disconfirmation conditions occur that produce a new round of the change process (Schein, 1996).

Based on the work of Kurt Lewin (1947, 1951), who was the first to describe organizational change as a process, many other researchers have developed multi-phase models that describe the steps of organizational change (e.g., Mintzberg and Westley, 1992;

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[35] During the search for a solution, if role models for the situation are available, the solutions employed by these role models will be used by the learning organization. If this is the case, the identification of a solution is a fast and simple process. However, because solutions are highly dependent on context (i.e., a solution may be successful only in certain kinds of organizational cultures), solutions employed by role models may not perfectly fit the context and must be adapted. If an organization aims to avoid adapting pre-existing solutions, it is important to not provide role models and to foster scanning and the development of an organization's own solution.

Armenakis, Harris, and Feild, 1999; Kotter, 1995). However, Lewin's model continues to be one of the most fundamental models of organizational development.

2.3.3 Forms of Organizational Change

Organizational change can occur continuously, but it can also occur in short episodes between longer phases of stability (Weick and Quinn, 1999). The process of change can be revolutionary in nature, but it may be evolutionary in other cases (Greenwood and Hinings, 1996). Change can be planned by an organization or by certain levels of an organization, but it can also occur in an emergent fashion when different actions produce an unplanned change (Mintzberg and Waters, 1985). Changes in an organization can be of a radical nature, causing the organization to cease to exist in its former structure. In contrast, change can be convergent, such that only slight modifications are enacted (e.g., Greenwood and Hinings, 1988, 1996; Miller and Friesen, 1984). Furthermore, the way in which a change is introduced can be either cooperative or confrontational in nature (Mintzberg and Westley, 1992). Types of change can be distinguished by their origin or by the initiator of the process (e.g., Ginsberg and Abrahamson, 1991).

As shown above, the different forms of organizational change can be determined by a broad range of dimensions. In this chapter on theoretical foundations, I will focus only on the most important types: radical versus incremental change, revolutionary versus evolutionary change, planned versus unplanned change, and continuous versus episodic change.

Radical versus incremental change: Radical change leads to the loss of the organization's concept in the form how it exists prior to the change (Greenwood and Hinings, 1988, 1996). According to Greenwood and Hinings (1993), radical change is also determined by a shift from one organizational archetype[36] to another. If the new structures

[36] Greenwood and Hinings (1993) use the formulation of 'organizational archetypes' to describe organizational structures and management structures of firms. According to the two authors, an

and firm culture are not consistent with the organization's structures, procedures, or culture prior to the change, the change is described as radical change. In contrast, incremental change, sometimes referred to as 'convergent change', is understood as the fine-tuning of the existing organization. Changes that are congruent with the existing organizational archetype and with the existing structures, rules, and culture of an organization are understood as incremental changes (Greenwood and Hinings, 1996).

Revolutionary versus evolutionary change: The distinction between evolutionary and revolutionary change is based on the pace and the scale with which the upheaval and adjustments occur (Miller and Friessen, 1980). Revolutionary changes describe changes that happen abruptly and that affect all parts of a firm (Bouncken and Jones, 2008), whereas evolutionary change describes a slower and more continuous form of change that often involves only gradual adjustments.

Planned versus unplanned change: According to Barnett and Carroll (1995), organizational change can be distinguished by whether it is planned or unplanned. Unplanned change may be the result of intended changes that take unexpected turns and lead to unexpected changes. Unplanned organizational change also occurs in the form of daily learning processes that can be considered a continuous adaptation to changing conditions (Bea and Göbel, 2010; Schulte-Zurhausen, 2010). In contrast, planned organizational change occurs when an organization decides to change its structures and initiates a process of organizational change. Thus, planned change is the intended transformation of an organization from the existing structure to a new structure (Bea and Göbel, 2010). According to some authors (e.g., Dunphy, 1996), planned change only becomes necessary in response to the employees' failure to create an organization that is able to continuously adapt to changing conditions.

Continuous versus episodic change: According to Weick and Quinn (1999), continuous and episodic change represent two different levels of perspective. The authors argue that an observer taking a macro-level perspective would see long phases of stability that are temporarily interrupted by short episodes of change. This perspective sees change

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organizational archetype is understood as a "set of structures and systems that reflects a single interpretive scheme".

as occurring episodically between long phases of stability. From a micro-level analysis, an observer sees a continuous process of minor adjustments and adaptations to shifting external conditions. Thus, this view sees change as occurring continuously (Weick and Quinn, 1999).

2.3.4 Measuring Outcomes of Organizational Change

The list of variables available to measure the outcomes of organizational change is long. To achieve a general understanding of how to assess a successful outcome of an organizational change project while avoiding a high degree of subjectivity, Barnett and Carroll (1995) suggest key criteria for any variable used to measure the outcome of organizational change.

One important criterion is the broad applicability of a variable to measure the outcome quality of organizational change. While some variables may be specific to a single case or to a small number of cases, these variables are not considered useful for comparisons with different industries or firm types (Barnett and Carroll, 1995).

Among researchers' most commonly used variables measuring the outcome of organizational change are success or failure variables. Financial ratios that measure profitability, such as returns on assets and returns on investments, or variables such as the market share are often used as variables to measure the success or failure of an organizational change effort (Armenakis and Bedeian, 1999). However, while such variables give an indication of the level of success or failure of a project, substantial changes in the numerator and denominator remain hidden due to an unchanged ratio value (Barnett and Carroll, 1995). An extreme form of success or failure variables that is used in many studies is firm mortality as a measure of failure (e.g., Barnett, 1994; Haveman, 1992). The most important reason for using firm mortality as a measurement variable in many studies is the possibility of measuring this variable with minimal ambiguity with regard to the status of a firm, in comparison to other failure variables (Barnett and Carroll, 1995).

Besides the performance criteria discussed above, people-related factors such as the employee behavior offer two benefits when used as a measure for the outcome of

organizational change projects. First, such criteria can be measured already during the change process and not only a certain time after this process is finished. Second, such criteria allow a certain allocation of where (i.e. in which parts of a firm) a change process is successful. According to Becker (1992), Becker et al. (1996), and Meyer and Allen (1997), the commitment or loyalty of employees is a suitable variable for assessing the success of organizational change projects. Three aspects are especially relevant in determining employees' degree of commitment. First, 'compliance commitment' describes the degree to which individuals are willing to comply with the organization's rules; second, 'identification commitment' represents the degree to which individuals feel affiliated with the organization; and third, 'internalization commitment' represents the degree to which individuals internalize the values of change and of the 'new' organization. Another option for measuring the outcome of an organizational change project is to use a variable measuring the opposite of what is intended, such as cynicism. According to Reichers et al. (1997), cynicism about organizational changes has detrimental effects on the outcome of organizational change projects because it negatively influences such important aspects as employee satisfaction, motivation, and commitment.

2.3.5 Summary

This theoretical foundations chapter discusses the phenomenon of organizational change from several perspectives. Beginning with the various theoretical positions on this topic, I outline the driving and restraining factors of organizational change and discuss one fundamental process model. Additionally, I present different forms of organizational change that are often distinguished in the literature. Finally, I discuss common variables that are often used to measure the outcomes of organizational change.

One important aspect of all of the perspectives on organizational change is the strong influence of any change project on the employees in an organization, including their behavior and their motivation. Important driving factors of organizational change are

directly related to an organization's personnel.[37] The behavior of employees has an even greater impact as a restraining factor for organizational change.[38] Because organizational change involves a high level of uncertainty for an organization's employees, they may resist the planned changes, especially if their self-interest is threatened (Clarke et al., 1996). Lewin (1947) recognized the importance of psychological factors and included the 'unfreeze' phase in his three-phase model, which is still considered one of the fundamental process models in this field. The goal of this phase is to make the organization (i.e., the employees) open to change and ready to learn. To this end, psychological barriers and restraints must be overcome.

The importance of the effect of organizational change on the behavior and motivation of the employees of an organization is also reflected in the outcome measures of organizational change. Although profitability variables can measure the success of organizational change projects, variables that focus on the effect of organizational change efforts on employees and their motivation can also be used.

This chapter on theoretical foundations clearly illustrates the significant influence of organizational change projects on employees' behavior, motivation, and loyalty (Hitt et al., 1996). Based on the foundations that I outline in this chapter, in Chapter 5, I will investigate the effect of organizational change projects, such as acquisitions or divestitures as well as general organizational and structural changes, on the innovative activities of firms.

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[37] For example, changes in the key personnel of an organization.

[38] Low morale, reduced productivity, and an increased sickness rate are examples of restraining factors reflected in the employees of an organization.

3. Commercializing User Innovations by Vertical Diversification: The Integrated User-Manufacturer Firm[39]

3.1 Introduction

User innovations are frequently of high commercial interest (e.g., Franke et al., 2006; von Hippel, 2005). Two methods of tapping this commercial potential have been described. First, a user innovator may transfer its innovation to a manufacturer that integrates it into new product development (von Hippel et al., 1999). In this scenario, the user innovator maintains its functional role as a user. Second, a user innovator may commercialize its innovation on the market by becoming a manufacturer (Baldwin et al., 2006; Haefliger et al., 2010; Shah and Tripsas, 2007); thus, the functional role of the user innovator changes. In both cases, the interaction between a manufacturer and a user innovator is typically limited because the lead users exist outside of the manufacturing firm or because the user innovator has permanently changed its functional role (von Hippel, 1988).

However, a close, long-term relationship between a user innovator and a manufacturer is conceivable if a user innovator who becomes a manufacturer retains both functional roles in the long term by remaining active in its original business as a user while selling its user innovations on the market. The obvious benefits of such a constellation are that it enables the firm to commercialize all of its user innovations – and so potentially a continuous stream of them – externally and that, in turn, the in-house lead user benefits most directly from improved commercial products. However, the sale of one's user innovations on the market and particularly to competitors entails the risk of giving away the competitive advantage that the user business would have derived from its innovations. As a

[39] Chapter partly based on Block, Bock, and Henkel (2010).

result, tensions might arise between the units that annihilate potential gains from synergies. In addition, in the eyes of many analysts or bankers such user-manufacturer diversification contradicts the common belief that a focus on core competencies is desirable (Gilley and Rasheed, 2000; Prahalad and Hamel, 1990; Quinn and Hilmer, 1994). Therefore, would an 'integrated user-manufacturer firm' be viable? Can the considerable commercial potential that such an arrangement holds be realized, and if so, what are the preconditions?

With this study, I aim to address the above questions. Using a case study approach, I explore the phenomenon of user-manufacturer firms and derive general propositions regarding the circumstances that should be favorable for this special type of diversification. Specifically, I analyze the history, organization, and innovation management of Bauer AG, a Bavaria-based firm that is active in both the specialist foundation engineering business and the machinery industry. Initially a focused construction firm with occasional user improvements to its machines, Bauer AG began to develop entirely new machines for its own use and ultimately decided to sell its machinery innovations as commercial products on the market. To demonstrate that my findings are valid beyond the confines of one particular firm or one industry, I analyze four additional cases from firms in the tunnel construction (WÜWA Bau GmbH & Co. KG), tea packaging (Teekanne Group, H&S Tee-Gesellschaft), and mining (DMT GmbH & Co. KG) industries. Although my propositions describe factors that are conducive to user-manufacturer integration rather than necessary conditions for this integration, I find that half of the propositions apply in all five cases.

These cases show that a successful and fruitful integration of user and manufacturer businesses can be achieved. Based on a detailed analysis of each case study and on economic reasoning, I propose that the viability of such integration is determined by factors that relate to innovation, markets, and corporate governance and organization. With regard to innovation, I propose that a continuous stream of innovations from the user unit, the prospect of receiving feedback from external customers, the risk of imitation, and the amount of investments required to turn user innovation ideas into products are factors that favor commercialization in the market. Market-related factors that should function similarly are the visibility of an innovation, the reputation of the focal firm in its original market, and the level of market volatility. Finally, I propose four factors that are related to corporate governance and organization that positively affect the market commercialization of a firm's

own user innovations: private ownership of the firm, the existence of large blockholders with undiversified portfolios, a low level of conflicts between the employees of both units, and a cooperative corporate culture with a management team that is capable of easing tensions.

The factors related to conflicts and corporate culture are particularly intriguing. The conversion of internal user innovations into commercial products and the sales of such products on the market provide competitors of the user unit access to these innovations. Thus, even if this diversification is beneficial for the focal firm as a whole, it may have negative consequences for the position of the firm in its original market. In this study, I show how company culture and management can be useful in overcoming the effects of the negative externality that user units encounter.

This study contributes to the literature pertaining to user innovation in three ways. First, I provide an example of user entrepreneurship that originates not from individual user innovators (as described by Baldwin et al., 2006, Haefliger et al., 2010, and Shah and Tripsas, 2007) but rather from an established corporation. Second, I show that the market commercialization of user innovations by the innovator itself is not restricted to the case of user entrepreneurship, with its focus on company creation and the likely implication that the original innovator eventually ceases its role as a user. Rather, the integration of the user and manufacturer units within one firm can be viable in a steady state. I indicate the preconditions for this arrangement and delineate its benefits and challenges. Finally, I establish a link between user innovation and corporate strategy. By tracing Bauer's expansion from a pure specialist foundation engineering firm to a diversified firm comprising machinery development and sales, I show how user innovation can affect one of the most central strategic questions, i.e, where to define the boundaries of a firm. I explore the intraorganizational implications and the challenges associated with the strategic decision to become an 'integrated user-manufacturer firm'.

The remainder of this chapter is organized as follows: I review the literature pertaining to the commercialization of user innovations as well as the concept of the 'integrated user-manufacturer firm' in Section 3.2. In Section 3.3, I describe the research method and data sources that are used and discuss the research setting and key quality

criteria. Following the methods section, I present five cases and the factors that lead to market commercialization decisions in Section 3.4.1. Based on the Bauer case, I derive the propositions regarding the market commercialization of user innovations in established firms in 3.4.1.1; subsequently, I validate these propositions with four additional cases in Section 3.4.1.2 to 3.4.1.5. In Sections 3.5, 3.6, and 3.7, I summarize the results, discuss the propositions, and conclude.

3.2 Theoretical Foundations

Von Hippel (1986) introduced the concept of 'lead users', which he defined by using two characteristics (von Hippel, 2005, p. 22): first, "they are at the leading edge of an important market trend(s), and so are currently experiencing needs that will later be experienced by many users in that market". Second, "they anticipate relatively high benefits from obtaining a solution to their needs, and so may innovate".[40] The effects of each of these characteristics on the commercial attractiveness of user innovations is studied by Franke et al. (2006), who find that being ahead of the market is associated with innovation attractiveness, but the level of expected benefits drives the likelihood of innovation.

In the literature, two methods by which lead users can benefit monetarily (i.e., other than by using it) from their user innovations are described. The first method of benefiting from an innovation entails licensing others to use the knowledge of this innovation and integrating it into their product development for a fee (von Hippel, 1988, p. 46). This option seems to be the easiest method by which a user can benefit from its own innovation (other than by using it), as the functional role of the user need not change.[41] Second, the user innovator may commercialize his innovation on the market by becoming a manufacturer (Baldwin et al., 2006; Haefliger et al., 2010; Shah and Tripsas, 2007); thus, the user innovator changes its functional role. However, despite the high commercial attractiveness

[40] For a more detailed description of lead user theory and the lead user concept, see section 2.1 of this work.

[41] Eric von Hippel (1988) considers the difficulties of changing the functional role from user to manufacturer as one of the key reasons that users rarely commercialize their innovations and become manufacturers. For further information on this perspective, see below or section 2.1.1.

of many user innovations (Urban and von Hippel, 1988), few lead users exploit this potential by becoming manufacturers and selling their innovations on the market. Von Hippel (1988, p. 45) attributes this fact to the difficulties of evolving from the user role to the manufacturer role; such difficulties arise as a result of the differences between the two roles in the customer base and in the sales, organizational, and production infrastructure. This is in line with the argumentation of the RBV that resources that can create a competitive advantage are not perfectly mobile, which means that these resources can not easily be transferred across firm boundaries (Section 2.2.1 and 2.2.2). Nevertheless, some user innovators do become manufacturers, as recently studied by Baldwin et al. (2006), Haefliger et al. (2010), and Shah and Tripsas (2007). To describe this phenomenon, Shah and Tripsas (2007, p. 124) introduce the term 'user entrepreneurship', which they define as "the commercialization of a new product and/or service by an individual or group of individuals who are also users of that product and/or service".[42]

In both forms how lead users can benefit monetarily from their user innovations (other than using it), by licensing others to use the innovation or by becoming manufacturers themselves, the manufacturer and the user innovator typically do not interact for long because the lead user is not part of the manufacturing firm or because the user innovator has permanently changed his functional role (von Hippel, 1988).

In this study, I demonstrate the existence of a third method by which established corporations that are users of a product can benefit from their innovations. The process of becoming an 'integrated user-manufacturer firm' entails retaining the user role while additionally adopting the manufacturer role. The stable integration of a user and a manufacturer business unit within one firm describes this third form of exploiting the potential of in-house developed innovations. In many cases, the roots of these innovations lie in the user business, as the development of user innovations is typically based on the need of the user business for a specific product.[43] However, the argumentation for the

[42] For a detailed description of user entrepreneurship and the different forms of this phenomenon, see section 2.1.3 of this work.

[43] The situation that leads to the development of a product can be compared to 'classic' lead-user behavior: the assumption of significant benefits that may be obtained from the solution of a particular problem in the user business allows firms to search for a solution and thus to innovate.

decision to commercialize a user innovation as an integrated user-manufacturer differs from those of the other two methods of obtaining monetary benefits from user innovations. Firms or individuals who aim to benefit from their innovations by licensing them or by changing their functional roles from that of the user to a manufacturer role can focus on the goal of maximizing their monetary benefits from the commercialization of such innovations. For integrated user-manufacturer firms, this decision is more complex because these firms retain their original functional role (the user role) while additionally adopting a new role (the manufacturer role). This duality of the activities of the integrated user-manufacturer firms causes additional factors to influence the decision of whether to commercialize an innovation. In addition to the argument that a firm can benefit monetarily from the commercialization of a user innovation, other aspects, such as the strengthening of competitors of the user business by selling user innovations to them, have an important role. In addition to these innovation-related factors, market-related factors and factors related to organizational and corporate governance influence commercialization decisions.

In the context of the commercialization of user innovations by established firms, I employ two key terms that I will introduce briefly in the following discussion: 'the integrated user-manufacturer firm' and 'market commercialization'.

Integrated user-manufacturer firm: In this work, the term 'integrated user-manufacturer firm' may be replaced by 'integrated user-manufacturer' or 'user-manufacturer firm'. Despite the slightly varying terminology, all terms refer to the above described firm type that integrates a user business and a manufacturing unit within the boundaries of one company. [44]

The term **market commercialization** is also named 'open commercialization'. With this term, I refer to the unrestricted sales of a user innovation on the market. Because the phase in which a user innovation is frequently sold without any restrictions to competing firms of the user business is in many cases preceded by a certain phase of

[44] While in many cases user-manufacturer firms may have their roots in the user business and become user-manufacturers by additionally adopting a manufacturer business, I also consider firms as user-manufacturing firms that have their roots in the manufacturer business an that additionally adopt the user role, as well as firms that do diversify by acquiring a new business instead of developing it from their core business.

selective sales to user firms that are active in different regions or markets, I aim to clearly distinguish between these two forms of user innovation sales.

3.3 Method and Data

In the underlying study, I employ a (multiple-)case study approach (Eisenhardt and Graebner, 2007; Siggelkow, 2007), which has two main advantages. First, the immersion into detailed case data and the use of various sources describing the phenomenon from different perspectives provide me with a deep understanding of the market commercialization decision and the mechanisms behind this decision. Second, the case studies investigate a phenomenon in its context without clearly defined boundaries between the context and the phenomenon (Gephart Jr., 2004). This method provides information regarding *why* these changes occur and *how* the underlying mechanisms work (Yin, 2003a).

My study consists of five cases; thus, this study is consistent with the guidelines of Eisenhardt (1989), who argues that a total of four to ten cases is ideal for case studies. A smaller number of cases may result in theoretical work that is less robust because the propositions may be grounded on limited empirical evidence (Eisenhardt and Graebner, 2007; Yin, 2003a). In contrast, the attempts to examine more than 10 cases provide a massive volume of data that is difficult to structure and synthesize (Yin, 2003b). I present a detailed user innovation history for all five cases and I derive the factors that influenced the commercialization decision from the Bauer Case[45]. I use the remaining four cases[46] to validate these propositions qualitatively and to ensure that my findings are robust and generalizable.

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[45] Bauer AG is a firm that is active in the field of specialist foundation engineering and the production of specialist foundation engineering machines. I choose this case for the derivation of the propositions because Bauer's development process from a 'user firm' to an 'integrated user-manufacturer firm' is very transparent and can be easily observed. Additionally, a broad range of information from various sources is available for Bauer. This information allows me to form a complete picture of this case.

[46] The 'validation cases' are the cases of Wüwa GmbH & Co. KG (a firm that is active in the tunnel construction business), DMT GmbH & Co. KG (which offers geological surveying services), and Teekanne Group and H&S Tee-Gesellschaft mbH & Co. KG (both firms are active in the tea-packing business).

The subsequent sections are structured as follows: I outline the data collection methods in Section 3.3.1, explain the data analysis in Section 3.3.2, and conduct a critical evaluation of the research design used in Section 3.3.3.

3.3.1 Data Collection

According to various authors (e.g., Eisenhardt, 1989; Yin, 2003a), the use of multiple data sources and data collection methods, such as archival data, interviews, observations, and quantitative measurement data, is a critical strength of the case study method. This triangulation of the data and data sources allows researchers to draw a complete picture of a particular situation and analyze it from different angles. However, as it is not the ultimate goal to use as many data and data sources as possible, it is important for every researcher to determine which data and data sources serve to construct the most complete picture of each case for his specific project.

Following the above described recommendations of Eisenhardt (1989) and Yin (2003a), I use different data sources and proceed by data triangulation. All of my case studies are based on two data collection methods: semi-structured interviews and archival data analysis. Although interviews are important, especially in the early stages of a research project, to gather facts and perspectives from the individuals who are involved in the project, archival information serves to enrich the information that is gained from interviews with additional background data in the later stages of a case study (Corey, Hollenbeck, and Ingols, 1990, p. 19; Schnell, Hill, and Esser, 2005, p. 322).

Semi-structured interview: Semi-structured interviews with managers and former managers of the focal firms is the prevalent data collection method that I use for my study.

In general, interviews are a major source of information for scholars who conduct qualitative research (Bortz and Döring, 2002, p. 307). Typically, interviews are conducted as face-to-face interviews or via telephone or e-mail. Depending on the goal of the interview, a researcher can choose standardized interviews, semi-structured interviews or explorative/open interviews (Schnell, Hill, and Esser, 2005, p. 323). I choose semi-structured interviews, as this method is particularly suitable for exploration, hypothesis

development, systematic organization of the pre-scientific findings, and the analysis of small groups of individuals who represent only a small share of large samples. Additionally, semi-structured interviews are appropriate for the validation of other research methods (Stier, 1999, p. 188; Schnell, Hill, and Esser, 2005, p. 387).

Compared with standardized interviews, semi-structured interviews are not based on a set of standardized interview questions; rather, semi-structured interviews rely on a broader interview guide that serves as a framework for the discussion. This interview guide ensures that at the end of an interview, all relevant topics have been discussed, and the outcomes of the interviews are comparable. Moreover, this flexible interview guide allows for sufficient space to address new questions or to focus the discussion on the most relevant topics. A semi-structured interview guide often includes only a bulleted list of the key topics that should be discussed in an interview, and it typically contains 'mandatory questions' and 'optional questions' (Schnell, Hill, and Esser, 2005, p. 322). This prioritization allows an interviewer to address the most important questions and offers sufficient flexibility for the remainder of the interview. An interview can be documented in three different ways: short notes that are written during the interview, notes that are written after the interview, or a full record and transcription of the interview (Schnell, Hill, and Esser, 2005, p. 388).

In the first and most detailed case study, I focus on Bauer AG (hereafter Bauer), a firm that is active in the specialist foundation engineering business and that became active in the production of specialist foundation engineering machines in the 1980s. Bauer is well suited for the investigation of my research questions for two reasons. First, I am able to observe the entire process of its development from a focused specialist foundation engineering firm to a user innovator of specialist foundation engineering machines and finally to a diversified firm that gains a large share of its revenues from its machine business. Second, a wide range of information sources was available for the construction of a complete picture of the firm's evolution and its current situation.

For the Bauer case, I conduct six semi-structured interviews with executives of the firm and ten semi-structured interviews with academic and industry experts in the foundation engineering business and in the field of mechanical engineering (Table 2

provides an overview). The executives from Bauer that I interviewed are Thomas Bauer, the chief executive officer (CEO) of Bauer AG (I interviewed him twice); Karlheinz Bauer, a member of the supervisory board of Bauer AG and a former CEO; and Erwin Stötzer, a former managing director of Bauer's machine business unit, who retired in 2008 (I interviewed him three times).

Table 2: Overview of Interviews Conducted for the Bauer Case

Interview	Interviewed Person	Position of Interviewed Person	Date	Duration	Interview Documentation
Interviews with Executives of Bauer AG					
1	Prof. Thomas Bauer	CEO of Bauer AG	Dec 2007	1:40 h	complete transcription
2	Erwin Stötzer	Managing director of Bauer Maschinen GmbH (retired 08/2008)	Jan 2008	2:00 h	complete transcription
3	Erwin Stötzer		Feb 2008	0:30 h	written notes
4	Erwin Stötzer		Apr 2008	1:40 h	complete transcription
5	Dr. Karlheinz Bauer	Member of the supervisory board of Bauer AG, former CEO	Apr 2008	0:05 h	written notes
6	Prof. Thomas Bauer	CEO of Bauer AG	Mar 2010	2:00 h	written notes
Interviews with Academic Experts					
7	Dr. Frank Ksienzyk	Researchers at Technische Universität Bergakademie Freiberg	Feb 2008	0:30 h	written notes
8	Prof. Dr. Matthias Reich		Feb 2008	0:10 h	written notes
9	Chris Reinhold		Feb 2008	0:05 h	written notes

10	Prof. Dr. Jürgen Grabe	Professor at Technische Universität Hamburg-Harburg	Feb 2008	0:15 h	written notes
11	Jörg Gutwald	Researcher at Technische Universität Darmstadt	Mar 2008	0:15 h	written notes
12	Ercan Tasan	Researcher at Technische Universität Berlin	Mar 2008	0:03 h	written notes
Interviews with Industry Experts					
13	(Name withheld)	Employee at Züblin Spezialtiefbau GmbH	Mar 2008	0:25 h	written notes
14	Mr. Maierhoff	Employee at Franki Grundbau GmbH & Co. KG	Mar 2008	0:10 h	written notes
15	Mr. Sedlmeyer	Employee at PST Grundbau GmbH	Feb/Mar 2008	0:05 h	written notes
16	Mr. Nolte	Owner and Managing Director of Nolte Grundbau GmbH	Feb/Mar 2008	0:04 h	written notes

Four of these six interviews can be considered key interviews and have an average duration of 1 hour and 50 minutes. Three of the four interviews are fully recorded in electronic form and transcribed thereafter[47] [48]. As the goal of these interviews is to obtain detailed information regarding the firm's user innovation history and the key factors that influence the commercialization decision at Bauer, I develop a new interview guide for each interview. This approach allows me to adapt the questions for each interview to the most relevant topics and to each specific interviewee. The interview guides for each of the key interviews can be found in the Appendices A.1 to A.4. The remaining interviews are documented in the form of written notes. I conduct these additional interviews to complement the findings of previous conversations and to obtain further technical

[47] One of the four interviews is documented by written notes because the permission for electronic recording was not granted.

[48] All of the interviews are conducted in German; therefore, they are transcribed in German.

information. All of these interviews are conducted face to face with the interviewees by two interviewers.

In addition to conducting the interviews with executives of Bauer AG, I conducted six interviews with academic experts in the fields of drilling and drilling machines, specialist foundation engineering, mining, and geo-techniques from four technical universities in Germany.[49] To enrich the information gained from the academic experts, I interviewed four industrial experts from foundation engineering and specialist foundation engineering firms. The additional interviews are 5 to 25 minutes per interview and are documented in the form of written notes.

With the remaining four cases (the 'validation cases'), I validate the results from the Bauer case with firms from the tunnel construction (WÜWA Bau GmbH & Co. KG), tea-packaging (Teekanne Group, H&S Tee-Gesellschaft), and mining (DMT GmbH & Co. KG) industries.[50] These four cases differ in terms of industry and firm life cycles; this variance allows for the assessment of the generalizability of the results from the Bauer case.

In total, I conducted seven interviews with executives of Wüwa, Teepack, H&S Tee, and DMT (see Table 3 for an overview): one interview with Hans Loser, a member of the Management Board of Wüwa; one interview with Stefan Lambertz, a member of the Management Board of Teepack; two interviews with Wilhelm Lohrey, a former technical director of Teepack; one interview with Gerhard Klar, a former CEO of H&S Tee; and two interviews with Bodo Lehmann, head of DMT's Exploration and Geosurvey Division. The average duration of these interviews is 50 minutes. Similar to the approach used for the Bauer case, all interviews were fully recorded and transcribed thereafter. In many cases, email communication with the interviewees enriches the information that was gained from the interviews and serves as a suitable instrument with which to clarify brief questions. The interview guide for the four validation cases is based on the knowledge that I gained from the Bauer case, for which I have conducted the most detailed analysis. Thus, the interview

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[49] The four universities are Technische Universität Bergakademie Freiberg, Technische Universität Berlin, Technische Universität Darmstadt, and Technische Universität Hamburg-Harburg.

[50] Eisenhardt and Bourgeois (1988) are a good example of case study research from the literature because their goal was to identify patterns over a number of cases by replication logic, as I have done in this study.

guide for the validation cases consists of two parts: the first part enabled me to obtain information regarding the user innovation history in the firms, and in the second part, I aimed to validate the propositions that were derived from the main case. I continuously modified the interview guide during the complete data collection period to adapt this guide to the most relevant topics. This continuous modification is consistent with the approach of Eisenhardt (1989), who argued that "a key feature of theory-building case research is the freedom to make adjustments". The final version of the interview guide is presented in Appendix A.5.

Table 3: Overview of Interviews Conducted for Validation Cases

Interviews with Executives of Companies for Validation Cases					
Interview	**Interviewed Person**	**Position of Interviewed Person**	**Date**	**Duration**	**Interview Documentation**
Wüwa					
17	Hans Loser	Member of the Management Board of WÜWA Bau GmbH & Co. KG	Nov 2010	1:30 h	complete transcription
Teekanne/Teepack					
18	Dr. Stefan Lambertz	Member of the Management Board of Teepack Spezialmaschinen GmbH & Co. KG	Feb 2011	0:55 h	complete transcription
19	Wilhelm Lohrey	Technical Director of Teepack Spezialmaschinen GmbH & Co. KG	Feb 2011	0:50 h	complete transcription
20	Wilhelm Lohrey		Mar 2011	0:30 h	complete transcription
H+S Tee					
21	Dr. Gerhard Klar	Former CEO of H&S Tee-Gesellschaft	Sept 2010	0:55 h	complete transcription

DMT					
22	Dr. Bodo Lehmann	Head of the Exploration & Geosurvey Division of DMT GmbH & Co. KG	Feb 2011	0:50 h	complete transcription
23	Dr. Bodo Lehmann	Head of the Exploration & Geosurvey Division of DMT GmbH & Co. KG	Apr 2011	0:10 h	complete transcription

Archival information: In addition to obtaining interview data, I also collect data from annual reports (Bauer AG, 2008, 2009, 2010), presentations at shareholder meetings (Bauer AG, 2007), company magazines (e.g., Bauer AG, 1994, 1998, 2001; Max Bögl, 2001, 2003, 2009), and books describing the history of the companies (Mayer, 2006; Stötzer et al., 2008, Teekanne GmbH & Co. KG, 2007). I also rely on data sources that can be obtained outside of the companies, such as analyst reports (Pfeifenberger and Akram, 2006; Stewart, 2006), Bauer's initial public offering (IPO) prospectus (Deutsche Bank AG, 2006), newspaper articles and press releases (Fasse, 2007; DMT, 2008; H&S, 2005, 2006, 2009), and the academic literature in the field of specialist foundation engineering (Buja, 2001; 2004; Kluckert, 1999; Stötzer and Schöpf, 2003).

Additional information from external sources is collected for two reasons. First, these external sources enrich the information gained from the interviews by providing additional background data. Second, the use of different data sources reduces the individual bias that is inherent to every interviewee and to every external data source. Thus, the triangulation of data sources is a method for extracting 'the truth' from a high volume of information from different data sources (Mathison, 1988).

3.3.2 Data Analysis

The propositions that I present in Section 3.4.1.1 of this work are derived from the Bauer case and are validated by the four additional cases (Section 3.4.2.2 to 3.4.2.5). Thus,

I systematically analyze the interviews for the Bauer case in a detailed manner using qualitative content analysis[51] (Mayring, 2002; Mayring, 2004). Based on the detailed analysis of the Bauer case, the interviews of the four remaining cases and the archival information are analyzed with a focus on the relevant topics. To the best of my knowledge, there is no evidence pertaining to the success factors of the commercialization of user innovations by firms; therefore, I choose an inductive approach to develop the coding scheme and to analyze my research questions (Eisenhardt, 1989; Eisenhardt and Graebner, 2007).

The goal of qualitative content analysis is to conduct a structured examination and a step-by-step analysis of the existing data material. This form of data analysis can enable a researcher to understand all of the information that is embedded in the respective context of communication. At the core of qualitative content analysis is a coding scheme, the development of which is a central point in the analysis of texts with a qualitative content analysis (Krippendorff, 1980, p. 85, 86; Mayring, 2008, p. 74). One may distinguish two approaches for developing coding schemes:

- **Deductive formation of categories:** Categories are derived from existing theories and literature that reflect the current state of the relevant research field. Each relevant text piece from the data material is assigned to one of the categories.
- **Inductive formation of categories:** Categories are developed and generalized directly from the data material without using any pre-defined coding scheme or reflecting existing theories. This approach is especially useful in the field of exploratory research, in which no existing theory or hypotheses are available.[52]

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[51] Mayring presents three different qualitative content analysis procedures that can be conducted independently or in combination: summary, explication, and structuring. In this work, only the structuring procedure is used. For further information regarding the summary and explication procedures, please see Mayring (2008).

[52] The inductive approach is also labeled as “open coding” in the context of grounded theory (Glaser and Strauss, 1967; Glaser and Corbin, 1990). Although I use an inductive approach for the development of the coding scheme, I do not follow the grounded theory approach that is described by Glaser and Strauss because this approach can be very time-consuming (Bortz und Döring, 2002, p. 334); furthermore, I do not expect better or more complete results compared with that of the qualitative content analysis, which is

According to Bortz and Döring (2002, p. 330) and Pratt (2009), the inductive and deductive approaches can also be combined in practice to optimally adapt an approach to a particularly setting.

Although many computer programs support the execution of qualitative content analysis (e.g., Kuckartz, 2010), I chose to execute my analysis using the spreadsheet software Microsoft Excel. Considerations regarding the additional functionalities that are provided by specific data analysis programs compared with the costs of such programs led me to the decision to use a spreadsheet software (Miles and Huberman, p. 311ff). Moreover, I use the program primarily for the coding of the information and for the structured storage of the data, which are functionalities that Excel can readily execute.

My analysis of the data material begins with a concise evaluation of the documented material from the interviews of the Bauer case, a line-by-line examination of the data material, the identification of the relevant text pieces, and the assignment of each text piece to a category. In situations in which a text piece fits the general definition but does not fit within a specific category, I form a new category (Mayring, 2002, p. 114). Thus, I modify and extend the coding scheme in a step-by-step manner until the final coding scheme is obtained. The interviews are analyzed and coded in a continuous process, which allows for continuous refinement and adaptation (Miles and Huberman, 1994, p. 65). The goal of this iterative process is to filter the relevant content from the text/data. The final coding scheme contains 48 categories on 4 levels (see Table 4). In sum, I coded approximately 220 text pieces. Although all interviews for the Bauer case are fully analyzed, the archival information is only partially included in the coding process. The decision of whether to include a data source is based on whether the information from a source directly contributes to the propositions or to the user innovation development history of the firms.

In the next step, the analysis of the interviews for the ‘validation cases’ is conducted along 11 different content blocks: one block for the user innovation history of the

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the approach that I chose. Compared with the qualitative content analysis, in the grounded-theory approach, “open coding” is only one coding step that is followed by a row of further steps to analyze the text. The resulting coding scheme of both approaches also differs: the grounded-theory approach aims to map precise interrelations of categories and subcategories, whereas the qualitative content analysis approach considers the categories to be only weakly linked (Bortz and Döring, 2002, p. 333).

respective firms and one block for each of the ten propositions that are derived from the Bauer case study.

Table 4: Coding Scheme

Code	Description
1 DevelopmentMEIndustry	Reasons why specialist foundation engineering (SFE) firms gain experience in machine engineering (ME)
1.1 MachineMaintenance	SFE firms gain experience in ME, because the existing equipment and machinery must be maintained
1.2 MachineModification	SFE firms gain experience in ME, because machines must be modified to meet the firm's requirements
1.3 ToolDevelopment	SFE firms gain experience in ME, because the tools for a new project often do not exist and must be developed
2 DevelopmentBauer	Development of Bauer AG
2.1 SelectiveComm	Bauer begins to commercialize its construction machines with highly selective sales of its user innovations (UIs)
2.2 OpenCommDecision	In the 1980s, Bauer's management decides to sell the machines in an unrestricted manner
2.3 CloseLinkMBAndSFEB	Since the beginning of Bauer's activities in the machine business (MB), close organizational links between the MB and the specialist foundation engineering business (SFEB) have existed
2.4 InternationalizationMB	The internationalization of Bauer's MB is closely linked to the international activities of Bauer's SFEB
2.5 CommercialImportanceMB	Today, Bauer's MB is of high economic importance to the firm
3.4 DualityMBAndSFEB	The differing economic cycles of both businesses limits the dependency of Bauer on each of these businesses
3.5 CompetitiveSituationSFEToday	Today's competitive situation in the SFEB in Germany and internationally
4 UI	UIs at Bauer
4.1 ReasonsUI	Reasons for the decision of Bauer to develop their own machines for SFE projects
4.1.1 Need	One reason is the need for specific machines for Bauer's challenging projects
4.1.2 LackOfAvailibility	One reason is the lack of available machines that meet Bauer's requirements regarding, for example, power and quality

4.1.3 LackManufacturer	One reason is the lack of manufacturers who possess the skills and/or willingness to build the required machines
4.2 ReasonsCommercializationUI	Reasons for the commercialization of UIs at Bauer
4.2.1 ReasonApproachesCustomer	One reason for the decision to selectively sell UIs is the existence of recurring approaches by other firms led by the desire to purchase Bauer machines rather than imitation machines
4.2.2 ReasonPreventionImitations	One reason for the decision to selectively sell UIs is the intention to prevent manufacturers from entering the market with imitations of the machines as a response to refused sales from Bauer
4.2.3 ReasonNoMarketOverlap	One reason for the decision to selectively sell UIs is that the market of the requesting firm did not overlap with that of Bauer
4.2.4 ReasonOCNoAdvantageSFEB	One reason for the decision to commercialize the machines in an unrestricted manner is that Bauer could not gain any competitive advantages from the UIs in its core business because of manufacturers that sell imitations of the product
4.2.5 ReasonOCEconomicPressure	One reason for the decision to commercialize the machines in an unrestricted manner was the difficult economic situation in the SFEB in Germany in the 1980s
4.3 ProblemsCommercializationUI	Problems that occur regarding the commercialization of UIs
4.3.1 MachineVisibility	One problem regarding the commercialization of UIs is the high visibility of the machines on the construction sites that allows competitors to observe the machines
4.3.2 Patentability	One problem regarding the commercialization of UIs are difficulties regarding the patenting of the machines as innovations often lie in the dimensioning
4.3.3 Imitators	One problem regarding the commercialization of UIs is that machine manufacturers enter the market with imitations of the Bauer machines
4.4 BenefitsUI	Benefits of UIs and their commercialization
4.4.1 PositiveEffectsOrg	Positive effects of the new organizational constellation on the firm’s success
4.4.2 Feedback	The commercialization of UIs may positively influence the feedback that a firm gets
4.4.2.1 FeedbackExternalSources	Feedback from external customers for Bauer's MB
4.4.2.2 FeedbackOwnSFEBusiness	Feedback from the own SFEB for Bauer's MB
4.4.3 ImportanceUserKnowledgeForUI	High importance of Bauer's experience in the SFE field as a machine user for machine development efforts
4.5 ConflictsUI	The commercialization of UIs may cause external and internal conflicts
4.5.1 ReasonsInternalConflicts	Reasons for internal conflicts between the newly created MB unit and the SFEB

4.5.1.1 SuccessMB	One reason for internal conflicts lies in the massive economic success of the MB compared with the SFEB
4.5.1.2 CompetitorSupportOfMB	One reason for internal conflicts lies in the sales of the Bauer machines to competitors of the SFEB that enable competitors to complete the same challenging projects as Bauer
4.5.1.3 Inequality	One reason for internal conflicts lies in the fact that the benefits of the MB from the open commercialization are obvious, but the employees of the SFEB often feel disadvantaged
4.5.2 WaysEaseInternalConflicts	Bauer develops various methods to ease the tensions between the two business units
4.5.3 TypesExternalConflicts	Different types of conflicts with external parties that result from the commercialization of UIs exist
4.6 ProductUI	The most important products that result from Bauer's UI efforts
4.7 InvestmentsUI	Investments in the development of new UIs
5 CompanyCulture&Org&Behav	The influence of the commercialization of UIs on the company culture, the organization and the behavior of Bauer
5.1 CultureFamilyFirm	Influence of the fact that Bauer is a family firm and is also managed by family members on the company culture as well as the importance of this for Bauer's success
5.2 KeyElementsLeadership	Relevance of the leadership style of Bauer's management for the success of the firm
5.3 KeyElementsOrg	Key elements of Bauer's organization that enable the firm to optimally manage its two business units
5.4 KeyChangesExtBehavior	Bauer had to change its formerly aggressive behavior toward its competitors
6. StrategyDiscussionFocusVsDivers	Bauer is involved in a continuous strategy discussion regarding the advantages and disadvantages of a diversification strategy vs. a focus on core competencies

3.3.3 Quality Considerations

Similar to quantitative research settings, the quality of a qualitative research design can be assessed using different criteria. Because the setting of qualitative studies differs, the variables to measure the quality criteria used in quantitative studies need to be adapted to the specific settings of qualitative research. It is important to apply measure variables that are designed to fit the particular research methods and analyses that are used in a study (Mayring, 2002, p. 140). The three criteria that many authors use to assess the quality of

qualitative research are **objectivity, reliability and validity** (e.g., Gibbert and Ruigrok, 2010; Miles and Huberman, 1994, p. 277ff; Bortz and Döring, 2003; p. 326ff).

Objectivity: This criterion is sometimes labeled 'external reliability' (Miles and Huberman, 1994, p. 278) and postulates the ability of another researcher to replicate a study using identical methods. To conduct an objective study, a researcher must ensure that the setting is free of researcher bias. Or, if a complete avoidance of researcher bias is impossible, the research should be explicit regarding the inevitable biases. Other strategies that assist in achieving objectivity are detailed descriptions of the methods used to collect the data and the data analysis procedures. In addition, one can achieve a certain degree of objectivity by ensuring that personal assumptions, values, and biases are transparent to readers (Miles and Huberman, 1994, p. 278).

These requirements are met in my study to the extent that such requirements can be met in a study that is based on semi-structured interviews. To ensure the transparency of my methods and procedures for readers, I attach the interview guides for all key interviews in Appendices A.1 to A.5 of this work. Furthermore, I provide a detailed overview of all data sources used for the study.

Reliability emphasizes the absence of random error and is often assured in the form of 'intercoder reliability' in the context of qualitative content analysis. Intercoder reliability indicates that coding is conducted under identical settings by two different researchers that compare their results and discuss agreements/disagreements.[53] Silverman describes reliability as "the degree of consistency with which instances are assigned to the same category by different observers or different occasions" (Silverman, 2005, p. 210). Reliability in the context of qualitative research is controversial because such studies cannot be replicated and because of the context-specific relevance of people's behavior (Lamnek, 2005, p. 169; Bortz and Döring, 2003, p. 327). According to Gibbert and Ruigrok (2010) and Miles and Huberman (1994, p. 278), reliability can be achieved by assuring

[53] However, this approach has also received criticism. According to Ritsert (1972, p. 70), a high degree of agreement can be achieved only in very simple analyses. It is more difficult to obtain reliable results for more differentiated coding schemes when coding is conducted by two different researchers. However, quality can also increase when this approach is taken.

transparency and clarification with regard to research procedures (e.g., if findings show meaningful parallels across the different sources used; if data are collected across the full range of appropriate settings, times, and respondents; and if the researcher's role is explicitly described).

In my study, I aim to ensure reliability with different data sources and data types from which I draw my conclusions. Furthermore, I explain the basic constructs and paradigms to the interviewees in each interview.

Validity in the context of qualitative research settings consists of three dimensions: *construct validity, external validity,* and *internal validity*.

Construct validity is particularly relevant in the data collection phase[54] and refers to the question of whether a study investigates what it aims to investigate. Conducting a study based on an appropriate set of methods rather than subjective judgment (Yin, 2003a, p. 35) is one of the key challenges regarding construct validity. Gibbert and Ruigrok (2010) recommend two key strategies for achieving construct validity. First, the triangulation of data sources, data collection methods and data in general ensures the adoption of different angles from which to examine a specific situation. Second, the provision of a detailed protocol of the procedure that is followed during a study enables readers to understand which data sources are selected, which data collection procedures are chosen, and the differences between the actual process and the originally planned process.

I aim to achieve construct validity in my study by proceeding with the triangulation of data sources and data types. Furthermore, I provide a detailed description of the data collection and data analysis methods that I chose for my study.

Compared with construct validity, *internal validity* applies to the data analysis phase. According to Gibbert and Ruigrok (2010), internal validity can be achieved by providing a theoretical framework that describes why one expects a certain effect of an independent variable on a dependent variable and why one assumes that this effect is not caused by another third variable. These authors also recommend matching the identified

[54] In contrast to construct validity, both internal and external validity are particularly important in the data analysis phase.

patterns with patterns identified in previous studies or patterns predicted by the literature to ensure internal validity (Gibbert and Ruigrok, 2010).

In my study, I aim to ensure internal validity by proceeding with the triangulation of the data and methods. As different sources of information produce converging results, one can assume that internal validity is given in my study.

External validity, or 'generalizability,' refers to the assumption that a certain theory is valid both in the specific setting in which it was studied and in other settings. In quantitative studies, a sufficiently large random sample provides generalizability, compared with single or multiple case studies, which do not allow for statistical generalization. According to Miles and Hubermann (1994, p. 279) and Gibbert and Ruigrok (2010), external validity can be assured with sampling that is theoretically diverse and sufficient to encourage the broader applicability of the results or with the provision of a clear rationale for the selection of the cases in the study. Additionally, the provision of broad detail in the case study context enables the reader to understand the researcher's case selection.

I aim to achieve generalizability by covering cases from different industries and firms in various stages. Additionally, I provide a substantial amount of information pertaining to each case; this volume of information should allow readers to follow my argumentation for the selected cases.

3.4 Results

In Section 3.1, I suggest that this study should be useful in obtaining information regarding the development process of user innovations and user innovation commercialization decisions. The goal of this study is not to develop a theory that is valid only for firms from one specific industry – or even one specific firm – but to develop a generalizable theory.

In the first part of the results section, I trace the development process of the firms in my study from 'user firms' to 'diversified user-manufacturer firms'. Based on the dissection of the user innovation commercialization process of Bauer AG, I derive ten

propositions that pertain to which factors favor and which factors impede a market commercialization strategy in the second part of this section. In the third part, I test these propositions qualitatively with the four remaining cases to analyze the validity of the propositions.

3.4.1 Cases

The goal of the first part of the results section is to understand the process of development from a typical 'user firm' toward a diversified 'user-manufacturer firm' for the five firms that constitute the focus of my study. These five firms are Bauer AG (a specialist foundation engineering firm), Wüwa (which is active in the tunnel construction business), DMT (which offers geological surveying services), and Teekanne and H&S Tee (which are both active in the tea-packing business).

In the first step, I aim to analyze the origin of the first user innovations in the firms. Based on this analysis, I trace the user innovation history over several years – or in some cases, over several decades – to the moment at which the commercialization decision is made. After analyzing the arguments that ultimately led to the decision to commercialize a user innovation, I then follow the development of the firm and its internal process from the commercialization decision to the firm's current situation.

3.4.1.1 Bauer AG

Becoming a User-Innovating Firm

Bauer is a family firm that was founded in 1790 in Schrobenhausen, Bavaria, Germany. The firm has been managed and owned by the Bauer family since its foundation. The current CEO is Thomas Bauer, who is a member of the seventh generation of the Bauer family and an honorary professor at Technische Universität München. The origins of the firm are rooted in the late eighteenth century, when Sebastian Bauer founded a copper forge. Approximately 100 years later, Andreas Bauer (a fourth-generation member of the Bauer family) began to expand the business from pure copper forging to public water supply and

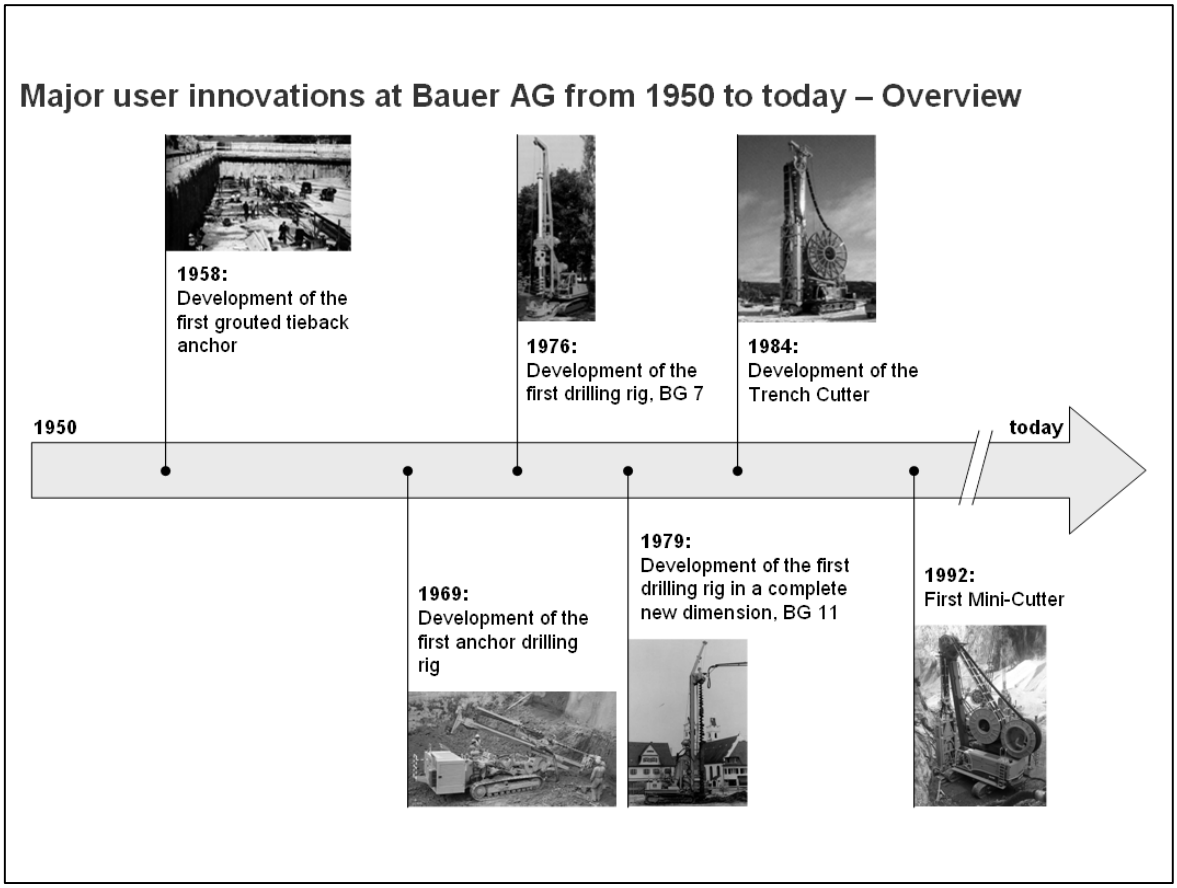
well-sinking works. After World War II, Karl Bauer and his son, Karlheinz Bauer, changed the firm's business model to specialist foundation engineering, an area in which the firm remains active today (Mayer, 2006).

An important moment in the history of Bauer was the development of the first user innovation, the grouted tieback anchor. In 1958, at the construction site of Bayerischer Rundfunk, Munich, Bauer's job was to repair the deep basement wall without any supporting elements that would hinder the work in the excavation pit. However, because of the loose soil, it was impossible to repair the wall with existing techniques. Because of the time constraints of the project and a lack of alternative methods, Bauer was forced to devise a new method to repair the wall. Bauer engineers developed the 'Bauer anchor' and subsequently applied for a patent for the 'grouted tieback anchor in loose sediment soils'[55] (Mayer, 2006; Stötzer [Interview 2]). In the following years, the anchor technique became widely accepted in the industry; today, this technique is still the standard approach to repairing excavation pits with anchors.

Figure 2 shows that the development of the grouted tieback anchor was not a singular event. Rather, this development marked the beginning of a period in which Bauer repeatedly developed its own machines and construction techniques. In most cases, these user innovations resulted from situations that were similar to the situation in 1958 at the construction site of Bayerischer Rundfunk: there existed inadequate material, machines or techniques for completing the challenging construction work, and manufacturers that could not devise solutions for the particular needs of Bauer forced the firm to develop its own construction machines (Bauer [Interview 1]; Mayer, 2006; Stötzer et al., 2008).

[55] Patent number: DE1104905 (B).

Figure 2: Overview of User Innovations of Bauer AG from 1950 to the Present



In its early years as a specialist foundation engineering firm, Bauer primarily used machines that were originally constructed for mining applications. Bauer's own repair shop modified and adapted these machines to the needs of their own construction business (Bauer AG, 2001; Stötzer [Interview 2]). The productivity of these machines was low. In the 1960s, CEO Karlheinz Bauer attempted to find a manufacturer to develop an anchor-drilling rig that would fulfill Bauer's needs. Because no manufacturer was willing to develop such a machine, Bauer opted to develop its own anchor-drilling rig. The fact that space was available in one building of the repair shop at Bauer's main firm site accelerated this decision (Bauer AG, 1996).

> *"Over the years, the constant modification and adaptation of machines led to the decision to construct a machine that met our requirements, from scratch, and only for our own use."*[56]
> (Thomas Bauer, CEO of Bauer AG [Interview 1])

In 1969, Bauer produced the first anchor-drilling rig in the repair shop of its construction business, and the result exceeded all expectations (Figure 2). The machine allowed for an increase in the productivity of anchor drilling and exceeded the efficiency of all comparable machines that were available at that time.

In the 1970s, the situation for pile drilling[57] was similar to the situation for anchor drilling almost 10 years earlier. Because of the low actuation power of the existing machines, the drilling of every pile was a time-consuming effort. Although drilling in loose ground with the existing machines was still feasible, drilling in hard ground was impossible (Stötzer and Schöpf, 2003). Again, no machines were available on the market to fulfill Bauer's requirements, and no manufacturer was willing or able to develop a machine that could be used for this purpose. As a result, in 1975, Bauer decided to develop a drilling rig that would be able to drill piles in both loose ground and hard, rocky ground (Bauer AG, 1996).

> *"When the need of our construction sites became a burning issue and no machine manufacturer would come anywhere near to meeting our requirements, we quickly took the decision: we'll build the machine that achieves our requirements, in an economical way."*
> (Dr. Karlheinz Bauer, member of the supervisory board of Bauer AG, former CEO of Bauer Spezialtiefbau GmbH, in: Bohrpunkt, 1996, p. 15)

The result was the BG 7, a machine that has been used in Bauer's construction sites since 1976 (see Figure 2) and that was revolutionary for pile drilling at that time (Buja, 2004; Kluckert, 1999).

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[56] In this chapter, all quotes from interviews and other sources were translated from German to English by a professional translator.

[57] Pile drilling describes the drilling of very deep vertical holes in the ground that are filled with concrete to serve as foundations for buildings, bridges, etc. .

Sporadic Sales of Bauer's User Innovations

Shortly after the development of the anchor-drilling rig, other firms in the field of specialist foundation engineering approached Bauer to purchase its machines. Bauer sold them to firms in Japan, France, the United Kingdom, Russia, and South Africa in the following years. However, Bauer strongly restricted these sales and sold anchor-drilling rigs only to firms that were not competitors (e.g., firms whose regional focus differed from that of Bauer). In particular, Bauer did not sell anchor-drilling rigs to firms in Germany. However, Bauer could not prevent other manufacturers from imitating its machines. Because Bauer had not filed patents on these machines, Klemm Bohrtechnik was able to enter the market and became the market leader for anchor-drilling rigs (Stötzer [Interview 2]).

In the late 1970s and early 1980s, Bauer's competitors again approached the firm with requests to purchase one of its machines, the newly developed pile-drilling rig BG 7. Again, Bauer decided to sell the machines on a selective basis to other firms. Thomas Bauer described the situation as follows:

> *"At the end of the 70s, beginning of the 80s we then decided, 'Ok, we'll sell; it's always better if customers buy from us than someone else deciding to copy our machines.' But at the start we only sold in a very restrictive way."*
> (Thomas Bauer [Interview 1])

In the 1980s, Bauer was increasingly pressured to sell its machines on a nonrestrictive basis as an increasing number of companies approached the firm. Furthermore, Bauer had learned from its experience with the anchor-drilling rigs that excessive restrictions in machine sales may leave the largest market share to imitators. However, Bauer continued to enjoy a competitive advantage from its machines in the construction business; market commercialization might have diminished or even destroyed this competitive advantage. Moreover, many of Bauer's employees were highly critical regarding the sale of the machines to competitors. These employees were proud of their engineering efforts and believed that a market commercialization strategy would result in distributing the core of the firm's knowledge (Mayer, 2006).

Considering these arguments in the 1980s, Bauer's management faced a difficult decision: whether to initiate the market commercialization of the Bauer machines or to continue to protect the machines and gain a competitive advantage from using them in its original business, which was the specialist foundation engineering business.

The Commercialization Decision

In 1984, after years of selective sales, Bauer management finally chose an unrestricted market commercialization strategy. Thomas Bauer joined the management board in 1982 and became the first CEO of the firm to possess a management education in 1986. He was an important driver of the commercialization decision, and the difficult economic situation of the construction business at the time was an additional driving force (Bauer [Interview 1]; Stötzer [Interview 2]). For many years, there was an incentive to find additional revenue sources. Erwin Stötzer, the former managing director of Bauer Maschinen GmbH (the machine business), described the effect of the difficult economic situation in the construction business on the market commercialization decision as follows:

> *"In the end the economic situation forced our hand. If things had gone well for us in the construction industry, so that we wouldn't have had to build machines, then we wouldn't have expanded machine manufacturing to the same extent."*
> (Erwin Stötzer, former managing director of Bauer Maschinen GmbH [Interview 2])

Further arguments to commercialize the machines on the market included the increased competition in the machine business and an increase in development costs, which increased the importance of producing larger volumes (Mayer, 2006). The latter argument is particularly important because the construction business is driven by end products; customers primarily pay for the end result (e.g., a repaired excavation pit) and are unwilling to bear the development costs of high-end construction machines.

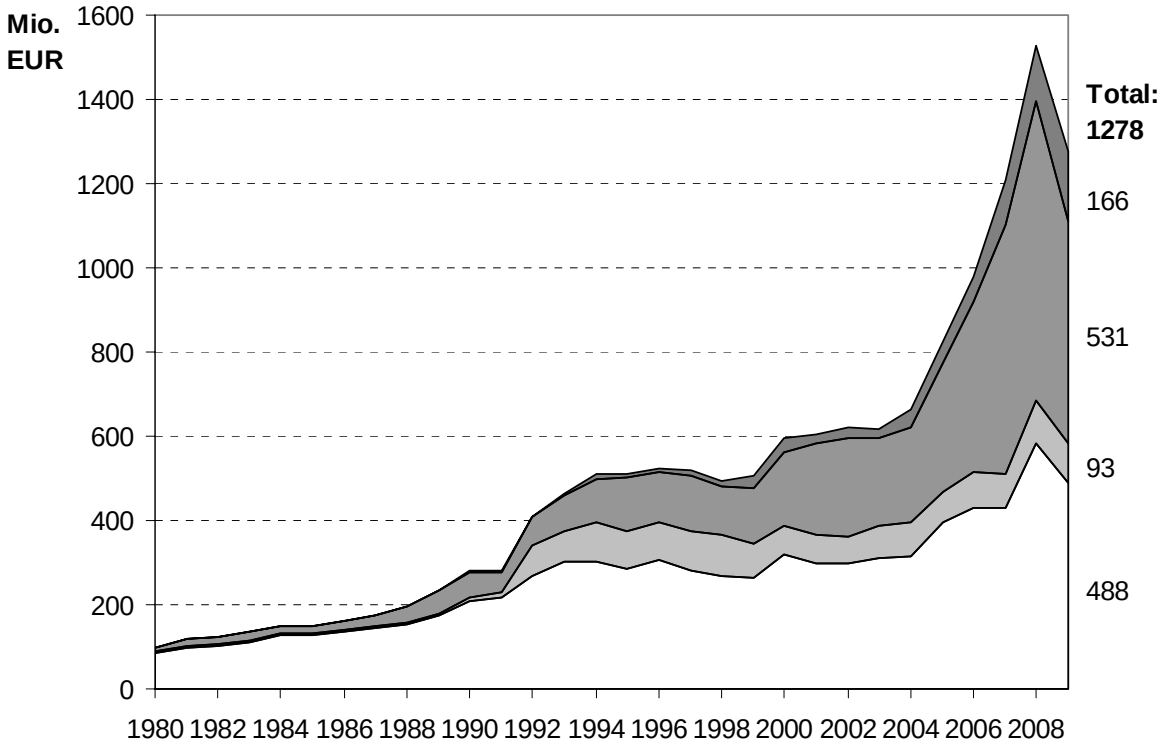
Despite the obvious benefits of a market commercialization strategy, the decision was difficult and was reached only after long, controversial discussions. Many employees were critical of the idea of Bauer selling machines to direct competitors in the construction

business; these changes even caused some employees to resign (Bauer [Interview 1]; Stötzer [Interview 2]).

> *"Selling your own machines didn't seem particularly easy at first. Here in Germany, where our machine sales were very strong, the customers automatically were our main competitors. The construction department was naturally not too pleased about that."*
> (Thomas Bauer [Interview 1])

Following the market commercialization decision, the growth of Bauer's machine business significantly exceeded the growth of its other businesses (see Figure 3). In 1988, Bauer management decided to place its machine business into a separate business unit (Bauer AG, 1994; Stötzer [Interview 2]), and in 1994, the revenues of this business unit exceeded the revenues of every competitor in the construction machine industry (Bauer AG, 2003; Mayer, 2006).

Figure 3: Development of Revenues from 1980 to 2009 by the Business Unit



Source: Bauer AG

Although Bauer acquired a number of firms in this field, the firm's growth was driven by these acquisitions only to a small extent. Most of the firms that were acquired were small and did not significantly influence the revenues of the machine business (Bauer AG, 2008; Bauer [Interview 6]).

In 2009, the machine business unit generated more than 40% of the total revenues of the Bauer group while employing only 31% of the employees (Table 5).

Table 5: Key Financial Figures of Bauer's Main Business Units (in 2009)

	Revenues* (in 1,000 €)	Percentage of Total Revenues (in %)	EBIT (in 1,000 €)	EBIT-Margin (EBIT in % of Revenues)	Number of Employees
Bauer Construction Business**	581	45.5%	25.7	4.4%	5,002
Bauer Machines Business***	531	41.5%	51.3	9.7%	2,739
Bauer Resources Business	166	13.0%	6.0	3.6%	886
Total	1278	100%	84.4	6.6%	8,872******

EBIT=Earnings before interest and taxes
*) after deductions of other/eliminations/consolidations
**) refers to Bauer Spezialtiefbau GmbH
***) refers to Bauer Maschinenbau GmbH
****) on average over the year

Source: Bauer AG

In addition, the 'earnings before interest and taxes (EBIT) margin' of the machine business is more than twice as high as that of the construction business (9.7% vs. 4.4% in 2009). As early as 2006, approximately 85% of the revenues of the machine business were generated abroad. Both of these facts underline the high importance of the machine business for the Bauer group (Bauer AG, 2007; Bauer AG, 2008).

However, after more than 20 years of machine sales, tensions between the two business units persist. Bauer's management team does not view these tensions as a problem; rather, these tensions are viewed as a source of competitive advantage, and the management team is convinced that these tensions do not prevent constructive working relationships between the two business units. The synergies between the two units are perceived as significantly greater than the negative effects. Thomas Bauer explains as follows:

> *"Being involved in both areas (in underground construction/ civil engineering and machine manufacturing), is good for the company - as we soon discovered. The synergies and each side learning from the other helps the company. In addition, the in-house competition enhances the work tempo."*
> (Thomas Bauer [Interview 1])

3.4.1.2 Wüwa GmbH & Co. KG[58]

Wüwa was founded as a family firm in 1984 by former employees of a specialist foundation engineering firm. Today, Wüwa is active in the fields of infrastructure tunnel construction[59], pipe-jacking machines[60], and equipment manufacturing[61]. Since 2000, Wüwa has been a 100% subsidiary of Max Bögl, the largest family-managed construction firm in Germany (Max Bögl, 2001). The firm (Wüwa only) generates revenues of 15.3 million EUR with approximately 67 employees (see Table 6).

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[58] Except where other references are given, all information regarding Wüwa was gained from an interview and e-mail correspondence with Hans Loser, a member of the management board of WÜWA Bau GmbH & Co. KG.

[59] Infrastructure tunnels are tunnels with a smaller profile than traffic tunnels that are used for, e.g., water supply or electricity.

[60] Pipe-jacking machines are machines that drill the infrastructure tunnels.

[61] Equipment manufacturing refers to drilling tools such as drilling heads.

Table 6: Overview of Validation Cases

	Industry of core business	User innovation business	Revenues (in mio. EUR)	Employees
WÜWA Bau GmbH & Co. KG	Tunnel construction, pipe jacking	Pipe jacking machines	15.3	67
TEEKANNE Group	Tea-packing (Teekanne GmbH & Co. KG)	Tea-packing machines (Teepack GmbH & Co. KG)	385 (Teekanne Group)[62]	220
DMT GmbH & Co. KG	Mining, exploration and geological surveying services	Geological surveying services instruments	106	611
H&S Tee-Gesellschaft mbH & Co. KG[63]	Tea-packing	Tea-packing machines	n/a	> 300

In the 1980s, the construction of infrastructure tunnels through tunnel drilling – rather than open construction – was still in its infancy, and no dedicated machine manufacturer existed at that time. Thus, during its early years as a tunnel construction firm, Wüwa perceived the urgent need to develop and manufacture its own machines (Max Bögl, 2003). In the following years, Herrenknecht[64], a newly founded firm in manufacturing industry entered the market and offered pipe-jacking machines as well as drilling equipment. However, since Wüwa found those machines too expensive to stay competitive with its construction business, the firm continued to develop and use its own machines in its construction business. Wüwa may have been a lead user with its tunnel construction efforts in the early times of this industry. However, even though the firm continued to

[62] Due to the fact that the interviewees of Teepack did not want to communicate concrete revenue numbers for Teepack, the revenues for Teekanne Group which consists of the two main subsidiaries Teekanne GmbH and Teepack GmbH as well as of nine other subsidiaries is given here.

[63] H&S Tee-Gesellschaft does in general not communicate key figures. While the approximate number of employees is mentioned in a press release of H&S (H&S, 2005), a value for the revenues of the firm could not be found.

[64] Today, Herrenknecht AG is one of the leading companies in mechanized tunnel drilling machines and equipment. With approx. 3200 employees the firm generated sales of 935 million € in 2010. The firm's headquarter is located in Schwanau in south-west Germany.

develop and construct its own machines to fulfil the needs of its own construction business, today, the firm is not a lead user anymore. According to Mr. Loser, Wüwa does not conduct particularly challenging projects that other firms could not do, nor, does Wüwa develop machines that are not available at other tunnel construction machines firms.

The decision to both use the construction machines internally and sell them to other firms was taken around the year 2000 and was primarily driven by economic factors: first, as only one machine manufacturer existed at that time, Wüwa's management assumed that there would be sufficient demand for a second player in the market. Second, the construction machine business seemed to be an attractive market, as the margins were high compared with the extremely low margins in the construction business. Additionally, Wüwa was already selling construction machines and drilling tools to other firms at that time, although the machines were not sold in a systematic way and the sales were not based on a strategic decision. This decision to sell the machines also externally was the beginning of Wüwa's own machine organization, as the firm then began to hire its own construction and sales employees who would be responsible for the machine business.

Similar to the decision in the Bauer case, the commercialization decision at Wüwa was accompanied by doubts that the machine sales would enable competitors of Wüwa's construction business to bid on the same projects as Wüwa did. However, the important difference from the Bauer case was the existence of other machine manufacturers that sold machines that were similar or even identical to Wüwa's machines.

> *"Of course we had the worry that we strengthen our competitors [by selling our machines to them]. On the other hand, I have to realize that if [a competitor] doesn't buy the machine from me, it will buy it from Herrenknecht."*[65]
> (Hans Loser, member of the Management Board of Wüwa Bau GmbH & Co. KG [Interview 17])

In contrast with Bauer, Wüwa has never been the only company on the market that offered specific construction machines. Thus, management focused on the positive aspects of the commercialization of the construction machines rather than the potential conflicts

[65] In this chapter, all quotes from interviews and other sources were translated from German to English by the author of this work and checked by a professional copyeditor.

resulting from a possible cannibalization of the construction business by the activities of the manufacturing business. Selling or renting the machines to other construction firms offered a method by which Wüwa could benefit from a project even if its construction business did not win the actual construction job.

> *"… if I don't win the construction job, maybe I can at least participate by selling machines."*
> (Hans Loser [Interview 17])

At Wüwa, the external conflicts with potential customers of the construction machines were and still are important: the competitors of Wüwa's construction business hesitate to purchase or rent machines from their competitor's machine business. However, this reluctance to purchase Wüwa's machines continues to decrease, as Hans Loser states below:

> *"On the other hand, our competitors find it difficult to buy or rent a machine from their competitor in the construction field. […] But this has improved. Today, we receive a lot more orders from direct competitors from Germany than we did some time ago."*
> (Hans Loser [Interview 17])

More importantly, the technical nature of the machines limits or slows the growth of Wüwa's construction machines sales. Smaller drilling machines typically consist of two components: the steering device and the drilling machine itself. Because drilling machines and steering devices from different manufactures are typically not compatible, the acquisition of new customers is a difficult effort for Wüwa. Firms that work with the drilling machines of one brand tend to remain with this brand, as the costs for a new drilling machine are much lower than the costs for a new drilling machine in addition to a new steering device. These increased costs for buying a new machine plus a new steering device compared to only buying a new machine are in the literature determined as 'switching costs' that increase the brand loyalty of customers (e.g., Klemperer, 1987; Klemperer, 1995).

Today, Wüwa remains active in both fields. Although tunnel construction is still the firm's core business, the machine business continuously gains in importance (Max Bögl,

2009). In 2010, approximately 25% of the firm's sales were generated by the machine business, 75% by the construction business.

Wüwa's machine engineers are responsible for the development and construction of the machines, whereas the construction engineers are responsible for the construction sites. However, the management team expects that both the machine engineers and the construction engineers have knowledge of both business units and actively participate in the discussions of both units. Compared with that of Bauer, Wüwa's machine business is not as self-sufficient as a completely separate business. New products or technologies are developed when customers request them; Wüwa does not employ development engineers who proactively develop and offer new products to customers. The machine business is too small for such efforts.

> *"Of course, our machine engineers develop modifications of existing machines, but they do not develop a new product without a concrete order from one of our customers. We do not have a true research and development department. We are too small for that."*
> (Hans Loser [Interview 17])

Examining today's tunnel construction market in Germany, one finds other firms that develop or modify their construction machines. However, no other firm is active on both sides of the business (the user and manufacturer sides) as Wüwa is.

3.4.1.3 Teekanne Group[66]

Teekanne is a family firm that was founded in 1882 in Dresden. Although the firm's roots lie in the packaged tea business, Teekanne began to develop and construct its own tea-packing machines in the early 1920s (Teekanne, 2007). Today, Teekanne consists of several subsidiaries; the two most important subsidiaries are Teekanne GmbH, the

[66] Except where other references are given, all information in this section was gained from interviews with Stefan Lambertz, a member of the management board of Teepack Spezialmaschinen GmbH & Co. KG, and Wilhelm Lohrey, retired technical director of the same firm.

packaged tea business, and Teepack GmbH, the tea-packing machine business.[67] The firm is still owned by the founding families Nissle and Anders, but it has been led by an external manager since 2001.

At the beginning of the last century, it was uncommon to sell tea in bags rather than loose tea. Then, during World War I, the military ordered large amounts of tea. To deliver the tea to the soldiers at the front lines and to facilitate the process of preparing the tea, the company developed the first tea bag: employees of Teekanne[68] filled a mixture of tea and sugar in small mull bags and fixed a suture at the top of each bag. To reduce the time that was necessary for the production of one tea bag, the company was already undertaking initial efforts to automate production. Immediately after the end of World War I, these efforts decreased in importance as other concerns took precedence (Teekanne, 2007, p. 31). In the 1920s, Adolf Rambold, a machine fitter who worked for a machine firm that maintained Teekanne's machines, was hired by Teekanne. He developed the first machine that automatically filled tea in mull tea bags. This first machine was called Pompadour. Several years after, Mr. Rambold developed a second machine and replaced the mull tea bags with tea bags that were composed of filter paper, which was used for coffee filters.[69] The invention of the Reliance machine in 1937 was an important step, as the new tea bags had the important advantage of being completely tasteless. In the book detailing Teekanne's history, this step is described as follows:

> *"The new generation of tea bags made from filter paper was superior to all former generations. The consequence was that Teekanne's tea bags quickly captured the world market."*[70]
> (in: Teekanne, 2007, p. 89)

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[67] Please see Table 6 for additional data pertaining to Teekanne Group.

[68] Teekanne was founded in 1882 in Dresden under the name of R. Seelig & Hille and changed its name to Teekanne GmbH in the summer of 1930. Despite this name change, I always use the name "Teekanne" – even when I refer to the firm in its early period prior to the name change – to ensure clarity in this work.

[69] The use of filter paper from coffee filters for the tea bags raised a patent conflict between Teekanne and Melitta, as Melitta invented the coffee filter paper and held a patent on this invention.

[70] In this chapter, all quotes from interviews and other sources were translated from German to English by the author of this work.

The origin of the idea to develop tea-packing machines was the intention to optimize production. Due to Mr. Rambold's capabilities to develop and construct tea-packing machines, Teekanne was soon in the position of a lead user that produced its own machines and that was approached by other firms to sell its machines. Thus, in the 1920s and 1930s, Teekanne was already selling its machines to other tea-packing firms in France, Switzerland, the Netherlands, Italy and, especially, the USA.

Immediately after World War II, Mr. Rambold developed another important innovation: the double-chamber tea bag[71] and the 'Constanta' machine to fill the tea in those bags. In 1948, together with the owning families of Teekanne, Anders and Nissle, Mr. Rambold founded a new firm, Teepack. This step demonstrates the post-war intention to sell the machines on the market and profit from these sales rather than using the machines only for their tea-packing business. Wilhelm Lohrey, former technical director of Teepack, explains as follows:

> *"The idea to use the Constanta machine only internally has never existed. The foundation of Teepack GmbH in 1948 and Mr. Anders's trip to our former customers in the USA soon after the firm's foundation demonstrate the clear intention to sell the machines to other tea-packing firms."*
> (Wilhelm Lohrey [Interview 19])

The breakthrough for the growth of the newly founded machine firm in the difficult times after World War II was an order that Mr. Anders generated on his trip to the USA. He presented the new tea bag and the machine to the management of Lipton, one of the largest tea-packing firms in the world. Lipton's management team was sufficiently convinced of this new tea bag to draft a contract. Teepack promised to give the first machines to Lipton[72], and the American tea-packing firm paid in advance for the machines; thus, this advanced payment eased the process of beginning production for Teepack.

> *"This contract with Lipton made not only the start of Teepack but also the resumption of Teekanne after World War II a lot easier. With the dollars from*

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[71] The double-chamber tea bag is the type of tea bag that is still in use today. The double-chamber design allows an optimal flow of water around the tea leaves in the tea bag and thus produces tea with an optimal taste.

[72] Lipton received the new Constanta machines even before they were given to Teekanne's production team.

> *Lipton, the firms were able to buy material to produce the machines and buy tea to be sold by Teekanne."*
> (Wilhelm Lohrey [Interview 19])

This contract was the beginning of a successful growth path for Teepack. Because of its powerful patent on the double-chamber tea bag and the Constanta machine, Teepack was essentially the only player in the tea-packing machine business until 1968. Teepack's machines were sold to firms throughout the world with the only restriction being that these firms were not direct competitors of Teekanne. This restriction endured beyond the end of the patent protection and continues to exist today in a slightly modified form. Today, Teepack also sells its machines to tea-packing firms in Germany. However, these firms are allowed to use the machines only at those production sites where the deliveries for other countries (e.g., Benelux) are produced. No machine has yet been sold to OTG (Ostfriesische Teegesellschaft), Teekanne's most important competitor in Germany.[73] Although Teepack has followed this restriction policy for decades, Mr. Lohrey is not convinced that the policy has always been advantageous for the firm.

> *"The patent on the double chamber tea bag machine lasted till 1968. And in this time [Teepack] has not supplied machines to [tea-packaging firms in] Germany. Thus, competitors [of the manufacturing unit] could position themselves. After expiry of the patent, many firms jumped at the tea bag and built machines. Two of these [firms] have remained."*
> (Wilhelm Lohrey [Interview 20])

Today, Teepack's greatest competitors are two machine manufacturing firms located in Italy. Both firms come from the packing machines-business and are not active in the tea-packing business[74], and at least one of the two firms positioned itself prior to the

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[73] The reason that such business does not exist is twofold: Teepack does not want to sell the machines to Teekanne's greatest competitor, and OTG does not want to strengthen Teekanne by purchasing Teepack's machines.

[74] In addition to these packing machine manufacturers, the H&S Teegesellschaft in Kressbronn near Lake Constance is active in the tea-packing machine business. The business model of this firm is similar to Teekanne's business model: H&S sells pharmaceutical teas and develops and produces tea-packing machines primarily for smaller production lines. Although the machines of Teepack and H&S do have a

patent expiry in 1968. This firm benefitted from the selective sales of Teepack as after the patent expiry, Teekanne's direct competitors in Germany that were not delivered with tea packing-machines from Teepack were the first customers of this firm.

Today, Teekanne is active primarily in the German market and in certain European markets. Because Teepack does not sell machines to Teekanne's direct competitors, internal conflicts between the user unit (Teekanne) and the manufacturer unit (Teepack) do not exist. If internal conflicts between these businesses arise, the conflicts typically involve customer-supplier topics, such as – among others – delayed deliveries or the speed with which problems are fixed by the service of Teepack. I outline these type of conflicts in greater detail in Section 3.4.1.2 in the case of Wüwa. The external situation is similar, as those firms that purchase machines from Teepack are not direct competitors of Teekanne. Mr. Lambertz, a member of the Management Board of Teepack Spezialmaschinen GmbH & Co. KG, describes the situation as follows:

> *"Of course, our customers are aware of the close link between Teepack and Teekanne. However, I have never noticed them holding back any information. Our customers know that they do not compete with Teekanne in any market."*
> (Stefan Lambertz [Interview 18])

Today, both firms are subsidiaries of one holding firm. Teekanne and Teepack are also closely linked in terms of their employees: although 'mixed careers'[75] are unusual because the jobs at Teekanne and Teepack typically have completely different focuses[76], Teepack trains future technicians who are responsible for the machine maintenance of Teekanne. Furthermore, machine engineers from Teepack regularly conduct joint projects with production engineers from Teekanne. Both firms are led by one managing director; thus, a holistic view of the two businesses is possible.

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slightly different focus, Teepack considers H&S to be a competitor. I will analyze H&S in more detail in Chapter 3.4.1.5 of this work.

[75] 'Mixed careers' refer to those careers that formally occur in both subsidiaries of Teekanne Holdings: Teekanne GmbH and Teepack GmbH. For example, a machine engineer of Teepack may become a machine engineer/maintenance professional at Teekanne and then, several years later, return to Teepack and bring the user and application knowledge directly to the manufacturing business.

[76] Most jobs at Teekanne are related to marketing and sales, whereas Teepack has a much stronger engineering focus.

3.4.1.4 DMT GmbH & Co. KG[77]

DMT was founded under the name DMT-Gesellschaft für Forschung und Prüfung mbH in 1990, and it is the successor of Westfälische Berggewerkschaftskasse. Today, DMT is a subsidiary of the TÜV Nord Group[78] (Creditreform, 2010; DMT, 2011) and consists of six business units, including an exploration and geological survey unit. This unit consists of seven departments: six departments offer exploration and geological surveying services, and one department is responsible for the development of instruments to conduct exploration services (DMT, 2011).[79]

Historically, the Westfälische Berggewerkschaftskasse was a joint organization that conducted knowledge-development projects for the mining companies in the Ruhrgebiet region that paid for these activities (DMT, 2008). Thus, the Westfälische Berggewerkschaftskasse was not envisioned to be a company that needed to be profitable; rather, it was viewed as a research institute that was financed by its customers, the mining companies (Lehmann [Interview 23]). The turning point was in 1990, when DMT was founded. Since the founding of DMT, the goal of creating a profitable business and offering products and services for the general market was clear.

> *"In the 1970s and 1980s at Westfälische Berggewerkschaftskasse, one did not think about how to be profitable. Then, in 1990, this perspective completely changed. The coal mining activities had already been reduced over the previous decades, and one knew that coal mining in Germany would someday be completely shut down. Thus, one had to think about new products and a new business model."*[80]
> (Bodo Lehmann, head of the Exploration and Geosurvey Division of DMT GmbH & Co. KG [Interview 22])

Following this decision, products and services were developed to serve industries in addition to the coal mining industry. With the new portfolio, the share of research and

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[77] Except where other references are given, all information in this section was gained from interviews with Bodo Lehmann, head of the Exploration and Geosurvey Division of DMT GmbH & Co. KG.

[78] In 2007, DMT became a member of TÜV NORD Group.

[79] Please see Table 6 for additional data pertaining to DMT.

[80] In this chapter, all quotes from interviews and other sources were translated from German to English by the author of this work.

development activities could be reduced from 100% to 5-10% within a relatively short time period, according to Mr. Lehmann.

Similar to the previous cases of this work,[81] the development of geological surveying instruments was rooted in the core business of Westfälische Berggewerkschaftskasse, later known as DMT. In the 1970s and 1980s, the main business of the organization was exploration services and underground surveying for the coal mining, oil, and gas industries. Specific machines were necessary for the work that was completed underground. As the Westfälische Berggewerkschaftskasse was a pioneer in the field of resource exploration, no such machines were available on the market. Thus, the firm decided to develop the exploration machines and instruments that were needed, and became a lead user in its field. When the decision to develop their own machines was made, the clear goal was to develop these machines for internal use only. However, at a later stage, selling the machines on a selective basis was considered. To prevent a cannibalization of the service business, company executives made the decision to sell the machines only to firms that were active in different regional markets (e.g., in China or Korea) rather than to firms in Germany or in the surrounding markets.

The critical argument for the decision to sell the instruments on the market was a monetary argument. Selective sales of the instruments to other firms allowed the firm to earn money from these sales without enabling direct competitors to conduct similar projects, as Westfälische Berggewerkschaftskasse did. The commercialization decision was followed by another important strategic decision: the decision to address international markets with the instruments business from the beginning.

> *"We made the decision to address the international market with the instruments business and, thus, to avoid any cannibalization effects between the instruments and service divisions in our home market. This concept worked well."*
> (Bodo Lehmann [Interview 22])

[81] Please see Chapter 3.4.1.1 for the case of Bauer AG, Chapter 3.4.1.2 for the Wüwa case and Chapter 3.4.1.3 for a description of the development of user innovations at Teekanne.

Today, the instruments unit can sell instruments to every customer who wants to purchase them, and only 10% to 20% of the instrument sales are generated by the own geological surveying unit. The clear international focus of the instruments unit is underlined by the following figures: Approximately 60% of the current service business of DMT is generated abroad, whereas 80% to 90% of the revenues of the instrument business are generated from countries other than Germany.[82]

DMT's currently unrestricted sales of its machines on the market are also in the interest of DMT's service unit. In the geological surveying service industry, a firm requires more instruments for the execution of a project than it owns. Thus, it is common for firms to rent instruments from competing firms for specific projects. For reasons of instrument compatibility, DMT prefers to rent its instruments from a competing service firm rather than instruments from another brand.

As the firm chose to sell the geological surveying instruments on the market without any restrictions, the service unit needed to differentiate itself from other geological surveying service firms. In this situation, the differentiation of the range of services that were offered gained in importance during recent years.

> *"Most of our competitors do offer specific geosurveying services. We are the only firm that is able to conduct a complete project, including the aggregation of the relevant data, the development of the measurement concept, the exploration concept, and the data analysis. Other firms do not have this holistic approach."*
> (Bodo Lehmann [Interview 22])

Today, only 10% to 15% of DMT's revenues are derived from the coal mining business. While five of DMT's six business units are active in the resource exploration of oil and gas deposits and geothermal exploration, only one unit continues to offer services for the coal mining industry. DMT's remaining activities in the coal industry are typically

[82] 'Abroad' in the case of the services unit frequently refers to Austria or Switzerland, as DMT conducts many projects in this area, whereas 'abroad' for the instrument business refers to Australia, China, India, or Saudi Arabia. Thus, if one were to compare the revenues in DACH (Germany, Austria, and Switzerland) with the 'rest of the world,' the difference in the percentage of international sales between the two business units would be even higher.

not conducted in Germany; rather, such activities are conducted abroad, such as in Mexico, the Czech Republic, or Siberia.

The employees in the above mentioned business units that are active in the field of resource exploration are responsible for the development, quality control and sales of the instruments, whereas the production of geological surveying instruments was outsourced years ago.

Although close links between both businesses exist, mixed careers are uncommon at DMT's exploration and geosurveying business. According to Mr. Lehmann, the primary reason for this lack of mixed careers is that the jobs in the two business units have different requirements: in the geological surveying services unit, geophysics is primarily required, whereas electrical engineers are more important in the geological surveying instruments unit. Exchanges of information and experiences between both units occur in joint workshops.

3.4.1.5 H&S Tee-Gesellschaft[83]

H&S was founded as a family business in 1949 in Kressbronn, which is near Lake Constance. Today, the firm is led by a third-generation member of the owning family, Dr. W. Peter Klar. The firm sells different brands of tea, primarily 'H&S Tee' (medicinal teas that are sold in pharmacies)[84] and 'Goldmännchen-Tee' and 'Clipper-Tee' (teas sold in supermarkets and the wholesale market). Additionally, H&S develops tea-packing machines and sells them to tea-packing firms throughout the world. Finally, the firm offers contract production capacities for tea to other tea-packing firms (H&S, 2005; H&S, 2006).[85]

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[83] Except where other references are given, all information in this section was gained from an interview with Gerhard Klar, former CEO of H&S Tee-Gesellschaft mbH & Co. KG.

[84] According to the market research institute 'IMS Health Services', H&S is the market leader in the medicinal tea business in Germany in terms of the number of pieces sold and the revenues (H&S, 2009).

[85] Please see Table 6 for additional statistics on H&S.

The roots of the firm date back to the time following currency reform (after World War II) in 1949. The founder of the firm, Ingeborg Sauter, obtained access to a small amount of tea and coffee and decided to sell these items in small bags to earn money. This effort became successful, especially for the tea that was sold.

Initially, the weighing of the tea and its packing in mull tea bags was completed manually, but the founder soon realized that technical support would be required to increase the productivity of this process. The first tool that technically supported the manual process was a basic machine (it was actually more of a tool than a 'real' machine) that closed the heat seal of the new tea bags, which were composed of filter paper.

During the 1950s, Gerhard Klar, the son of the firm founder, made the first machine development efforts. Although the technology that was used was very basic, the first machine was able to cut the paper of the tea bags in the correct form, weigh the correct amount of tea, and fill the tea in tea bags semi-automatically. This first machine still needed an operator to control the machine with his foot. The next generation of the machine was even further developed; the labels needed to be fixed on the tea bags manually when using the first-generation machines, but it was possible to automate this step with the new machines. To produce the parts that were needed to build the first machines, Gerhard Klar approached technicians in the Lake Constance region.

Although the first tea-packing machines were already available on the market at that time, H&S exerted the effort to develop its own machines. Thus, although the ideas for H&S's tea-packing machines came from the user business, H&S has never been a lead user in the sense that the firm had needs that were ahead of the needs of other players in the market. Because the firm had only recently been founded, H&S did not have sufficient capital to purchase a tea-packing machine on the market.[86] The price of approximately 20,000 Deutschmarks was excessively high for the young tea-packing business.

[86] The tea-packing machine that H&S could have purchased was Teepack's Constanta machine (see Chapter 3.4.1.3 in this work for a detailed description of the machine development process and the situation at Teepack during this time).

> *"If we had had more capital during that time, we probably would have bought the machines on the market. Maybe then we would not sell tea-packing machines today."*[87]
> (Gerhard Klar, former CEO of H&S Tee-Gesellschaft mbH & Co. KG [Interview 21])

The first machine sales occurred almost immediately after the development of the first machines. H&S's management never made a clear decision regarding whether to sell the machines to external customers rather than solely using the machines in their own tea-packing business; rather, a firm from Zurich, with which the first business relations existed,[88] approached H&S with the desire to purchase a machine. Shortly after the first sales, the next machines were then sold to an Austrian firm. In contrast to the Bauer case, the discussion of whether H&S was cannibalizing its core business with the machine sales never arose because H&S had never had a monopoly on its machines.

> *"The question of whether we cannibalized our core business has never been important for us, as we have never had a monopoly on the tea-packing machines. If you are active in a market with several competing players, you would even sell your machines to your direct competitor if he wants one. The reason for this is that if you do not sell your machine to him, he will use his own machines or buy them from one of your competitors."*
> (Gerhard Klar [Interview 21])

Today, H&S's tea-packing business even benefits from the machine sales of the machine business. At one of H&S's production sites, the firm offers contract production of tea to other tea-packing firms; if a firm uses H&S's machines, the contract production business can offer its services to this firm, while such service offerings are significantly more difficult, if not impossible, if a firm uses machines from a different brand.

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[87] In this chapter, all quotes from interviews and other sources were translated from German to English by the author of this work.

[88] According to Gerhard Klar, this firm likely was a tea supplier of H&S. However, it was not possible for me to definitively discover the reason for the existing relations with the Swiss firm.

In the early years of H&S's tea-packing machine business, the clear goal was to satisfy the needs of the tea-packing business, but this situation has changed over the decades.

> *"The general focus of our machines is highly influenced by our tea-packing business and the needs of it. However, the details of the machines that we produce depend more on the needs of the general market and not on our own business."*
> (Gerhard Klar [Interview 21])

Today, H&S consists of two main business units: the tea-packing business and the tea-packing machine business. Approximately 10% to 20% of the revenues are generated with the tea-packing machine business. The focus of H&S's tea-packing machines lies in the ability of the machines to produce small batches as needed in H&S's medium-sized tea-packing business rather than the production speed of the machines. Not surprisingly, the typical customers of H&S are small or medium-sized tea-packing firms rather than the larger players on the market. The own tea-packing business plays only a minor role compared to external customers of H&S tea-packing machines.

Today, the largest share of the machines is sold to tea-packing firms abroad because of the presence of strong competitors in Germany (among which Teepack is the most important one). A benefit of this situation is that the customers of H&S's tea-packing machine business typically have a completely different regional focus than H&S; thus, its customers are not direct competitors of the firm's tea-packing business.

Although the two business units are closely linked and many new product development efforts occur with the involvement of employees of both business units, mixed careers in both businesses do not exist in the firm.

3.4.2 Propositions

Drawing on the above dissection of Bauer's development from a specialist foundation engineering firm to a diversified user-manufacturer firm in Section 3.4.1.1 of this work, I derive propositions regarding which factors favor and which factors impede the market commercialization of the user innovations of such firms. As said earlier, market

commercialization refers to the unrestricted sale of a product to all interested customers in a market. I structure these propositions into three groups that are related to innovation, market, and corporate governance and organizational aspects.

All propositions are of the form that X (a certain condition) favors (or – in the case of Proposition 9 – impedes) the commercialization of a user innovation. The evaluation of the propositions is conducted as follows: 'A' means that condition X is given and favors (or impedes, in the case of Proposition 9) the commercialization of user innovations in the respective case. 'B' describes a situation in which X is given, but it does not have an influence on the commercialization decision or I have no information if it has an influence on the commercialization decision in the way that it favors or impedes the commercialization. 'C' means that X is not given or the proposition in general is not applicable in the respective case.

The following sections aim to qualitatively test the propositions that were derived from the Bauer case with four firms in other industries (i.e., the tunnel construction, tea-packing, and geological surveying industries). This proposition validation draws on the cases that I present in Sections 3.4.1.2 to 3.4.1.5 . In this part of the study, I aim to test which propositions hold in general, which propositions might be industry-specific and which propositions are valid only in the explicit context of a specific firm.

Because my propositions address factors that favor the market commercialization of a firm's own user innovations (rather than necessary conditions for it), only a subset of my propositions naturally applies in each of the following cases. For an overview of the propositions and their validity in each of the five cases, see Table 7.

Table 7: Proposition Validity – Overview

Validity of User-Manufacturer Propositions in Different Company Cases					
Propositions		**Case Examples**			
		Bauer AG		**WÜWA Bau GmbH & Co. KG**	
		Y/N?	Comment	Y/N?	Comment
P1	A continuous stream of user innovations from the core business leads to the accumulation of deep user-specific and solution knowledge and therefore favors a market commercialization strategy.	A	Bauer has a long history of user innovations. With each innovation, the firm has accumulated additional user knowledge.	A	A continuous stream of user knowledge assisted the firm in building its own machines and in entering the market with these machines.
P2	The more a firm expects to receive feedback from external customers that helps to improve the quality of the user innovation, the more likely the firm will pursue a market commercialization strategy.	A	External feedback allowed for the production of machines that address the needs of the general market rather than only the firm's own specialist foundation engineering business.	A	Feedback from external customers (working under different conditions than the firm's construction business) is important to develop and improve the machines.
P3	A high risk of imitation of a firm's user innovations favors a market commercialization strategy.	A	Imitation is a significant problem, as projects are often conducted in collaboration with a firm's competitors.	B	This risk is not as important as in the construction business, as machines are less visible. However, joint projects with competitors imply a risk of imitation.
P4	The higher the investments that a firm has to make in the development of its user innovations, the more likely it is that the firm will pursue a market commercialization strategy.	A	Each new product development effort required considerable investments. Thus, selling the machines externally allowed for the spread of these investments over a large number of units sold.	A	Such investments enabled the financing of the steady growth of the repair shop toward a 'real' engineering department.
P5	Being visible and having a high reputation with its original business in the target market facilitates a firm's marketing of user innovations and thus favors a market commercialization strategy.	A	A high level of credibility of the core business together with already existing activities on the target market allowed for the successful market entry of the new business.	A	Both arguments are important marketing factors.

P6	If a firm's original and new businesses follow asynchronous economic cycles, then a high market risk and strong market cyclicality in the original business favor a market commercialization strategy.	A	Being active in two fields allowed Bauer to compensate for the negative effects of a downturn in each of the respective businesses in the past.	B	The volume of machinery sales is too small to observe this effect. However, having two main businesses assists the firm in managing small decreases in sales volume.
P7	During periods in which the prevailing management doctrine speaks against diversification, firms that are more independent of the stock market are more likely to pursue a market commercial-lization strategy.	A	Its status as a family firm allowed Bauer to continuously pursue its diversification strategy and ignore the recommendations of financial analysts.	B	Wüwa is a subsidiary of Max Bögl, the largest family-owned construction firm in Germany. The family is fully committed to Wüwa's machine activities.
P8	The existence of large undiversified (family) blockholders in a firm increases the likelihood of a market commercialization strategy.	B	According to Thomas Bauer, this argument has never been important in the case of Bauer.	B	Wüwa was founded as a family firm and is currently a fully owned subsidiary of a family firm, however, I do not have any information if this fact had an important influence on the commercialization decision.
P9	Potential conflicts arising from market commercialization of own user innovations between the employees of the original and those of the new business unit make a market commercialization strategy less likely.	A	Today, the conflicts between the employees of both Bauer businesses continue to exist.	C	Existing conflicts are more often supplier-customer conflicts than related to the user-manufacturer duality.
P10	A corporate culture and a management that is able to ease tensions between employees of both units (original and new business) favor a market commercialization strategy.	A	Bauer's management team is able to ease these conflicts and utilize them to stimulate internal competition.	C	The CEO often manages conflicts (because it is a small firm). Conflicts are generally unrelated to the user-manufacturer duality.

A Condition X is given and favors/impedes the commercialization of user innovations
B Condition X is given, but it does not have an influence on the commercialization decision/ I do not have any information if this condition favors/impedes the commercialization of user innovations
C Condition X is not given/ the proposition in general is not applicable in this case

Validity of User-Manufacturer Propositions in Different Company Cases						
	Case Examples					
	Teepack Spezialmaschinen GmbH & Co. KG		DMT GmbH& Co. KG		H&S Tee-Gesellschaft	
	Y/N?	Comment	Y/N?	Comment	Y/N?	Comment
P1	A	Ideas from the core business (Teekanne) are one of three major sources of Teepack's innovations.	A	The user unit is highly involved in new product development efforts of the instruments unit.	A	The roots of the tea-packing machine business lie in the user business. Today, ideas for new or modified machines continue to be generated by the user business.
P2	B	Customers are an important feedback source, as machine customers that serve markets for packaged tea in other regions have significantly different requirements.	B	Customer feedback is an important source and is used for new product development. However, today, the geographical distance to international customers makes it difficult to involve these customers.	C	External customers are not actively involved in product development. The needs of internal and external customers do not vary significantly.
P3	C	A powerful patent protected Constanta over several decades, and the technical complexity of tea-packing machines increases the difficulty of imitation.	B	There have been occasional efforts to copy the instruments. DMT's goal is to make imitation efforts as difficult as possible.	C	Machines with similar functionalities were available on the market when H&S began its machine development efforts. Machines are invisible for potential imitators.
P4	A	Constanta was only built when a U.S. customer (the first buyer of Constanta, even before Teekanne) paid in advance (difficult situation after WW II); still a relevant today.	A	Especially in the early stages, it was necessary to spread the development costs over a large number of units to be able to finance these development efforts.	A	The money that was earned from the machine sales was used to construct a development department and to finance subsequent machine development efforts.
P5	A	These arguments are important to ensure differentiation from classic machine manufacturers.	A	Both points are important marketing factors, especially in direct competition with companies that focus on selling instruments only (no services).	A	H&S's practice of using its machines in its own tea-packing business is an important advantage compared with its machine-producing competitors.
P6	B	The flexibility of Teekanne orders is	B	This argument is less relevant for	B	The duality of its businesses assisted

		more important than asynchronous economic cycles (Teekanne orders can easily be postponed or accelerated depending on Teepack's utilization).		DMT, as the firm engages in risk diversification by serving different industries (i.e., the oil, gas, construction, and geothermal energy industries).		the firm in better managing downturns in the past.
P7	B	The family's commitment to a dual strategy allows the firm to act more independently. Today, a non-family manager heads the firm, and a dual strategy continues to be pursued.	B	Westfälische Berggewerkschafts-kasse, DMT's predecessor, was a joint organization that supported mining activities in the Ruhrgebiet area. Today, DMT is a subsidiary of TÜV Nord, which is owned by three non-profit organizations.	B	H&S is owned and managed by the third generation of the founding family, who is fully committed to the duality of H&S's business.
P8	B	Teekanne has always been a family firm, however, I do not have any information if this fact had an important influence on the commercialization decision.	B	DMT is a subsidiary of the TÜV Nord group. However, I do not have any information if this fact facilitated the commercialization decision.	B	H&S has always been a family firm. However the volatility reduction was not considered as an argument to follow a strategy of user-manufacturer diversification.
P9	C	Conflicts are usually supplier-customer conflicts (e.g., related to machine quality or delivery times)	C	Conflicts may arise when the firm's service unit encounters a problem and the instrument unit prioritizes another customer (typical supplier-customer conflicts). No conflicts of a strategic nature exist.	C	Conflicts between employees of both business units exist and are not rare phenomena.
P10	C	Problems (which are more likely to be product-related than related to the firm's duality) are discussed in meetings, which also address information that is obtained from external customers.	C	Conflicts are addressed and resolved in meetings with the heads of the respective units.	C	Evidence that conflicts between employees are solved on the management level can be found. However, these conflicts were not directly addressed in the interview.

A Condition X is given and favors/impedes the commercialization of user innovations
B Condition X is given, but it does not have an influence on the commercialization decision/ I do not have any information if this condition favors/impedes the commercialization of user innovations
C Condition X is not given/ the proposition in general is not applicable in this case

3.4.2.1 Bauer AG

Innovation Aspects

As outlined above, there existed a similar pattern across all of Bauer's major user innovations beginning with the grouted tieback anchor in 1958: urgent needs in the context of a challenging construction project combined with the lack of suitable machines available on the market (Bauer AG, 1996; Stötzer et al., 2008).

With each user innovation, Bauer's machine engineers gained additional knowledge regarding the target market of its machines because the users of the innovations were part of the same firm. The fact that Bauer often conducted challenging projects made the firm to a lead user in the construction business and made the knowledge that came from the construction sites even more valuable as it reflected in many cases the future needs of the market. Without conducting any classical market research, Bauer became increasingly familiar with the specific needs of its target market, the technical solutions that satisfy these needs, and the willingness of its customers to pay, all of which contributed to accumulating a valuable body of knowledge (Stötzer [Interview 2]).

The more a firm generates user innovations, the more it accumulates user- and market-specific knowledge in the respective field, and the more it makes sense to profit from this knowledge by also selling the products. This leads to the first proposition:

> *P1: A continuous stream of user innovations from the core business leads to the accumulation of deep user-specific and solution knowledge and therefore favors a market commercialization strategy.*

In the 1960s, Bauer began to develop construction machines whose sole purpose was to satisfy the firm's own needs (Stötzer [Interview 2]). In turn, the firm's engineers relied on feedback from their own construction business to optimize the first prototypes. In the following years, Bauer began to sell the machines selectively to other construction firms. These sales provided Bauer's engineers with feedback from other firms working under different conditions. When Bauer began to unrestrictedly sell its machines in the 1980s, the feedback from the market became important; this feedback allowed Bauer to optimize the product technically. Moreover, its own construction business benefited from

improved machines. Furthermore, the external feedback allowed Bauer to manufacture the product in a way that fulfilled the needs of the specialist foundation engineering sector in general rather than solely the needs of its own construction business (Bauer [Interview 1]; Bauer AG, 1998; Stötzer [Interview 4]).

P2: The more a firm expects to receive feedback from external customers that helps to improve the quality of the user innovation, the more likely the firm will pursue a market commercialization strategy.

When Bauer began to develop its own construction machines in the 1960s and 1970s, the firm did not intend to commercialize these machines on the market; rather, the firm intended to gain a competitive advantage from using these machines in its core business (Bauer AG, 1996; Mayer, 2006). In the construction business, several firms – even competitors – often work together on one construction site; therefore, it is almost impossible to maintain secrecy with regard to an innovative machine. Thus, shortly after the development of a new machine, other firms approached Bauer with requests to purchase the new machine. Bauer usually declined these requests in the early years of its machine development. This response encouraged manufacturers who had realized the market potential of such machines to enter the market with imitations of Bauer's innovations (Bauer [Interview 1]; Stötzer [Interview 2]).

When Bauer realized that it could not gain a sustainable competitive advantage with its user innovations in its own business because of imitation, the firm's management decided to profit from the innovations by selling them to other firms. Thus, I conclude that when there is a greater risk that a user innovation will be imitated, it is preferable to commercialize this innovation on the market rather than hoping to gain a sustainable competitive advantage from this innovation within the core business. This reasoning leads to the next proposition:

P3: A high risk of imitation of a firm's user innovations favors a market commercialization strategy.

As I outlined in the argumentation of P1, since the development of the grouted tieback anchor in 1958, all of Bauer's user innovations were developed as a result of

substantial pressure from construction sites that were in need of adequate machines to complete their challenging projects (Bauer AG, 1996; Stötzer et al., 2008). For each new machine project, Bauer had to undertake considerable investments. When faced with higher levels of investments, it was preferable to spread these investments over a large number of units to reduce development costs per unit (Bauer [Interview 1]; Mayer, 2006). This rationale leads to Proposition 4:

> *P4: The higher the investments that a firm has to make in the development of its user innovations, the more likely it is that the firm will pursue a market commercialization strategy.*

Market Aspects

In the 1980s, when Bauer began its market commercialization strategy, the firm was already active in international markets with its construction business. These activities, in addition to the high observability of construction machines in general, created awareness for the Bauer brand in the construction sector in its home market of Germany and in other regions of the world (Mayer, 2006; Stötzer et al., 2008). Thus, when Bauer entered new markets with its machines (e.g., in Asia), the awareness that Bauer was a firm with significant experience in the specialist foundation engineering business already existed. Furthermore, because of the activities of Bauer's construction business, initial contact with potential customers had already been established (Bauer [Interview 1]).

Already existing contact with potential customers and brand awareness for the Bauer name in their target markets assisted Bauer in commercializing its machines on an international basis. Furthermore, Bauer's credibility as a machine manufacturer was high from the beginning, as the firm has always been known for its deep user-specific knowledge in the specialist foundation engineering business. Thus, Bauer encountered fewer struggles associated with typical market entry barriers, such as access to customers and the establishment of credibility. Thus, I offer the following proposition:

> *P5: Being visible and having a high reputation with its original business in the target market facilitates a firm's marketing of user innovations and thus favors a market commercialization strategy.*

The 1980s were an extremely difficult period for the construction sector in Germany, Bauer's home market (Mayer, 2006; Stötzer et al., 2008). Thus, the firm was forced to seek additional revenue sources and decided to begin the market commercialization process of its construction machines (Mayer, 2006; Stötzer [Interview 2]). By applying the knowledge that was gathered in the construction business to the launch of the new machine business, Bauer was able to survive the long economic recession in the German construction sector. In addition, its engagement in two fields with fairly asynchronous economic cycles also would assist Bauer in mitigating the effects of a potential downturn in the machine sector[89] (Bauer AG, 2009; Bauer [Interview 1]; Deutsche Bank AG, 2006). These considerations lead to the following proposition:

> *P6: If a firm's original and new business follow asynchronous economic cycles, then a high market risk and strong market cyclicality in the original business favor a market commercialization strategy.*

Corporate Governance and Organizational Aspects

After Bauer institutionalized its machine business in the 1980s, financial analysts and bankers regularly approached the firm with recommendations to focus on one business rather than overseeing two separate business units in the firm. Because most of these counselors possessed a background in finance and had limited experience in the construction sector, they were often unaware of the synergies between the two business units. Furthermore, the stock market and the business world generally follow management trends (Abrahamson and Fairchild, 1999). In the 1980s, Edzard Reuter, the former CEO of Daimler-Benz, acquired several firms from various industries to develop Daimler-Benz into an 'integrated technology firm', a vision that was exemplary for that period. In the early 1990s, the stock market began to reward core competence strategies, as postulated by Prahalad and Hamel (1990). Thus, the analysts recommended that the firm sell off the less successful business unit and focus on the more successful unit, the machine business.

[89] Similar to how Bauer was able to survive the recession in the construction sector due to the firm's activities in the construction machines business, the construction business could help Bauer to mitigate the effects of a downturn in the construction machines business as the economic cycles of both businesses are not identical. Thus, if the construction machines business experiences a downturn it could be possible to earn enough money with the construction business to survive such crisis.

However, the Bauer management was convinced that the synergies and even the tensions between both business units had a positive influence on the firm's success. Thus, Bauer ignored the recommendations and continued to follow its vertical diversification strategy even after its IPO in 2006. Because Bauer was and continues to be a family firm (after the IPO, the Bauer family still owned 48% of the shares), the firm was able to follow its own strategy (Bauer [Interview 1]; Stötzer [Interview 2]). Today, the former fact is clearly supported by analysts (Pfeifenberger and Arkram, 2006; Stewart, 2006). Thus, I present the following proposition:

> *P7: During periods in which the prevailing management doctrine speaks against diversification, firms that are more independent of the stock market are more likely to pursue a market commercialization strategy.*

Founding families as shareholders usually own large blocks of stock. However, compared with other blockholders, such as institutional owners, families as blockholders are often less diversified in their investment portfolios. As family owners typically reinvest the major share of their profits into their firm, they usually do not hold any major shares of firms from other industries. The situation is similar for Bauer AG. The Bauer family, who is the major blockholder of Bauer AG, owns approximately 48% of the firm (the other 52% of the shares are free-floating shares). Thus, by initiating the market commercialization of its construction machines in the 1980s (and by founding Bauer Resources GmbH in 2007), the Bauer family diversified its own investment portfolio and thus reduced its dependency on its original business. Furthermore, this diversification arguably rendered the firm a more stable employer; thus, the diversification efforts also benefitted the employees of Bauer AG, all of whom the Bauer family viewed as crucial stakeholders of the firm. Although Mr. Bauer did not perceive the diversification of his family's investment portfolio as a motive behind the focal commercialization decision, the argument that was developed above should hold in general. This reasoning leads to the following proposition:

> *P8: The existence of large family blockholders in a firm increases the likelihood of a market commercialization strategy.*

The creation of the new business unit dedicated to selling construction machines had a major effect on Bauer's business model, as the competitors in its core business

subsequently became potential customers of the newly created machine business. These changes in Bauer's business model and concurrent adaptations in its organizational structure had a significant influence on the firm's market behavior and internal culture. The construction unit had to change its formerly aggressive behavior toward its competitors, and Bauer had to cope with internal conflicts between both units (Bauer AG, 1994; Bauer [Interview 6]). The sales of the products of the machine business to competitors of the construction business enabled competitors to achieve Bauer's level of technology and caused deep resentments in Bauer's construction business unit. Today, the firm still must manage conflicts between both units (Bauer [Interview 1]; Stötzer [Interview 2]; Stötzer et al., 2008). When such conflicts are more pronounced, a market commercialization strategy will become more difficult to pursue. Thus, I offer the following proposition:

> *P9: Potential conflicts arising from the market commercialization of a firm's own user innovations between the employees of the original business and those of the new business unit decrease the likelihood of a market commercialization strategy.*

To manage these conflicts and to utilize them to stimulate internal competition[90], Bauer's senior management intensively communicates and, therefore, integrates the two units at the management level. These efforts ensure that both units follow a corporate strategy rather than business unit-specific substrategies. This close link between both business units is supported by Bauer's characteristic as a family firm with a long-term perspective rather than a firm that focuses on the short term (Le-Breton-Miller and Miller, 2006; James, 1999; Lansberg, 1999). The focus on long-term success allows for internal competition and collaboration between the two business units rather than the elimination of the less successful unit (Bauer [Interview 1]).

As the senior management of a firm's business units increase their communication and its leadership becomes more capable of managing conflicts between both of its units (e.g., as a result of a company culture that is focused on long-term goals), the firm is more

[90] 'Internal competition' in this context describes the positive outcome of conflicts that might occur due to the dual activities of a firm (as described in Proposition 9). These conflicts might turn into a competitive situation between the employees of both business units in the form that the employees work particularly hard to achieve better results than the other business unit.

likely to be successful in its market commercialization strategy. This reasoning leads to the final proposition:

> *P10: A corporate culture and a management that is able to ease tensions between employees of both units (original and new business) favor a market commercialization strategy.*

3.4.2.2 Wüwa GmbH & Co. KG

As outlined above, Wüwa began to develop its own tunnel-drilling machines because no adequate machines were available on the market when the firm began its tunnel construction business. Because of the continuous information flow from the construction sites to the machine engineers, Wüwa's machine business accumulated a broad stock of user-specific knowledge, which increased with each new machine project that the firm conducted. This case supports Proposition 1, which postulates that a continuous stream of user innovations from the core (user) unit to the manufacturer business leads to the accumulation of user knowledge, which favors a market commercialization strategy.

Similar to the Bauer case, Wüwa used the feedback from external customers to improve the quality of its machines after its initial commercialization; as I have argued in Proposition 2, this benefit favors a market commercialization strategy. This benefit is particularly valuable because the conditions for tunnel construction vary significantly between different regions. Mr. Loser describes the situation as follows: "As we wanted to be active with the tunnel construction machines business internationally we had to meet the requirements of our customers that work under different geological conditions than we do" (Loser [Interview 17]). Hence, by selling machines to firms that work in different regions and thus face different soil conditions, Wüwa obtains information regarding its machines that it could not easily have generated through its own use. By implementing this feedback, Wüwa improves the quality of its machines and increases their attractiveness to customers worldwide.

In Proposition 3, I postulate that the risk of one firm imitating another firm's machines favors a market commercialization strategy, as the commercialization of the machines offers a method by which the firm can continue to benefit from them, even

though the competitive advantage that result from the usage of the machines in the core business does not exist anymore. This proposition is especially valid in complex industries[91] in which it is difficult to protect an innovation with strong patents. While the risk that imitators might copy Wüwa's machines principally exists, it is limited. In addition the negative effects of such imitation are limited for Wüwa. As Wüwa develops and builds tunnel-drilling machines, these machines are obviously less visible to potential imitators than 'normal' construction machines. The reduced visibility of the design of the drilling tool greatly reduces the risk that manufacturing firms will imitate the machine. Second, Wüwa's machines are not as unique as, for example, Bauer's machines. Thus, the negative effect of an imitation of Wüwa's machine is not as strong as it is for Bauer.

The Wüwa case also supports Proposition 4, which concerns the need to recoup R&D investments. According to Mr. Loser, "at the beginning, the repair shop both maintained Wüwa's machines and was active in the construction of new machines" (Loser [Interview 17]). The ability to spread these development costs over a larger number of units was an important motive behind the commercialization decision.

Similar to the Bauer case, Wüwa's activities and its strong reputation in its core business serve as valuable marketing tools for its machine unit (Proposition 5). Wüwa's management is convinced that its activities in the construction business are a selling point for their customers, as the use of the machines on Wüwa's own construction sites demonstrates their functionality. "I am convinced that we have an advantage compared to our manufacturing-only competitors as our customers see that we use our machines on our construction sites successfully" (Loser [Interview 17]). Additionally, Wüwa's familiarity with the tunnel construction business and with other construction firms increases the ease with which the company can approach potential customers.

Proposition 6 states that when two businesses of a firm follow different economic cycles, a market commercialization strategy is likely. While Wüwa's two businesses follow

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[91] Complex industries have products that comprise a large number of patents that are thus difficult to protect against imitators. An example of a complex industry is the computer industry. In contrast, products in discrete industries can typically be protected by a relatively small number of patents, as is the case in the pharmaceutical industry (e.g., Kusonaki et al., 1998; Kash and Kingston, 2000; Cohen et al., 2000).

not identical economic cycles this condition was of limited relevance for the decision to sell the user innovations. Although the economic cycles of tunnel-drilling machines and the tunnel-drilling business are slightly different, the machine sales of Wüwa are still limited. Thus, if Wüwa sells more machines in the future, this effect will probably appear.

In contrast to the Bauer case, the fact that being independent of the stock market facilitates the initiation of a commercialization strategy during periods in which other strategy types are favored by economists (Proposition 7) can not be confirmed by the Wüwa case. Wüwa has always been a family firm; in its early years, the firm was managed by its founders, since 2000, it has been a subsidiary of Max Bögl, the largest family-operated construction firm in Germany. Wüwa's parent company is interested in the machine construction component and thus supports the dual activities of Wüwa. Thus, a high independence from the stock market has always existed. However, I do not have any information if this fact had a positive influence on the commercialization decision.

As mentioned in Proposition 7, Max Bögl as a large undiversified (family) blockholder is Wüwa's parent company since 2000. However, in this case I can not confirm that being owned by an undiversified family firm increased the ease with which Wüwa pursued the machine development and production efforts. (Proposition 8).

In Proposition 9, I postulate that potential conflicts between the employees of the two business units (the user unit and the manufacturer unit) as a result of market commercialization reduce the likelihood of a commercialization strategy. This proposition can not be confirmed by the Wüwa case. The main cause of conflicts in the Bauer case was that the employees of the user unit felt deep resentment toward the manufacturing employees because they felt that the manufacturing unit enabled the competitors to achieve a technological level that was identical to that of Bauer's construction unit. According to Mr. Loser, the situation at Wüwa is of different nature, as "if a competing tunnel construction firm does not buy a machine from us, it will buy it from Herrenknecht" (Loser [Interview 17]). Because other construction firms can purchase machines of equal quality from other manufacturers, such as the above described conflicts do not exist. Wüwa's internal conflicts between the user and manufacturer units tend to be of a classic supplier-

customer nature[92]; therefore, I could not find any support for Proposition 9 in the Wüwa case.

Because of the small size of the firm, Wüwa's management is highly involved in the resolution of any internal conflicts between the two business units. When necessary, the CEO himself eases any upcoming conflicts. However, as described in Proposition 9, the conflicts between the user and manufacturer units at Wüwa typically do not result from the commercialization of the machines; such conflicts are usually related to disputes between suppliers and customers. Thus, Proposition 10 that states that the ability of management to ease general tensions and commercialization-related tensions between both units is not applicable in this case. While the CEO eases the tensions, these tensions differ from those postulated in Proposition 10.

As Table 7 shows, Propositions 1, 2, 4, and 5 are fully supported by the Wüwa case. While the conditions for Propositions 3, 6, 7, and 8 are given, I can not fully confirm these propositions as I can not confirm that the existence of the given conditions really caused the commercialization decision in the case of Wüwa. Propositions 9 and 10 can not be confirmed by the Wüwa case or are not applicable.

3.4.2.3 Teekanne Group

Similar to what observed in the Bauer case, the combination of machine engineering knowledge with detailed user knowledge is the basis for the success of Teekanne's machine business (Proposition 1). In its early years, Teekanne was deeply involved in the development of tea-packing machines. Eventually, Teepack became more independent from its parent firm, and external customers became increasingly important in terms of revenues and relevant customer feedback. However, presently, Teepack and Teekanne continue to work together closely, and Teepack benefits strongly from the lead user knowledge generated by Teekanne. In addition, Teepack profits from Teekanne's vast tea-

[92] Conflicts between the supplier and the customer of a product are typically the result of information asymmetries together with opportunistic behavior of one or both parties involved (Ciborra, 1993; Kumar, 1996). For example, these conflicts may result in disagreements regarding delivery or service times or product quality.

packing knowledge. While the competitors of Teepack sell only tea-packing machines, Teepack benefits from Teekanne's knowledge and offers its customers complete tea-packing lines (tea-packing machines, conveyor lines, and machines that pack the tea bags in boxes and on trays).

Similar to my observations in the Bauer case, the feedback from external customers is an important source of ideas for improving Teepack's tea-packing machines (Proposition 2). However, it is more a consequence of the commercialization of Teekanne's user innovations and not a reason for the commercialization decision. According to Mr. Lambertz, Teepack currently receives feedback from three main sources. One of these critical sources is feedback from external customers[93] (Lambertz [Interview 18]). At the beginning of the development of the tea-packing machines, the clear focus was to satisfy Teekanne's needs. With the foundation of Teepack, a first step toward a broader market focus was undertaken, although the firm continued to pay more attention to the feedback from Teekanne compared with the feedback that was obtained from external customers. In recent decades, Teepack has become increasingly self-sufficient, and today, the ratio of 'market feedback' to 'feedback from Teekanne' is approximately 1:1.

Compared with that of Bauer, the risk of imitation of the tea-packing machines was less important for Teepack's commercialization strategy (Proposition 3). The double-chamber tea bag and the Constanta machine were protected by an effective patent, which enabled Teepack to have a monopoly on tea-packing machines worldwide until the end of the 1960s. Thus, the risk of imitation until this time was almost nonexistent. In the following years, imitators entered the market with good starting positions, as Teekanne's direct competitors were immediate customers of the machines.[94] Despite the emergence of imitators, Teepack continued with its restrictive sales policy and did not sell any machines to direct competitors of the tea-packing business. Today, patents (although they are less powerful than the famous Constanta patent) protect many of the technical details of the

[93] The two other sources are the feedback from Teekanne's tea-packing business and the firm's own development engineers, who have accumulated a broad base of technical knowledge.

[94] As a result of Teepack's restrictive sales policy, Teekanne's direct competitors could not purchase machines from Teepack; thus, these competitors were awaiting the emergence of a new machine supplier.

machines. However, the protection of the machines does not only result from the patents but also from the technical complexity of the machines and the presence of a very limited number of potential imitators on the market.

The Teekanne case fully supports Proposition 4 in which I postulate that high levels of investments in the development of user innovations favor a commercialization strategy. As I describe in Section 3.4.1.3, Teepack's initial growth is closely linked to its deal with Lipton. According to Mr. Lambertz, "the first machines were sold to Unilever[95] in the US with the goal to recoup the development costs" (Lambertz [Interview 18]). Thus, shortly after World War II, Teepack would not have been able to afford the high production costs of the machines. Lipton's advance payment allowed Teepack to produce and sell the first machines. Today, Teepack has sufficient monetary resources at its disposal to pay for the development efforts of new machines. However, the revenues that are generated by external customers are essential for the profitability of the machine business.

Similar to that of Bauer, Teekanne's machine business also benefits from the strong reputation of the core business (Proposition 5). Two facts assist in creating customer confidence in Teepack's machines. First, the machines are developed to satisfy the requirements of the firm's own user business. Second, Teepack machines are used in the tea-packing business of the firm. These two points serve as important reasons for other tea-packing firms to purchase Teekanne machines rather than purchasing machines from a purely machine-focused manufacturer.

In Proposition 6, I postulate that if two businesses follow asynchronous economic cycles, then commercialization is a means to reduce company risk. While the tea-packing and the tea-packing machines business do not follow identical economic cycles, this fact did not serve as an argument to conduct the commercialization in the case of Teekanne. The duality allows the firm to compensate for high variations in the machine orders of external customers. According to Mr. Lambertz, "in years with a low volume of orders, Teekanne orders can be accelerated with the goal to fill gaps in external machines orders" (Lambertz [Interview 18]). However, this volatility-reduction argument has never been a strategic

[95] Lipton was and is, still today, a brand of the multinational corporation Unilever that owns many brands in the field of consumer products.

priority of Teekanne. Moreover, the firm's former management team did not consider the risk-reduction argument when deciding to build the machine business, and risk reduction through diversification is not a high priority on the agenda of today's management.

In the Teekanne case a certain independence from the short-term nature of the stock market is given. However, I do not find evidence that this argument favored the decision to commercialize user innovations (Proposition 7). In contrast, I can confirm that this fact is supportive of following this strategy of user-manufacturer diversification, still today. Today, a non-family manager leads Teekanne; nevertheless, the two founding families have active roles on the supervisory board and support the firm's user-manufacturer diversification strategy. Additionally, "the fact that the firm is owned by two families made it always easy to follow this strategy" (Lambertz [Interview 18]).

Proposition 8 postulates that the existence of large undiversified blockholders in a firm facilitates diversification strategies. However, the argument of diversifying a families' business portfolio did not serve as a reason for conducting a commercialization strategy. As I described in Proposition 7, Teekanne and Teepack have always been owned by two families, who first initiated and later supported the activities of both businesses: the tea-packing business and the tea-packing machine businesses. While the former generations actively chose to follow the dual strategy, the generation that currently represents the owning families on the supervisory board were accustomated to the dual strategy and has learned that this strategy has worked well over the decades. Thus, the current generation fully supports the dual strategy.

Potential conflicts between the employees of the user and manufacturer units limit the likelihood of a commercialization strategy (Proposition 9). I did not find any evidence for this proposition in the Teekanne case. First, the decision to sell the machines was made more than 50 years ago. Thus, all parts of the firm accept the practice of selling machines to other tea-packing firms. Second, and even more importantly, the firm continues to follow a restrictive sales strategy and does not sell machines to direct competitors of Teekanne – or at least not to those production sites of competitors who produce tea for the German market. This restrictive policy prevents internal conflicts between both business units with regard to the firm's strategy.

As described in the previous paragraph, strategic conflicts between the employees of both business units rarely exist. Supplier-customer conflicts arise (although they are infrequent) and are typically resolved in joint meetings of both business units.

Proposition 10 postulates that a management team who is able to ease upcoming tensions between both businesses has a positive effect on a successful commercialization strategy; this proposition is not applicable in the Teekanne case. Although the management team is able to ease upcoming tensions, such conflicts are not usually rooted in the dual strategy but rather in more operative topics.

Table 7 summarizes the validation of the propositions. The Teekanne case fully supports Propositions 1, 4, and 5. While the conditions for Propositions 2, 6, 7, and 8 are given, I can not fully confirm these propositions as I can not confirm that the existence of the given conditions really facilitated the commercialization decision in the case of Teekanne. No evidence for Propositions 3, 9, and 10 could be found or these propositions are not applicable in the case of Teekanne.

3.4.2.4 DMT GmbH & Co. KG

As in the case of Bauer, the geological surveying instruments unit of DMT benefits from a continuous transfer of user knowledge from the exploration services unit that is a lead user in its field (Proposition 1). According to Mr. Lehmann, “the engineers of the instruments department spend 99% of their time at their office. Therefore, they rely on the user experience of the geological surveying services unit” (Lehmann [Interview 22]). At DMT, joint workshops between the machine business and the services unit are the basis for DMT’s new machine development.

In Proposition 2, I postulate that feedback from external customers is a valuable source of ideas for the improvement of a user innovator’s products. While feedback from external customers is an important source of information for DMT, the perspective of gaining this feedback in addition to feedback from internal sources was not used as an argument to commercialize DMT’s user innovations. In its early years, when most customers were in Germany or in the surrounding areas, DMT involved its own user unit in

the development of new products and conducted user workshops in which external customers were involved. In these workshops, DMT presented product ideas with the goal of discussing these ideas with customers and receiving feedback on these ideas. Today, because customers are located in various parts of the world, these workshops occur less frequently with the active involvement of customers. However, even today, DMT occasionally receives feedback or the improvement ideas from its customers and uses such feedback as a basis for product improvement.

Proposition 3 states that the risk that a competitor will imitate a firm's products increases the likelihood of a user-manufacturer to commercialize its machines. In the case of DMT, such imitations efforts exist, but are not considered as an argument to commercialize the firm's user innovations. Although there have been attempts to copy instruments or instrument parts, DMT ensures that these products are difficult to copy. A typical method with which to reduce imitation risks is the intelligent design of instrument parts that render the imitation as difficult as possible. Although patents for instruments and instrument parts exist, such patents do not serve as strong protection against imitators (Lehmann [Interview 22]).

By selling the machines to competitors, DMT is able to cover its investments in the development of its machines (Proposition 4). This aspect was particularly important in the early days of DMT's machine business, although the development of the instruments business was relatively risk-free because of the special business model of the Westfälische Berggewerkschaftskasse, i.e., when a research project was initiated, the firm hired the engineers who were needed to conduct the project and to develop the machines with a time contract. After a project was completed, the firm often retained the engineers for subsequent projects. Because of limited monetary pressure, the extension of contracts was relatively easy. Thus, the creation of a dedicated instruments division was a continuous process that occurred over the course of several years in a relatively risk-free environment. However, in the early years, the firm used the additional revenues to finance its new product development initiatives, and this practice continues today.

Similar to what observed in the Bauer case, DMT benefits greatly from the strong reputation of the core business (Proposition 5). In addition to the firm's familiarity with its

target markets, the activities of DMT in both the user and manufacturing businesses are an important selling point compared with its direct competitors. In Mr. Lehmann's words: "if you produce and sell tools and if you additionally offer the related services you are really familiar with a field" (Lehmann [Interview 22]). The firm's competitors only sell surveying instruments, whereas DMT is the developer, producer, seller, and also the user of these instruments.

Proposition 6 states that the differing economic cycles of the two businesses are associated with risk reduction and thus have a positive effect on the decision of a firm to commercialize its products. While such differing economic cycles exist, they are not very relevant, as DMT uses other methods for reducing the firm's risk. Its service to different industries, such as the oil, gas, and construction industries, and its geological surveying instruments and services allow DMT to diversify its risk.

While DMT has always been independent of the stock market, this independency did not facilitate the strategy of user-manufacturer diversification in the case of DMT (Proposition 7). The Westfälische Berggewerkschaftskasse, DMT's predecessor organization, was a joint organization that was financed by mining companies, and the objective of this organization was to support the mining activities in the Ruhrgebiet region. Today, the TÜV Nord AG, of which DMT is a subsidiary, is owned by three nonprofit organizations that are active in the field of technical examination services.

In Proposition 8 I state that the existence of large undiversified blockholders (whether they are family blockholders or other individuals or organizations) increases the likelihood that a firm will commercialize its user innovations. As mentioned in Proposition 7, DMT is a subsidiary of TÜV Nord AG, which is owned by three nonprofit organizations that act as primary blockholders. However, I can not fully confirm this proposition as I do not have any further information about the degree of diversification of these blockholders. In addition, this constellation did not have an influence on DMT's commercialization decision.

Proposition 9 postulates that strategic conflicts between the employees of two business units limit the likelihood of a successful commercialization strategy. I could not find evidence for this proposition in the DMT case. Although conflicts between the two

business units (the user unit and the manufacturer unit) exist, these conflicts are not caused by the duality of DMT's business. As mentioned in the case studies of Wüwa and Teepack,[96] the conflicts between DMT's two business units are simply the results of disagreements of the kind that often exists between suppliers and customers. Although the user unit expects that the manufacturer units will resolve problems immediately, the manufacturer unit often prioritizes its external customers.

Proposition 10, which states that if the management of a firm is able to ease tensions between the employees of both of its business units, then one can expect a more successful commercialization strategy is not applicable in the DMT case. At DMT, weekly management meetings occur; during these meetings, both the daily business and the problems between the two business units are discussed (Lehmann [Interview 23]). However, these problems are typically related to topics that include a delay in the delivery of an instrument or a delayed service because of the needs of an external customer that were prioritized by the instrument business units.

Table 7 summarizes the propositions that are supported by the DMT case. I found evidence for Propositions 1, 4, and 5. While the conditions for Propositions 2, 3, 6, 7, and 8 are given, I can not fully confirm these propositions as I can not confirm that the existence of these conditions really favored DMT's commercialization decision. I cannot confirm Propositions 9 and 10 or these propositions are not applicable for the DMT case.

3.4.2.5 H&S Tee-Gesellschaft

The H&S case fully confirms Proposition 1, which states that a continuous stream of user innovations from the core business leads to an accumulation of user-specific knowledge and thus favors a commercialization strategy. The development of the first tea-packing machines at H&S occurred because the machines that one could purchase on the market at that time were far too expensive to use in the recently founded tea-packing business. However, there began to exist a need to increase the efficiency of production. Due

[96] For the discussion of Proposition 9 for the Wüwa case, please see Chapter 3.4.1.2; for Teekanne, please see Chapter 3.4.2.3 of this work.

to these two reasons, Gerhard Klar made the first efforts to develop the firm's own machines. Even today, new or improved machines result from a permanent learning process in the user business and continuous improvement efforts in the machine business (Klar [Interview 21]).

Proposition 2 postulates that feedback from external customers is a highly valuable source to improve user innovations and thus constitutes an argument for the commercialization of user innovations. I could not find evidence for this proposition in the H&S case. Although the development of new or improved machines occurs in close association with the firm's own tea-packing business, the feedback from external machine customers is not actively used to better adapt the machines to the customer's needs. The main reason for the fact that external customers are not involved is that "the needs of the own tea-packing business and external customers are essentially identical" (Klar [Interview 21]).

In Proposition 3, the risk of imitation of the machines by competing firms is addressed. In this proposition, I state that a high risk of imitation increases the likelihood that a firm will commercialize its user innovations. This proposition could not be confirmed by the H&S case. When H&S began developing its tea-packing machines, one could already purchase a machine with identical functions on the market (H&S is not a lead user in its field). Additionally, tea-packing machines are not easily visible for every competitor, as they are 'hidden' at a firm's production sites. Because nearly identical machines already existed and the machines would not have been visible to the competitors in the absence of commercialization efforts, the risk of imitation of H&S's machines did not influence the commercialization decision. Thus, Proposition 3 can not be confirmed by the H&S case.

The argument that the commercialization of the machines generates money to finance new development efforts and to spread the investments over a large number of units sold (Proposition 4) is greatly important for H&S. According to Mr. Klar, shortly after the beginning of the machine development process, it became a clear goal to sell the machines externally without restrictions and to use the money generated by the machine business unit to finance new product development efforts. Furthermore, the money generated from the external machine sales was used to construct a dedicated machines department in a step-by-

step manner; such construction would otherwise not have been affordable in the early years of the firm's existence.

The visibility and the high reputation of H&S's core business have a positive influence on the commercialization of the machines, as I postulated in Proposition 5. Compared with its machines-only competitors, H&S has an important competitive advantage because it uses its machines in its own production and is thus able to demonstrate the operation of its machines to customers at its own production sites. In the words of Mr. Klar, "H&S has an advantage compared to pure machine manufacturers as we can demonstrate the machines in our own production sites." Additionally, customers associate tea-packing competence with the name of H&S due to the firm's tea-packing activities; this association is highly advantageous for the firm.

Proposition 6 postulates that if two business units follow different economic cycles, diversification allows for risk reduction and thus has a positive effect on the decision of a firm to commercialize its products. Mr. Klar states that "the two businesses do not follow identical economic cycles" (Klar [Interview 21]). Furthermore, according to the former CEO, this effect is even stronger "as H&S has an additional packing-machine business, which typically serves industries other than the tea-packing industry" (Klar [Interview 21]). The duality of H&S's activities has already assisted the firm in the past. The downturn in the 1990s and the recent downturn in 2008 were fairly manageable, as the firm was able to rely on two businesses that do not depend on identical influencing factors. While the conditions for this proposition are given in the underlying case of H&S, these conditions did not serve as an argument to follow a strategy of user-manufacturer diversification. Thus, this proposition is not fully confirmed by the underlying case.

In Proposition 7, I postulate that a limited dependence on the stock market also enables a firm to follow a diversification strategy during periods in which analysts reward strategies that 'focus on core competencies.' This proposition is not fully confirmed by the H&S case. According to Gerhard Klar, because the firm is not owned by a large number of shareholders, the owning family and the management team (which are identical in the H&S case) have the freedom to follow a certain strategy even in situations in which analysts or the stock market favor a different strategy type. However, the above mentioned argument

has not been considered as a reason to follow a strategy of user-manufacturer diversification.

Proposition 8, which states that the existence of large non-diversified blockholders increases the likelihood of a commercialization strategy, is not fully confirmed by the case of H&S. While the conditions mentioned in this proposition are given, these conditions did not facilitate H&S's commercialization decision. As described by Mr. Klar, the former CEO of H&S, the family, today, considers the diversification of H&S's activities as an instrument with which to diversify the family's risk. As stated in Proposition 7, H&S is owned by its founding family and led by family members of the third generation.

In the case of Bauer, Proposition 9, which postulates that the existence of conflicts between the employees of both business units has a negative influence on the successful commercialization of user innovations, is important. This proposition is not confirmed by the H&S case as conflicts at H&S do not result from the duality of the firm's businesses. According to Mr. Klar, "conflicts between the employees of the two business units do always exist and are not rare phenomena" (Klar [Interview 21]). However, tensions between the two business units as for Bauer do not exist at H&S, as "the employees focus on their own work and do not engage in comparisons and competition with their colleagues or other business units" (Klar [Interview 21]).

The existence of a management team who is able to ease potential tensions between the two businesses is highly important in the case of Bauer (Proposition 10). Although the topic was not directly addressed in the interview with Gerhard Klar, some information leads me to the assumption that upcoming conflicts are resolved between the managers of the firm or at the board level, as H&S is a small firm. However, as this topic was not addressed directly in the interview, this proposition is not applicable for H&S.

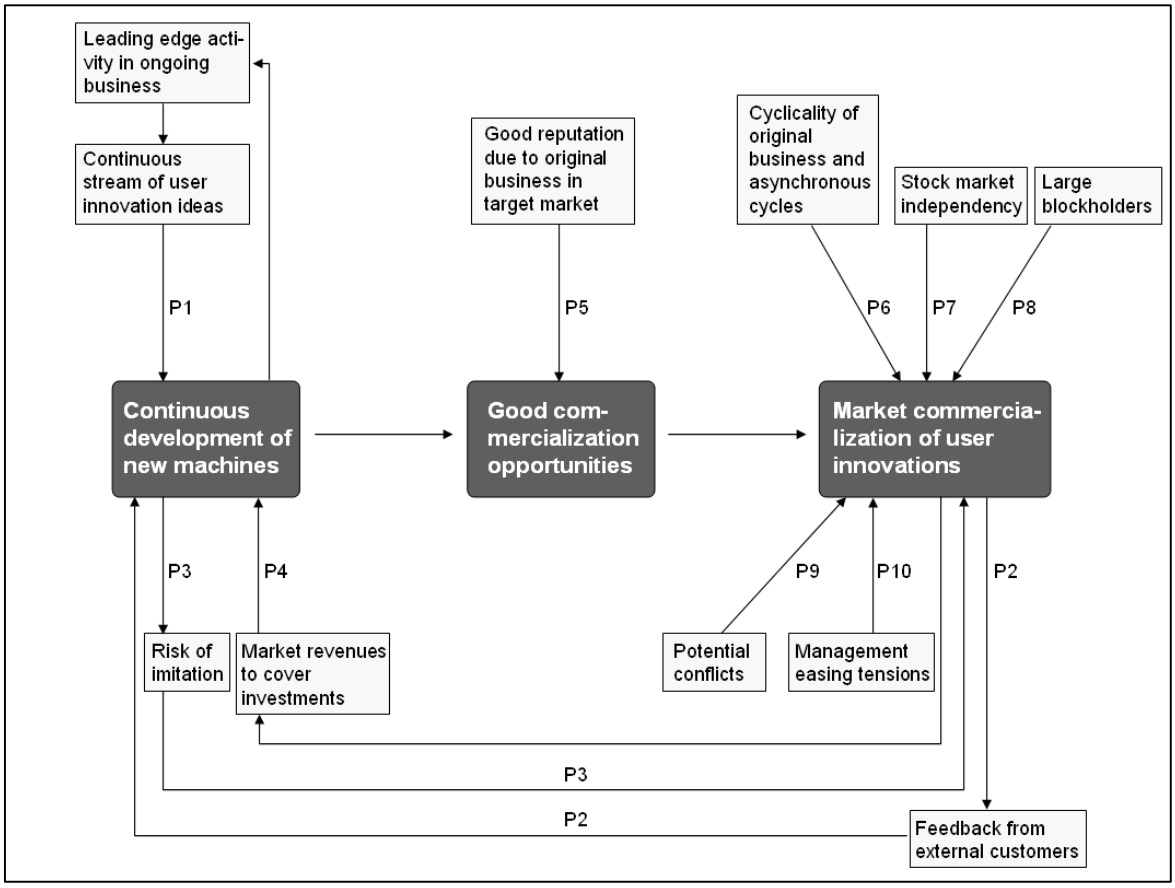
As is shown for the other validation cases, Table 7 summarizes the propositions that are supported by the H&S case. I found evidence for Propositions 1, 4, and 5. In contrast, I could find evidence that the conditions of Propositions 6,7, and 8 are given, whereas I can not confirm the influence of these conditions on the commercialization decision of H&S. Propositions 2, 3, 9, and 10 could not be confirmed by the H&S case or are not applicable.

3.5 Summary

As presented in Sections 3.4.2.1 to 3.4.2.5, I identify ten factors that can favor or hinder[97] the commercialization of user innovations by a user-manufacturer firm. However, not all of these factors influence the process in which a classic 'user firm' becomes an 'integrated user-manufacturer firm' in the same way. In addition to the direct influence of these factors on the commercialization process, indirect influences and feedback loops from the development process exist. In this section, I aim to summarize the propositions that have been derived and validated in the previous sections of this work and to describe the process by which a 'classic user firm' becomes an 'integrated user-manufacturer firm,' including when and how the influential factors affect the process (see Figure 4 for an overview).

[97] Propositions 1 to 8 and Proposition 10 describe conditions that are favorable for the commercialization decision of user innovations in the case that they are given, while they may impede the commercialization decision in situations in which the conditions do not occur. In contrast, the conditions described in Proposition 9 do hinder commercialization when they occur, but commercialization is likely when the conditions for this proposition are not given.

Figure 4: The Process towards an Integrated User-Manufacturer Firm



In all of the firms examined in my study, the causes of the market commercialization of user innovations lie in the continuous development of new machines, and the primary goal of such development is to satisfy the needs of a firm's own user business. The lack of adequate machines and the superior technological knowledge makes these firms to lead users in their business and let them develop their own machines. Typically, this continuous development is nurtured by a continuous stream of user innovations from a firm's core business (Proposition 1). The availability of new, technologically superior machines allows a core business to conduct cutting-edge activities, which may subsequently lead to a continuous stream of user innovations.

The development of machines that are used for a core business may create the risk of imitation, as observed in the case of Bauer (Proposition 3). The observation of the

machines by competitors on the construction sites, where Bauer worked together with these competitors, caused competing firms to imitate these machines. This risk of imitation affects the development process toward an 'integrated user-manufacturer firm' because the risk of imitation may accelerate the market commercialization of user innovations.

When the internal development of machines whose goal is to satisfy the needs of a firm's own user business is established, the next phase in the process towards an integrated user-manufacturer firm typically begins: the identification of commercialization opportunities for user innovations. This identification may occur in a strategic, systematic manner, as I observed in the Teekanne case,[98] or it may occur accidentally, as I observed in the Bauer case.[99] At this step of the process, the reputation of the original business in the relevant markets typically fuels the demand for the user innovation from other firms (Proposition 5). Because the user-innovating firm is already active in a market and has gained a certain reputation with its original business, the interest of other firms in the user-innovation product increases. As can be observed in the case of Wüwa (see Section 3.4.1.2), its experience as a user firm in the tunnel-construction business increases trust in the tunnel-construction machines that were developed by the firm. Additionally, the activities of the original business typically lower the market entry barriers, such as the access to potential customers or distribution channels, as shown in the case of Bauer.

The phase of the identification of commercialization opportunities leads to the next phase, which begins with the decision to sell a user innovation on the market without any restrictions: the phase of the market commercialization of user innovations. This phase (and particularly the decision based on which this phase opens up) is influenced by many factors, including the cyclicality of the original business and the asynchronous economic cycles of the original business and the user-innovation business (Proposition 6). If the original business demonstrates cyclicality, then the differing economic cycle of the user-innovation

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[98] As described in section 3.4.1.3, from the beginning of the first development efforts after World War II, the goal was to sell the Constanta machine to external customers. This goal becomes even clearer when one considers that the first Constanta machines were sold to a firm in the US rather than to the firm's own user business.

[99] As mentioned in section 3.4.1.1, when the first competitors approached Bauer with the desire to purchase its machines, the firm did not sell the machines to these competitors. Thus, over the years, the machines sales were selective until the firm decided to open itself up to the demands of the market.

business affects the commercialization decision. As described in Section 3.4.2.1 in the Bauer case, this risk-reducing function of the user-innovation commercialization had an important role in the decision to commercialize the firm's user innovations.

A factor that is important both for the decision to commercialize a user innovation and in the subsequent commercialization phase is a firm's independence from the stock market (Proposition 7). Being relatively independent from quarterly reports and the recommendations of analysts allows a firm to follow a strategy that is not favored by the stock market at a particular time. In the case of Bauer, this independence from the stock market favored the firm's decision to commercialize a user innovation and may have become even more important in the permanent commercialization phase after the decision was made. As the strategies that are rewarded by the stock market typically change over time,[100] the adoption of a continuous strategy[101] over the course of many years is significantly easier without permanent pressure from analysts or bankers.

The existence of large undiversified blockholders (e.g., families) (Proposition 8) may influence the decision to commercialize a user innovation and is less important at later stages when the market-commercialization phase has already begun. If one family or other individuals hold a high percentage of the shares of a firm, then the decision to diversify the firm's business (i.e., to commercialize a user innovation) may be considered to be a form of risk diversification by these individuals. While financial investors diversify their risks by investing in different firms or industries, a large blockholder of one firm can diversify his risk by diversifying the firm's business. As described by Mr. Klar, the former CEO of H&S, today, the family considers the diversification of H&S's activities as an instrument with which to diversify the family's risk.

Two factors influence the decision to commercialize a user innovation because they predict how successful and stable a firm's actions will be in the commercialization phase: the emergence of potential conflicts between employees of the original business unit and the young user-innovation business (Proposition 9); and the capability of the firm's

[100] Although a diversification strategy was favored in the 1980s, the beginning of the 1990s ushered in an era of strategies that favored a 'focus on core competencies'.

[101] For Bauer, this strategy was a diversification strategy.

management team to ease tensions between the employees of both business units (Proposition 10). As I discovered in the case of Bauer AG, the activities of the user-innovation business caused (and continue to cause) conflicts with the original business because the manufacturer business, by selling the machines to competing firms, enables competitors of the original business to conduct the same challenging projects as Bauer's user business does. Thus, if a firm assumes that such conflicts may occur in the future, then the decision to commercialize its user innovations may be reconsidered. In contrast, if the management of a firm anticipates that it will be able to ease these tensions and utilize these tensions to stimulate internal competition, then it may proceed with its decision to commercialize its user innovations. This situation occurred in the case of Bauer AG, in which conflicts between the employees of both business units do exist and, according to the CEO of the firm, in which the management of the firm is responsible for handling these conflicts.

One factor that is influenced by the commercialization decision or the commercialization phase of a user innovation and then reconnected by a feedback loop to the first step in the development process is the continuous development of new machines because commercialization allows the user-innovating firm to generate revenues that assist in covering the investments of such development efforts (Proposition 4). However, this factor can also be viewed as an argument that supports commercialization decisions: expectations of revenues from user-innovation sales that assist in financing the high levels of investments required for a product development effort (whether these investment were already made and the firm aims to recoup the money or whether the revenues serve to finance upcoming development projects) may favor the decision to commercialize a firm's user innovation. In the case of Teekanne, only those revenues generated by the external sales of its user innovations allowed the development and production of the machines, as resources were scarce immediately after World War II.

Similar to the argument above regarding revenues is the influence of feedback from external customers (Proposition 2). If a firm decides to commercialize its user innovations, it can anticipate feedback from both its own user business and other user firms that may have different needs. This feedback is directly linked to the first step of the development process and can be used as an information source for the development of new machines. In

the case of Wüwa and Bauer, for example, the feedback from external customers who work under different soil conditions is a highly relevant source of information for the development of new machines.

3.6 Discussion

Previous research regarding the commercialization of user innovations focuses on end-user innovators. Haefliger et al. (2010), Shah and Tripsas (2007), and Baldwin et al. (2006) identify several factors that influence the likelihood of end users commercializing their user innovations via a start-up company. These factors can be categorized into innovator-related factors (e.g., the opportunity costs of the user entrepreneur), innovation-related factors (e.g., the need for complementary assets), and market-related factors (e.g., the market structure and the degree of uncertainty).

This research extends the studies by Baldwin et al. (2006), Haefliger et al. (2010), and Shah and Tripsas (2007). By focusing on the commercialization of user innovations from professional user innovators rather than end-user innovators, I discover additional factors that influence the likelihood and the process of the commercialization of user innovations. Furthermore, in addition to studying the emergence of a manufacturing firm based on user innovation, I also analyze the factors that favor the long-term coexistence and collaboration of a user-innovating unit and a manufacturing unit within one corporation. I summarize these factors in ten propositions, a selection of which are included in the following discussion.

Proposition 2 states that the prospect of obtaining feedback from external customers to further improve user innovations favors the market commercialization of user innovations. A similar pattern exists for user innovations from end-user innovators, who emphasize the importance of feedback from a community for the quality of an end-user innovation (Shah and Tripsas, 2007; Hienerth, 2006; Franke and Shah, 2003; Franke et al., 2006).

My argument that user feedback assists in addressing the variegated needs of users more broadly, as opposed to only the needs of in-house users, partially corresponds to the

proposition of Shah and Tripsas (2007), who claim that a high level of variety in demand favors user entrepreneurship. However, the mechanisms by which such a variety affects user entrepreneurship differ. I argue that if a variety of needs exists, then the prospect of receiving feedback from external users favors market commercialization because this feedback allows a business to build products that satisfy various needs. In contrast, Shah and Tripsas (2007) argue that end-user entrepreneurs develop and commercialize products specifically for the market niche that corresponds to their own needs.

My cases further show (Proposition 4) that the process of commercializing a user innovation by an established firm on the market is a path-dependent process (Sydow et al., 2009). When a firm has made higher levels of investments in the development of its user innovations, its need to recoup these investments is greater; thus, the likelihood of a market commercialization strategy increases. Anticipating this need, a firm may even undertake a major user-innovation project only if it perceives that market commercialization is feasible and intends to pursue such a strategy. This argument complements the arguments offered by Baldwin et al. (2006), who state that the amount of capital that an end-user manufacturer has invested in an innovation project gives the firm a competitive advantage over other manufacturers that seek to enter the market. These arguments are complementary insofar as Baldwin et al. (2006) refer to the quality-enhancing effect of investments in innovation, whereas I focus on the need to recoup such investments.

Proposition 7 underlines that corporate governance can have an important role in the decision to follow a market commercialization strategy. I suggest that, because of the long-term nature of market commercialization strategies, firms that are entirely or primarily privately held (and thus are more independent from the stock market) may be more likely to pursue a market commercialization strategy than firms of which all stocks are traded. Independence of the stock market, and from trends and analysts' recommendations, may also be driven by a firm's status as a family firm (some of whose shares may still be traded on the market). Family firms are likely to think in terms of longer time periods (Le-Breton Miller and Miller, 2006). A family firm symbolizes the heritage and tradition of a family and is part of this family's identity. Families as owners often intend to transfer their firms to the next generation (James, 1999; Lansberg, 1999; Tagiuri and Davis, 1992). Therefore, families think in terms of generations rather than quarterly results. The interviews for this

study showed that such a long-term perspective is required when commercializing user innovations on the market.

These arguments are consistent with prior research on the effects of corporate governance on the long-term orientation of public firms. For example, Porter (1992) and Laverty (1996) argue that short-term perspectives may be the result of short-term relationships between firms and the capital market. Institutional investors, such as investment funds, move their funds from company to company with the goal to maximize their profits; therefore, such investors do not understand or care about the long-term strategies of the companies in which they invest. The management of a public firm may experience difficulty in convincing these types of investors of the merits of the market commercialization of the firm's user innovations. Shareholders in public companies are primarily interested in strong short-term results and increases in the value of their stock. Thus, managers in these firms prefer short-term investments that yield rapid monetary results to enhance their personal reputations on the market for executives (Narayanan, 1985; Thakor, 1990) and to increase job safety (Hirshleifer and Thakor, 1992).

For the cases in my study, the commercialization of a firm's user innovations on the market changed the structure of the firm with the emergence of a new business unit. This unit exerted a negative external force on the original unit by selling to competitors of the original unit; in turn, these sales caused conflicts between these units. The ability of management to contain these conflicts is crucial for the success of a market commercialization strategy. Previous literature suggests that family firms enjoy a particular advantage over other firms with regard to overcoming such intra-organizational conflicts (Carney, 2005; Le-Breton Miller and Miller, 2006).

3.7 Conclusion

Von Hippel (1988) argued that few user innovations are commercialized on the market by the user innovators themselves because it is difficult to change a firm's (or even an individual's) functional role from that of a user to that of a manufacturer. Nevertheless, such cases do exist, as some authors have recently shown (Baldwin et al., 2006; Haefliger

et al., 2010; Shah and Tripsas, 2007). This study extends this stream of research to the field of 'corporate user entrepreneurship' by demonstrating that under certain conditions, the ongoing coexistence and collaboration of both functions within one firm is feasible. Bauer, a firm that was originally active in the field of specialist foundation engineering, has not changed its role as a user to that of a manufacturer of construction machines. Rather, the firm has maintained its original role as a user and has additionally adopted the role of a manufacturer of construction machines. Since this duality emerged due to user innovation, and since joint innovation by the user and the manufacturer unit is one of the reasons for its sustainability, such a firm can be aptly called a 'user-manufacturer innovator'. The same pattern was found in the four other cases that I analyzed: the cases of Wüwa, Teepack, DMT, and H&S.

The five cases and the general discussion show that this commercialization of user innovations on the market entails benefits and challenges. The main benefit is that a firm can generate new sales and thus can benefit from its experiences as a user and its past development efforts regarding user innovation. In addition, the cases show that there exist substantial synergies with regard to the marketing of such user innovations. The main challenge is to manage the inner-firm tensions that may arise when a manufacturer unit sells its products to firms that compete with the original user business. Another challenge is to communicate the benefits of such a diversification strategy to external stakeholders, such as banks or shareholders. Such stakeholders often prefer a strategy of focusing on core competencies and may suggest a spin-off of the newly created manufacturing department after its successful launch.

This study has several limitations. As a study of multiple cases, this research is restricted to the specific industries of the five cases. Although I am confident that the propositions are generalizable (because they are based on several cases from various industries and on economic reasoning), future work should study the phenomenon of user-manufacturer integration in a large-scale quantitative study. By conducting such a study, researchers may be able to identify the additional influences of industry characteristics on the likelihood and the process of market commercialization of user innovations. Similarly, a large-scale quantitative study would allow researchers to study the effects of corporate governance, firm culture, industry structure, and countries of origin on user-manufacturer

innovations. Effective approaches to reducing inner-firm tensions and communicating the benefits of user-manufacturer integrations to external stakeholders are of interest to scholars and practitioners. Furthermore, industry-wide studies should analyze how user innovations affect industry structures and how user-manufacturer innovators relate to focused competitors in either industry. With these goals and numerous other unanswered questions, I believe that this study has created interesting avenues for future research.

4. User-Manufacturer Integration and the Innovativeness of Manufacturers

4.1 Introduction

Extant empirical studies analyze the effect of a firm's degree and type of diversification on performance, innovativeness, and innovation activities (e.g., Garcia-Vega, 2006; Hitt, Hoskisson, and Kim, 1997, Baysinger and Hoskisson, 1989; Doi, 1985). Garcia-Vega (2006) finds that the degree of technological diversification is positively related to R&D intensity and innovation output. Hitt, Hoskisson, and Kim (1997) emphasize that the degree of international diversification is positively related to performance in firms that are highly diversified in terms of their product range and negatively related to performance in firms that are not diversified regarding their products. Furthermore, the degree of international diversification is also positively related to R&D intensity, but the interaction effects on product diversification are negative. Most of the existing studies analyze related diversification (see Section 2.2.5), which implies that the firm can benefit from assets gained in former business activities when starting new ones. These synergies make related diversification efforts generally more successful than unrelated ones (e.g., Rumelt, 1982; Chatterjee and Wernerfelt, 1991).

However, all of these studies of the degree and type of related diversification and innovativeness do not consider one specific form of related diversification that has been analyzed in Chapter 3: the 'integrated user-manufacturer firm'. In the study "Commercializing User Innovations by Vertical Diversification: The User-Manufacturer Innovator", the term 'integrated user-manufacturer firm' describes primarily those firms that are active in the user business of an industry and then diversify by additionally adopting a manufacturer business. In addition, all firms that I consider 'integrated user-manufacturer firms' in the qualitative study in Chapter 3 are originally user firms that founded their own manufacturer business and expanded the business over years. For the

present chapter, I aim to make explicit that the definition that I present in Section 3.1 includes those firms that are active in a user and a related manufacturer business, independent of how the adoption of the new business unit took place.

In Chapter 3, I analyzed the commercialization process of user innovations of five firms from four different industries. In that study, I show that user-manufacturer innovators benefit in various ways from the duality of their business under suitable conditions. In particular, if the downstream unit is a lead user (von Hippel, 1986), then the upstream unit may benefit from a continuous stream of user innovations and from positive reputation externalities, while the downstream unit benefits from a prompt supply of innovative products fitting its needs. These arguments suggest that firms exhibiting this specific type of vertical diversification[102] should be more innovative in their upstream unit than stand-alone manufacturers. Existing studies of the effects of firm diversification have not addressed this issue.

With the underlying study, I aim to fill the existing research gap and extend the existing findings regarding the effects of firm diversification by analyzing the relationship between diversification and innovation in the field of 'integrated-user manufacturer firms'. Additionally, in contrast to the existing studies, I aim to focus on innovation quality and not innovation quantity or innovative input. The goal of this research project is to determine whether and to what extent the manufacturing units of user-manufacturer firms are more innovative than non-vertically diversified manufacturers in the same industry. To this end, I compare approximately 416 patents in two 3-digit IPC classes from three vertically diversified and five non-vertically diversified firms in terms of patent quality.

The remainder of this study is structured as follows. In Section 4.2, I outline the concept of 'integrated user-manufacturer firms'. Furthermore, I review the literature on the effects of firm diversification on innovativeness in this section and derive the hypothesis I aim to test based on existing literature and the findings from my previous study. In Section 4.3, I describe the data sources I use and the process of dataset composition and the

[102] 'User-manufacturer diversification' can be considered a special form of vertical diversification. While it is not vertical along the supply chain, it is vertical along the chain of capital goods needed to offer a specific product or service.

variables at the core of my analysis. Following the methods and data section, I present the results of the descriptive and the multivariate analyses and elaborate on the model in Sections 4.4 to 4.6 of this work. In Section 4.7, I summarize and discuss, and in Section 4.8 I conclude.

4.2 Hypothesis Development

The 'Integrated User-Manufacturer Firm'

While in Section 3.2, I describe with the term 'integrated user-manufacturer firm' primarily those firms that are active in the user business of an industry and then diversify by additionally adopting a manufacturer business, this term explicitly includes all firms that are active in a user and a related manufacturer business independent of how the diversification took place. A typical constellation is that the upstream (manufacturer) unit of such organizations sells its products to the downstream (user) unit and to competitors of its downstream unit. As I outline in Chapter 3, these firms typically benefit greatly from the duality of their activities. As the manufacturer business receives a continuous stream of user innovations and new product ideas – the more innovative the downstream business is, the more valuable these ideas are for the upstream business –, the downstream business benefits from innovative machines that are designed to satisfy its needs. Besides these positive effects, the complete organization benefits from many other factors. These benefits include a certain risk diversification that can be achieved by the dual activities of the firm and reputation gains for one business due to the activities of another business. On the other hand, negative effects may also result from this duality of a firm's activities. Besides external conflicts with customers who do not want to buy their machines from their competitors, internal conflicts may also arise between the employees of both businesses. In many cases, these conflicts are caused by the fact that the manufacturer business of the firm sells its products to the direct competitors of the user unit and, thus, jeopardize a potential competitive advantage that the user unit might have derived from the usage of the user innovation.

Firm Diversification and Innovativeness

Many studies investigate the influences of firm diversification on innovativeness. However, while there is a high level of consensus that an effect of diversification on the innovativeness of firms exists, some disagreement exists regarding what exactly this effect is. This disagreement is not only reflected by the results of empirical studies in the field, but also by the theoretical argumentations of innovation and management scholars.

Before presenting important empirical studies, I give a detailed overview of both argumentation streams on which most of the later presented studies rely.

Nelson (1959) being one of the first researchers who works on the relationship between diversification and innovativeness postulates that diversified firms are more likely to benefit from new technological opportunities than more specialized firms. Many researchers, such as Granstrand (1998) and Suzuki and Kodama (2004), extend Nelson's hypothesis by arguing that technologically diversified firms achieve a higher innovativeness than less-diversified firms because the former benefit from their diversification in the sense that fertilization effects between different though related fields may exist. Additionally, positive effects from the exchange between unrelated fields may put these firms in a better position to innovate (Garcia-Vega, 2006). Another field of arguments is based on Nelson's (1959) hypothesis that diversification is favorable for basic research due to the fact that basic research activities often fail or provide discoveries in unexpected fields. Doi (1985) and Garcia-Vega (2006) extend Nelson's hypothesis by arguing that diversified firms may tend to invest more in R&D activities than relatively focused firms because broader R&D investments reduce the negative effects of a failure of every single effort. Moreover, diversified firms have more outlets for innovations and thus can more easily benefit from their innovative activities monetarily (Doi, 1985). Furthermore, diversified firms may benefit from economies of scale (Doi, 1985) and economies of scope (Teece, 1980; Kamien and Schwartz, 1982; Porter, 1985) between related fields. In addition, Quintana-García and Benavides-Velasco (2008) argue that technologically diversified organizations are better capable to recombine their knowledge in new settings and combinations and, thus, are capable to benefit from their diversification. Another argument of Doi (1985) for why diversified firms engage more in R&D activities

is based on the assumption that highly diversified firms in most cases are larger corporations than relatively focused firms. According to the author, diversified firms often gain greater and more stable profitability. Hence, these firms control enough financial resources that allow them conducting often expensive R&D activities.

In contrast, Burgelman (1983), Hayes and Abernathy (1980), Hill, Hitt, and Hoskisson (1988), and Hoskisson, Hitt, and Hill (1993) argue that the focus on financial incentives for managers of highly diversified corporations negatively influences the innovation activities of their firms. According to Baysinger and Hoskisson (1989) and Hitt, Hoskisson, and Ireland (1990), increasing product diversification of firms causes a shift of managers from strategic to financial control mechanisms. These financial incentives for managers may create disincentives for them to invest in risky and often uncertain R&D projects, but to focus on short-term financial results. Similarly, Hitt, Hoskisson, and Kim (1997) argue that the firm scope exceeds the managerial capabilities in highly diversified corporations, which leads managers to shift from an emphasis on strategic controls to financial controls. This shift again has the above described negative influence on innovative activities. Furthermore, Breschi et al. (2003) argue that companies that focus their activities in a small number of technological fields may benefit from this specialization for various reasons. In addition to synergies in the learning process, the knowledge transfer from one field to another (related) field is relatively easy and may thus lead to a technological advantage.

Building on the arguments of, among others, Granstrand (1998), Suzuki and Kodama (2004), and Nelson (1959), Garcia-Vega (2006) investigates the impact of technological diversity on the R&D intensity and on the innovative output from R&D active European firms and finds evidence that both innovative input and innovative output increase with increased technological diversification of the firms in her sample. Quintana-García and Benavides-Velasco (2008) come to similar findings when exploring the effect of technological diversification of a firm on its innovative competence.[103] The two authors

[103] Quintana-García and Benavides-Velasco (2008) consider two specific types of innovative capabilities: Exploitive innovation meaning experimentation along an existing knowledge dimension, whereas exploration describes extensive search in a new field with the goal of discovering new knowledge.

find that a high degree of technological diversification has a positive effect on the capacity of firms to innovate. This increased innovative capacity than allows firms obtaining more innovations in the future. In addition, authors, such as Audretsch and Feldman (1999) support the thesis that diversification positively influences innovation activities.

In contrast, Hitt, Hoskisson, and Kim (1997) find evidence for a negative interaction effect of product diversification on the relationship between international diversification and innovative input. Their study builds mainly on the above described argumentation that managers of highly diversified firms are more driven by financial than by strategic incentives which negatively influences the innovation activities of these firms. Other researchers that support a negative relationship between product diversification and innovation are Hoskisson and Hitt (1988) and Baysinger and Hoskisson (1989) who find that U.S. firms with a high level of product diversification invest less in R&D than less diversified firms. Doi (1985) finds the same relationship between diversification and innovation input for his sample of highly diversified Japanese firms.

Interestingly, Cardinal and Opler (1995) do not find any significant effect of a firm's degree of diversification on the efficiency of a firm's innovative activities.

As I show above, some disagreement exists regarding the relationship between firm diversification and the innovative activities of firms. These diverse empirical results may to some extent be the consequence of a high diversity of study settings and methods that are employed with the goal to evaluate the relationship between diversification and innovation.

Baysinger and Hoskisson (1989) aim to provide empirical evidence of how the diversification strategy of a firm affects its innovative input and therefore cluster the firms into four main classes of diversification strategy. In contrast, entropy measures are a popular instrument to measure firm diversification in strategic management research (e.g., Hill et al., 1992; Baysinger and Hoskisson, 1989; Hoskisson, Johnson, and Moesel, 1994; Palepu, 1985; Mendoça, 2006). While Quintana-García and Benavides-Velasco (2008) and Garcia-Vega (2006), among others, measure the technological diversification of firms using a Herfindahl index of diversification based on patents as a proxy for technological knowledge, Hitt, Hoskisson, and Kim (1997) measure the product diversification of firms in their study using an entropy measure based on the sales of firms in the different product

segments. Doi (1985) uses a variable that measures the 'distances' between the SIC classes in which the firms are active in addition to an entropy measure based on segment sales. Moreover, Cardinal and Opler (1995) measure a firm's degree of diversification with an entropy index based on the number of employees in the firm's businesses. The most common variable to measure innovative input is R&D intensity, which is usually the ratio of R&D expenses to sales[104] (e.g., Doi, 1985; Hitt, Hoskisson, and Irleland, 1991, Rogers, 2002). Innovation output in terms of quantity is often measured by the number of patents (e.g., Garcia-Vega, 2006). Cardinal and Opler (1995) use R&D efficiency as a key measure by counting the number of new products per R&D dollar.

Hypothesis

As outlined above, depending on the study setting, the sample choice as well as on several other aspects, the hypothesis whether an increased degree of diversification has a positive or negative influence on the innovativeness of firms varies – although the number of arguments that support the hypothesis that innovation is positively related with firm diversification outweigh the contrary arguments. However, these studies neither consider the specific type of relatedness of businesses that is present for an 'integrated user-manufacturer firm' nor focus on the quality of the innovative output, but rather on its quantity.

The goal of this study is to empirically test whether user-manufacturer firms produce qualitatively better innovative output than non-diversified firms in similar businesses. From the previous study in Chapter 3, I learned that 'integrated user-manufacturer firms' benefit extensively from their dual activities. In particular, the upstream business (i.e., the manufacturing business) benefits from a continuous stream of user innovations from the user unit, which allows for the creation of products that are perfectly suited to match the market requirements, allowing the manufacturing unit to gain a competitive advantage.

[104] While most studies use the R&D-expenses-to-sales-ratio as the measure for R&D intensity, some studies also replace the firm's sales by assets (e.g., Miller, 2004), employees (e.g., Hitt, Hoskisson, and Kim, 1997), or other measures for firm size.

Thus, I aim to extend the existing theory and empirical studies based on my findings from the study in Chapter 3 by postulating and evaluating the following hypothesis:

Hypothesis: User-manufacturer firms are more innovative in terms of innovation quality of the manufacturing compared to classic manufacturing firms in the same sector.

4.3 Method and Data

To analyze the above outlined hypothesis, I proxy innovations by inventions, which I can measure using patents. I then use the number of forward citations that a patent receives as a proxy for the quality of inventions. To this end, I first match patent data from eight European firms[105] that are active in the wider construction and mining sector with company data. To be able to measure if patents from the manufacturer divisions of the 'integrated user-manufacturer firms' are qualitatively superior compared to patents from the manufacturing-only firms, I match the patent and company data with forward patent citations as a measure of patent quality, as proposed by, e.g., Trajtenberg (1990), Narin et al. (1987), Harhoff et al. (1999), and Hall et al. (2005).

The subsequent sections are structured as follows. I provide an overview of the data sources I use for my study in Section 4.3.1 and outline the dataset composition process in Section 4.3.2. In Sections 4.3.3 and 4.3.4, I present the variables that I use in my study.

[105] Three of these eight firms are 'integrated user-manufacturer firms'. The other five are manufacturing-only firms or firms that are diversified into completely different fields, i.e., firms that are not able to benefit from the duality that characterizes the user-manufacturers. Some of the five non-'integrated user-manufacturer firms' are direct competitors to the manufacturing units of the user-manufacturer firms, while others are active in similar industries.

4.3.1 Data Sources

To identify the patents that each firm in my dataset holds, I use Thomson Reuter's Derwent Innovations Index[106]. In the next step, I match the patent information with patent citation data and additional patent data from the 'European Patent Office's[107] Worldwide Patent Statistical Database' (PATSTAT) from April 2009[108] with the goal of measuring the innovative output quality of the firms in my dataset. PATSTAT contains static bibliographic patent data from all national patent authorities that transmit their data to the EPO. Finally, I match the complete list of patent data with company data of the firms from the Thomson Worldscope database[109].

4.3.2 Dataset Composition

The initial step in the construction process of my sample is the identification of user-manufacturer firms for the empirical analysis. Therefore, I define two key industries in which I conduct my investigation. I choose the wider construction and mining industries because I expect more user-manufacturer firms in these fields compared to other industries[110]. In the next step, I then identify user-manufacturer firms that are active in at least one of these industries using 'Standard Industrial Classification' (SIC), a system from

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[106] For further information on Derwent Innovation Index, please see http://ip.thomsonreuters.com/training/dii/#overview (accessed 19.09.2011).

[107] Henceforth, EPO.

[108] Please see http://www.epo.org/searching/subscription/raw/product-14-24.html for further information on the PATSTAT database (accessed 19.09.2011).

[109] Please see http://thomsonreuters.com/products_services/financial/financial_products/a-z/worldscope_fundamentals/ for further information on the Thomson Worldscope database (accessed 19.09.2011).

[110] The main reason why I assume that more user-manufacturer firms than in other industries exist in the construction and the mining industries is threefold. First, in both industries, technologically advanced machines are essential to conduct challenging projects. Second, many sub-fields in each of these industries are too small to make these businesses interesting markets for manufacturer-only firms. Third, as I learned in the previous study of this dissertation (in Section 3), many innovations in the downstream businesses in these fields lead to a need for technical innovations in the upstream business. Thus, a user-manufacturer business models seems interesting for firms active in the wider construction and mining fields.

the US government to classify firms into industries via a four-digit numerical code.[111] To this extent, I define those SIC codes that represent user business activities and those that describe manufacturer activities in the two industries. A check to ensure completeness of the defined SIC codes is conducted by searching for the SIC codes of 47 competitors of Bauer AG: 30 competing construction machines firms and 17 construction firms (Bauer, T., 2010). SIC codes that are used to describe the activities of these firms and that are not yet included in the list are added to the SIC code list. Next, I conduct a search using Thomson Worldscope to identify those firms in the database that are described by at least one user-SIC code and one manufacturer-SIC code, suggesting that a firm that is described by a user- and a manufacturer-SIC code follows a business model that matches my definition of an 'integrated user-manufacturer firm'. To assure that each of the identified firms actually follows a user-manufacturer-business model, I conduct a manual check by searching the internet for comprehensive information on the respective firms. To complete my dataset, I conduct a second search in Thomson Worldscope with the goal of adding manufacturer-only firms to my database. Therefore, I search for firms that are described by a manufacturer-SIC code of one of the two defined industries without being additionally assigned to a user-SIC code. For 32 randomly selected manufacturer-only firms (which represent approximately 12% of all manufacturer-only firms in my sample), I conduct a manual check to determine whether the activities of those firms are in accordance with the fields suggested by the SIC codes.

From this list of firms, I choose only the firms from Western (i.e., European and North American) countries and eliminate all firms from other countries from the list. The main motivation for this reduction of the number of firms is to construct a homogeneous sample and, thus, eliminate firms from completely different cultural backgrounds. Because patenting behavior might differ from one country to another, I aim to reduce the influence

[111] Although the North American Industry Classification System (NAICS) (a second industry classification system) has supplanted the SIC classification system to increasingly greater extents since 1997, I stay with the SIC classification system. The simple reason for this choice is because NAICS codes are only available for Mexican, Canadian, and US firms, while my sample contains a significant number of European firms. Additionally, the compatibility of both classification systems is given.

of the propensity to patent[112] in my dataset by eliminating firms from non-Western backgrounds.

In the next step of the dataset composition process, I generate a list of patents held by each firm in the dataset. To this extent, I run a patent search using the Derwent Innovations Index, searching not only for the exact name of the applying firm but also for slight modifications of the name to assure that all patents a firm has applied for are included in the resulting patent list. To assure that only those patents that are held by the focal firms – and not by firms or individuals with similar names – remain in the dataset, I conduct a manual control of each patent for the applicant name and eliminate all patents that were applied for by other firms or private persons[113]. This manual control is conducted based on the applicant name, the inventor name, and the abstract of the patent; in some rather specific cases, a detailed patent analysis is also necessary. To complete the new list of firms and patents with additional patent information, I match the list with the PATSTAT database and add the relevant patent information.

In the last step of the dataset construction process, I add financial and company data to the firm and patent information. Because I aim to investigate the effect of a specific form of diversification on the quality of the innovative output of firms, I attempt to control for all influencing factors that may dilute the direct effect of diversification on innovation output quality that I am interested in. Therefore, I match the existing dataset with company and financial data from the Thomson Worldscope database.

In the first phase of the data analysis, I aim to investigate my research question at the company level. To this extent, I aggregate all patent information (e.g., number of patents, number of patent citations) at the company level and compare integrated user-manufacturer firms with manufacturer-only firms. In this phase, difficulties in the analysis

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[112] I will further explain the propensity to patent and its influence on firm's patenting behavior in the discussion of this Section 4.7).

[113] The firm names I base my patent search on should ideally be as generic as possible to assure that all patents that the respective firm applied for are included in the results list. Thus, for most firms, some false positives appear in the results list. For example, when searching for 'Bauer' meaning the firm 'Bauer AG', the results list contains false positives, such as 'Peter Bauer', a private person that applied for a patent, and 'Bauer Media Group', a media corporation that is not related to Bauer AG.

of the data appeared, which led me to shift the analysis level in my study. Many of the user-manufacturer firms in my sample are larger corporations that consist of several business units, under which are, among others, user and manufacturer units. Thus, it is almost impossible to allocate patents and especially R&D investments to the one manufacturer business unit that I am interested in. This lack of information may cause an important bias in my dataset. Thus, I decide to shift the analysis from firm level to patent level. I reduce the number of firms from 285 to 8, all active in the wider construction and mining fields. Three of these eight firms are user-manufacturers, while five are machine-manufacturers only. To deal with the problem that a clear allocation of innovation input and innovation output to business units is difficult, I define the relevant three-digit 'International Patent Classification' [114] -classes [115] that describe patents in the construction, mining and construction and mining machines fields. Thus, I ensure that only those patents of the firms in my dataset are included in the analysis that are held by the construction or mining machines business unit of the diversified firms. Second, the clear focus on the patent quality instead of the patent quantity eliminates the importance of the effect that R&D investments cannot be directly assigned to the specific business unit.

To finalize the patent level-dataset, I add patent citation information to the list of patents from the selected firms[116] and complete the dataset by adding the company and financial data of the holding firms to the dataset. Finally, I drop all patents with an application date later than 31.12.2003. The reason for dropping the newer patents is that I use five-year forward citations of patents as a measure of patent quality. Because I use the PATSTAT database from April 2009, the five-year period is necessary to measure the five-year forward citations for all patents in the sample.

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[114] Henceforth, IPC.

[115] The 'International Patent Classification' is a hierarchical system that serves to classify patents into different industry classes using a four-digit alphanumerical code to define the patent section, class and subclass, which is followed by a one- to three-digit code to define the group. The IPC system was created under the Strasbourg Agreement in 1971 and is regularly updated by a group of experts. The IPC classification is assigned to a patent by a patent examiner.

[116] I conduct a detailed manual check of these eight firms to assure that, for each firm, the business model as suggested by the SIC codes is consistent with the businesses in which the firms are actually active.

The final dataset that I use for my empirical study consists of 416 patents in two three-digit IPC classes:[117] 75 held by user-manufacturer firms and 341 held by manufacturer-only firms. For an overview of the firms that hold the patents I analyze, please see Table 8.

One key point that is highly important for the construction process of my dataset is the reliability of SIC code information. Because I base the selection of firms that I include in my dataset on a search for SIC codes describing the industries I aim to address in my work, the reliability of the SIC classification of the firm's businesses is of high importance for the quality of my results. Because the SIC codes are not assigned by the governmental institution, which is the publisher of the SIC classification system, but by the firms themselves, the reliability of the classification may vary between firms and also within one firm from year to year because it is highly dependent on the person who takes care of the classification of a firm. In addition, the priority that the management of a firm gives to this classification process has an influence on the quality of a firms' classification. The problems that result from this arbitrariness are manifold. First, the SIC codes describing one business segment of a firm may vary from year to year for many reasons, e.g., because the responsible employee has been replaced by someone who decides that one business segment is better described by a different SIC code. In addition, if in one year the most important business segment is described by one SIC code and the second important business segment is described by another SIC code, these codes may change from year to year, although no change in the importance of these segments takes place. Again, the reason for this change can be as simple as the responsible employee changing the order of the two segments without being aware that the order represents the importance. These difficulties with the SIC classification for the fields in which a firm is active necessitate a manual check of all user-manufacturer firms and also of a certain percentage of the manufacturer-only firms in the sample and probably mean that my search missed a good number of user-manufacturer firms. I eliminate a considerable number of firms from my dataset because the SIC classification and the real activities of the firm are not consistent in

[117] The IPC classes E02 and E21 both can be found in section E 'Fixed Constructions'. The IPC class E02 describes all tools, machines, and instruments that are used for 'Hydraulic Engineering, Foundations, and Soil Shifting', while the IPC class E21 describes the field of 'Earth or Rock Drilling and Mining'.

those cases. For the patent-level dataset that contains the patents from only eight firms, I conduct a manual check of SIC codes versus business activities for each firm.

Table 8: Overview of Patent Holding Firms in the Dataset

Firm	Country	User-Manufacturer Firm (Yes/No)
Bauer AG	Germany	Yes
Linde AG	Germany	Yes
Trevi Fin Industriale	Italy	Yes
Atlas Copco AB	Sweden	No
Hunting PLC	United Kingdom	No
Sandvik AB	Sweden	No
Metso OYJ	Finland	No
Volvo AB	Sweden	No

4.3.3 Dependent Variable

The dependent variable in my models is the patent quality.[118] An often-used proxy for the quality is the number of forward citations that a certain patent receives within a defined time period (e.g., Trajtenberg, 1990; Harhoff and Reitzig, 2004; Harhoff et al., 2003; Albert et al., 1991; Narin, 1994; Lanjouw and Schankerman, 2001). The rationale for this proxy can be understood as follows. Every new patent must refer to the current technological status and, therefore, cites existing patents. Thus, the more often a patent is cited, the higher its technological contribution is.

[118] As already mentioned above, I use the patent quality (i.e. invention quality) as a proxy for innovation quality in my study.

To control for the patent age, which for obvious reasons has an effect on the number of forward citations that a patent receives, I use five-year truncated forward citations to measure patent quality (Hall et al., 2001). To control for strategic citing behavior, I conduct the analysis both with and without self citations. Because the self citations for a patent are only available for a patents' 'lifetime basis' in my sample, I use the share of self citations of total forward citations on a lifetime basis to calculate a proxy for the five-year truncated self citations. Using these values, I calculate the five-year truncated forward citations, excluding self citations that I use for my analysis.

Table 9 provides the correlation matrix of all independent and control variables in the sample. As most control variables are firm-specific variables[119] that take one value for each firm in each year, a certain clustering effect underlies the correlation matrix.

The variance inflation factors are below 1.57 for all variables, while the mean VIF is 1.43. Thus, according to O'Brien (2007), I can reject multicollinearity.

4.3.4 Independent and Control Variables

Vertical Diversification

The independent variable in my models is vertical diversification, a dummy variable that indicates whether the applicant of a patent is a user-manufacturer or a manufacturer-only firm. This variable takes values of '1' for user-manufacturer or '0' for manufacturer-only firms.

Firm Size

Substantial economies of scale and cross fertilization effects between different R&D projects may exist in the innovation process, which both may lead to increased innovation quality (Garcia-Vega, 2006; Acs and Audretsch, 1988; Hansen, 1992). To control for these effects, I employ total assets as a proxy for firm size.

[119] From the control variables assets, debt per assets, return on assets, and the percentage of R&D expenses of net sales are firm-specific variables, while the application year is a patent-specific variable.

Profitability

Firms, which are monetarily more successful than others, may have more freedom to invest money in new innovation efforts. In addition, more successful firms may be better at generating high-quality innovative output from the R&D investments they undertake. Thus, I control for the profitability of a firm, which is proxied by the return on assets in my study.

R&D Intensity

As shown by previous research, a strong relationship between innovative input and innovative output exists (Hagedoorn and Cloodt, 2003). Thus, I control for innovative input using the R&D intensity as a proxy. I calculate R&D intensity as the ratio of R&D expenses to net sales.

Debt Level

A negative relationship between the debt level of a firm and its innovative output has also been suggested by the existing literature (Baysinger and Hoskisson, 1989). Thus, I control for a firm's debt level using the ratio of debt to assets as a proxy.

Application Year

Patents that are applied for earlier may be cited more often than older patents due to a change in citing bevior. Thus, I control for the influence of this time effect by including the application year of each patent as a control variable in my dataset.

I measure all variables that control for characteristics of the firms holding the patents one year prior to the application year of each patent. The R&D intensity and profitability are not available for approximately 6% (profitability) and 17% (R&D intensity) of all patents in my dataset, which is why I employ the mean R&D intensity and the mean profitability for these years of all other firms in my sample as a proxy for the R&D intensity and the profitability of those firms in the respective years.

Table 9: Correlation Matrix of the Independent Variable and Control Variables

	User-Manufacturer Firm	Application Year	Assets	Debt per Assets	Return on Assets	Percentage R&D Expenses of Net sales	VIF
User-Manufacturer Firm	1						1.31
Application Year	0.1155	1					1.56
Assets	-0.0716	0.0419*	1				1.35
Debt per Assets	-0.0105	0.3587*	0.3076*	1			1.42
Return on Assets	-0.4051*	-0.1563*	-0.0940	-0.3144*	1		1.40
Percentage R&D Expenses of Net sales	-0.2975*	-0.4234*	0.0080	-0.3522*	0.3403*	1	1.55

* significant at the 1%-level.

Variance inflation factors (VIFs) are calculated based on an OLS model with 'Five-Year Forward Citations'[120] (including self citations) as the dependent variable.

[120] Only patents that were applied for before 31.12.2003 are included in the regression to allow for a five-year period to measure forward citations.

4.4 Descriptive Results

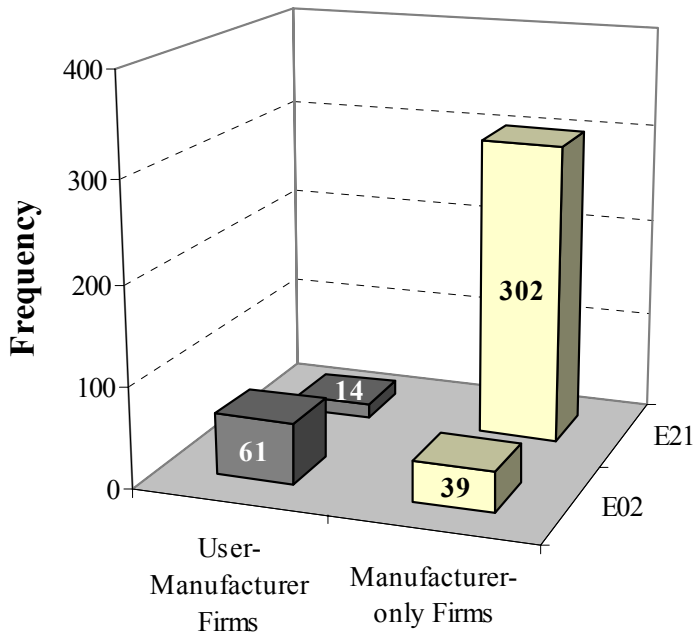
The complete dataset of my empirical study contains data of 416 patents from two IPC classes: 75 held by user-manufacturer firms and 341 held by manufacturer-only firms. The ratio of five-year forward citations to the number of patents is 0.60 for the user-manufacturer firms and 0.44 for the manufacturer-only firms in the sample. For the user-manufacturer firms, the number of five-year forward citations excluding self citations is approximately 16% lower than the number of forward citations including self citations. In contrast, the number of forward citations decreases by only approximately 5% when self citations for the manufacturer-only firms are excluded. Thus, while the ratio of five-year forward citations to patents excluding self citations is still higher for user-manufacturer firms than for manufacturer-only firms, the difference is lower than that between the ratios including self citations is (0.51 for user-manufacturer firms compared to 0.42 for manufacturer-only firms). Table 10 provides an overview of the patents held by user-manufacturer firms and manufacturer-only firms.

Table 10: Overview of Patents of User-Manufacturer Firms and Manufacturer-Only Firms

	User-Manufacturer Firms	**Manufacturer-Only Firms**
Number of Patents	75	341
Number of Five-Year Forward Citations	45	150
Ratio five-year Forward Citations/Patent	0.60	0.44
Number of five-year Forward Citations Excl. Self Citations	38	142
Ratio five-year Forward Citations Excl. Self Citations/Patent	0.51	0.42

Figure 5 sheds additional light on the distribution of the patents in my sample by technological fields[121] and the diversification type[122] of the holding firm. More than 80% of the patents that are held by the user-manufacturer firms in my sample can be found in the IPC class E02, while only approximately 11% of the patents of the manufacturer-only firms are in E02. This difference shows that the two groups of firms in my sample obviously have different focuses of their business activities in the construction and mining fields. Thus, I must be cautious in interpreting the findings of my data analysis. I will further discuss this point in Section 4.7 of this study.

Figure 5: Number of Patents in the Sample by IPC Class and Firm Type



[121] As described in section 4.3.2, I measure the technological field of a patent by the IPC class.

[122] User-manufacturer firm or manufacturer-only firm.

Comparing the five-year forward citations of the patents held by user-manufacturer firms with those held by manufacturer-only firms, I do not find any significant differences (at the 10%-level) for the number of forward citations (Table 11). Conducting the test with five-year forward citations excluding self citations does not influence the test results.

Table 11: Comparison of Patents from User-Manufacturer Firms and Manufacturer-Only Firms

Group	Obs.	Mean	Std. Err. of Mean	Std. Dev. of Var.
User-Manufacturer Firms	75	0.60	0.1421	1.2303
Manufacturer-Only Firms	341	0.4399	0.7681	1.4184
Combined	416	0.4688	0.6797	1.3863
p-value	0.3658			

Comparing only the patents in IPC class E02 of the two firm groups, I find a significant effect (p-value: 0.0125): patents from user-manufacturer firms receive more forward citations than patents held by manufacturer-only firms do (Table 12). Conducting the test excluding self citations does not change the test results. I additionally conduct the test excluding the firm with the highest number of patents in the IPC class E02[123] and a median test[124], which both lead to identical results. However, as I mentioned above, I must be cautious regarding these results and will further investigate this relationship in Section 4.6; moreover, I will provide a comprehensive discussion in Section 4.7.

[123] Linde AG holds 41 patents in the IPC class E02 – 42% of all patents in IPC class E02 in my dataset.

[124] As a median test, I conduct a two-sample Wilcoxon-Mann-Whitney test.

Table 12: Comparison of Patents in IPC Class E02 from User-Manufacturer Firms and Manufacturer-Only Firms

Group	Obs.	Mean	Std. Err. of Mean	Std. Dev. of Var.
User-Manufacturer Firms	61	0.7377	0.1700	1.3279
Manufacturer-Only Firms	39	0.1539	0.1074	0.6704
Combined	100	0.51	0.1150	1.1503
p-value	0.0125			

The comparison of the patents held by the two groups of firms in IPC class E21 does not show any significant differences regarding the number of forward citations that the patents receive (Table 13). One important point regarding this test is that the 14 patents held by user-manufacturer firms do not receive any forward citations. Thus, the mean, the standard error, and the standard deviation of the variance all are zero. The reason why the test of difference of the means is not significant probably lies in the small number of cases for the group of user-manufacturer firms. Thus, the difference in the means of the two groups can still be random and not due to a difference between the two groups.

The same analysis conducted for forward citations excluding self citations leads to similar results. Conducting a median test instead of a test of the mean and conducting the test excluding the firm Sandvik AB, which holds approximately 57% of all patents in the IPC class E21 in my sample, produces results that are even less significant.

Table 13: Comparison of Patents in IPC Class E21 from User-Manufacturer Firms and Manufacturer-Only Firms

Group	Obs.	Mean	Std. Err. of Mean	Std. Dev. of Var.
User-Manufacturer Firms	14	0	0	0
Manufacturer-Only Firms	302	0.4768	0.8542	1.4845
Combined	316	0.4557	0.08182	1.4545
p-value	0.2310			

4.5 Specification of the Multivariate Model

To determine whether patents of user-manufacturer firms are qualitatively better and, thus, receive more forward citations than patents from manufacturer-only firms, I estimate a negative binomial model with the number of forward citations as the dependent variable and a dummy variable that measures whether a firm is a user-manufacturer firm or a manufacturer-only firm as the independent variable. I use STATA version 10 to analyze the data.

Negative binomial models are typically used to estimate count data when the restriction of equidispersion of the Poisson model is not fulfilled by the data (Hausman et al., 1984; Hilbe, 2008; Greene, 2008). The negative binomial model accounts for overdispersion by adding an error ε_i, reflecting unobserved heterogeneity among the observations. The marginal negative binomial distribution is

$$E\left[y_i \mid x_{i,}, \varepsilon_i\right] = \exp\left(\alpha + x_{\#}\beta + \varepsilon_i\right) = h_i\lambda_i$$

where $h_i = \exp\left(\varepsilon_i\right)$ is unknown and is drawn from a one-parameter gamma distribution (Greene, 2008). This process leads to a negative binomial regression in which the parameter α determines the degree of dispersion in the predictions.

The parameters in the negative binomial model are estimated using maximum likelihood estimators (e.g., Greene, 2003).

4.6 Multivariate Results

In this section, I present the results of the estimations of the three main models in my sample: the estimation for IPC class E02, for IPC class E21 and for the combination of both IPC classes. I also conduct several robustness checks for my estimations.

In Model 1, I conduct the analysis for all patents in my sample, independent of whether they are assigned to the IPC class E02 or to E21. I do find strong significant support (at the 0.05%-level) for my hypothesis that patents held by user-manufacturer firms are qualitatively better and thus receive more forward citations than patents held by manufacturer-only firms (Table 14). Conducting the same analysis for patents in the IPC class E02 only, I also find strong support for my hypothesis. The coefficient of the dummy variable measuring diversification is positive and highly significant at the 0.05%-level. Thus, I confirm my hypothesis for Models 1 and 2. In Model 3, I include only patents of the IPC class E21 in the analysis. I do not find support for my hypothesis in this model. In contrast, the coefficient is negative and highly significant.

Comparing the results of the three models, it is interesting that a highly significant positive effect is found in Model 1 for the full sample, consisting of patents that are assigned to IPC class E02 or E21 and in Model 2 for patents in IPC class E02, while a significant negative effect is found for patents in IPC class E21. I will further discuss this point and try to explain these differences in the discussion of this study (Section 4.7).

Table 14: Estimation Results[125]

	Model 1[126]		**Model 2**[127]		**Model 3**[128]	
Sample	**IPC Classes: E02+E21**		**IPC Class: E02**		**IPC Class: E21**	
Variables	**Coeff.**	**Robust Std. Err.**	**Coeff.**	**Robust Std. Err.**	**Coeff.**	**Robust Std. Err.**
User-Manufacturer Firm	0.5659**	0.2826	2.7905**	1.1117	-14.304***	0.8359
Assets	-3.99e-11	2.55e-11	-1.33e-11	6.58e-11	-1.14e-10	1.54e-10
Debt per Assets	-2.2384	2.2856	0.05435	2.4950	-1.8490	2.9592
Return on Assets	0.06293	0.04488	0.07297	0.1333	0.06372	0.04802
Percentage R&D Expenses of Net sales	0.1262	0.3217	1.1347**	0.4391	0.1252	0.1851
Year	-5.84e-4	0.1329	-0.02197	0.02543	0.01825	0.03175
Constant	0.02285	26.378	37.672	50.324	-37.281	62.026
Observations	416		100		316	
Log-Pseudo-likelihood Value	-308.37		-81.20		-218.45	

* p < 0.1, ** p < 0.05, *** p < 0.01

[125] To account for the possibility that patents that are held by one firm have correlated errors, I relax the usual requirement that observations have to be independent and employ clustered standard errors and cluster by firm (Gambardella et al., 2008).

[126] Standard Errors for 8 clusters based on variable 'firm_id'.

[127] Standard Errors for 7 clusters based on variable 'firm_id'.

[128] Standard Errors for 7 clusters based on variable 'firm_id'.

I also conduct all analyses in Table 14 with forward citations excluding self citations, which turns the significant effect of user-manufacturer firms in Model 1 insignificant ($p = 0.204$) and which does not influence the results of Models 2 and 3 such that it makes insignificant effects significant or vice versa. The fact that the analysis of Model 1 excluding self citations turns the former significant effect insignificant leads me to the insight that user-manufacturer firms tend to cite their own patents more often than manufacturer-only firms do. However, this fact does not tell me anything about the reason for the difference in the frequency of citing own patents between user-manufacturer and manufacturer-only firms. While this difference can result from a strategic behavior of these firms to cite own patents, it can also result from the better quality of the user-manufacturers' patents.

Regarding control variables, I find that the innovative input – in my study, measured by the R&D-to-sales-ratio – has a positive effect on the quality of patents (though the effect exists in all three models, it is only significant at the 0.05 level in Model 2). The reason for this positive effect is relatively obvious, as firms that invest more in their innovation activities do not only generate a higher innovative output, but also an innovative output that is of higher quality than those firms that invest less in their innovative activities.

To check robustness of my Models, I conduct three estimations, again using a negative binomial model (Table 15). To check the robustness of Model 1, I replace assets as the control variable for firm size by sales, which does not lead to any changes in the effect of the type of diversification (user-manufacturer or manufacturer-only firm) on the number of forward citations that the patents receive. Similar to Model 1, conducting the same analysis using forward citations excluding self citations turns the significant effect insignificant ($p = 0.131$). To check for the robustness of Model 2, I exclude Linde AG, which holds the most patents in IPC class E02 in my sample; this exclusion slightly reduces the significance of the positive effect of diversification on the quality of patents. While the effect is significant at the 5%-level in Model 2, it is still significant at the 10%-level in Model 5, which excludes patents from Linde AG. Conducting the same regression (Model 5) with sales instead of assets as a control for firm size and with forward citations excluding self citations makes the effect of diversification on the quality of patents significant at the 5%-level again. Model 6 aims to test the robustness of Model 3 by exclusion of Sandvik AB,

the firm holding the most patents in IPC class E21. Model 6 shows significant results for the diversification type, which does not change if the regression is conducted by replacing assets by sales or excluding self citations from the number of forward citations.

As I describe in Section 4.3.4, I replace the missing values for variables R&D intensity and profitability of some observations by the mean R&D intensity and the mean profitability for the relevant years of all other firms in my sample. Thus, I conduct the analyses of Models 1, 2, and 3 also excluding the control variables R&D intensity and profitability to check for the robustness of my model. Leaving out the two control variables turns the significant effect in Model 1 insignificant, whereas it makes the significant effect in Model 2 only slightly more insignificant (10%-level). The significant negative effect of Model 3 remains significant when leaving out the two variables profitability and R&D intensity.

Table 15: Estimation Results - Robustness Checks

	Model 4[129]		**Model 5[130]**		**Model 6[131]**	
Sample	**Model 1 – with sales as control for size**		**Model 2 – excluding Linde AG**		**Model 3 – excluding Sandvik AB**	
Variables	**Coeff.**	**Robust Std. Err.**	**Coeff.**	**Robust Std. Err.**	**Coeff.**	**Robust Std. Err.**
User-Manufacturer Firm	0.6584**	0.2901	45.796*	26.287	-18.571***	0.8684
Assets			1.59e-9**	7.83e-10	-7.67e-10***	1.03e-10
Sales	-1.34e-11	2.06e-11				
Debt per Assets			-50.559	53.689	1.7657	1.8614
Debt per Sales	-3.2387	2.0794				
Return on Assets	0.06545	0.04299	0.3132	0.9358	-0.08726***	0.02419
Percentage R&D Expenses of Net sales	0.1295	0.2772	-0.7370	1.3612	0.2721	0.3880
Year	-0.002264	0.1313	-1.9359*	1.0268	0.08754***	0.01476
Constant	3.4230	26.011	3842.1	2039.5	-174.18***	30.044
Observations	416		58		136	
Log-Likelihood Value	-307.61		-30.50		-58.74	

* p < 0.1, ** p < 0.05, *** p < 0.01

[129] Standard Errors for 8 clusters based on variable ‘firm_id’.

[130] Standard Errors for 6 clusters based on variable ‘firm_id’.

[131] Standard Errors for 6 clusters based on variable ‘firm_id’.

4.7 Summary and Discussion

In the underlying study, I investigate how being a user-manufacturer firm affects the quality of innovations[132] that a firm generates compared to classic manufacturer-only firms. To this end, I analyze patents from eight European firms that are active in the wider construction and mining sectors. I compare the patents held by user-manufacturer firms that are active in the construction or mining businesses and in the construction/mining machines business with patents from manufacturer-only firms active in the construction/mining machines business but not in the field of construction or mining in terms of patent quality, which is measured by the number of forward citations that a patent receives.

The results of my analysis show that my hypothesis that patents of user-manufacturer firms are qualitatively better than those of manufacturer-only firms is confirmed for patents in the IPC class E02, which is a core IPC class of the user-manufacturer firms in my sample. In contrast, I find a contrary effect for patents in IPC class E21, in which most patents are held by manufacturer-only firms. Moreover, I do find significant support for my hypothesis in the full sample of both IPC classes, E02 and E21, although this effect is not very robust to variations.

Thus, my empirical study extends the findings of existing empirical work on the relationship between diversification of firms and their innovativeness. As outlined in Section 4.2, existing studies produce diverse results regarding the relationship between the two variables, applying a diversity of measures for diversification and innovativeness to a wide range of study settings. To this variety of studies, I add an empirical analysis that investigates the effects of a form of diversification not studied before, on the innovativeness of firms. Additionally, all existing studies that I am aware of analyze the influence of diversification of firms either on the innovative input or on the quantity of the innovative output (e.g., Hitt, Hoskisson, and Kim, 1997; Cardinal and Opler, 1995; Garcia-Vega, 2006). By conducting my analysis on the patent level, focusing on the quality of the innovative

[132] As mentioned earlier, I proxy innovations by a measurable form of inventions (patents) and use patent forward citations as a proxy for invention quality.

output that diversified firms generate compared to non-diversified firms, I add a new dimension to existing research.

I choose the wider construction and mining sector for my analysis and, thus, select the two three-digit IPC classes, E02 and E21, as the field of my analysis. While the other three-digit IPC classes in Section E describe more concrete construction works,[133] the two IPC classes that I chose represent more basic works – meaning excavation and foundation-related works – in the construction field and activities in the mining business. I do expect these fields to be well suited for the existence of user-manufacturer firms for the three reasons outlined in Footnote 110 (Section 4.3.2).

Interestingly, my study confirms the hypothesis that user-manufacturer firms are more innovative than classic manufacturer-only firms in terms of patent quality for IPC class E02, although it does not confirm the hypothesis for patents in IPC class E21. As shown in Figure 5, the distribution of patents is very different for the two groups of firms. While approximately 61% of the patents in IPC class E02 in my sample are held by user-manufacturer firms, almost 96% of the patents in IPC class E21 are held by manufacturer-only firms. Thus, especially when interpreting the results for IPC class E21, I must always keep in mind that I compare patents in the major patent category in the construction/mining field from one firm type with patents from a minor field of activities of the other firm type. In addition, an important factor in class E21 besides the very high percentage of patents held by manufacturer-only firms is that the approximately 4%[134] of patents held by user-manufacturer firms receive zero forward citations. While the t-test conducted in Section 4.4 does not find a significant difference between the means of the two groups, because of the small absolute number of patents from user-manufacturer firms, the multivariate models does. In consequence, I have to take care with interpreting these results.

[133] IPC class E01 is, for example, "Construction of Roads, Railways, or Bridges", while IPC class E05 represents all activities in the field of "Locks, Keys, Window or Door Fittings, and Safes".

[134] These approximately 4% of all patents in IPC class E21 that are held by user-manufacturer firms correspond to 14 patents.

Summarizing the results of my study, I find a significant positive effect for user-manufacturer firms in IPC class E02[135] and in the full sample consisting of patents from both IPC classes, although the latter is not very robust against variations in the study setting, which is why I have to interpret it with some caution. In contrast, I find a significant negative effect for IPC class E21, which I have to interpret with even greater caution due to the above described fact that it compares 302 patents held by manufacturer-only firms with only 14 if patents held by user-manufacturer firms. While these results may be caused by some unobserved heterogeneity, it may also be that user-manufacturer firms are able to benefit from the duality of their activities in one field, though they cannot produce a positive innovative outcome in their organization in another technological field. That said, I see four possible reasons why user-manufacturer firms may be able to benefit from the duality of their business in only one of the two considered IPC classes.

First, in the foundations and soil-shifting field[136], methodological innovations in the user business may cause patentable machine inventions more often than in the rock drilling and mining field. As I learned from Mr. Bauer, many innovations especially in the field of drilling machines lie in the dimensioning of a machine and are often not patentable as these innovations are not based on a new technology (Bauer [Interview 1]). Thus, it may be that user-manufacturers would be able to benefit from their dual business model primarily in the field of foundations and soil-shifting.

In addition, the reason for the different results may lie in the structure of the two markets. User businesses belonging to user-manufacturer firms will probably give their user-based innovative ideas to their own manufacturing business unit rather than manufacturer-only firms. If in the foundations and soil-shifting business the percentage of user firms belonging to a user-manufacturer firm is higher than in the rock drilling and mining field, then the manufacturing businesses of user-manufacturer firms may benefit strongly, while the manufacturer-only firms must rely on very limited information channels from the user-only firms in the market.

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[135] As mentioned above, in E02 the majority of the patents are held by user-manufacturer firms.

[136] This field of activities is described by IPC class E02.

A third potential argument considers technical and market differences between the two fields as a potential reason why user-manufacturer firms are able to benefit from the duality of their businesses in only one of the two considered technological fields. The rock-drilling and mining market may be larger and/or less specific regarding the machines needed compared to the soil-shifting and foundations field. Based on the first point, one could argue that a higher number of units sold could make the rock-drilling and mining field more attractive for manufacturer-only firms compared to the foundations business. Additionally, if the machines needed by user firms in the rock-drilling and mining market are more standardized, the competitive advantage that user-manufacturer firms could gain from their business model would be reduced, making this market more attractive to manufacturer-only firms.

The last argument addresses differences regarding the patentability of the innovations in the two technical fields. It may be that innovations in the foundations and soil-shifting occur more often in the form of patentable inventions than those in the rock-drilling and mining field. As I mentioned above, especially drilling machines often contain innovations that are not patentable as they are not based on a new technology (Bauer [Interview 1]). This asymmetry could mean that, although user-manufacturer firms may benefit from the duality of their businesses in both fields, a result of this constellation in terms of patent citations could only be measured in one field.

This last argument leads me to the second important discussion point of my study: I use the number of forward citations as a measure for the quality of the innovative output that a firm generates. The usage of raw patent counts as a measure for innovativeness of firms, including its advantages and shortcomings, is extensively discussed in the literature (e.g., Cohen and Levin, 1989; Griliches, 1998; Archibugi, 1992; Dosi, 1988). However, in many economic studies, patents are used and accepted as a good measure of innovative performance (e.g., Acs and Audretsch, 1989; Patel and Pavitt, 1995; Pavitt, 1988). In addition to patent counts that only reflect the quantity of innovative output, patent forward citations also give an indication of the innovative quality (e.g., Trajtenberg, 1990; Jaffe et al., 1993; Stuart, 2000; Rosenkopf and Nerkar, 2001). However, both measures share one key shortcoming. Besides the fact that not all innovations of firms may be equally suited to be patented, the individual propensity of a firm to patent may also influence these measures

(Scherer, 1983; Brouwer and Kleinknecht, 1999). However, evidence for the validity of patent citations as a measure of innovative quality can be found in various studies (e.g., Albert et al., 1991; Pavitt, 1988; Karki, 1997).

Another important fact that needs further discussion is the usage of patent quality as a measure of innovative output in my study. In contrast to the previous paragraph, not the individual propensity to patent, but a general increase in the propensity to patent of firms has an influence on the applicability of patent quality as a measure for innovative output. According to the World Intellectual Property Organization (WIPO), an explosion of patent applications has taken place over the last years which is reflected in the total number of worldwide patent applications that increased of 7% from 2004 to 2005 (WIPO, 2007). Many practicioners as well as researchers argue that with this strong increase in the propensity to patent of firms the average quality of patent applications decreases (Hall, 2007). Often mentioned reasons for this decrease in the patent quality due to an increased propensity to patent are that patents in many cases are used as strategic instruments to get financing (Hall, 2004) or for defensive purposes (Ziedonis and Hall, 2001) instead of for the appropriation of financial returns. This being said, the patent quality in my study may not only be influenced by the fact that the firm that holds the patent is a user-manufacturer or a manufacturer-only firm, but also by a general effect due to an increase in the number of patent applications. However, I control in all models for the application year and do only find a significant negative effect at the 10%-level in Model 5.

4.8 Conclusion

The results of my study are of interest to management scholars and managers and might also contain interesting information for analysts and bankers.

As mentioned above, existing empirical studies regarding the relationship between diversification and innovativeness focus on selected forms of diversification (e.g., Hitt, Hoskisson, and Kim, 1997; Cardinal and Opler, 1995; Garcia-Vega, 2006). My study extends this stream of research by demonstrating that under certain conditions, firms may benefit from a very specific form of related diversification, which has not been analyzed

before. Additionally, I add a new dimension to the existing research in this field by analyzing the influence of diversification on the quality of a firm's innovative output and not – as in existing studies – on the quantity of the innovative output or on the innovative input of firms.

The managerial implications of my study are twofold. First, managers of non-user-manufacturer firms could use my results as a basis to rethink their diversification strategy and determine whether the industry of their activities is well suited for such a dual business model. Second, managers of user-manufacturer firms could use the results of my study to rethink their innovation strategy with the goal of ensuring that they achieve a competitive advantage based on their dual business model.

Finally, my study is also of interest to analysts and bankers, who could use it to rethink their strategic recommendations to firms. Although it is currently often postulated that a focus on core competencies might be a successful strategy in many cases, this fact does not mean that diversification strategies cannot be a successful path in some cases.

My study has several limitations. The first limitation results from the use of patent quality as a measure of innovative output. As I discuss in the previous section of this work, practitioners and researchers discuss the effect of the explosion of the number of patent applications on the quality of patents. In addition, other factors that I do not control for may also influence the quality of patents that a firm holds. Thus, I would recommend that future research focuses on such not yet controlled effects with the goal to reduce the bias that results from omitted variables in my study. Third, the five-year forward citations excluding self citations in my study are constructed based on values for the overall forward citations and overall self citations due to the fact that self citations on a five-year basis are not available for my sample. While I am confident that this choice does not have any larger influence on the results of my study (because I am not aware of any argument why the number of self citations should increase or decrease over time), I would recommend that future work conduct a similar analysis using correct five-year forward citation data. A fourth limitation results from the use of IPC classes for the definition of technological fields. Besides the fact that it is impossible to assure with 100% reliability that a patent in one IPC class is generated by the manufacturer business unit (and not by the user business unit), the

focus on one business unit that is part of a larger corporation may lead to a comparison of the patents of the most important business unit in one firm with those of a minor business unit in another firm. Thus, I would recommend that scholars devote greater attention to this point in the future.

In addition to the points mentioned above, other interesting paths for further research exist. First, conducting a similar study with the goal of investigating the influence of user-manufacturer diversification on the quantity of the innovative output would complement my results. Second, setting up a study investigating the same topic on the firm level would allow researchers to approach the topic from different angles and, thus, might complete the picture regarding the effects of user-manufacturer diversification on the innovativeness of firms.

5. The Impact of Organizational Change on the Innovative Activities of Firms[137]

5.1 Introduction

Numerous studies analyze the effect of acquisitions and divestitures on the innovative activities of firms (e.g., Hitt et al., 1996; Johnson, 1996; Hitt et al., 1990; Hitt et al., 1991). Many of these studies find that firms that have conducted organizational change efforts often experience a consequent reduction in their internal innovative activities. There may be several reasons for this reduction. First, the reduction of internal innovation activities may be intentional, as acquisitions are considered a replacement for internal innovation (Hill and Snell, 1989). Furthermore, monetary resources may be reallocated from diverse strategic projects toward an important organizational change effort (Constable, 1986). Alternatively, the reasons for a reduction in internal innovation activities may be unintended. This may occur due to a shift in managerial attention from formerly important strategic projects to the acquisition/divestiture project and the subsequent integration/organizational restructuring effort (Haspeslagh and Jemison, 1991; Hitt et al., 1990). The fundamental uncertainty of such organizational change efforts can lead to lower morale among employees as well as a lower motivation level and reduced productivity, leading to lower levels of innovation (Johnson et al., 1990; Hayes, 1972; Nees, 1981).

My work extends existing studies by concentrating not only on the effects of the most fundamental forms of organizational change – acquisitions and divestitures – but also including restructuring efforts independent of the reason why they are conducted. Among other reasons, restructuring may be undertaken to better adapt a firm to its external environment or to match a firm's structures with a modified strategy, making the firm more successful and more profitable.

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[137] This chapter benefitted strongly from the bachelor's thesis of Stefanie Senger.

In the comparison of the innovativeness of user-manufacturers and manufacturer-only firms that I present in Chapter 4 of this dissertation, I analyze whether patents that are held by user-manufacturer firms are of better quality than patents held by manufacturer-only firms. In that study, I focus on a comparison between vertically diversified[138] user-manufacturer firms and manufacturer-only firms that are not diversified or that are diversified differently. I do not investigate the effect on a firm's innovativeness of diversifying from a manufacturer-only firm to an integrated user-manufacturer firm. As previous studies have shown, such organizational change efforts may have an important influence on a firm and its innovative activities (e.g., Hitt et al., 1991; Hitt et al., 1996), which is why I emphasize this topic in the following, more general study, considering organizational change in the form of acquisitions, divestitures, and major organizational change efforts. I extend the types of organizational change that I include in this study for two reasons. First, investigating the effect on a more general level allows drawing implications regarding the effects of organizational change on the innovative performance of firms that are valid beyond the one specific type of diversification that I investigate in Chapter 2 and 3 of my dissertation. Second, including only firms that diversify form manufacturer-only to user-manufacturer firms would have strongly reduced the number of firms in my sample to a level that does not allow drawing valid and robust findings from the study.

In addition, I extend the focus of my study by analyzing not only the effect of acquisitions on innovativeness but also divestiture activities and major restructuring activities, independent of the reasons those activities are conducted.

I base my study on the results of a survey conducted annually among German firms, the 'Mannheimer Innovationspanel' (MIP). The survey evaluates the innovation behavior of German firms. Information regarding the launch of new products, services, and processes pertaining to costs related to the innovation and the success of innovation activities is generated through the MIP (ZEW, 2011a).

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[138] Please see Footnote 102 for a detailed description of the specific form of vertical diversification referred to here.

The remainder of this study is structured as follows. In Section 5.2.1, I outline the different forms of organizational change included in this study. I articulate the hypotheses that I aim to test in my research in Section 5.2.2. In Section 5.3.1, I present the data source for this study, describe the dataset, and provide an overview of the key variables. Following the data section, I present the descriptive results (Section 5.4), specify the multivariate model employed (Section 5.5), and present the multivariate results of my work (Section 5.6). In Section 5.7, I summarize and discuss the results.

5.2 Hypothesis Development

There is an extensive body of literature regarding different forms of organizational change and the relationship between this change and the innovative activities of firms. Thus, before proposing the hypotheses to be tested in the remainder of this study, I introduce the forms of organizational change that I investigate.

5.2.1 Forms of Organizational Change

In his paper on the antecedents and outcomes of the refocusing efforts made by firms, Johnson (1996) distinguishes between three forms of corporate restructuring: **portfolio restructuring**, including spin-offs, sales of business lines, and mergers and acquisitions; **organizational restructuring**, which may occur in the form of changes in the organizational structure of a firm, reorganizations, or the downsizing of businesses; and **financial restructuring**, such as stock repurchases or leveraged buy-outs. In my study, I focus on organizational change caused by the former two types of corporate restructuring as portfolio restructuring and organizational restructuring cause changes in the organizational structure of a firm, whereas financial restructuring efforts may not be reflected by changes in a firm's organization. In the area of portfolio restructuring, I analyze acquisitions and divestitures, whereas I concentrate on changes in the organizational structures of firms in the field of organizational restructuring.

Acquisitions: Acquisitions are a type of firm diversification that leads to a change in the boundaries of a firm (Williamson, 1981). The acquisition of a firm or a new business expands a firm's boundaries. This is one way for firms to grow in size. The final success of an acquisition is highly dependent on how a firm manages the organizational restructuring that is necessary to adapt the structures and procedures to the new boundaries of the firm. The activities involved in integrating two firms are known in the management literature as 'postmerger integration' (e.g., Shrivastava, 1986; Picot, 2002; Epstein, 2004). According to Shrivastava (1986), the integration of two firms includes three dimensions: procedural integration, which is intended to align and standardize work procedures; physical integration, which involves the consolidation of technologies, product lines, and R&D projects as well as equipment and assets; and managerial and sociocultural integration, which involves changes in the organizational structure, the development of a corporate culture, and gaining buy-in from employees. Kitching's (1973) estimation that one-third of all merger failures are caused by faulty integration demonstrates how difficult it is for firms to successfully implement the organizational changes involved in completing an acquisition.

Divestitures: According to the literature (e.g., Porter, 1987; Ravenskraft and Scherer, 1987), divestitures may be a consequence of firms' continuous acquisition activities over time. Although there are several reasons for this relationship between acquisitions and divestiture activities, I will focus on three arguments in my work. First, in many cases, acquisitions do not generate the expected returns;[139] thus, firms decide to divest the acquired businesses to reduce future losses and to improve the value of the firm (Jensen, 1988). Second, firms that follow an acquisition strategy with the primary goal of diversification may become overdiversified (Hoskisson and Hitt, 1994; Markides, 1992,

[139] There are many arguments for why, in many cases, acquisition activities do not result in the expected synergistic effects or monetary success. I provide an explanation based on the transaction cost theory. Acquisitions typically entail substantial transaction costs, such as negotiation costs, costs for bidding, and monitoring costs. Key difficulties involved in such transactions include the high level of uncertainty and complexity related to the transaction (Jones and Hill, 1988). To achieve the highest possible price for a firm, the managers of the firm being acquired only provide the other involved parties with information that increases the price of the target firm. As a result of existing information asymmetries and the high degree of complexity of the negotiations, managers of acquiring firms are typically not able to estimate the synergies between the firms that can realistically be achieved. Thus, if estimations of potential synergies are based on information from the target firm managers, in many cases, the economies of scale and the economies of scope that can actually be achieved are lower than expected (Haspeslagh and Jemison, 1991; Jemison and Sitkin, 1986).

1995; Shleifer and Vishney, 1991). These firms may conduct divestiture activities with the goal of strategically refocusing their business activities (Johnson, 1996). A third reason for firms to conduct divestiture activities is to increase cash flow to pay debts (Hoskisson et al., 1994; Scherer, 1988; Lee and Cooperman, 1989).[140]

In addition, firms may conduct divestitures for reasons that are unrelated to previous acquisition activities. Changes in the environment of a firm may increase the need to divest businesses to refocus on core activities and to better prepare for increased global competition (Shleifer and Vishny, 1991; Hoskisson and Hitt, 1994). Firm governance, strategy, and performance may be rationales for divestiture activities (Hoskisson et al., 1994).

Similar to acquisition activities, divestitures change the boundaries of a firm. Consequently, it is necessary to adapt the organizational structure and procedures to the setting of the 'new' organization. In addition, 'damage control' in the remaining organization is important to manage the reduced morale of the remaining employees, which may result from the high degree of uncertainty (Nees, 1981; Taylor, 1988).

Major Restructuring Activities: Changes in the organizational structure of a firm are not necessarily a consequence of the acquisitions or divestiture activities of the firm but may occur for numerous reasons. Structural changes may be undertaken with the goal of improving a firm's efficiency, whereas a new organizational structure may be implemented in response to changes in the external environment of a firm (e.g., Greenwood, Hinings, 1996). These changes may also be the consequences of a new strategy or new management concepts and the consequent new responsibilities. These changes may include an entire organization, or they may focus on one specific business unit. There is a broad range of reasons for structural changes in a firm's organization, but most restructuring efforts share the same goal: to better adapt a firm's organization to the external conditions as a way of improving its efficiency and profitability.

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[140] In many cases, firms that follow an active acquisition strategy manage high debt loads and may therefore divest assets to increase cash flow. Thus, this argument for divestiture activities may, at least in some cases, be linked to a firm's acquisition activities (Hitt and Smart, 1994).

5.2.2 Hypotheses on the Influence of Different Forms of Organizational Change on the Innovativeness of Firms

Based on the above described forms of organizational change, I develop six hypotheses regarding the impact of organizational change, in the form of acquisitions, divestitures, and major organizational restructuring activities, on the innovative activities of firms. All these hypotheses underlie a certain degree of endogeneity, which is why I must be cautious with interpreting my findings. I will further address this topic in the hypothesis development section as well as in the discussion section of this study (Section 5.7)

Acquisitions

As described in Section 5.2.1, an acquisition process is a complex and time-consuming process that requires substantial attention from the management of the involved firms. The integration period that directly follows the immediate acquisition of a firm has a major influence on the success of the acquisition. Thus, the managers of the acquiring firm must pay a great deal of attention to the integration effort involved in this phase of the acquisition project. As a result, managerial attention is often diverted from other strategically important initiatives, such as innovation projects, over a relatively long time period (Haspeslagh and Jemison, 1991; Hitt et al., 1990). According to Constable (1986), an acquisition strategy and internal innovation projects do not only compete for managerial attention, but also for the monetary resources of a firm. Firms that follow an active acquisition strategy may use acquisitions as a replacement for internal innovation activities because an acquisition strategy may be considered less risky than internal innovation projects, which are often highly uncertain. These firms may invest less in internal R&D projects than firms that do not actively pursue acquisition projects (Hill and Snell, 1989).

As described above, acquisitions influence the innovative activities of the acquiring firm. In addition, the influence of such activities on the behavior of the target firm is of importance. In target firms, the management often focuses on the short-term development of the business to increase its attractiveness. Thus, in many cases, the management postpones long-term investments in strategic projects (such as R&D projects) that would reduce the firm's cash position (Hitt et al., 1996). These arguments lead to the following hypothesis:

Hypothesis 1a: Innovative input of firms that have conducted recent acquisition activities is smaller compared to the innovative input of firms that have not conducted recent acquisition activities.

Whereas I consider the allocation of resources above, I focus on the influence of an acquisition effort on these resources in the next hypothesis. Hayes (1972) and Johnson et al. (1990) report that an acquisition may lead to lower morale, higher turnover, and lower productivity of employees in response to high uncertainty. Hitt, Hoskisson, Ireland, and Harrison (1991a) and Hitt, Hoskisson, and Ireland (1990) argue that the strong focus of a firm's executives on the acquisition process leads to less commitment and, consequently, reduced monetary resources dedicated to internal innovation projects. In addition, if top managers are less willing to reward internal innovative activities of their employees, the employees at lower firm levels will engage less in innovation projects. These arguments together with hypothesis 1a lead me to the assumption that the innovative output is a fortiori reduced for firms that have conducted recent acquisition activities.

This hypothesis underlies a certain degree of endogeneity: while most researchers see a relationship between innovative output and acquisition activities in the form that acquisition activities influence the innovative output of firms (e.g., Hitt, Hoskisson, Ireland, and Harrison, 1991a), an influence of the innovative performance of a firm on its acquisition activities seems to be also realistic. My second hypothesis states:

Hypothesis 1b: Innovative output of firms that have conducted recent acquisition activities is smaller compared to the innovative input of firms that have not conducted recent acquisition activities.

Divestitures

As described in Section 5.2.1, firms that divest businesses may do so for various reasons, such as poor performance by the respective business unit or a high debt load. These firms do often not have the resources to invest the money gained from these divestiture activities in innovation projects, which are risky and uncertain and may require

several years to pay off (Hitt et al., 1996). Both acquisition activities and divestitures require internal restructuring activities, which demand a high level of managerial attention and divert this attention from other strategically important projects, such as innovation projects.

In contrast, Hoskisson and Johnson (1992) find that if divestment activities in firms at intermediate levels of diversification reduce the diversified scope of the firm's business activities, these divestiture activities lead to an increase in the firm's innovation activities. However, I do not restrict my analysis to firms at intermediate levels of diversification, nor can I test for a reduction in the degree of diversification of each firm. Thus, I expect that, in my sample, the former effect outweighs the latter. As a result, I postulate the following:

Hypothesis 2a: Innovative input of firms that have conducted recent divestiture activities is smaller compared to the innovative input of firms that have not conducted recent divestiture activities.

The arguments that lead me to Hypothesis 2b, regarding the relationship between the divestiture activities of firms and innovative output, are similar to those for Hypothesis 1b. Also, I would expect that the innovative output of firms that have conducted recent divestiture activities is a fortiori smaller than the innovative input of these firms. However, the above mentioned arguments are of even greater importance in the case of divestiture activities. The high uncertainty that is caused, in many cases, by a lack of information or contradictory information may lead to low morale, high turnover, and reduced productivity among the employees in the remaining businesses of the firm (Hayes, 1972; Johnson et al., 1990). Mistrust between employees and managers leads to highly conservative behavior that aims to avoid mistakes in times of potential job insecurity and leads to low levels of innovation (Hitt et al., 1996). In addition, divestitures may interrupt existing information networks between employees of different business units, which might have fostered innovative activities prior to the divestiture (Gemünden et al., 1992). According to Hitt et al. (1996) and Fulmer and Gilkey (1989), this high level of uncertainty typically persists several years after a divestiture is completed, especially in firms that have completed multiple divestitures.

The hypothesis 2b also underlies a certain degree of endogeneity, although it is of a different form than that underlying hypothesis 1b. Whereas one would expect that firms that currently have a low level of innovative output and that acquire another firm do this with the goal to foster the own innovative output (e.g. a pharma firm that acquires a biotech start-up with the goal to refill the own product pipeline), firms with a low level of innovative output that divest are most likely firms that are not in a very well cash position and divest with the goal to improve this situation. My hypothesis 2b is the following:

Hypothesis 2b: Innovative output of firms that have conducted recent divestiture activities is smaller compared to the innovative input of firms that have not conducted recent divestiture activities.

Major Organizational Restructuring Activities

As in the hypotheses describing the effects of organizational change through acquisitions and divestitures on the innovative activities of firms, I also expect a negative effect of organizational change in the form of major restructuring activities on innovative input and on innovative output. Although there are a variety of studies on the relationship between acquisition and divestiture activities and the innovativeness of firms, I am not aware of empirical studies that analyze the effect of major organizational restructuring activities, independent of the reason for those efforts,[141] on the innovativeness of firms. However, regardless of the origin or form of organizational change, I expect that the management's focus on a reorganization project diverts the attention of the top management from other strategic efforts. Furthermore, I expect a reallocation of monetary resources from other strategic projects (such as innovation projects) to an important reorganization effort. Thus, similar to Hypotheses 1a and 2a, I expect the following:

Hypothesis 3a: Innovative input of firms that have recently conducted major organizational restructuring activities is smaller compared to the innovative input of firms that have not recently conducted major organizational restructuring activities.

[141] Major organizational restructuring efforts are not always caused by such fundamental changes as acquisitions or divestment activities. They can also occur with the intention to adapt to the external environment and to improve performance.

Organizational restructuring efforts that are not based on acquisition or divestiture activities may also cause a high degree of uncertainty among employees, which can persist for a relatively long time after the restructuring efforts are completed. The key reason for this uncertainty is the fear among employees that the restructuring activities may have subsequent radical consequences, including job losses for some employees.

A certain degree of endogeneity can also be expected underlying this hypothesis. While conducting a major restructuring effort may influence the innovative performance, a contrary relationship seems also to be realistic: firms that suffer from a low innovative performance may conduct major restructuring efforts with the goal to increase the innovative output. Due to the above described arguments, I expect similar effects as in the case of divestitures:

> *Hypothesis 3b: Innovative output of firms that have recently conducted major organizational restructuring activities is smaller compared to the innovative input of firms that have not recently conducted major organizational restructuring activities.*

5.3 Data

I test the hypotheses by comparing the innovative input and output of firms that have conducted an organizational change process within the last three years with the innovative input and output of firms that have not undergone such effort. I use 'R&D expenses over sales' as a proxy for innovative input, whereas I use the measure 'percentage of new and significantly improved products of total sales' as a proxy for innovative output.

The subsequent sections are structured as follows. I provide detailed descriptions of the data source and the dataset in Section 5.3.1 (data source) and Section 5.3.2 (dataset), followed by an overview of the dependent variables in Section 5.3.3 and a description of the independent and control variables in Section 5.3.4.

5.3.1 Data Source

All data for my analysis come from the 'Mannheimer Innovationspanel' (MIP), a survey that has been conducted annually since 1993 by the Zentrum für europäische Wirtschaftsforschung (ZEW).[142] The MIP is part of the 'Community Innovation Survey' (CIS), a survey conducted by the European Union (EU) (ZEW, 2011b).

The goal of the MIP is to evaluate the innovation behavior of German firms by generating information on the launch of new products, services, and processes, innovation expenses and the success of innovation activities. The survey asks questions about future investments and factors that may foster or impede such investments. The MIP delivers representative data for six sectors in Germany: manufacturing industries, mining, energy, construction, business support services, and distributive services (ZEW, 2011a).

The survey is designed as a panel survey that includes the same firms every year. To ensure that the survey is representative for every year, the sample is modified every other year to take acquisition activities and the closing of firms into account. Additionally, newly founded firms are included in the dataset. Since 1998, a reduced questionnaire has been sent to a smaller sample of firms in the even years, and the complete questionnaire has been sent to the full sample of firms in uneven years. The sample in uneven years consists of approximately 8,000 to 10,000 firms; a response rate of 20% to 25% is typically achieved (ZEW, 2011b).

The data from the MIP are made available to scientists, in an anonymous form because of the sensitivity of the data for the participating firms.

[142] For further information on the MIP, please see http://www.zew.de/de/forschung/projekte.php3?action=detail&nr=374 and http://kooperationen.zew.de/dfgflex/links/datensaetze-deutschland/mannheimer-innovationspanel.html (both accessed 20.10.2011).

5.3.2 Dataset Description

I use data from the 2003 MIP survey on the manufacturing, mining, construction, and energy industries to analyze the questions regarding the influence of acquisitions and divestiture activities on the innovative activities of firms. To investigate the relationship between major restructuring activities in general and innovative input and output, I use the 2001 dataset from the manufacturing industries survey of the MIP.

I use different datasets because the MIP questionnaire changes over the years. The aspects regarding organizational restructuring in general are covered in the 2001 survey but not in the 2003 survey. In addition, the 2001 questionnaire does not include some of the variables that I employ as control variables in my analysis. Thus, I use 2003 data to analyze the hypotheses related to acquisitions and divestitures, whereas I use the older (and, in some areas, less complete) 2001 dataset to investigate my hypotheses on organizational restructuring. The 2003 dataset contains information from 2,064 firms, and the 2001 dataset contains data from 2580 firms from the manufacturing industries.

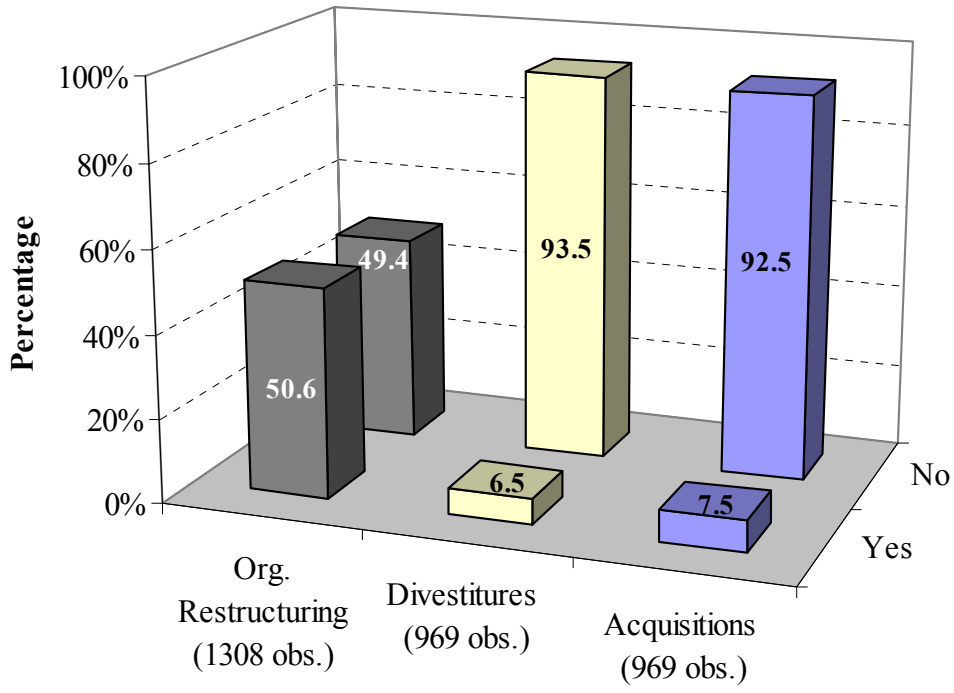
As mentioned in the previous section, the dataset is anonymized by the authors of the MIP to maintain the confidentiality of the participating firms. The procedures followed to make the data anonymous are as follows (ZEW, 2011b):

- Data that are measured in monetary units are changed to ratio measures, with the number of employees or sales as the denominator variable.
- Sales and employees are anonymized through the multiplication of the values of each firm by a random variable that is constant for each firm over the different evaluation years.
- Variables that show percentages of sales or employees are grouped into categories.
- Outliers that could cause a firm to be identified even after grouping into categories are eliminated from the dataset.

In the section of this study describing the variables (Sections 5.3.3 and 5.3.4), I describe the extent to which each variable that I employ in my models has undergone such anonymization.

After eliminating all observations that contain missing values in one of the variables, the final dataset contains 969 observations (2003), of which 73 conducted an acquisition between 2000 and 2002 and 896 did not. The numbers for divestiture activities are similar: 63 firms underwent a divestiture process between 2000 and 2002, and 906 of the firms in the dataset did not. 20 firms conducted an acquisition **and** divestiture in the period between 2000 and 2002. After eliminating all observations that contain missing values, the 2001 dataset includes 1,308 observations. Of these 1,308 firms, 662 conducted a major organizational restructuring activity between 1998 and 2000, whereas 646 firms did not. For a detailed overview of the groups of firms that I compare based on the reason for organizational change, please see Figure 6.

Figure 6: Overview of Firms in the Dataset Grouped by the Type of Organizational Change



5.3.3 Dependent Variables

Innovative Input

I use the ratio of innovation expenses to sales as a proxy to measure innovative input (Hagedoorn and Cloodt, 2003; Hitt et al., 1991). The variable is trimmed for all observations that exceed the value of 0.35 to anonymize the data, which is why a cluster of observations can be found at 0.35. To avoid a bias in the data resulting from the peak at the value of 0.35, I categorize the variable into five categories. The 2003 dataset of the MIP is based on 2002 data for innovative input (innovation-expenses-to-sales-ratio), whereas the innovation-expenses-to-sales-ratio from the 2001 dataset is based on 2000 data. The innovation-expenses-to-sales-ratio is constructed by the authors of the MIP survey based on the responses of the firms to the questionnaire.

Innovative Output

I use the percentage of total sales generated by new or significantly improved products as a proxy for innovative output. Many researchers use the number of patents that a firm holds as a proxy for innovative output (e.g., Acs and Audretsch, 1988; Pakes and Griliches, 1980). This approach is subject to a longstanding debate because not all innovations are patented, and some may not even be patentable, as I discuss in Section 4.7. The variable that I use, the percentage of sales generated by new or significantly improved products of total sales,[143] is categorized by the MIP authors on a 10-step scale from 0% to 100% to maintain the anonymity of the firms. I use 2002 data for the output variable when using the MIP 2003 dataset, and I work with the data for the year 2000 when using the 2001 survey.

Table 16 and Table 17 provide the correlation matrices of the independent and control variables. The variance inflation factors are all less than or equal to 1.10. The mean VIFs are 1.04 and 1.05 respectively. Thus, I can reject multicollinearity.

[143] Hitt et al. (1996) use a similar variable; they measure new product announcements as a proxy for innovative output.

5.3.4 Independent and Control Variables

Acquisitions

The first independent variable in my models is a dummy variable that indicates whether a firm conducted an acquisition process in the three years prior to the time that I measure the firm's innovative input/innovative output (i.e., between 2000 and 2002 and between 1998 and 2000). This variable equals 1 if a firm responded in the questionnaire that it conducted at least one acquisition between 2000 and 2002 (1998 and 2000), and it equals 0 if the firm responded that it did not engage in such an activity in this time period.

Divestitures

The next independent variable in my study is a dummy that indicates whether a firm conducted divestiture activities between the years 2000 and 2002 (1998 and 2000). Similar to the acquisition dummy, the variable equals 1 if a firm answered in the MIP survey that it conducted divestiture activities, whereas it equals 0 if the firm answered that it did not divest any business in the relevant time period.

Major Organizational Restructuring

The third independent variable in my models is only available in the 2001 dataset and represents firms' responses to whether they implemented new organizational structures between 1998 and 2000 (independent of the reasons for such changes in the organizational structures). This is a dummy variable that can be 'yes' or 'no' depending on a firm's answer to the above question.

Firm Size

According to Schumpeter (1961), large firms have some advantages with regard to a high level of innovative activities because larger firms have established efficient R&D programs. Other authors (e.g., Schumpeter, 1934; Nelson and Winter, 1982; Kamien and Schwartz, 1982) reach different conclusions, but a relationship between the size of the firm and its innovativeness has been shown to exist (Hitt et al., 1990). Thus, I control for firm size by using 'number of employees' as a proxy for the size of the firm. To maintain the

anonymity of the firms, the MIP authors divide the variable 'number of employees' into three categories. Thus, I use two dummy variables to control for firm size.

Profitability

Firms that are monetarily more successful than others are freer to invest money in innovation projects without incurring additional debt (Hitt et al., 1991). In addition, these firms may be better able to generate high-quality, innovative output from innovative input compared to less successful firms. Thus, I control for the profitability of firms by using the return on sales as a proxy.

Industry

I control for potential industry influences by using the industry code assigned to each firm by the authors of the MIP. The authors assign each firm to 1 of 13 industry categories.[144]

The Degree of Concentration

As prior research has shown, a firm's degree of concentration has a substantial influence on its R&D intensity. Studies suggest using an entropy measure to control for the degree of concentration (Palepu, 1985; Jacquemin and Berry, 1979; Baysinger and Hoskisson, 1989). As a proxy for the degree of concentration and for the often-used entropy measure, I use the percentage of sales generated by the most important product in the 2003 dataset. The analyses based on the 2001 dataset are conducted without this control variable because the variable was not collected for the year 2001.

[144] The categorization of firms into industry categories is based on the 'Wirtschaftszweigklassifikation WZ 93'. This category system is based on the 'NACE' system of the European Union. While the authors of the MIP use a system of 13 categories describing activities in the manufacturing and mining industries for the 2002 survey, in the 2003 survey, they use a combined category system of 22 categories that describe activities in the manufacturing and mining industry and in the service sector. The two category systems are consistent because the combined categorization includes the former manufacturing and mining category system combined with the former services system. For an overview of the combined category system, please see Appendix A.6.

Table 16: Correlation Matrix of the Independent and Control Variables for Regressions Regarding Relationship Between Acquisitions/Divestitures and Innovative Activities (MIP 2003-Survey)

	Acquisitions	Divestitures	Employees	Return on Sales	Percentage Sales of Major Product	VIF
Acquisitions	1					1.10
Divestitures	02419*	1				1.09
Employees[145]	0.1303*	0.0794	1			1.05
Return on Sales	0.0331	-0.0672	0.0331	1		1.01
Percentage Sales of Major Product	-0.0403	-0.0733	-0.2047*	-0.0165	1	1.03

* significant at the 1%-level.

Variance inflation factors (VIFs) calculated based on an OLS model with the same dependent variable.

[145] The correlations for the ordinal variable 'Employees' are calculated using a spearman rank correlation coefficient.

Table 17: Correlation Matrix [146] of the Independent and Control Variables for Regressions Regarding Relationship Between Organizational Restructuring and Innovative Activities (MIP 2001-Survey)

	Major Organizational Restructuring	Employees	VIF
Major Organizational Restructuring	1		1.04
Employees	0.2202*	1	1.04

* significant at the 1%-level.

Variance inflation factors (VIFs) calculated based on an OLS model with the same dependent variable.

5.4 Descriptive Results

The complete datasets of this study include 969 (2003) and 1308 (2001) observations respectively of firms from 13 different industries. In both years, the metal and mechanical engineering industries represent the largest groups in the samples, accounting for 30.4% (2003) and 29.8% (2001) of the observations. In the 2003 survey, the next-largest groups are the medical instruments, steering and control devices, and optics (MMSRO) and the electrical engineering industries, which account for 12.1% and 9.6% of the observations. In the 2001 survey, the electrical engineering industry represents a slightly larger share than in 2003 (10.0% in 2001), whereas the medical instruments, steering and control devices, and optics industry (MMSRO) is of less importance (7.3% of the observations and the seventh-largest group in the sample compared to its position as the third-largest group in 2003). The smallest groups in both samples are the mining, furniture, automotive, and glass/ceramics industries. For a more detailed overview of the industry distribution of the firms in the survey, please see Table 18.

[146] The correlation is calculated using a spearman rank correlation coefficient.

Table 18: Distribution of Firms in the Datasets over Industries

Industry	2003-Survey		2001-Survey	
	Number	%	Number	%
Metals	147	15.2	192	14.7
Mechanical Engineering	147	15.2	198	15.1
Medical Instruments, Control and Steering Technology, Optics	117	12.1	95	7.3
Electrical Engineering	93	9.6	131	10.0
Wood/Paper	77	8.0	101	7.7
Plastics	72	7.4	124	9.5
Chemicals	58	6.0	90	6.9
Food/Tobacco	58	6.0	106	8.1
Textile	56	5.8	71	5.4
Automotive and Other Vehicles	44	4.5	49	3.8
Glass/Ceramics	43	4.4	72	5.5
Furniture	38	3.9	43	3.3
Mining	19	2.0	36	2.8
Total	**969**	**100.1**[147]	**1308**	**100.1**[148]

Table 19 shows that the distribution of the firm sizes in the datasets is very similar for the two years. In both years, small firms with 50 or fewer employees represent the largest group, with almost 50% (46.4% in 2003 and 48.0% in 2001). Firms with 50 to 249 employees represent the second group, with 33.1% (2003) and 32.3% (2001), whereas large

[147] Differences to 100% result from rounding of the values in the three firm size-categories.

[148] Differences to 100% result from rounding of the values in the three firm size-categories.

firms with 250 or more employees represent the smallest group, with approximately one-fifth of the firms in both datasets.

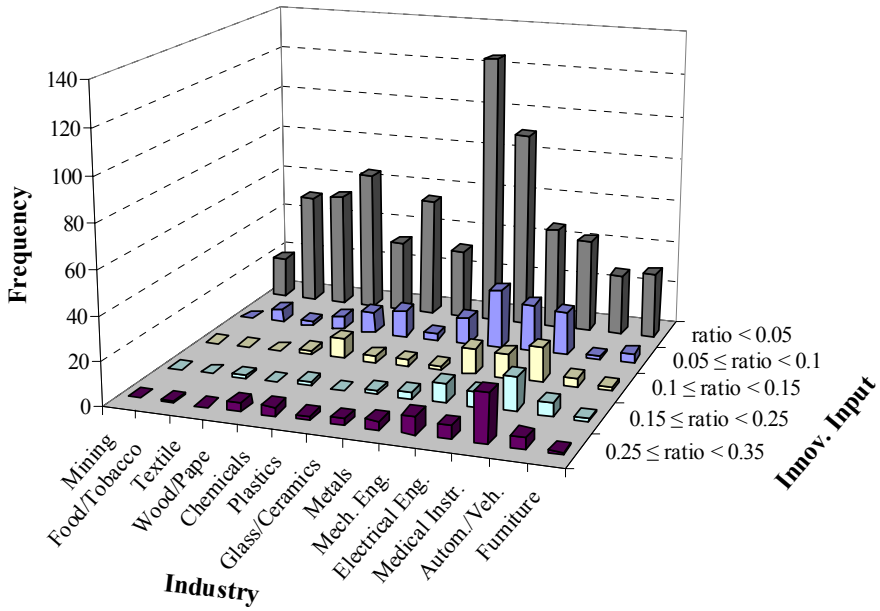
Table 19: Distribution of Firms in the Datasets over Firm Size

Firm Size	**2003-Survey**		**2001-Survey**	
	Number	%	Number	%
≤ 50 Employees	450	46.4	628	48.0
50 – 249 Employees	321	33.1	423	32.3
250+ Employees	198	20.4	257	19.7
Total	**969**	**99.9**[149]	**1308**	**100**

Figure 7 sheds some light on the distribution of the innovative input (proxied by the innovation-expenses-to-sales-ratio) of the firms in my sample (for the year 2003) by industry. In all industries, the firms with an innovation-expenses-to-sales-ratio of less than 0.05 represent the largest group. Comparing the industries, the medical instruments, steering and control devices, and optics industries have the highest level of innovative input. Electrical engineering, mechanical engineering, and, to some degree, the metal industry represent industries in which some firms have high levels of innovative input. The industries with the lowest number of firms with a medium or high level of innovative input are mining, textile, food/tobacco, and furniture.

[149] Differences to 100% result from rounding of the values in the three firm size-categories.

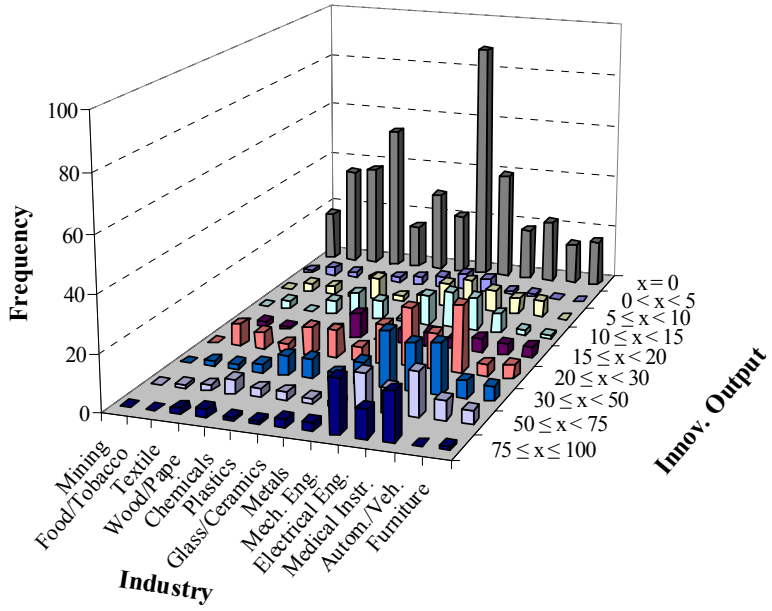
Figure 7: Innovative Input[150] by Industry (2003-Dataset)



Comparing innovative output (operationalized by the percentage of sales generated by new or significantly improved products), unsurprisingly, the industries with a large number of firms with higher levels of innovative input are also those with a large number of firms with higher innovative output (see Figure 8). Thus, the medical instruments, steering and control devices, and optics industry and the mechanical and electrical engineering industries have the largest number of firms with high levels of innovative output. Plastics and chemicals have a medium share of sales generated by new or significantly improved products, although few firms in these industries have high levels of innovative input.

[150] The innovative input is proxied by the innovation-expenses-to-sales-ratio. This variable consists of 5 categories.

Figure 8: Innovative Output[151] by Industry (2003-Dataset)

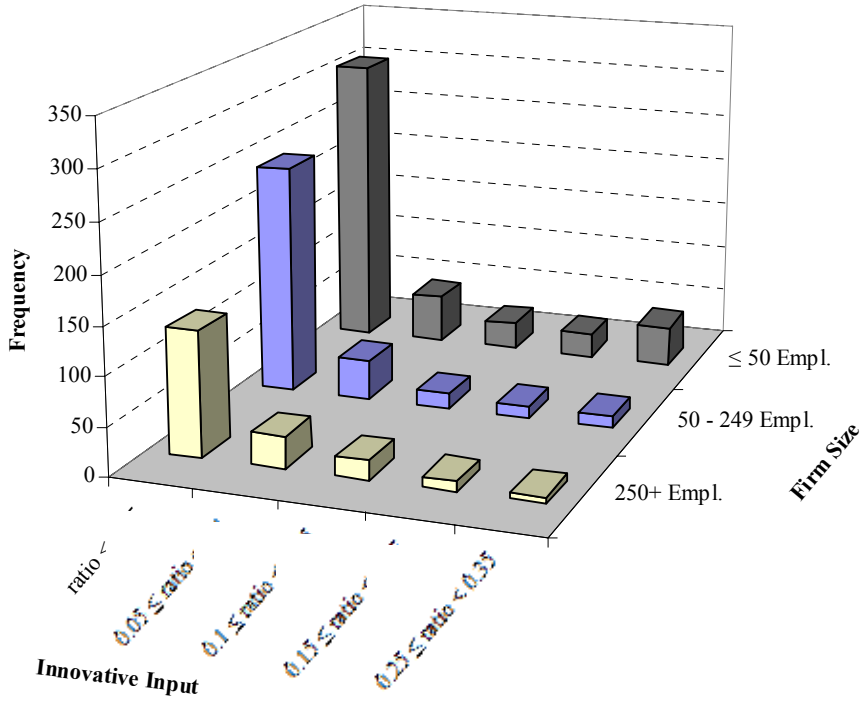


Comparing the distribution of the innovative input of firms by size (see Figure 9) reveals only small differences among the three groups of firm size. In all three groups, the lowest category of innovative input represents the largest group of firms. The two following categories of innovative input (innovation-expenses-to-sales-ratio between 0.05 and 0.15) are largest for the group of large firms in the sample. The number of firms with an innovation-expenses-to-sales-ratio of more than 0.25[152] is largest in the group of small firms.

[151] The innovative output is proxied by the percentage of sales generated by new or significantly improved products to total sales. This variable consists of nine categories.

[152] According to the categorization and the trimming of the innovation-expenses-to-sales-ratio at 0.35, this group contains all firms with a value of more than 0.25 (the firms with higher innovation-expenses-to-sales-ratios are trimmed to the value of 0.35).

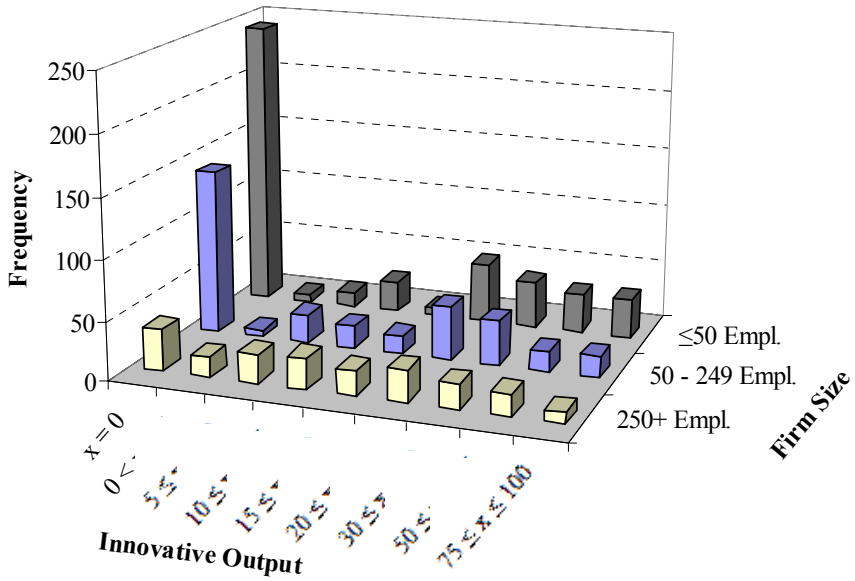
Figure 9: Innovative Input[153] Firms by Size (2003-Dataset)



Interestingly, the distribution among the categories of the innovative output of firms as a percentage of total sales generated by new or significantly improved products differs among the three groups of firm size (see Figure 10). In all size categories the number of firms with 0% of sales generated by new or significantly improved products is the largest. However, whereas for the group of large firms the number of firms with 0% of sales generated by new products is only 30% higher than the next largest category, among small and medium-sized firms the number of these firms is almost five times (small firms) and three times (medium-sized firms) higher than the next largest category.

[153] Again, the innovative input is proxied by the innovation-expenses-to-sales-ratio, which consists of five categories.

Figure 10: Innovative Output[154] of Firms by Size (2003-Dataset)



5.5 Methods and Specification of the Multivariate Model

Following a detailed description of the dataset and variables and the presentation of the descriptive results of my study, I present the methods that I use in Section 5.5.1 and specify the multivariate model in Section 5.5.2.

5.5.1 Methods

The dependent variables in my models consist of five innovative input and nine innovative output categories measured on an ordinal scale, which indicates an ordered logistic regression (ologit model) as the appropriate methodology to analyze the data. One key assumption of the ologit model is that the relationships among all outcome groups are

[154] As already described in Footnote 151, the innovative output is proxied by the percentage of sales generated by new or significantly improved products to total sales.

identical. This means that the coefficient describing the relationship between the lowest and all higher categories of the dependent variable is the same as the coefficient describing the relationship between the two lowest and all higher categories. This is called the 'proportional odds assumption', and it leads to the estimation of only one model when using an ordered logit model. To test whether this assumption of proportional odds is violated in the case of this study, I employ a Brant test (Brant, 1990) with a significance level of 10%. The result of the Brant test shows that the proportional odds assumption is violated for some variables. Therefore, I must apply a 'generalized ordered logit model' (Williams, 2006) that is robust to the violation of the assumption of proportional odds.

When using the generalized ordered logit model (gologit model), I do not assume proportional odds. Therefore, I must estimate dedicated coefficients for each threshold. For the variables that do not violate the proportional odds assumption, I impose constant coefficients for all categories, which leads to only one set of coefficients for these variables. For a description of the groups of the two dependent variables in my sample, please see Table 20 and Table 21.

Table 20: Overview of Groups of Dependent Variable 'Innovative Input'

Group Number	Group Description
0	Innovation-expenses-to-sales-ratio ('ratio') < 0.05
1	0.05 ≤ 'ratio' < 0.1
2	0.1 ≤ 'ratio' < 0.15
3	0.15 ≤ 'ratio' < 0.25
4	0.25 ≤ 'ratio' < 0.35

Table 21: Overview of Groups of Dependent Variable 'Innovative Output'

Group Number	Group Description
0	Percentage of sales with new or significantly improved products of total sales ('percentage') = 0%
1	0% < 'percentage' < 5%
2	5% ≤ 'percentage' < 10%
3	10% ≤ 'percentage' < 15%
4	15% ≤ 'percentage' < 20%
5	20% ≤ 'percentage' < 30%
6	30% ≤ 'percentage' < 50%
7	50% ≤ 'percentage' < 75%
8	75% ≤ 'percentage' ≤ 100%

The gologit model provides results for the comparison of group 1 with the aggregation of all higher groups, for group 1 and 2 with the aggregation of all higher groups, for group 1 to 3 with all higher groups and so forth. For an overview of the comparisons using the generalized ordered logit model, please see Table 22 (for innovative input proxied by the innovation-expenses-to-sales-ratio as the dependent variable) and Table 23 (for innovative output proxied by the percentage of sales generated by new or significantly improved products of total sales).

Table 22: Overview of Ordered Group Comparisons (Dependent Variable 'Innovative Input')

Comparison Step	Description	Included Group Numbers		Included Group Numbers	Description
1	'Ratio' < 0.05	0	vs.	1, 2, 3, 4	'Ratio' ≥ 0.05
2	'Ratio' < 0.1	0, 1	vs.	2, 3, 4	'Ratio' ≥ 0.15
3	'Ratio' < 0.15	0, 1, 2	vs.	3, 4	'Ratio' ≥ 0.15
4	'Ratio' < 0.25	0, 1, 2, 3	vs.	4	'Ratio' ≥ 0.25

Table 23: Overview of Ordered Group Comparisons (Dependent Variable 'Innovative Output')

Comparison Step	Description	Included Group Numbers		Included Group Numbers	Description
1	'Percentage' = 0%	0	vs.	1, 2, 3, 4, 5, 6, 7, 8	'Percentage'> 0%
2	'Percentage' < 5%	0, 1	vs.	2, 3, 4, 5, 6, 7, 8	'Percentage' ≥ 5%
3	'Percentage' < 10%	0, 1, 2	vs.	3, 4, 5, 6, 7, 8	'Percentage' ≥ 10%
4	'Percentage' < 15%	0, 1, 2, 3	vs.	4, 5, 6, 7, 8	'Percentage' ≥ 15%
5	'Percentage' < 20%	0, 1, 2, 3, 4	vs.	5, 6, 7, 8	'Percentage' ≥ 20%
6	'Percentage' < 30%	0, 1, 2, 3, 4, 5	vs.	6, 7, 8	'Percentage' ≥ 30%
7	'Percentage' < 50%	0, 1, 2, 3, 4, 5, 6	vs.	7, 8	'Percentage' ≥ 50%
8	'Percentage' < 75%	0, 1, 2, 3, 4, 5, 6, 7	vs.	8	'Percentage' ≥ 75%

5.5.2 Specification of the Multivariate Model

A generalized ordered logistic regression model with two categories is equivalent to a logistic regression model, whereas a gologit model with more than two categories is equivalent to a series of binary logistic regressions in which categories of the dependent variable are combined (Williams, 2006).

The logistic regression model is typically used to analyze the choice between two different alternatives. In my case, the alternatives are, for example, whether a firm has an innovation-expenses-to-sales-ratio of less or more than 0.25. The logistic regression uses maximum-likelihood estimation to estimate the model parameters of the regression model. The goal of the maximum-likelihood method is to estimate the parameters such that the likelihood of obtaining the empirical results is maximized (Backhaus, 2003). The likelihood function underlying the estimation can be formulated as follows:

$$L = \prod_{k=1}^{K} \left(\frac{1}{1+e^{-z_k}} \right)^{y_k} \cdot \left(1 - \frac{1}{1+e^{-z_k}} \right)^{1-y_k} -> \max .$$

Taking the logarithm of the likelihood function results in the following log likelihood function:

$$LL = \sum_{k=1}^{K} \left[y_k \cdot \ln\left(\frac{1}{1+e^{-z_k}} \right) \right] + \left[(1-y_k) \cdot \ln\left(\frac{1}{1+e^{-z_k}} \right) \right].$$

5.6 Multivariate Results

In this section, I present the results of the multivariate analyses of this study. Models 1, 2, and 3 show the results for the analyses that test the effect of acquisitions, divestitures, and general major organizational restructuring, respectively, on the innovative input of the firms in my sample. Models 4 to 6 show the effect of these three forms of organizational change on the innovative output of firms.

In Model 1, I do not find support for my Hypothesis 1a, that acquisitions have a negative influence on the innovative input of firms (Table 24). In contrast, I find a contrary effect that suggests that acquisitions might influence the innovative activities of firms positively. The dummy variable that indicates that a firm has recently conducted acquisition activities is positive, while not significant when estimating Category 0 of the innovation-expenses-to-sales-ratio against all higher categories. As the coefficient value increases and becomes highly significant over the other levels, it suggests that having conducted acquisition activities increases the likelihood that a firm has a higher innovation-expenses-to-sales-ratio. Examining the control variables, the data suggest that a high level of concentration (i.e., a high percentage of sales generated by the most important product) decreases the likelihood that a firm has high innovative input. Moreover, the industry dummies for chemicals, glas/ceramics, mechanical engineering, electrical engineering, MMSRO, and automotive and other vehicles are significantly positive which means that the likelihood that firms from these industries have a high innovation-expenses-to-sales-ratio is increased compared to the reference industry. In Model 2, I test the hypothesis that divestitures have a negative influence on the innovative input of firms, and I test Hypothesis 3a, that major restructuring activities influence the innovative input of firms negatively in Model 3. In both models, I do not find significant support for the two hypotheses. In Model

2, the effects of the industry control variables are identical with those that I describe above, whereas in Model 3 only chemicals, electrical engineering, and MMSRO are significantly positive and food/tobacco and textile significantly decrease the likelihood that firms from these industries have a high innovation-expenses-to-sales-ratio compared to the reference industry. In addition, the variable 'employees' is in both models significantly negative over all levels except the first, which means that a high number of employees decreases the likelihood that a firm has a higher innovation-expenses-to-sales-ratio.

Table 24: Generalized Ordered Logit with Innovative Input as Dependent Variable

	Model 1[155]		**Model 2[156]**		**Model 3[157]**	
Indep. Variable	**Acquisitions (2003)**		**Divestitures (2003)**		**Organiz. Restructuring (2001)**	
	Coeff.	**Std. Err.**	**Coeff.**	**Std. Err.**	**Coeff.**	**Std. Err.**
Ctrl. Variables			**Cat. 0 vs. 1 – 4[158]**			
Acquisition	0.4304	0.2735				
Divestiture			0.3587	0.2983		
Org. Restruct.					0.1703	0.1437
Employees	-0.05919	0.1052	-0.04847	0.1044	0.07204	0.0923
Return on Sales	-0.001922	0.03751	0.002431	0.03748		
1 – Diversi-fication	-0.05425*	0.03268	-0.05185	0.03263		

[155] When testing for the violation of the proportional odds assumption, the assumption is only violated for the variables 'acquisition' and 'employees', which is why I impose on these variables constant coefficients for all categories, which leads to only one set of coefficients.

[156] When testing for the violation of the proportional odds assumption, the assumption is only violated for the variables 'divestiture and 'employees', which is why I impose on these variables constant coefficients for all categories, which leads to only one set of coefficients.

[157] When testing for the violation of the proportional odds assumption, the assumption is only violated for the variables 'major organizational restructuring and 'employees', which is why I impose on these variables constant coefficients for all categories, which leads to only one set of coefficients.

[158] This part of the results table displays the results for the estimation of the lowest category (also labeled 'group' of the dependant variable against all higher categories, whereas the next part shows the results of the estimation of the two lowest categories against all higher categories and so forth.

Industry Dummies[159] [160]						
Mining	-13.4255	471.1564	-14.2319	706.3221	-14.3412	502.2042
Food/ Tobacco	-0.2522	0.4666	-0.2540	0.4663	-0.7602*	0.3986
Textile	-1.002838	0.6392	-1.0299	0.6390	-1.1975**	0.5498
Wood/Paper	0.1205	0.3934	0.09466	0.3936	-0.3266	0.3642
Chemicals	1.4956***	0.3506	1.5323***	0.3513	0.7376**	0.2989
Plastics	0.5354	0.3617	0.5332	0.3616	0.2677	0.2954
Glas/ Ceramics	0.7862*	0.4211	0.7503*	0.4226	0.2533	0.3555
Mech. Engineering	1.2547***	0.2882	1.2432***	0.2884	0.4192	0.2547
El. Engineering	1.6889***	0.3050	1.6591***	0.3046	1.1732***	0.2586
MMSRO	2.3413***	0.2954	2.3222***	0.2953	1.9708***	0.2688
Automotive, other vehicles	1.6533***	0.4030	1.6367***	0.4037	0.3245	0.3927
Furniture	0.5356	0.4620	0.5123	0.4614	-0.03256	0.4545
Constant	-1.2985***	0.4413	-1.3324***	0.4424	-1.8191***	0.2518
			Cat. 0 & 1 vs. 2 – 4			
Acquisition	0.9199***	0.2909				
Divestiture			0.04130	0.3758		
Org. Restruct.					-0.04851	0.1795
Employees	-0.2681**	0.1220	-0.2041*	0.1217	-0.4294***	0.1275
Constant	-1.8272***	0.4543	-1.8805***	0.4563	-1.7761***	0.2862
			Cat. 0 – 2 vs. 3 & 4			
Acquisition	1.27***	0.3123				
Divestiture			0.2466	0.4249		
Org. Restruct.					-0.1968	0.2288
Employees	-0.5149***	0.1479	-0.4270***	0.1473	-0.5273***	0.1730
Constant	-2.0952***	0.4711	-2.1456***	0.4734	-2.2135***	0.3478

[159] The metal industry which is the industry with the highest number of observations in my sample is chosen as the reference category.

[160] As the aggregation of industry variables to an aggregated industry variable causes some major changes in the results, I decide to conduct my analysis using one separate control variable for each of the 13 industries.

	Cat. 0 – 3 vs. 4					
Acquisition	1.5655***	0.3729				
Divestiture			0.3089	0.5420		
Org. Restruct.					-0.4935	0.3503
Employees	-0.8038***	0.2102	-0.6575***	0.2046	-0.5149**	0.2525
Constant	-2.4099***	0.5129	-2.4925***	0.5148	-3.0279***	0.4475
Prob > F	0.0000		0.0000		0.0000	
Observations	969		969		1308	

* p < 0.1, ** p < 0.05, *** p < 0.01

I conduct three robustness checks for each of these models. First, I conduct an ologit regression, second, I use an OLS regression model, and third, I use a tobit model that is censored at the right side. All robustness checks confirm the findings of Models 1, 2, and 3. While the ologit estimation, the OLS regression, and the tobit model find a significant positive effect for the variable 'acquisition' on the innovative input of firms, none of these regression models finds a significant effect for the two other variables.

In addition to the three above discussed models, I estimate a fourth model being an aggregation of Models 1 and 2. Whereas Model 1 compares firms that have recently conducted an acquisition with firms that have not, Model 2 compares firms that have recently conducted divestiture activities with firms that have not undergone such efforts. In the additional model, I compare firms that have either conducted an acquisition or divestitures activities or both with firms that have not conducted any of these activities. For this model, I find a significant positive effect that implies that having undergone acquisition or divestiture activities increases the likelihood of a high innovative input for firms.

Furthermore, I conduct several estimations that analyze the influence of acquisitions, divestiture activities, and major organizational changes on the innovative input in selected innovative industries, namely electrical engineering, mechanical engineering, and MMSRO. While I do not find any effect of major organizational restructuring activities on the innovative input in any of the three industries, acquisitions seem to have a significant

positive effect on the innovative input in the mechanical engineering industry, whereas divestiture activities seem to positively affect the innovative input in the electrical engineering industry. However, I have to be cautious with interpreting these data, due to some degree of endogeneity that underlies my hypotheses and that I will further discuss in the summary and discussion section of this chapter (Section 5.7).

In Model 4, I analyze Hypothesis 1b, which states that acquisitions have a negative effect on the innovative output of firms. I do not find significant support for this hypothesis in the model (Table 25). The coefficient for the variable 'acquisition' is positive, while not significant at most estimation levels and turns significant (at the 10% level and at the 5% level) only at two estimation levels. Thus, no effect of recent acquisition activities on the innovative output is found based on this analysis. Examining the control variables, I find a significant positive effect of 'employees' for the lower categories that turns negative for the higher categories. This means that a high number of employees increases the likelihood that a firm has a lower innovative output, whereas it decreases the likelihood of being in one of the higher innovative output categories. In contrast, an opposing effect for the concentration variable exists: the coefficients for 'concentration' are significantly negative for the lower categories, whereas they increase for the higher categories. Moreover, the industry dummies for chemicals, plastics, mechanical engineering, electrical engineering, MMSRO, and automotive and other vehicles are significantly positive which means that the likelihood that firms from these industries have a high innovation-expenses-to-sales-ratio is increased compared to the reference industry, whereas the industry control variable for industry 1 is negative. Similar to Model 4, in Model 5 I do not find a systematic significant effect that supports Hypothesis 2b, which states that divestitures have a negative influence on the innovative output of firms. Model 6 analyzes the influence of major organizational restructuring on the innovative output of firms (Hypothesis 3b). I find a significant positive effect of organizational restructuring activities on the likelihood that a firm has an increased level of innovative output, which contradicts my hypothesis. Examining the control variables, I find effects that are similar to those discussed for Models 4.

Table 25: Generalized Ordered Logit with Innovative Output as Dependent Variable

	Model 4[161]		Model 5[162]		Model 6[163]	
Indep. Variable	**Acquisitions (2003)**		**Divestitures (2003)**		**Organiz. Restructuring (2001)**	
	Coeff.	**Std. Err.**	**Coeff.**	**Std. Err.**	**Coeff.**	**Std. Err.**
Ctrl. Variables	**Cat. 0 vs. 1 – 8[164]**					
Acquisition	0.3019	0.30989				
Divestiture			0.05557	0.3120		
Org. Restruct.					0.5570***	0.1238
Employees	0.7220***	0.1017	0.7260***	0.1009	0.8419***	0.08527
Return on Sales	-0.02128	0.03142	-0.01901	0.03151		
1 – Diversi-fication	-0.1365***	0.03363	-0.1374***	0.03372		
Industry Dummies[165]						
Mining	-2.3986**	1.05135	-2.4166**	1.0522	-2.2209***	0.7556
Food/ Tobacco	-0.1860	0.3168	-0.1821	0.3156	-0.1515	0.2530
Textile	-0.1568	0.3379	-0.1858	0.3369	-0.2181	0.3092
Wood/Paper	-0.05923	0.3042	-0.0503	0.3043	-0.01414	0.2616
Chemicals	0.8193***	0.2870	0.8584***	0.2850	0.6198**	0.2392
Plastics	0.6545**	0.2702	0.6771**	0.2706	0.7883***	0.2204

[161] When testing for the violation of the proportional odds assumption, the assumption is only violated for the variables 'acquisition, 'employees', and '1-diversification', which is why I impose on these variables constant coefficients for all categories, which leads to only one set of coefficients.

[162] When testing for the violation of the proportional odds assumption, the assumption is only violated for the variables 'divestiture', 'employees', and '1-diversification', which is why I impose on these variables constant coefficients for all categories, which leads to only one set of coefficients.

[163] When testing for the violation of the proportional odds assumption, the assumption is only violated for the variables 'major organizational restructuring' and 'employees', which is why I impose on these variables constant coefficients for all categories, which leads to only one set of coefficients.

[164] This part of the results table displays the results for the estimation of the lowest category (also labeled 'group' of the dependant variable against all higher categories, whereas the next part shows the results of the estimation of the two lowest categories against all higher categories and so forth.

[165] The metal industry which is the industry with the highest number of observations in my sample is chosen as the reference category.

Glas/ Ceramics	0.5324	0.3429	0.5352	0.3440	0.2118	0.2839
Mech. Engineering	1.4722***	0.2279	1.4517***	0.2277	1.05178***	0.1969
El. Engineering	1.6961***	0.2501	1.6792***	0.2496	1.5280***	0.2135
MMSRO	2.0094***	0.2410	2.0077***	0.2411	1.9265***	0.2352
Automotive, other vehicles	0.9606***	0.3238	0.9629***	0.3257	0.9904***	0.3050
Furniture	1.2164***	0.3415	1.2135***	0.3415	0.4025	0.3347
Constant	-0.5780	0.4004	-0.5660	0.4015	-2.1267***	0.2096
			Cat. 0 & 1 vs. 2 – 8			
Acquisition	0.2217	0.2947				
Divestiture			-0.2939	0.30000		
Org. Restruct.					0.5332***	0.1234
Employees	0.5776***	0.09870	0.5974***	0.09845	0.7298***	0.08297
1 – Diversi-fication	-0.1344***	0.03318	-0.1399***	0.03337		
Constant	-0.5065	0.3959	-0.4690	0.3982	-2.0467***	0.2081
			Cat. 0 – 2 vs. 3 – 8			
Acquisition	0.4679*	0.2799				
Divestiture			0.1905	0.2923		
Org. Restruct.					0.6261***	0.1237
Employees	0.3421***	0.09471	0.3472***	0.09431	0.5563***	0.08045
1 – Diversi-fication	-0.09865***	0.03248	-0.09965***	0.03261		
Constant	-0.7051*	0.3885	-0.6921*	0.3903	-2.0042***	0.2073
			Cat. 0 – 3 vs. 4 – 8			
Acquisition	0.2924	0.2722				
Divestiture			0.1529	0.2908		
Org. Restruct.					0.4209***	0.1253
Employees	0.2422**	0.0944	0.2406**	0.09386	0.4530***	0.07989
1 – Diversi-fication	-0.07978**	0.03243	-0.0808**	0.03243		
Constant	-1.0130***	0.3874	-0.9981**	0.3889	-2.0869***	0.2088

Cat. 0 – 4 vs. 5 – 8						
Acquisition	0.5647**	0.2718				
Divestiture			0.08642	0.2945		
Org. Restruct.					0.4383***	0.1283
Employees	0.03975	0.0963	0.06207	0.09538	0.3463***	0.08110
1 – Diversi-fication	-0.06846**	0.03260	-0.07036**	0.03269		
Constant	-0.9774**	0.3898	-0.9721**	0.3909	-2.1675***	0.2119
Cat. 0 – 5 vs. 6 – 8						
Acquisition	0.4754	0.2904				
Divestiture			-0.05396	0.3421		
Org. Restruct.					0.3351**	0.1413
Employees	-0.002877	0.1074	0.02431	0.1070	0.05650	0.09066
1 – Diversi-fication	-0.01548	0.03627	-0.01839	0.03623		
Constant	-1.9915***	0.4221	-1.9849***	0.4237	-2.2291***	0.2247
Cat. 0 – 6 vs. 7 & 8						
Acquisition	0.8117**	0.3192				
Divestiture			0.2095	0.3905		
Org. Restruct.					0.3385*	0.1835
Employees	-0.06725	0.1324	0.02003	0.1341	-0.09477	0.1193
1 – Diversi-fication	0.06672	0.04571	0.0711	0.04613		
Constant	-3.2993***	0.5169	-3.4331***	0.5333	-2.8660***	0.2790

	Cat. 0 – 7 vs. 8					
Acquisition	0.2158	0.5015				
Divestiture			1.6411***	0.5395		
Org. Restruct.					0.2919	0.2703
Employees	-0.1581	0.1811	-0.2565	0.2013	-0.1617	0.1739
1 – Diversi-fication	0.07520	0.06290	0.1541**	0.0709		
Constant	-4.0417***	0.6693	-4.6311***	0.7657	-3.6912***	0.3697
Prob > F	0.0000		0.0000		0.0000	
Observations	969		969		1308	

* p < 0.1, ** p < 0.05, *** p < 0.01

As above, I conduct three robustness checks for each of the three above presented models by using an ologit model, an OLS regression and a right-censored tobit model. While all three models confirm my findings from Model 5 and 6, my findings regarding the effects of acquisitions on the innovative output of firms (Model 4) are not confirmed by the three models used for a robustness check.

In addition to Models 4 to 6, I estimate another model that aggregates Models 4 and 5, similar to as I describe it earlier in this section. Whereas Model 4 compares firms that have recently conducted an acquisition with firms that have not, Model 5 compares firms that have recently conducted divestiture activities with firms that have not undergone such efforts. In the additional model, I compare firms that have either conducted an acquisition or divestitures activities or both with firms that have not conducted any of these activities. For this model, I do not find a systematic significant effect on the innovative output of the firms in my sample.

Furthermore, I conduct several estimations that analyze the influence of acquisitions, divestiture activities, and major organizational changes on the innovative output in selected innovative industries, namely electrical engineering, mechanical engineering, and MMSRO. While I do not find any effect of acquisitions and divestiture activities on the innovative output in any of the three industries, major organizational changes seem to have a

significant positive effect on the innovative output in the MMSRO industry, whereas no effect is found for the two other industries. However, I have to be cautious with interpreting these data, due to some degree of endogeneity that underlies my hypotheses and that I will further discuss in the summary and discussion section of this chapter (Section 5.7).

5.7 Summary and Discussion

With this study, I aim to investigate the effect of organizational change in the form of acquisitions, divestitures, and major organizational restructuring efforts on the innovativeness of firms. To this end, I analyze data from the 'Mannheimer Innovationspanel' (MIP) from the years 2001 and 2003. I compare the answers regarding the innovative input and innovative output of firms that responded that they conducted an acquisition/divestiture/major restructuring effort in the previous three years with the innovative input and innovative output information of firms that indicated they did not conduct such an effort.

Interestingly, based on the results of my analysis, I am unable to support any of the six hypotheses that I present in Section 5.2.2. When analyzing the effect of organizational change on innovative input, I find a significant positive effect of acquisitions. This finding suggests evidence contradicting my Hypothesis 1a[166] because it means that firms that have conducted acquisitions are more likely to have higher innovation-expenses-to-sales-ratios. However, I must be careful with interpreting these results because all my hypotheses underlie a certain degree of endogeneity. This means that, while I test the hypothesis that acquisition activities influence the innovative input of firms, the reverse relationship (the innovative input level influences the degree to which a firm conducts acquisition activities) seems also possible. I do not find any significant effect for the variables 'divestitures' and 'major organizational restructuring'. Regarding the analyses of the influence of the three forms of organizational change on innovative output, I do not find systematic significant effects for acquisitions and divestitures, but only some random effects for selected

[166] Hypothesis 1a states that firms that have conducted acquisitions have lower innovative input levels than firms that have not executed such activities.

categories that may be caused by remaining heterogeneity in the model or by omitted variables. In contrast, the effect of major organizational restructuring on innovative output is significantly positive. Interpreting this result, again, one must be cautious due to the existing endogeneity underlying my hypotheses. These results suggest with regard to my hypothesis 3b that firms that have conducted a major restructuring effort are more likely to have a higher new/improved-product-sales-to-total-sales-ratio and thus contradict my hypothesis. In contrast, one could also assume a reverse relationship (that firms that have a high innovative output tend to conduct more restructuring efforts than firms with a low innovative output level.

As outlined in the previous paragraph, my study contradicts not only previous studies that postulate a negative relationship between acquisitions and divestiture activities and the innovativeness of firms (e.g., Hitt et al., 1990; Hill and Snell, 1989; Hitt et al., 1996) but also my hypotheses regarding the effect of major organizational restructuring on innovative input and output. I now discuss some potential reasons why the findings of my study differ so significantly from my hypotheses.

The first reason for the surprising results may lie in the nature of the independent variables that I use in my analysis. All three independent variables (‘acquisitions’, ‘divestitures’, and ‘major organizational restructuring’) are dummy variables that represent the responses of the participating firms to the question of whether they conducted an acquisition/divestiture/major organizational restructuring in the previous three years. Thus, this variable does not contain any qualitative information[167] on the degree to which such an event influences the original business of a firm. I expect that the greater the influence on the original business of organizational change in the form of acquisitions, divestitures, or major organizational restructuring efforts, the more these activities influence the innovativeness of a firm. Thus, more nuanced independent variables measuring organizational change may lead to different results.

[167] This refers to information such as the number of acquisitions/divestitures/major organizational restructuring efforts conducted in the relevant period, the percentage of the original business that is significantly influenced by these efforts, or the relatedness of an acquisition to the original business.

A second argument for the unexpected results may lie in the structure of the dependent variables. Both variables are ratio variables, meaning that they not only reflect changes in the innovative input and output of firms but also respond to fluctuations in the total sales of a firm. Thus, if the total sales of a firm increase or decrease significantly in response to changes in the market environment,[168] the variables measuring innovative input and output in my model will reflect these changes.

The nature of the dataset that I use to analyze my hypotheses may be a third aspect that influences my results. The dataset is focused on German firms from 13 manufacturing industries. The clear focus of the firms in the dataset is on small (fewer than 50 employees) and medium (between 50 and 249 employees) firms. Thus, while the total MIP dataset is representative of Germany, it may not be well suited to analyzing my hypotheses. In particular, the fact that approximately four-fifths of the dataset represents small or medium firms that often do not follow an active acquisition/divestiture strategy or strategic restructuring efforts may make the dataset inappropriate for my research questions.

Further reasons that may produce the unexpected results are linked to the nature of the dataset that I use, although these reasons are of a more technical nature than the aspects that I outline in the previous paragraph. As I discuss in Sections 5.3.3 and 5.3.4, many variables in the MIP dataset are categorized or trimmed to allow for the anonymity of the participating firms.[169] This modification of the original survey data may contribute to the fact that potential existing effects are hidden by the anonymization of the data. In addition, an important aspect when analyzing survey data is the survey itself. The questions asked may leave room for individual interpretation and differing understandings, as is the case for the variable that I use to measure innovative input, the innovation-expenses-to-sales-ratio. In the questionnaire, the term ‘innovation expenses’ is not further explained; therefore, each firm answering the question may have a slightly different understanding of which expenses

[168] For example, another player launches a competing or superior product or a market campaign strongly increases the firm’s image.

[169] While the variable that I use to proxy the first dependent variable (innovative output) is categorized, the variable that I use to proxy the dependent variable ‘innovative input’ is trimmed by the authors of the MIP. In addition, control variables ‘employees’, ‘return on sales’, and ‘1-diversification’ are categorized by the MIP authors.

are included in this definition and may thus provide a different answer to the question. The situation is similar for the variable 'percentage of total sales generated by new/significantly improved products', which I use to measure innovative output. Thus, information gathered from surveys can only be as good as the questions in the survey and the resulting answers from the participants.

This study has several limitations. First, as mentioned above, the independent variables are dummy variables measuring whether a firm conducted an organizational change effort. These variables do not contain any qualitative information on the extent to which an organizational change project affects a firm. Second, especially for the regressions analyzing the effect of major organizational restructuring on the innovative activities of firms, a lack of relevant variables in the dataset makes it impossible to control for broad external influences on innovative input and output. Thus, regarding the results of those regressions, in particular, I must account for a relatively high omitted-variables bias. Third, as mentioned above, the anonymization of the data may obscure existing effects and make the dataset less insightful regarding my research question than it originally was. It seems obvious that the best way to overcome most of these limitations would be to conduct a similar study not based on anonymized survey data. Thus, I recommend that an analysis be conducted of the effects of organizational change on the innovative activities of firms based on (non-anonymized) survey data matched with publicly available data on acquisitions and divestitures and the innovative input and output of firms. Matching the survey data with publicly available data would allow for verification and completion of the information gathered through the survey.

Another interesting path for further research would be to conduct a similar analysis of the effects of organizational change using a panel dataset. Using panel data would not only allow for a comparison of the innovation data of firms that conducted an organizational change effort with firms that have not conducted such projects as done in this study, but it would additionally allow, monitoring the influence of an acquisition, divestiture, or major restructuring effort on the innovation activities of a single firm over time.

6. Conclusion

In the literature, two types of user innovators are studied in great detail: end consumers and 'professional users,' i.e. individuals who innovate in their professional environment. This dissertation explores a third form of user innovations that exists among corporations that use a certain product and become innovators of a related product. This form of user innovations and -entrepreneurship also represents a specific form of diversification that has not been explored so far and that allows firms to benefit from a high level of synergies.

The research questions of this dissertation were motivated by the American Airlines case presented in Section 1.1. American Airlines faced serious problems handling seat bookings in the 1950s, when passenger volume strongly increased within a short period of time. In 1964, all the booking functions of American Airlines were taken over by the 'SABRE' system, which was the result of a joint development effort by American Airlines and IBM. Although the system was originally developed for exclusive use by American Airlines, it was expanded to travel agencies, and other airlines later began using SABRE or similar booking systems. In 2000, American Airlines and SABRE separated. Sabre Holdings is now a publicly traded firm that is active in the travel technologies market, whereas American Airlines still acts primarily in the airline and transportation market.

This case of user innovation generated by a corporate user is of major interest. American Airlines, like many other firms that innovate and later commercialize their innovations, separated its businesses at one point. In contrast, some firms keep both the user and the manufacturer businesses and become integrated user-manufacturer firms.

How user innovators in general can benefit from their innovation (other than by using it) is an important question in user innovation research (e.g., von Hippel, 1988, 2005). The existing literature focuses on two options. First, user innovators may license knowledge of their innovation to others for a fee; second, the user innovator may commercialize his innovation on the market by becoming a manufacturer (Shah and Tripsas, 2007; Baldwin et al., 2006; Hienerth, 2006; Haefliger et al., 2010). In both options, the manufacturer and the

user innovator typically do not interact for long, either because the lead user is not part of the manufacturing firm or because the user innovator has permanently changed his functional role (von Hippel, 1988). In this dissertation, I addressed this gap by investigating a third method by which established corporations, as users of a product, can benefit from their innovations.

In Chapter 3 of this dissertation, I analyzed the phenomenon of integrated user-manufacturer firms. The specific goal of this study was to understand whether integrated user-manufacturer firms are viable over the long term and whether the commercial potential of this arrangement can be realized. Furthermore, I aimed to explore the circumstances that promote and hinder this special type of diversification.

To this end, I conducted a qualitative study using a case study approach, which I presented in Chapter 3. Based on 13 interviews with executives of five user-manufacturer firms from four different industries, this study provided detailed information about the dual business model of 'integrated user-manufacturer firms' and the benefits and challenges that result from such a business model. The information from the interviews was enriched with archival information from various sources and information from academic and industry experts. These cases showed that a successful and fruitful integration of user and manufacturer businesses can be achieved. According to my results, the viability of such integration is determined by factors that relate to innovation, markets, and corporate governance and organization. With regard to innovation, I found that, among other factors, the prospect of receiving feedback from external customers and the risk of imitation are factors that favor commercialization in the market. Market-related factors that should function similarly include the visibility of an innovation and the reputation of the focal firm in its original market. Finally, I identified factors that are related to corporate governance and organization that positively affect the market commercialization of a firm's own user innovations. These factors include private ownership of the firm and a low level of conflicts between the employees of the two units.

In addition to the manifold contributions to the user innovation literature, the results of this study may be of interest for managers of integrated user-manufacturers and of user innovator firms that have not yet conducted the diversification step toward becoming an

integrated user-manufacturer firm. The cases and the general discussion showed that such commercialization of user innovations on the market entails benefits and challenges. The main benefit is that the firm can generate new sales, thus benefiting from its experiences as a user and from its past efforts in developing the user innovation. In addition, the cases showed that substantial synergies in the marketing of the user innovation exist. The main challenge is to manage the tensions that may arise within the firm when the manufacturer unit sells its products to firms that compete with the original user business. Another challenge is to communicate the benefits of such a diversification strategy to external stakeholders, such as banks or shareholders. Such stakeholders often prefer a strategy of focusing on core competencies and may suggest a spin-off of the newly created manufacturer department after its successful launch.

Chapter 4 of this dissertation built on the findings of the previous chapter by analyzing the quality of the innovative output of manufacturing units of integrated user-manufacturer firms. The specific research questions of this study were to explore whether the manufacturing units of user-manufacturer firms are more innovative than non-vertically diversified manufacturers in the same industry. Specifically, the effect of such a dual business model on the quality of patents held by these firms was analyzed.

Therefore, I analyzed 416 patents in two 3-digit IPC classes: I compared 75 patents held by user-manufacturer firms that are active in the construction or mining business and in the construction/mining machines business with 341 patents held by manufacturer-only firms active in the construction/mining machines business, but not in the field of construction or mining itself, in terms of patent quality, which I proxied using the number of forward citations that a patent received. I analyzed the quantitative data using negative binomial regression models. Interestingly, the patents of user-manufacturer firms are qualitatively better (in the sense that they receive more forward citations) than those of manufacturer-only firms in the IPC class that the user-manufacturer firms in my sample focus on. In contrast, I found the opposite effect for patents in an IPC class in which most patents are held by manufacturer-only firms. In the overall sample, user-manufacturer firms generate qualitatively better patents. Although the effect is not very robust to variations in the model specifications.

In addition to the contributions to existing empirical work on the relation between diversification of firms and their innovativeness (e.g., Hitt, Hoskisson, and Kim, 1997; Cardinal and Opler, 1995; Garcia-Vega, 2006), the results of this study imply insights for managerial practice. First, managers of non-user-manufacturer firms may use them as a basis to rethink their firms' diversification strategy and to determine whether their firms' industry is well suited for such a dual business model. Second, managers of user-manufacturer firms may use the results of this study to optimize their dual business model. In addition, this study may serve as a source of information for analysts and bankers, who could use these results to rethink their strategic recommendations to firms. Although, today a focus on core competencies is often postulated, this fact does not mean that diversification strategies cannot be a successful path in some cases.

Whereas I investigated the effect of the dual business model of user-manufacturer firms on innovation quality in Chapter 4, I explored the influence of major organizational changes on the innovative activities of firms in Chapter 5. The specific research questions of this study were to investigate the influences of different forms of organizational change on firms' innovative input and output.

For the study in Chapter 5 of this dissertation, data from the 'Mannheimer Innovationspanel' were used. This survey is conducted annually by the Zentrum für europäische Wirtschaftsforschung. Based on the survey information, the innovative input and output of firms that responded that they had conducted an acquisition, divestiture or major restructuring project in the previous three years were compared with those of firms that reported no such project. Therefore, 1308 and 969 firms, respectively, were compared, and the data were examined using generalized ordered logistic regression models. Interestingly, the forms of organizational change do not influence the innovative input and output of the firms in my sample in the expected form. While I do not find any effect for divestiture activities, I find a positive effect for acquisitions on innovative input and a positive effect of major organizational changes on innovative output. These findings are particularly surprising as they are contradictory to previous studies that have analyzed the relationship between acquisition and divestiture activities and the innovativeness of firms (e.g., Hitt et al., 1990; Hill and Snell, 1989; Hitt et al., 1996). In addition, some caution with interpreting these results is recommended due to the fact that my hypotheses in this study

underlie a certain level of endogeneity. In general, I would recommend conducting a similar analysis using a panel dataset to verify and extend my results.

This dissertation sheds light on the phenomenon of integrated user-manufacturer firms and their innovative activities. Both the answers to the research questions introduced in Section 1.2 and the limitations of the three presented studies suggest some interesting possibilities for further research.

The case study approach that I chose for the qualitative study in Chapter 3 of this dissertation allowed me to analyze the path from a user-innovating firm to an integrated user-manufacturer firm in great detail for each of the five firms in my study. A large-scale quantitative study focusing on facilitating and hindering factors in the domains of innovation, markets, and corporate governance and organization would provide additional insights regarding the influence of industry characteristics, cultural aspects, and other factors that affect the likelihood and the process of commercialization of user innovations.

My finding that user-manufacturer firms seem to generate qualitatively better patents in some technological fields is based on a comparison of patents that are held by user-manufacturer firms with patents of manufacturer-only firms in two 3-digit IPC classes. Conducting a similar study on the firm level and in more technological fields would provide additional insights regarding fields in which user-manufacturer firms can benefit from their dual business model. Furthermore, it would provide additional insights into the effects of user-manufacturer diversification on the innovativeness of firms from a different angle, which would yield a more complete picture of the user-manufacturer integration business model.

Appendix

A.1: Interview Guide for Interview 1 with Thomas Bauer, December 2007

Wie viel Zeit haben Sie für das Interview zur Verfügung?

Wären Sie mit einer Aufnahme des Gesprächs einverstanden?

1) Gründe für Nutzerinnovation

- Warum hat die Bauer AG in den 60er Jahren damit begonnen, Maschinen für den Spezialtiefbau zu entwickeln? Warum konnten etablierte Hersteller von Baumaschinen, ggf. mit Spezifikationen von Bauer Tiefbau, diese Maschinen nicht entwickeln und herstellen?
- Warum hat die Konkurrenz im Spezialtiefbau solche Maschinen nicht entwickelt?
- Welche Wettbewerbsvorteile ergaben sich für die Bauer AG durch die Nutzerinnovation?
- Abgesehen von den besonderen Anforderungen, denen sich Bauer im Tiefbau gegenüber sah, welche anderen (organisatorischen) Eigenschaften des Unternehmens spielten eine Rolle für die Entscheidung, selbst Baumaschinen zu entwickeln?
- Inwieweit war eine unternehmerische Einstellung (Risikobereitschschaft, langfristiges und vorausschauendes Handeln) bei der Entscheidung über die Eigenentwicklung förderlich bzw. notwendig?
- Inwieweit haben hier Familienunternehmen im Vergleich zu Nicht-Familienunternehmen (gleicher Größe, nehmen wir mal an) evtl. Vorteile?
- Erscheint es möglich, eine Liste von größeren und kleineren Innovationen zu erstellen, die innerhalb der Bauer AG vom Tiefbau zum Spezialmaschinenbau kamen?

2) Kommerzialisierung der Nutzerinnovation

- Warum hat die Bauer AG begonnen, die ursprünglich nur für den Eigenbedarf entwickelten Maschinen der Konkurrenz zugänglich zu machen?
    - Wie lief der Entscheidungsprozess ab?
    - Welche Vorteile und Nachteile ergaben sich für das Unternehmen Bauer?

- Inwieweit würden Sie den Prozess der Kommerzialisierung der Nutzerinnovationes als einen geplanten Prozess beschreiben, inwieweit war es eher ein zufälliger Prozess?
- In welche einzelnen Schritte würden Sie den Prozess der Kommerzialisierung der Nutzerinnovation unterteilen? War es eine punktuelle Entscheidung, oder wurde zuerst auf kleiner Skala, in Einzelfällen, verkauft, bevor der Verkauf größere Dimensionen annahm?
- Inwieweit war eine unternehmerische Einstellung (Risikobereitschaft, langfristiges und vorausschauendes Handeln) bei der Entscheidung, die Kommerzialisierung zu betreiben, notwendig?
- Inwieweit haben hier Familienunternehmen im Vergleich zu Großunternehmen evtl. Vorteile?

3) Nutzerinnovationen, vertikale Integration und Synergien?

- Welche Synergien sehen Sie zwischen den beiden Geschäftsfeldern „Spezialmaschinenbau“ und „Spezialtiefbau“
- Wann und unter welchen Umständen hat Ihr Unternehmen die Entscheidung getroffen, die Nutzerinnovationen auf dem Markt zu verkaufen? Selektiv oder
  - in Bezug auf die Qualität der Spezialtiefbaumaschinen?
  - in Bezug auf den Vertrieb der Spezialtiefbaumaschinen?
  - in Bezug auf die Gewinnung von Aufträgen im Bereich Spezialtiefbau?
- Gibt es noch andere Synergien? Wenn ja, welche?
- Gibt es Probleme zwischen den Geschäftsfeldern? Wenn ja, welche?
- Fallen Ihnen weitere Beispiele für eine solche vertikale Integration in ihrer Branche ein?
- Fallen Ihnen vielleicht weitere Beispiele aus anderen Branchen ein?

4) Nächste Schritte

- Wir möchten gern „Lead User Integration“ am Fall der Bauer AG gründlich untersuchen. (Weitere Gespräche, Erstellung einer Liste von Innovationen, …)
- **Ziel:** Publikationen in der wissenschaftlichen Presse, Fachpresse und Zeitungen. Und: vertieftes Verständnis für Bauer AG selbst über Prozesse der LU-Integration

A.2: Interview Guide for Interview 2 with Erwin Stötzer, January 2008

1) Gründe für Nutzerinnovationen

- Welche Gründe gab es Ende der 60er Jahre, Anfang der 70er, damit zu beginnen selbst Maschinen zu bauen? (umständliches Anpassen von Maschinen für andere Zwecke?, Technische Herausforderung?, Qualifikation der Mitarbeiter?, Gedanken an mögliches Geschäft?)
- Konstruierten Sie die ersten Maschinen von Grunde auf neu? Gab es dazu Tests und Rückläufe aus der Anwendung im Baubetrieb?
- Entwickelten andere Unternehmen aus dem Spezialtiefbau auch Maschinen? Vor allem nachdem sie den Erfolg bei Bauer sahen? Warum nicht?

2) Entwicklung der Nutzerinnovation

- Wie war der Bau der Maschinen anfangs im Unternehmen organisiert? (Werkshof…) Wie wurde die Sparte später in das Unternehmen integriert? Wurden Ingenieure aus dem Bau „abgezogen“, wechselten sie zwischen den Tätigkeiten, wurden neue eingestellt?
- Wie lief der Entscheidungsprozess bei Bauer ab, der zur Kommerzialisierung der Maschinen führte? (hohe Entwicklungskosten, Furcht vor Nachahmern,…) Von wem kam der Anstoß dazu? Inwieweit war dieser Prozess bei Bauer geplant, inwieweit eher zufällig?
- In welche Schritte würden Sie den Prozess der Kommerzialisierung der Nutzerinnovation unterteilen? Wurde erst punktuell verkauft, restriktiv (weil man Anfragen nicht abschlagen konnte?), was sich dann herumsprach und andere Kunden anlockte (die „gleich behandelt“ werden wollten?)
- Wurden/werden auch andere Wege der Kommerzialisierung erwogen? (Lizenzierung, Verkauf…) Warum ist Bauer damals mit seinen Spezifikationen nicht an einen etablierten Maschinenhersteller herangetreten und hat die Produktion an ein bereits etabliertes Unternehmen abgegeben? Welche Vorteile und Nachteile ergaben sich aus dem gewählten Weg für das Unternehmen Bauer?

- Wie funktioniert das Zusammenspiel der beiden Bereiche auf dem Wege von einer Idee zum marktfähigen Produkt genau? (gezielte regelmäßige Teamtreffen, Motivation einzelner Mitarbeiter Ideen zu äußern) Worin sehen sie den besonderen Vorteil dieser Verknüpfung bei Bauer, den andere Unternehmen nicht haben?
- Inwiefern spielte bei der Entscheidung zur eigenen Produktion das vorhandene Baugeschäft als Marketing- und Vertriebsweg eine Rolle? (die Internationalisierung erfolgte später ja maßgeblich über das Tiefbaugeschäft) Inwiefern spielte auch die unternehmerische Einstellung eine Rolle bei der Entscheidung zur Kommerzialisierung? (Risikobereitschaft, langfristiges und vorausschauendes Handeln) Gab es einen Vorteil durch die Form eines Familienunternehmens?

3) Liste der Nutzerinnovationen

- Ist es möglich eine Liste von Nutzerinnovationen bei Bauer zu erstellen, mit Angaben zur Entstehung, technischen Änderungen etc. In welchem Rahmen wäre dies sinnvoll? Wie könnte man so eine Liste eingrenzen? (nach Baugruppen, nach Zeitrahmen…)

4) Nutzerinnovationen heute

- Wie sind die die beiden Bereiche heute miteinander verknüpft? (gezielte Jobrotation, gemeinsame Hierarchien, Reporting) Kommen Ingenieure aus dem Spezialtiefbau gezielt zum Maschinenbau um neue Erkenntnisse umzusetzen? Welchen beruflichen/akademischen Hintergrund haben die Ingenieure im Maschinenbau? Welchen Einfluss denken Sie, hat diese Verknüpfung auf die Qualität und die kommerzielle Attraktivität der Produkte?
- Wie gehen sie intern mit dem Problem um, dass aus vielen guten Ideen aus dem Tiefbau Produkte in der Maschinenbausparte entstehen, die dort für hohe Umsätze sorgen und auf der anderen Seite die Konkurrenz im Baugeschäft stärken? (finanzielle Anreize, oder Transfers in den Spezialtiefbau?)
- Gibt es konkrete Spannungsfelder zwischen den Bereichen? Wo liegen die? Werden solche Spannungsfelder auch gezielt innerhalb des Unternehmens genutzt, um einen positiven Wettbewerb zu fördern und die Innovativität zu steigern? Inwiefern werden formale Anreizsysteme und besondere Karriereaussichten eingesetzt, um den Austausch zwischen den Bereichen zu fördern?
- Existiert eine besondere Unternehmenskultur, die die Mitarbeiter zu Innovationen und deren Umsetzung motiviert? Inwiefern hat die Tatsache, dass es sich um ein Familienunternehmen handelt, einen Einfluss darauf? Wer entscheidet heute im Einzelfall über die

Kommerzialisierung? (Unternehmensleitung, Leitung „Spezialmaschinenbau“, Mitsprache „Spezialtiefbau“)

- Welche Kriterien gibt es bei dieser Entscheidung? Gibt es auch Nutzerinnovationen, die bewusst nicht an die Konkurrenz verkauft werden?

5) Weitere Interviews

- Könnten Sie uns weitere Interviewpartner nennen, die wir bezüglich:
    - der Liste der Nutzerinnovationen befragen können?
    - der Organisation der zwei Bereiche befragen können?
    - der Kommerzialisierungskriterien befragen können?

A.3: Interview Guide for Interview 4 with Erwin Stötzer, April 2008

1) Liste der Nutzerinnovationen von Bauer

- Ziel ist die Erstellung einer Liste mit Innovationen, die bei Bauer entstanden sind. (z.B. wie ist die Innovation von der Baustelle in die Maschine gekommen (verriegelbare Kelly, Steuerung, GPS)?
- Warum wurde gerade eine BG 40 entwickelt? (BG 40: 2002 entwickelt in Schrobenhausen, Hr. Hackel (Konstrukteur), Bedürfnis: sehr starkes Bohrgerät)
- Welche Innovationen wurden patentiert? Welche nicht? Warum wurden manche nicht patentiert?
- Wurden nicht patentierte Innovationen (z.B. Kellystange) auf dem Markt verkauft? Oder begannen Konkurrenten, die Maschinen nachzubauen und zu verkaufen?

2) Dualität Bauer Spezialtiefbau und Bauer Maschinenbau - Historie

- War es damals so, dass Entwicklungen aus dem Bau in den Maschinenbau herüberkamen? Hat man da irgendwie zusammengearbeitet? Oder wurden mehr die Anforderungen des Baubereichs an den Maschinenbau gerichtet, der daraufhin eine neue Technik/eine neue Maschine entwickelt hat?
- Nachdem der Maschinenbaubereich gegründet wurde, gab es da Barrieren zwischen dem Baubetrieb und dem Maschinenbau insofern, als dass der Baubetrieb eigene Innovationen nicht an den Maschinenbau weitergegeben hat?
- Inwieweit konnte auch Bauer Spezialtiefbau von dem Maschinenverkäufen des Baubereichs profitieren?
- Wie viele Maschinen wurden eigentlich über die Jahre, in denen der Maschinenbau noch nicht, institutionalisiert war, verkauft? Gibt es da Zahlen?

3) Dualität Bauer Spezialtiefbau und Bauer Maschinenbau - heute

- Entsteht eigentlich ein Konkurrenzkampf zwischen dem Bau und Maschinenbau bei der Entwicklung von neuen Maschinen?

- Wie geht der Bauer Maschinenbau mit Feedback aus dem eigenen Baubetrieb bzw. von externen Kunden um? Gibt es da einen Unterschied?
- Inwieweit hat die Bedeutung des Spezialtiefbaus für die Maschinenentwicklung in den letzten Jahren nachgelassen?

4) Kommerzialisierung der Bauer Maschinen

- Gab es bereits frühzeitig die Überlegungen, dass man mit den Innovationen aus dem Baubetrieb auf dem Markt Geld verdienen kann?
- Inwieweit wurde das Unternehmen Bauer von anderen Bauunternehmen angesprochen, die die Bauer Maschinen kaufen wollten?

5) Bauer Spezialtiefbau, Spezialtiefbau allgemein

- Kann man sagen, Bauer Spezialtiefbau hat sich speziell auf schwierige und komplexe Projekte spezialisiert oder speziell solche Projekte angenommen, um daran besser zu werden und auch bessere Maschinen entwickeln zu können?
- Wir haben gelernt, dass Bauer früher Projekte angenommen hat, bei denen zu Beginn noch nicht klar war, mit welchen Technologien diese bearbeitet werden können bzw. bei denen sich existierende Technologien als nicht anwendbar herausgestellt haben. Passiert das heute noch manchmal, dass man bei einem Projekt nicht weiterkommt und dann ein bestehendes Verfahren modifizieren bzw. etwas Neues entwickeln muss?
- Wie funktioniert eigentlich die Ausschreibung von Bauprojekten? Wird in der Ausschreibung eines Projekts auch ein Verfahren festgelegt?

6) Investitionsentscheidungen

- Inwieweit war es nötig bereits zu Beginn des Maschinenbaubetriebs in größerem Umfang zu investieren? Gab es einen Punkt, an dem man sich überlegen musste, ob die Nachfrage einmal so groß sein wird, dass sich die Investitionen rentieren?

A.4: Interview Guide for Interview 6 with Thomas Bauer, March 2010

- Ich habe mich in den letzten zwei Monaten intensiv mit Ihrem Unternehmen auseinandergesetzt (2 Bücher, Bohrpunkte, Jahresberichte, auch die Interviews mit Ihnen und Herrn Stötzer).
- Ich habe einmal einige Punkte herausgearbeitet, die nach unserem Verständnis die Kernfaktoren dafür darstellen, dass Bauer mit seinem Geschäftsmodell erfolgreich ist. Gerne würde ich mit Ihnen diese Punkte einzeln durchgehen und jeweils Ihre Perspektive darauf erfahren.

Diese Punkte habe ich abstrahiert dargestellt, um sie allgemein gültiger zu machen:

- A high risk of potential conflicts between the employees of both units (core and new business) negatively influences an open commercialization strategy.
- A good ability of the management to ease tensions between employees of both units (core and new business) positively influences an open commercialization strategy.
- A limited dependency on the stock market allows a firm to realize a diversification strategy and therefore positively influences an open commercialization strategy.
- A high risk of imitation of the firm's user innovations by manufacturers positively influences an open commercialization strategy.
- A reduction of a firm's dependency on its core business due to the commercialization of a user innovation positively influences a commercialization decision.
- A continuous stream of user innovations from the core business leads to the accumulation of deep customer-specific knowledge and therefore positively influences an open commercialization strategy
- The more a firm commits to sunk costs wich are related to its user innovations, the more likely it is to follow an open commercialization strategy.
- Intensive customer feedback that is considered as an opportunity to further improve the quality of the user innovation favors an open commercialization strategy.

- Being active with the core business on the target markets positively influences an open commercialization strategy.

Weitere Fragen:

- Sie haben steiles Umsatzwachstum im MB-Bereich gehabt, haben aber auch viele Unternehmen akquiriert, weitgehend sehr kleine Unternehmen (größtes: Klemm mit ca. 20 Mio), haben die Akquisitionen das Umsatzwachstum wesentlich verstärkt oder kam es größtenteils aus der Bauer Maschinen GmbH?
- Situation in den 80ern: Spezialtiefbau sehr schwach, mit MB aber Geld verdient –warum? Weil MB viel internationaler (sprich Nachfrage nach Maschinen von intern. Baustellen)? Aber Bau zu der Zeit doch auch schon sehr international – oder nicht?

Abschluss:

- Es werden sich sicherlich im Zuge der weiteren Arbeit noch einige konkrete Fragen zu Zusammenhängen ergeben, wäre es möglich, dass wir –nach Rücksprache mit Ihnen- Kontakt zu Herrn Stötzer aufnehmen?
- Wenn das, was Sie nun gesehen und gehört haben, für Sie so in Ordnung geht, würden wir daran weiter arbeiten und zu einem späteren Zeitpunkt, wenn wir einen finalen Stand haben, Ihnen das vollständige Paper zum Prüfen übergeben, selbstverständlich bevor es irgendeiner Person, die nicht zu unserem Lehrstuhl gehört, zugänglich gemacht wird.

A.5: Interview Guide for Interviews with User-Manufacturer Innovators for Proposition Validation

Teil 1:
Verstehen der Nutzerinnovationshistorie und der Ursachen für Nutzerinnovationen im Unternehmen

Teil 2:
Diskussion von 10 Faktoren aus anderen Interviews/weiterer Studie, die Kommerzialisierung begünstigt bzw. Erfolg langfristig möglich gemacht haben.

Teil 1 - Nutzerinnovationshistorie

- Welches ist das Kerngeschäft in Ihrem Unternehmen und seit wann existiert es?
- Wie und wann kam es dazu, dass Sie begonnen haben, Nutzerinnovationen zu entwickeln?
- Für welchen Zweck haben Sie die ersten Nutzerinnovationen entwickelt (Nutzung in eigenem Kerngeschäft oder schon im Hinblick auf Kommerzialisierung)?
- War/Ist die Entwicklung von Nutzerinnovationen in Ihrem Unternehmen ein wiederkehrender Prozess oder handelte es sich um einen einmaligen Fall?
- Wenn wiederkehrend: welche gab es? In welchem Zeitfenster?
- Werden die in Ihrem Unternehmen entwickelten Nutzerinnovationen auf dem Markt verkauft? Oder findet lediglich ein selektiver Verkauf an einzelne Kunden (z.B. befreundete Unternehmen oder solche, die einen anderen Geschäftsfokus haben) statt? Oder handelt es sich um Innovationen, die Sie lediglich intern nutzen?
- Wenn Kommerzialisierung:
    - Wann und unter welchen Umständen hat Ihr Unternehmen die Entscheidung getroffen, die Nutzerinnovationen auf dem Markt zu verkaufen? Selektiv oder ohne Einschränkungen? Welches waren die Hauptfaktoren, die Ihre Entscheidung beeinflusst haben?
    - (Welches sind die positiven Effekte, die diese Kommerzialisierung für Ihr Unternehmen mit sich gebracht hat? Welches waren die „Gegengründe“? Welches sind die heute auftretenden Probleme?)

- Wie sieht das organisatorische Konstrukt für das Kerngeschäft und das Nutzerinnovationsgeschäft in Ihrer Firma aus?
- Branchenperspektive: Wie sieht die Situation in Ihrer Branche allgemein aus? Gibt es andere Unternehmen, mit einer ähnlichen Historie wie Ihrer? Gibt es andere Unternehmen die beides anbieten? Wer sind die anderen Unternehmen, die Ihre Branche beliefern? Wer sind die anderen relevanten Unternehmen in Ihrer Branche?
- Wenn Nutzung lediglich intern:
    - Haben Sie je über eine Kommerzialisierung nachgedacht oder stand diese nie zur Diskussion?
    - Warum haben Sie sich gegen die Kommerzialisierung Ihrer Nutzerinnovationen entschieden? Welches waren die Hauptgründe, die die Entscheidung beeinflusst haben?
    - (Was waren die negativen Aspekte, die Sie als Konsequenz der Kommerzialisierung befürchtet hätten? Welche positiven Effekte würden Sie sich erhoffen?)

Vielen Dank, dass Sie uns geholfen haben, die Ursachen der Nutzerinnovationen in Ihrem Unternehmen sowie den Prozess hin zu der heutigen Unternehmensform besser zu verstehen. Jetzt würden wir gerne zum zweiten Teil unseres Interviews kommen. Und zwar haben wir basierend auf Interviews mit anderen Unternehmen aus unterschiedlichen Branchen insgesamt 10 Faktoren herausgearbeitet, die in den anderen Fällen die Entscheidung zur Kommerzialisierung begünstigt haben bzw. zum Erfolg der langfristigen Co-Existenz beigetragen haben. Diese Faktoren würden wir gerne einmal mit Ihnen diskutieren, um zu verstehen, ob diese Faktoren auch im Fall Ihres Unternehmens von Bedeutung waren bzw. welche anderen Gründe möglicherweise noch relevant waren.

Teil 2 – Validierung der Hypothesen

Zunächst die Aspekte, die in Zusammenhang mit der Innovation als solcher stehen:

- P1: A continuous stream of user innovations from the core business leads to the accumulation of deep user-specific knowledge as well as solution knowledge and therefore positively influences a market commercialization strategy.
- P2: The more a firm can expect to receive feedback from external customers which helps to improve the quality of the user innovation, the more likely the firm will follow a market commercialization strategy.

- P3: A high risk of imitation of the firm's user innovations by other firms favors a market commercialization strategy.
- P4: The more a firm has made investments in the development of its user innovations, the more it needs to recap these investments, which leads the firm to follow a market commercialization strategy.

Die sogenannten „Marktaspekte":

- P5: Being visible and having a high reputation witch the core business in the target market facilitates the marketing of the user innovations and thus favors a market commercialization strategy.
- P6: If the original and the new business follow asynchronous economic cycles, then a high market risk and strong market cyclicality in the original business favor a market commercialization strategy.

Solche Aspekte, die in Zusammenhang mit der Organisation des Unternehmens stehen:

- P7: In periods in which the prevailing management doctrine speaks against diversification, firms that are more independent of the stock market are more likely to pursue a market commercialization strategy.
- P8: The existence of large family blockholders increases the likelihood of a market commercialization strategy.
- P9: Potential conflicts arising from market commercialization of own user innovations between the employees of the original and of the new business negatively influence a market commercialization strategy.
- P10: A corporate culture and a management that is able to ease tensions between employees of both units (original and new business) favor a market commercialization strategy.

A.6: Combined Category System of Production and Service Sectors

Branche-Nr.	Kurzbezeichnung	Wirtschaftszweig nach WZ 93 bzw. NACE-Rev.1	2 Steller nach WZ93
1	**Bergbau**	Bergbau u. Gewinnung von Steinen u. Erden	10-14
2	**Ernährung, Tabak**	Ernährungsgewerbe, Tabakverarbeitung	15, 16
3	**Textil**	Textil-, Bekleidungs- und Ledergewerbe	17-19
4	**Holz, Papier**	Holz-, Papiergewerbe, Druckgewerbe	20-22
5	**Chemie**	Mineralverarbeitung, Kokerei, Chemische Industrie	23, 24
6	**Kunststoff**	Herstellung von Gummi- u. Kunststoffwaren	25
7	**Glas, Keramik**	Glasgewerbe, Keramik, Verarbeitung von Steinen u. Erden	26
8	**Metall**	Metallerzeugung und -bearbeitung, Stahl, Leichtmetallbau, Herstellung von Metallerzeugnissen	27, 28
9	**Maschinenbau**	Maschinenbau, Herstellung von Waffen und Munition; Herstellung von Haushaltsgeräten a.n.g.	29
10	**Elektrotechnik**	Herstellung von Büromaschinen, Datenverarbeitungsgeräten u. -einrichtungen, Herstellung von Geräten der Elektrizitätserzeugung, Elektrizitätsverteilung u.ä., Rundfunk-, Fernseh- u. Nachrichtentechnik	30-32
11	**MMSRO**	Herstellung von Medizin-, Mess-, Steuer- u. Regelungstechnik, Optik	33
12	**Fahrzeugbau**	Herstellung von Kraftwagen und deren Teilen, sonst. Fahrzeugbau, Luft- und Raumfahrzeugbau	34, 35
13	**Möbel**	Herstellung von Möbeln, Schmuck, Musikinstrumenten, Sportgeräten, Spielwaren	36

14	**Großhandel**	Handelsvermittlung u. Handelsvermittlung u. Großhandel (ohne Handel mit Kraftfahrzeugen)	51
15	**Einzelhandel, Kfz**	Kraftfahrzeughandel, Instandhaltung u. Reparatur von KFZ, Tankstellen; Einzelhandel, Reparatur von Gebrauchsgegenständen	50, 52
16	**Verkehr, Telekommunikation**	Landverkehr, Transport von Rohrfernleitungen; Schifffahrt; Luftfahrt; Hilfs- u. Nebentätigkeiten für den Verkehr, Verkehrsvermittlung; Postdienste u. private Kurierdienste	60-63, 641
17	**Banken, Versicherungen**	Kredit- und Versicherungsgewerbe	65-67
18	**EDV, Telekommunikation**	Datenverarbeitung u. Datenbanken, Telekommunikation	72, 642
19	**Technische DL**	Forschung u. Entwicklung; Architektur- u. Ingenieurbüros; Technische, physikalische u. chemische Untersuchung	73, 742, 743
20	**Unternehmensnahe DL**	Rechts-, Steuer- u. Unternehmensberatung, Markt u. Meinungsforschung, Beteiligungsgesellschaften; Werbung	741, 744
21	**Sonstige DL**	Gewerbsmäßige Vermittlung u. Überlassung von Arbeitskräften; Auskunfts- u. Schutzdienste; Gebäudereinigung; Erbringung sonstiger Dienstleistungen für Unternehmen; Abwasser- u. Abfall-beseitigung u. sonstige Entsorgung	745, 746, 747, 748, 90
22	**Wohnungswesen, Vermietung**	Grundstücks- u. Wohnungswesen; Vermietung beweglicher Sachen	70, 71

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